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SOCIAL SCIENCES, ARTS AND SCIENCES

*Special Issue Editors*

Rev. Sr. Dr. MARY PRAMILA SANTHI | Dr. K. SATHYA

Mrs. J. MARIA PRAVEENA



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## International Journal of Research in Humanities, Arts and Science

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Secretary

### FOREWORD

I am pleased to provide the foreword for the manuscript volumes presented at the BODHI Hybrid International Interdisciplinary Conference on Recent Trends in Social Sciences, Arts and Sciences, held on Tuesday 17 October 2023. This conference was a collaborative effort organized by St. Antony's College of Arts and Science for Women in Dindigul and Oriental College in Kohima, Nagaland. Notably, this event marks the third consecutive international conference organized by SAC in recent times.

SAC always firmly believes that collaboration between institutions to conduct conferences and seminars offers numerous advantages, including a broader range of expertise, increased resources, enhanced program content, networking opportunities, and more. Such collaborative efforts contribute to the advancement of knowledge and facilitate interdisciplinary and international connections, ultimately benefiting the academic and professional community at large.

SAC never fails in its commitment to research by the faculty and the students. Presenting research papers at conferences is a critical aspect of faculty research that supports the dissemination of knowledge, peer engagement, networking, and professional development while contributing to the academic community and enhancing the researcher's own work.

At the same time, it recognizes that student research is not only a valuable component of higher education but also a meaningful way for students to grow academically and personally, contribute to the academic community, and prepare for future academic or professional endeavors. It fosters a culture of inquiry and discovery that is fundamental to the advancement of knowledge and society.

I wish to express my sincere gratitude and appreciation to Dr. S. Balakrishnan, Publisher & Managing Editor of BODHI Journal. The objective of organizing conferences extends beyond the presentation of research papers; it is to incorporate valuable suggestions from the scholarly audience and to publish these papers, making them accessible to a wider readership who may not have had the opportunity to attend the conference. Ultimately, the impact and success of a manuscript are measured by its citation, and BODHI, being an indexed journal, plays a pivotal role in facilitating this significant service.

I commend the commendable efforts led by the principal, the conference convenor, coordinators, and the enthusiastic student participants. I extend my best wishes to all of them for their future endeavors.

God Bless!

*Sr. Arul Devi* 17.10.2023  
Sr. Arul Devi  
SECRETARY  
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*Date: 27.10.2023*

I am writing to express my enthusiastic endorsement for the book publication of the International Multidisciplinary Conference on "Recent Developments in Social Sciences, Arts, and Sciences", jointly organized by ST. ANTONY'S COLLEGE OF ARTS AND SCIENCES FOR WOMEN DINDIGUL, ORIENTAL COLLEGE KOHIMA & BODHI INTERNATIONAL JOURNAL OF RESEARCH IN HUMANITIES, ARTS AND SCIENCE, INDIA.

The conference, which brought together scholars, researchers, and practitioners from diverse disciplines, served as a platform for meaningful interdisciplinary dialogue. The papers presented showcased the latest developments and advancements in social sciences, arts, and sciences, highlighting the interconnectedness of these fields and the collaborative spirit of the academic community.

I extend my heartfelt gratitude to the authors for their scholarly contributions and to the organizing committee for their meticulous efforts in ensuring the success of the conference. I trust that this book will find its place among the distinguished publications and catalogs, reflecting the high academic standards and the spirit of interdisciplinary collaboration upheld by the conference.

I wish the co-organizers, professors and scholars the very best in all the future events.

(Mr. Viu Belho)

Chairman,  
Sponsoring Body,  
Oriental College Kohima



## **Editorial**

BODHI's multidisciplinary international conference conducted through a hybrid mode, collaborated and organized by St. Antony's College of Arts and Science for Women, Dindigul, TN and Oriental College, Kohima, Nagaland aims to leverage the benefits of both in-person and virtual participation to promote inclusivity, knowledge sharing, collaboration, and sustainability while accommodating the diverse needs and circumstances of participants. Hybrid conferences enable participants from around the world to attend and present their research, regardless of geographical constraints. This inclusivity promotes a broader exchange of ideas and collaboration. Moreover, virtual participation allows individuals who may have limitations related to travel, finances, or physical disabilities to access conference content and engage with the academic community.

The purpose of a multidisciplinary conference is to create a platform for cross-disciplinary collaboration, problem-solving, and knowledge exchange. It plays a vital role in advancing research, innovation, and the collective understanding of complex global challenges. This conference served as a collaborative platform for two host institutions, each offering a wide range of academic disciplines, including arts, sciences, social sciences, and the humanities. Students from diverse academic backgrounds had the opportunity to attend a keynote address that transcended the traditional boundaries of academic disciplines. Moreover, they could enrich their knowledge in their respective fields by participating in two concurrent technical sessions. The closing valedictory address emphasized the importance of human values.

BODHI stands out by publishing both in-person and online papers after conducting thorough plagiarism checks. Some papers are sent back to authors for revisions, while others are declined due to issues with originality. BODHI actively promotes student involvement, regardless of their academic year, as it is dedicated to fostering a culture of research among them. The journal firmly holds the belief that academic paper writing should not be limited to a select few academic elites.

**Rev. Sr. Dr. Mary Pramila Santhi**  
**Dr. K. Sathya**  
**Mrs. J. Maria Praveena**



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**Aim & Objectives**

Academic Excellence in research continues promoting research support for young Scholars. Humanities, Arts and Science researches motivate all aspects of encounters across disciplines and research fields in multidisciplinary views, by assembling research groups and consequently projects, supporting publications with this inclination and organizing programmes. Internationalization of research work is the unit that seeks to develop its scholarly profile in research through quality publications. And visibility of research creates sustainable platforms for research and publication, such as series of books; motivating dissemination of research results for people and society.

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# SYNTHESIS AND CHARACTERISATION OF $\text{SiO}_2/\text{Ni-Cu}$ NANOCOMPOSITE

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## Abstract

*Nanocomposite  $\text{SiO}_2/\text{Ni-Cu}$  were synthesised using simple chemical phase method and their structural characterizations were evaluated by Scanning electron microscopy (SEM). It has been found that  $\text{SiO}_2/\text{Ni-Cu}$  of Nanocomposite (catalyst) exhibited superior degradation ability owing to the large surface area and high absorption ability of the composite.*

**Keywords:**  *$\text{SiO}_2/\text{Ni-Cu}$  Nanocomposite, SEM.*

## Introduction

Nanoscience and technology has become an identifiable, if very broad and multidisciplinary, field of research and emerging applications in recent years. It is one of the most visible and growing research areas in materials science in its broadest sense. The International Technology Research Institute, World Technology Division (WTEC), supported a panel study of research and development status and trends in nanoparticles, nanostructured materials, and nanodevices during 1996–1998[1]. This report tried to cover the very extensive field of nanostructure science and technology. A conclusion of the report is that better understanding of the relationships between nanostructure and properties and how these can be engineered [2-8]. In recent years much attention has been paid to silica ( $\text{SiO}_2$ ) nanoparticles, owing to their large pore volume, high surface area, tunable pore sizes, narrow size distribution, nontoxic nature, good surface permeability, highly ordered hexagonal structure with narrow pore size distribution, and large surface area, which aid the constructive applications of  $\text{SiO}_2$  as an effective catalyst in photocatalytic application [9-11]. However,  $\text{SiO}_2$  exhibits certain disadvantages such as low chemical stability in aqueous medium, functionality degradation, unfavorable charge

distribution, and heterogeneous electron transfer. An extreme interest has been generated by metals, such as Co, Ni, Cu and Fe, since they exhibit superior catalytic activity [12-17].

## Materials and Methods

### Materials

Ethanol, ammonia, tetra ethyl ortho silicate (TEOS), Nickel chloride hexahydrate ( $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$ ), Copper Chloride ( $\text{CuCl}_2$ ) were purchased from sigma – Aldrich. All reagents were of analytical grade and were used as without further purification. The ethanol is distilled through vacuum distillation and the distilled ethanol is used for the synthesis of silica and silica nanocomposites.

### Preparation of Silica Nanoparticles

The silica nanoparticles were synthesized by using the following procedure. In the mixture of 80 ml absolute ethanol, 2 ml deionized water and 2.6ml ammonia, Tetraethyl Orthosilicate (TEOS) 1.6 ml was added by drops under constant stirring. The above solution mixture stirred for about 2 h at the room temperature, and the formed white precipitate was centrifugally separated from the suspension, and washed with three times absolute ethanol and water.



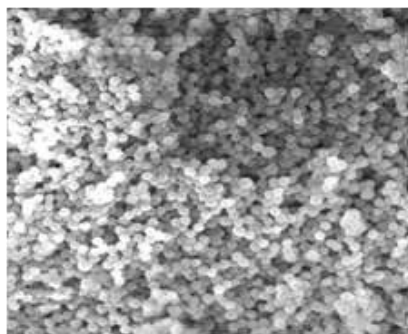
## Preparation of Nickel – Copper Doped Silica Nanoparticles

0.1g of silica was ultrasonically dispersed in 10ml of ethanol and 0.025g of Ni Cl<sub>2</sub> and 0.025g of CuCl<sub>2</sub>. Then 0.1ml of ammonia added to the mixture stir for 4 hours. Then, the sample was separated by centrifugation to obtain a dark green precipitate.

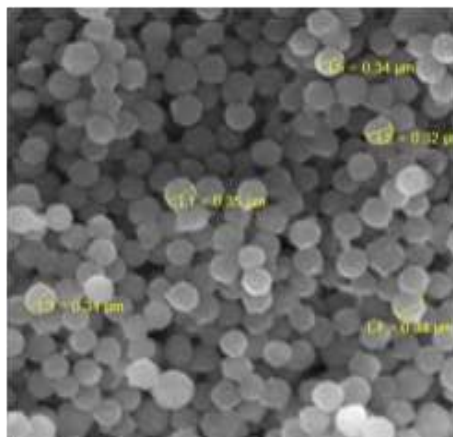
## Results and Discussion

### Morphological Properties

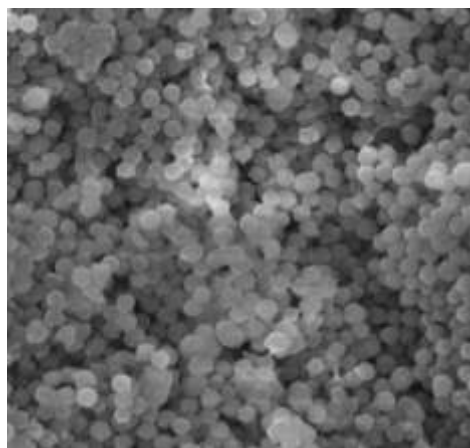
The morphological features of prepared nanostructures elucidated by using SEM are depicted in Figures 3.1. The monodispersed, well separated and spherical shaped SiO<sub>2</sub>- Ni nanoparticles with smooth surface were obtained under chemical phase route and the average diameter of obtained spheres is in the range of 350 nm (Figs. 3.1 a and 3.b). The morphological images of SiO<sub>2</sub>/Ni-Cu composite clearly demonstrated that tiny particles Cu deposited on spherical SiO<sub>2</sub>/Ni particles without any obvious aggregation (Figs. 3.1c and 3.1d). The size of the spherical structure almost remain same as SiO<sub>2</sub>-Ni denoting the presence of Cu has not influenced any morphological change in the composite. The addition of NiCl<sub>2</sub> and CuCl<sub>2</sub> to the negatively charged SiO<sub>2</sub> matrices, produces intermediate (Si-O-Ni<sup>2+</sup> and Si-O-Cu<sup>2+</sup> and ) bonds through electrostatic interactions, and the subsequent addition of ammonia leads to the reduction of Ni<sup>2+</sup> and Cu<sup>2+</sup> to Ni<sup>0</sup> and Cu<sup>0</sup> respectively. From Figs it is clear that Ni and Cu nanoparticles were effectively embedded in the SiO<sub>2</sub> pore channels, and no other scattered particles were found outside of the channels, indicating the strong interaction between the Ni-Cu nanoparticles and the porous SiO<sub>2</sub> matrix.



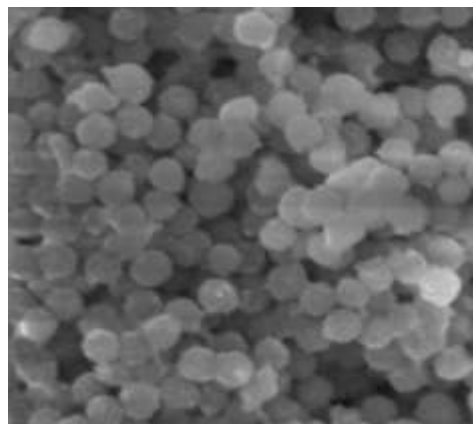
(a)



(b)



(c)



(d)

Figures 1 SEM Images of SiO<sub>2</sub>/ Ni (a, b) and SiO<sub>2</sub>/ Ni-Cu (c, d) Composites

## Conclusion

SiO<sub>2</sub>/Ni-Cu Nanocomposite with large surface area and pore volume were synthesised using a simple and effective chemical method. The morphological characterizations revealed that the SiO<sub>2</sub>/Ni and SiO<sub>2</sub>/Ni-Cu nanocomposites composed of spherical structure with Cu nanoparticle impinging on it.

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# CORROSION BEHAVIOUR OF HIGH MANGANESE STEELS

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## Abstract

*Corrosion is the degradation of materials usually metal owing to chemical reaction with the environment which result in a functional failure of component. Corrosion is a reverse extractive metallurgy, which depends on the concentration of environment, stress, erosion and the temperature. It causes major economic losses ranges from 1% to 5% of GNP per year for any nations. In addition, corrosion not only increases the costs of component but it also responsible for life losses and safety hazard. Hence, the aim of this review paper is to provide an overview of distinct types of corrosion and their preventive method. So, that corrective action may be taken to minimize the effect of corrosion related problems.*

## Introduction

Corrosion is the disintegration of material due to chemical reactions with its environment. This includes electrochemical oxidation of metals by reaction with an oxidant such as oxygen. Formation of an oxide of iron due to oxidation of the iron atoms is a well-known example of electrochemical corrosion, commonly known as rusting. This type of damage typically produces oxide(s) and/or salt(s) of the original metal.

Many alloys corrode on exposure to moisture in the air, but the process can be strongly affected by exposure to certain chemicals. Corrosion can be concentrated locally to form a pit or crack, or uniformly corroding the surface. Corrosion is a diffusion-controlled process. As a result, any method that can reduce the activity of the exposed surface, increase a material's corrosion resistance.

## Experimental Work

### Size of the Specimen

Before the size, shape and finish test specimens are specified, the objectives of the test program should be determined, taking into consideration any restrictions that might dictate fabrication requirements. The duration, cost, confidence level and expected results affect the choice of the shape, finish and cost

of the specimen. Test specimens are generally fabricated into disks (or) rectangular shapes. New our specimen size one inch square, 6mm thickness (ASTM G<sub>4</sub>.01(2008)) we decided rectangular shape. Rectangular specimens are fabricated by either parching, shearing. Punched disk shaped specimens are the most economical if the quantity is sufficiently high to initial die cost. Fabrication is more cost – effective for rectangular specimens than for disks when ground finished and machined sides are required and they can be made using very few shop tads. In some Cates, rectangular specimens are more awkward to mount.

### Preparation of Test Specimen

The test specimen edges should be machined. The cold-worked area caused by shearing (or) punching operations can provide valuable information on alloy susceptibility of stress corrosion caking. The ability to compare the information among specimen of different material. The depth of cold work associated with punching and shearing operations typically extends back from the cut edge to a distance equal to the thickness. Removal of the cold worked areas can be performed by grinding (or) careful machining the specimen edges. The finish of the specimen should replicate that of the surface

finish of the material to be used for equipment fabrication. The mill scale and the amount of oxides on the surface can vary as well. Surface finishes are difficult to apply to edges that have been distorted by punching as shearing. Since the primary requirement is usually to determine the corrosion resistance of the material itself a clean metal surface is most often used. The purpose of the test dictates the required finish of the specimen. The specimens are generally punched by sheared and finished by blasts with glass beads. This is one of the most economical ways of preparing corrosion test specimens. The available surface finishes are sanded with abrasive cloth (or) paper (for example sics) and mill finish. The surface finish most widely used in produced by sanding with an abrasive cloth (or) paper. Sanding removes the mill scale and oxides as well as other defects in the material such as scratches, pits, etc, that produce misleading results when the data are being analyzed. A 120 grit finish is generally acceptable and is readily produced without the need for specialized equipment. Other surface finishes may be obtained through the appropriate use of abrasive papers (or) cloth.

### **Identification of Test Specimen**

It may be necessary in special instances to notch the edge of the specimens for identifications; it is preferable that they be stamped with a code number. The stamped number has been additional advantage. Most metallic specimens may be marked by stenciling, i.e., imprinting the designation code into the metal surface using hardened steel. Stencil stamps hit with a hammer. The resulting imprint will be visible even after substantial corrosion has occurred. This procedure introduces localized strained regions and the possibility of superficial iron contamination in marked area. Edge notching is especially applicable when extensive corrosion and accumulation of corrosion products is anticipated. Long term atmospheric tests and sea water immersion tests on steel alloys are examples where this approach is applicable. It is necessary to develop a code system when using edge notches.

### **Initial Specimen Measurements**

After the specimen has been cut to size and the final surface finish applied, it should be cleaned in an organic solvent (like acetone) and the mass determined on an analytical balance. The total surface area is also determined to an accuracy of  $\pm 1\%$ . These measurements are filed for later use in corrosion rate calculation. During fabrication, each specimen should be stamped with code number for identification. The record of the details of the test exposure (dimensions, weight, and time of immersion) should be kept in a permanent, bound log book. Responsibility for properly maintaining the records in this log book throughout the test should be specifically assigned to one individual.

### **Specimen Holder**

The location of the test specimens in the operating equipment will be governed by the information that is desired. This may require tests at more than one location in the same piece of equipment, such as below the level of the test liquid at the level of the liquid. It is desirable to have the specimen holder securely fixed in place. The preferred position of the holder is with the long axis horizontal as to prevent drip of corrosion products from one specimen to the other. The specimen should be so placed that any flow of liquid will be against the edges of the specimens. The same condition of agitation of the liquid should be encountered by all specimens. Specimen should be supported in a manner on an acrylic plastic strip (or) nylon thread using the free end of the specimen to the holder.

### **Duration of Exposure**

The test duration may be based on known rates of deterioration of the materials in use. The test duration of at least 30 days is suggested. It is governed by the convenience with which plant operation may be interrupted to introduce and remove test specimens. Possible changes in the rate of corrosion may be studied either by successive exposures. It is desirable to run the test with various time intervals to that changes in corrosion rates with exposure time can be evaluated.

### Immersion Test

Carbon steel has immersed for two different media like chloride and sulphide with constant level urea and then with different concentrations. Basically small sections of the candidate material are exposed to the test medium and less of weight of the carbon steel material is measured for period of time, immersion testing remains the best method of screening and eliminating from further consideration. These materials that should not be considered for specific application, there is no simple way to extrapolate the results obtained from these tests to the prediction of system lifetime.

Medium for NaCl with urea and different concentrations are assumed.

- Urea- 23300 mg per liter (2.33%)
- NaCl- 4390 mg per liter (0.44%)

The different concentrations are 3.5%, 1%, 0.44%, 0.1%, and 0.01% of NaCl with same constant level urea weight.

Medium for Na<sub>2</sub>S with Urea, then different concentrations are assumed due to measure corrosion rate.

- Urea- 23300 mg per liter (2.33%)
- Na<sub>2</sub>S - 2300 mg per liter (0.23%)

The different concentrations are 1%, 0.23%, 0.1%, 0.01%, and 0.01% of Na<sub>2</sub>S with same constant level urea weight.

The five different concentrations of NaCl with urea solutions are prepared. Carbon steel specimen is immersed with prepare different concentration of chloride medium and also preferred. Similarly five different concentration of sulphide with urea solution prepared, for conduct immersion test.

### Volume of the Solution

The size of the carbon steel specimen has already mentioned. The solution prepared depending with size of the specimen (steel). Test solution should be prepared accurately from chemicals conforming to the specification of the analytical reagents and distilled water. Chemical content should be reported as percentage by weight of solutions. The composition of the test should be checked by analysis at the end of test to determine the extent of change in composition such as result from

evaporation (or) depletion. Evaporation losses may be controlled by a constant level device (or) by frequent addition of appropriate solution to maintain the original value within ±1% collect the containers and cleaned properly then wash with acetone and air dry it. Volume of test solution should be large enough to avoid any appreciable change in its corrosivity during the test either through exhaustion of corrosive constituents (or) corrosion products that might affect further corrosion. Solution volume to specimen area ratio use 0.20 ml/mm<sup>2</sup> (125ml/in<sup>2</sup>) of specimen surface and 0.40ml/mm<sup>2</sup> (250ml/in<sup>2</sup>). [ASTM G31-72(1999)]. When the test objective is to determine the effect of a metal on the characteristic of the test solution, it is desirable to reproduce the ratio of volume to exposed metal (carbon steel) that exists practice. The actual time of contact of the metal with the solution must also be taken into account. Any necessary distortion of the test conditioning must be considered when interpreting the results.

### Determination of Volume of Solution using Given Surface Area

Total surface area of the square shape specimen =  $2a^2 + 4at$

We have given size 1 inch square, thickness 6mm

Total surface area of the specimen =  $2(12)4(1) \times 6$   
(6mm = 1/4 inch) =  $2+4(1) \times 1/4 = 2+1$

Total surface area of the steel specimen = 3 inch<sup>2</sup>

1 inch<sup>2</sup> = 250 ml [ASTM G31-72(1999)]

3 inch<sup>2</sup> = 3 × 250

Volume of the solution = 750ml

For each steel specimen with immersed in the 750 ml solution. Prepare different concentration of the chloride and sulphide medium made up to 750ml for each steel specimen will immerse. Duplicate steel specimen prepared and immersed for our convenience.

### Removal of Test Specimen

The steel specimens after removal from container should be noted and recorded in removing specimens from the holder exercise care to keep them in proper sequence relative to each other so that any test

specimen may be identified from the original record of its position on the holder. It is important of corrosion has been too severe that identification makes have been removed. A record should be made of the appearance and any films on the surface of the steel specimen after washing. It may be desirable to photograph the steel specimens. Samples of any products resulting from corrosion may be preserved for surface analytical studies.

### Method of Cleaning the Steel Specimen

Steel specimen should be cleaned after removal from test. Corrosion product removal procedure can be divided into three types. There are mechanical cleaning, chemical cleaning, and electrolytic cleaning. Now our job using chemical cleaning. The cleaning procedure should be replated for each steel specimen. Chemical cleaning involve immersion of the corrosion test specimen (steel) in a specific solution that is designed to remove corrosion products with minimal dissolution of any metal.

Material	Solution	Time	Remarks
Iron and Steel	1000ml HCl (sp.gr 1.19) 20g antimonies trioxide (Sb <sub>2</sub> O <sub>3</sub> ) 50g stannous chloride (SnCl <sub>2</sub> )	10–15 min	Solution should be vigorously stirred on the steel specimen should be brushed

From above solution steel specimens should be cleaned by light brushing ad remove corrosion products. Then the steel specimen washed soap water and then washed with distilled water. Degrease the specimen and air dry it, then the steel specimen weight is recorded after cleaning.

### Weight Loss Measurements

Mass loss data calculated from steel specimen weighing before and after testing.

{Weight of steel {Weight of steel  
Weight loss= specimen before - specimen after  
Immersion test} Immersion test}

Determine the weight loss and record it.

### Calculate Corrosion Rate

The initial total surface area of the specimen and mask lost during the test are determined.

87.6 X weight loss (mg)

Corrosion rate = (mmpy) = Area (cm<sup>2</sup>) x time (hrs)  
x Density  
(Mmpy = millimeters per year)

Corrosion rate are calculated from weight loss of the steel specimen, total surface, total surface area of steel sample, immersion time of exposure in hours, and density of the carbon, steel specimen.

### Crevice Corrosion

The crevice geometry aspects such as crevice depth are to be studied. When steel specimens are cut by shearing, it is recommended that the deformed material be removed by surface grinding. The need to provide parallel surfaces between the crevice former and the steel specimen is an important consideration in providing maximum consistency in the application of crevice former. Appropriate holes should be drilled in the steel specimen to facilitate attachment of the crevice former. The diameter of the holes should be large enough to allow clearance of the fastener (and insulator) otherwise additional crevice sites may be introduced. The steel specimen should be identified, mechanical stenciling is generally suitable provided that the coding on surfaces away from the intended crevice sites. Identification making should be applied prior to the final test specimen clearing before test. The steel specimen may be prepared by providing a surface definable.

The possible variation between as produced ally surface finishes, this will tend to minimize the variability of crevice geometry in contact areas. Surface grinding with 120 grit sic abrasive paper is a suitable method for preparing steel specimens. Wet grinding is preferred to avoid any heating and remove sharp edges. Then the steel specimens cleaned with distilled water and degrease with organic solvent like acetone, then air dry it. Weight loss data calculated from steel specimen weighing before and testing may provide some useful information in specific cases, comparisons of alloy performance based solely one mass loss may be misleading because highly localized corrosion which is typical of crevice corrosion can after result in relatively small mass loss.

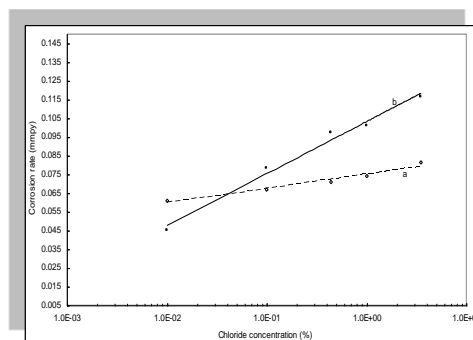
## Potentiodynamic Polarization

A potentiostat that will maintain an electrode potential within 1mv of a present value over a range of applied currents should be used. The steel specimen supplied, the potentiostat should have a range -250mv to +250mv and anodic current output range of 1.0 to  $10^5 \mu\text{A}$ . A scanning potentiostat is used for potentiodynamic measurements. Potential and current are plotted continuously using an X-Y recorder and algorithmic converter for a current. The working electrode is steel specimen. The counter electrodes prepared from platinum flat stock and wire. Counter electrodes should have an area at least twice large as the working electrode. A saturated calomel electrode is recommended. The potential of calomel electrode should be checked at periodic intervals to ensure the accuracy of the electrode. Urea and sodium chloride for different concentrations like 0.01%, 0.1%, 0.44%, 1% and 3.5%. Solution prepared with reagent grade materials. Similarly urea and sodium sulphide for different concentrations like 0.01%, 0.1%, 0.23% and 1% solution prepared to run the potentiodynamic polarization test.

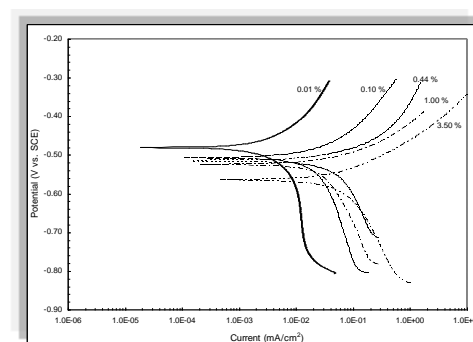
The steel specimen prepared for wet grind with 240 grit SIC paper, wet polish with 600 grit sic paper until previous coarse scratches are removed, rinse with distilled water and decrease clean the steel specimen with acetone, then air dry it. Prepare the different concentrations of Urea and NaCl solution by dissolving in distilled water. Assemble the electrodes and place in polarization cell. Immerse the steel specimen for one hour before initiating polarization. A sliding seal can be used to ensure that an oxygen free environment is maintained while the specimen is lowered. It is important that all oxygen be removed by purging prior to polarization and initial corrosion potential values will be observed. Platinum and calomel electrodes are immersed after 50 min in the polarization cell. Record the open circuit potential of steel specimen before beginning polarization. Start the potential scan one hour after specimen immersion. Record the current continuously with change in potential on an x-y recorder.

## Results and Discussion

From the figure 1, Line-a shows a simple weight loss test and Line-b shows crevice corrosion test. It can be seen that the corrosion rate increases with increasing chloride concentration. At lower concentration of chloride (0.01%), the difference between weight loss and crevice corrosion is minimal, while crevice attack is predominant at a higher concentration (3.5%).

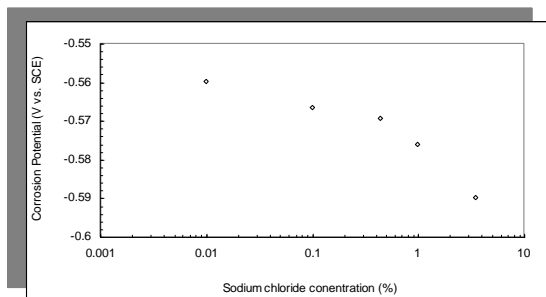


**Figure 1 Effect of Chloride Content on the Corrosion Rate of Steel in Urea Solution, (a) Control & (b) Crevice**



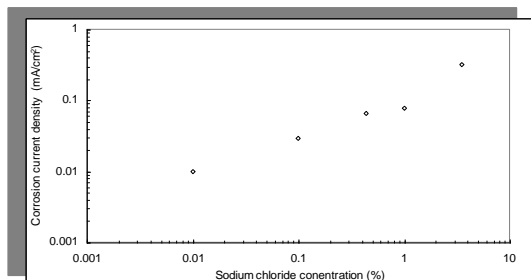
**Figure 2 Effect of Chloride Content on the Polarization Behavior of Steel in Urea Solution**

From the figure 2, with increase in chloride concentration, the current density of the polarization curve increases, and the potential shifts to more negative values. This behavior shows that the metal becomes more prone to corrosion with increase in chloride concentration. From the polarization graph, the electrochemical parameters viz., corrosion potential, corrosion current density and polarization resistance were determined.



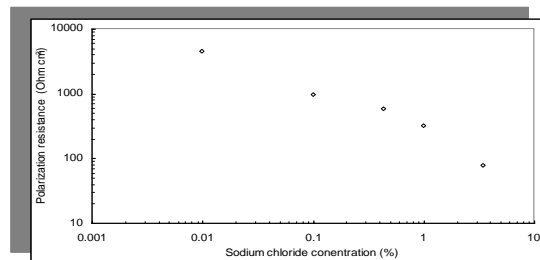
**Figure 3 Effect of Chloride Content on the Corrosion Potential of Steel in Urea Solution**

From the figure 3, we infer that the corrosion potential shifts to more negative values with increasing chloride concentration. Corrosion potential at a concentration of 0.01% is -0.56V and at a concentration of 3.5% is -0.59V, with a shift of 30mV.



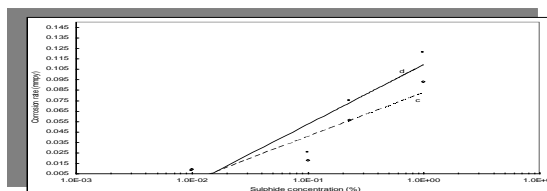
**Figure 4 Effect of Chloride Content on the Corrosion Current Density of Steel in Urea Solution**

Figure 4. shows at a chloride concentration of 0.01%, the corrosion current density has a value  $\sim 0.01 \text{ mA cm}^{-2}$ , where as the same at a concentration of 3.5% has the value  $\sim 0.8 \text{ mA cm}^{-2}$ . This clearly shows that the corrosion current density increased one order magnitude from 0.01 to 3.5% of chloride concentration. As expected, a decrease in polarization resistance with increasing chloride concentration was observed. This is evident from the plot of polarization resistance versus  $\text{Cl}^-$  concentration shown in figure 5. At a  $\text{Cl}^-$  concentration of 0.01%, the polarization resistance was  $\sim 6 \text{ M}\Omega \text{ cm}^{-2}$ , where as at a  $\text{Cl}^-$  concentration of 3.5%, the same had a value  $\sim 0.1 \text{ M}\Omega \text{ cm}^{-2}$ .



**Figure 5 Effect of Chloride Content on the Polarization Resistance of Steel in Urea Solution**

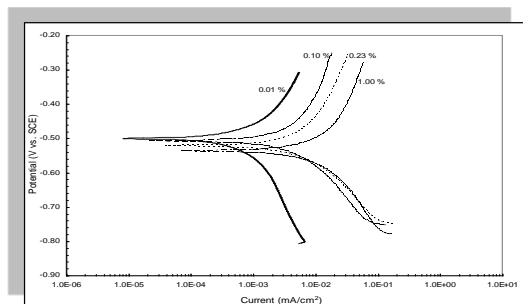
Shift of corrosion potential to more negative values, increase in corrosion density and decreased polarization resistance with increase in  $\text{Cl}^-$  concentration, corroborate with each other indicating that the metal becomes more susceptible to corrosion when  $\text{Cl}^-$  concentration increases.



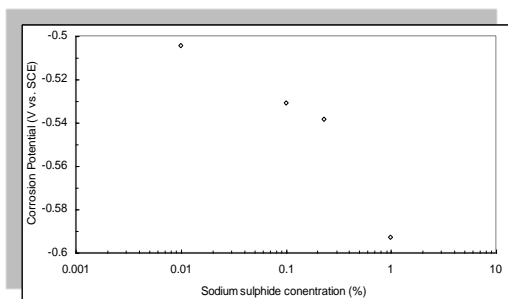
**Figure 6 Effect of Sulphide Content on the Corrosion Rate of Steel in Urea Solution, (c) Control & (d) Crevice**

From the figure 6, at a lower concentration of sulfide, there exists a small difference between the crevice corrosion and weight loss, as evident from Line-c in the graph below. While, at a higher concentration of sulfide (1%), crevice corrosion phenomenon predominates, Line-d. Polarization behavior of carbon steel in aqueous urea solution containing different concentrations of sulfide. From the fig.7 it is evident that the polarization curve shifts to a higher current density and a more negative potential, with increasing sulfide concentration. However, the extent of shift in the polarization curves is greater in chloride containing aqueous urea solution than that of the sulfide containing solution.



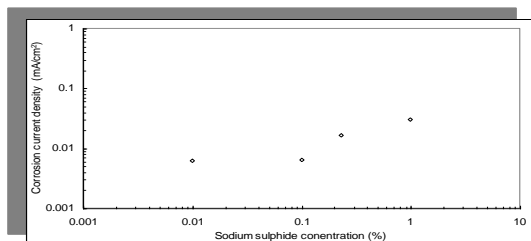


**Figure 7 Effect of Sulphide Content on the Polarization Behavior of Steel in Urea Solution**



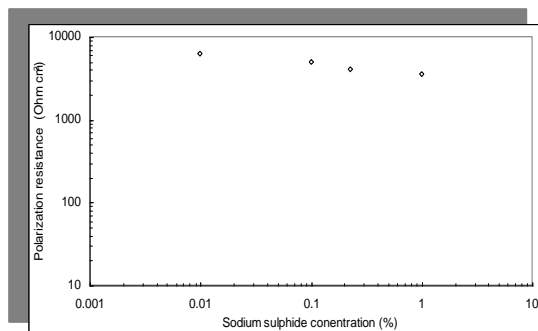
**Figure 8 Effect of Sulphide Content on the Corrosion Potential of Steel in Urea Solution**

Effect of sulfide content on the corrosion potential of carbon steel in aqueous urea solution as done in figure 8. The graph explained corrosion potential shift more negative with increasing sulfide concentration (0.01 to 1 %). The lowest concentration 0.01% of sulfide solution with corresponding potential is  $\sim -0.502$  V and the higher concentration 1% of sulfide solution with corresponding corrosion potential is  $\sim -0.596$  V. Shift voltage increases with increasing sulfide containing urea solution (0.01 to 1%).



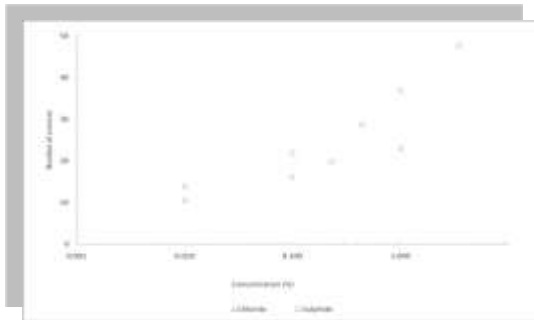
**Figure 9 Effect of Sulphide Content on the Corrosion Current Density of Steel in Urea Solution**

Corrosion current density varies with different concentration of sulfide containing aqueous urea solution on the carbon steel as infer from the figure 9. The concentration of sulfide containing aqueous urea solution increases with increasing corrosion current density, i.e., corrosion current density shift towards right. The lowest concentration of sulfide solution has the value of corrosion current density  $\sim 0.008$  mA/cm<sup>2</sup>, the higher concentration of sulfide solution have the corrosion current density value  $\sim 0.05$  mA/cm<sup>2</sup> which is approximately one order magnitude increases. From the figure 10. Shows the effect of sulfide content on the polarization resistance of carbon in aqueous urea solution. The concentration of sulfide solution increases with decreasing polarization resistance. The polarization resistance decreases from  $\sim 8000$   $\Omega$ cm<sup>2</sup> to less than  $6000$   $\Omega$ cm<sup>2</sup>, and concentration of sulfide solution increases from 0.01 to 1%.

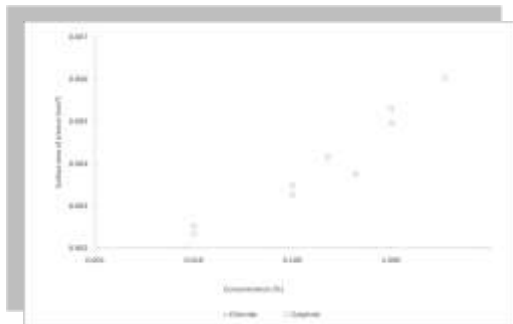


**Figure 10 Effect of Sulphide Content on the Polarization Resistance of Steel in Urea Solution**

As Cl<sup>-</sup> is a very reactive species, the expected number of crevice corrosion sites (crevices) will be greater in the Cl<sup>-</sup> medium than the sulfide. The same was observed in the graph expects in Figure 11. The number of crevices in carbon steel, increased with increasing concentration of both Cl<sup>-</sup> as well as sulfide containing aqueous urea solutions. But their number was much greater in the former than the latter. For instance, the number of crevices found on carbon steel immersed in a Cl<sup>-</sup> solution of concentration 3.5% were  $\sim 48$ , which was much greater than those found in the sulfide solution ( $\sim 24$ ).

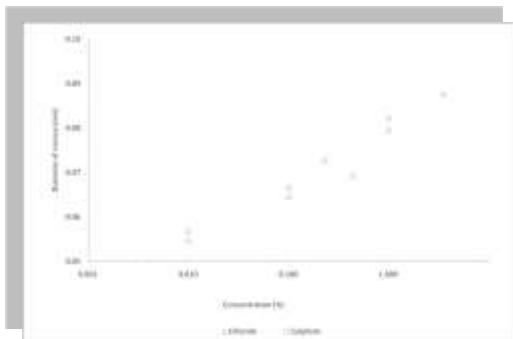


**Figure 11 Effect of Chloride and Sulphide on the Crevice Sites of Steel in the Urea Solution**



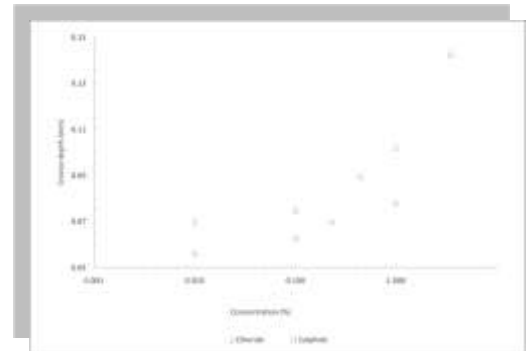
**Figure 12 Effect of Chloride and Sulphide Content on the Surface Area of Crevice (mm<sup>2</sup>) of Steel in the Urea Solution**

Effect of sulfide and  $\text{Cl}^-$  concentration on the surface area of crevice (mm<sup>2</sup>) in carbon steel is done in the figure 12. The surface area of crevice in carbon steel, increases more in the sulfide containing aqueous urea solutions compared to the  $\text{Cl}^-$  containing solutions. As the surface area of the crevice increases, the extent of damage to carbon steel also increases.



**Figure 13 Effect of Chloride and Sulphide on the Diameter of Crevice (mm) of Steel in the Urea Solution**

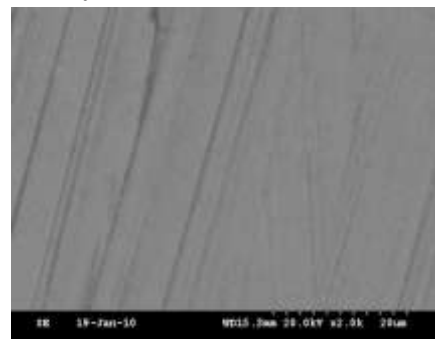
It is evident from the graph (Figure 13) that the diameter of crevice increases with increasing concentrations of sulfide and  $\text{Cl}^-$ , but the increase in crevice diameter in carbon steel is more in a sulfide containing aqueous urea solution than the  $\text{Cl}^-$  containing solution.



**Figure 14 Effect of Chloride and Sulphide on the Crevice Depth (mm) of Steel in the Urea Solution**

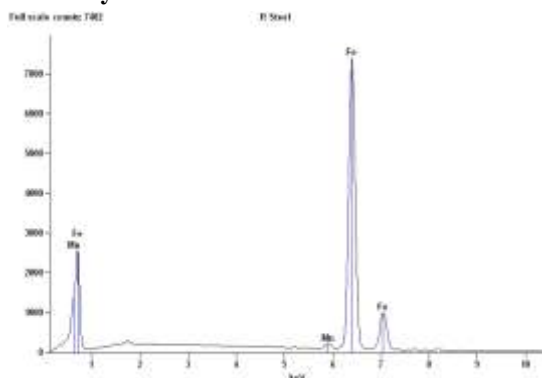
Crevice depth in carbon steel specimens immersed in sulfide and  $\text{Cl}^-$  containing aqueous urea solutions was measured and the results are shown in the figure 14. The crevice depth increased with increasing concentrations of sulfide and  $\text{Cl}^-$  containing aqueous urea solutions. But the damage was more and severe with the increase of latter's concentration. For instance, crevice depth in carbon steel in a solution containing 1%  $\text{Cl}^-$  was ~0.10 mm whereas the same in solution containing 1% sulfide was ~0.08 mm. It is quite evident from the above results that the extent of damage inflicted to carbon steel by  $\text{Cl}^-$  species is much greater than that of sulfide.

#### Surface Analysis of Carbon steel



**Figure 15 SEM Image of the Surface of Carbon Steel**

## EDS Analysis



**Figure 16 EDS Analysis of the Carbon Steel Specimen**

## Quantitative Results Steel

Element	Net counts	Weight %	Atom %
Mn	1842	1.31	1.33
Fe	128467	98.69	98.67
Total		100.00	100.00

SEM and EDS analyses give a clear picture of the surface and composition of the metal under consideration. In this case, the surface of the carbon steel was almost uniform, without any pits or scratches.

It's evident from the EDS analysis that the carbon steel contains mainly iron (98.69% w/w) and trace amount of Manganese (1.31% w/w). The analysis also shows that there are no impurities like copper, which could enhance the corrosion phenomenon.

## Conclusion

From the electrochemical measurements, it can be concluded that the severity of corrosion is more when  $\text{Cl}^-$  species are present in the medium, compared to the sulfide. The crevice depth has a direct impact on the amount of crevice corrosion. As can be seen from the results, the crevice depth is greater due to the  $\text{Cl}^-$  than the sulfide. Thus, the presence of  $\text{Cl}^-$  species in the environment could accelerate the rate of crevice corrosion in carbon steel and consequently, the damage is also severe.

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# CORROSION RESISTANCE COPPER IN ARTIFICIAL SWEAT IN THE PRESENCE OF SODIUM CHLORIDE

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## Abstract

*The corrosion resistance of copper in artificial sweat in the absence and presence of 100 ppm of sodium chloride by electrochemical studies such as polarization technique and AC impedance spectra (EIS – electrochemical impedance spectra). The study reveals that in the presence of excess of chloride ions in the sweat, the corrosion resistance of copper decreases. It implies that people wearing ornaments or watches made of copper must be careful about the sodium chloride level in their sweat.*

**Keywords:** *Corrosion resistance, copper, artificial sweat, electrochemical studies, sodium chloride influence.*

## Introduction

Human perspiration (sweat) comes in contact with a number of consumer products. Contact can cause a variety of undesirable effects. Dyes can bleed or discolour, components can corrode and/or malfunction, residues can be unsightly. The problem of metal corrosion resulting from contamination by palmar sweat is common to many industrial occupations. Constant handling of metal parts by some individuals causes an accumulation of rust. In the manufacture of highly finished metal products, for example ball-bearings, and also in subsequent assembling and packing processes, serious consideration must be given to this effect [1-10]. The present investigation is undertaken to study the corrosion resistance of copper in artificial sweat in the absence and presence of 100 ppm of sodium chloride by electrochemical studies such as polarization technique and AC impedance spectra (EIS – electrochemical impedance spectra).

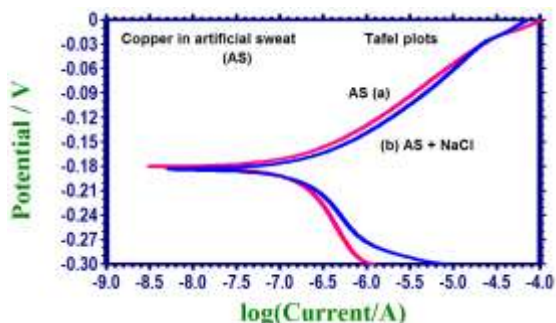
## Experimental

Electrochemical studies such as polarization studies and AC impedance spectra are employed to study the corrosion resistance of very pure copper.

The metal specimens were immersed in artificial sweat (the ISO standard ISO 3160-2), whose composition is: 20g/l NaCl, 17.5 g/l NH<sub>4</sub>Cl, 5g/l acetic acid and 15 g/l d,l lactic acid with the pH adjusted to 4.7 by NaOH. In electrochemical studies, copper is used as working electrode. Artificial sweat (AS) is used as the electrolyte. The temperature is maintained at  $37 \pm 0.1^\circ\text{C}$ .

## Results and Discussion

The polarization curves of copper in simulated (artificial) sweat in presence of sodium chloride and is shown in Figure 1. The corrosion parameters, namely, corrosion potential ( $E_{\text{corr}}$ ), Tafel slopes ( $b_{\text{c}}$  = cathodic;  $b_{\text{a}}$  = anodic), Linear Polarization Resistance (LPR) and Corrosion Current ( $I_{\text{corr}}$ ) are given in Table 1.

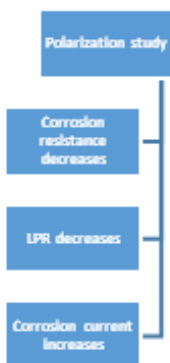


**Figure 1 Polarization Curves of Copper in Various Test Solutions. (a) Artificial sweat (b) AS + NaCl**

**Table 1 Corrosion Parameters of Copper Immersed in Artificial Sweat in the Absence and Presence of 50 ppm of NaCl obtained from Polarization Study**

System	E <sub>corr</sub> mV vsSCE	b <sub>c</sub> mV/de cade	b <sub>a</sub> mV/de cade	LPR Ohmcm <sup>2</sup>	I <sub>corr</sub> A/cm <sup>2</sup>
copper in artificial sweat	-180	154	79	97382	2.322 x10 <sup>-7</sup>
copper in artificial sweat + NaCl 50 ppm	-183	60	81	76767	35.50 x10 <sup>-7</sup>

It is well known that when corrosion resistance decreases, LPR value decreases and corrosion current increases (Figure 2) .



**Figure 2 Correlation among Corrosion Parameters of Polarization StudyCopper in Simulated Sweat System**

When copper is immersed in Simulated Sweat (SS) system (Figure1) the corrosion potential is - 0.180mV vs SCE. The LPR value is 460267 Ohmcm<sup>2</sup> and the corrosion current is 2.322 x10<sup>-7</sup>A/cm<sup>2</sup>.

**Copper in Simulated Sweat + 100 ppm NaCl system**

When Copper is immersed in SS solution+ NaCl system (Figure 1) the corrosion potential is -183 mV vs SCE. The LPR value is 76767 Ohmcm<sup>2</sup> and the corrosion current is 35.50 x10<sup>-7</sup>A/cm<sup>2</sup>. There is decrease in LPR value and increase in corrosion current. This indicates that in presence of excess of chloride ions in the sweat, the corrosion resistance of copper decreases.

**Implication**

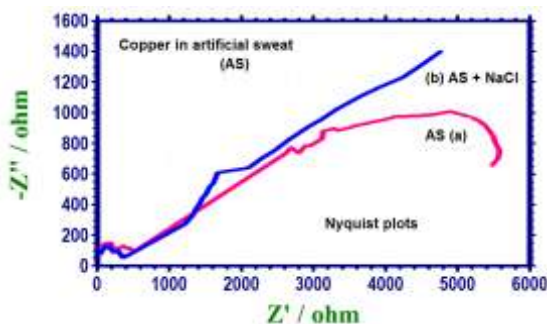
People wearing ornaments or watches made of copper must be careful about the sodium chloride level in their sweat.

**Analysis of AC Impedance Spectra**

The AC impedance spectra are shown in Figure 3. The corrosion parameters are given in Table 2. Bearing in mind that in AC impedance spectral analysis, when corrosion resistance decreases, charge transfer resistance decreases, impedance value decreases, phase angle decreases and double layer capacitance increases (Figure 4), it is inferred that when copper comes in contact with sweat containing sodium chloride, the corrosion resistance of copper decreases.

**Implication**

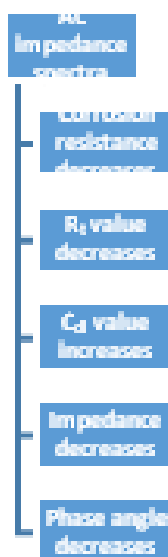
People wearing ornaments or watches made of copper must be careful about the sodium chloride level in their sweat.



**Figure 3 AC Impedance Spectra of Copper in Various Test Solutions. (a) Artificial sweat (b) AS + NaCl**

**Table 2 Corrosion Parameters of Mild Steel Immersed in Sea Water in the Absence and Presence of Inhibitor Systems Obtained from AC Impedance Spectra**

System	$R_t$ Ohm $cm^2$	impedance log(Z/ohm)	Phase angle °	$C_{dl}$ F/ $cm^2$
copper in artificial sweat	5610	3.744	66.13	$9.091 \times 10^{-10}$
copper in artificial sweat + NaCl 50 ppm	4792	3.694	60.79	$10.64 \times 10^{-10}$



**Figure 4 Correlation among Corrosion Parameters of AC Impedance Spectra**

## Conclusion

- The corrosion resistance of copper in artificial sweat in the absence and presence of 100 ppm of sodium chloride by electrochemical studies such as polarization technique and AC impedance spectra (EIS – electro chemical impedance spectra).
- The study reveals that in the presence of excess of chloride ions in the sweat, the corrosion resistance of copper decreases.
- It implies that people wearing ornaments or watches made of copper must be careful about the sodium chloride level in their sweat.

## Acknowledgement

The authors are thankful to the management for their help and support.

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# INFLUENCE OF SODIUM CHLORIDE ON CORROSION RESISTANCE NI-CR ALLOY IN ARTIFICIAL SWEAT

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## Abstract

*The corrosion resistance of Ni-Cr alloy in artificial sweat in the absence and presence of 100 ppm of sodium chloride has been analyzed by electrochemical study such as polarization technique and AC impedance spectra (EIS – electrochemical impedance spectra). The study reveals that in the presence of excess of chloride ions in the sweat, the corrosion resistance of Ni-Cr alloy increases. It implies that people wearing ornaments or watches made of Ni-Cr alloy need not worry about the sodium chloride level in their sweat.*

**Keywords:** *Corrosion resistance, Ni-Cr alloy, artificial sweat, electrochemical studies, sodium chloride influence.*

## Introduction

Human perspiration (sweat) comes in contact with a number of consumer products. Contact can cause a variety of undesirable effects. Dyes can bleed or discolour, components can corrode and/or malfunction, residues can be unsightly. The problem of metal corrosion resulting from contamination by palmar sweat is common to many industrial occupations. Constant handling of metal parts by some individuals causes an accumulation of rust. In the manufacture of highly finished metal products, for example ball-bearings, and also in subsequent assembling and packing processes, serious consideration must be given to this effect [1-15]. The present investigation is undertaken to study the corrosion resistance of Ni-Cr alloy in artificial sweat in the absence and presence of 100 ppm of sodium chloride by electrochemical studies such as polarization technique and AC impedance spectra (EIS – electrochemical impedance spectra).

## Experimental

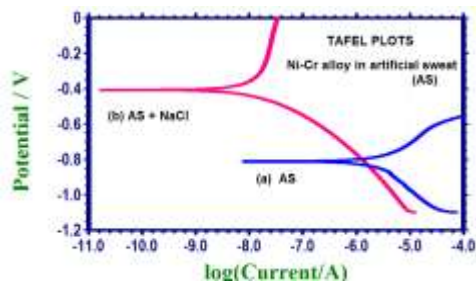
Electrochemical studies such as polarization studies and AC impedance spectra are employed to study the corrosion resistance of very pure Ni-Cr alloy.

The metal specimens were immersed in artificial sweat (the ISO standard ISO 3160-2), whose composition is: 20g/l NaCl, 17.5 g/l NH<sub>4</sub>Cl, 5g/l acetic acid and 15 g/l d,l lactic acid with the pH adjusted to 4.7 by NaOH. In electrochemical studies, Ni-Cr alloy is used as working electrode. Artificial sweat (AS) is used as the electrolyte. The temperature is maintained at 37 ± 0.1°C.

## Results and Discussion

The polarization curves of Ni-Cr alloy in simulated (artificial) sweat in presence of sodium chloride and is shown in Figure 1. The corrosion parameters, namely, corrosion potential ( $E_{corr}$ ), Tafel slopes ( $b_c$  = cathodic;  $b_a$  = anodic), linear polarization resistance (LPR) and corrosion current ( $I_{corr}$ ) are given in Table 1.



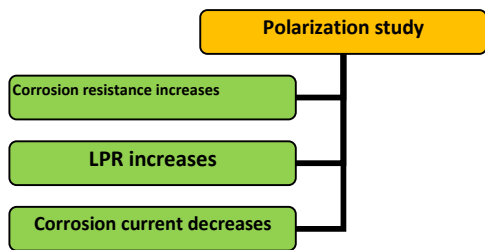


**Figure 1 Polarization Curves of Ni-Cr Alloy in Various Test Solutions. (a) Artificial Sweat (b) AS + NaCl**

**Table 1 Corrosion Parameters of Ni-Cr Alloy Immersed in Artificial Sweat in the Absence and Presence of 50 ppm of NaCl Obtained from Polarization Study**

System	E <sub>corr</sub> mV vs SCE	b <sub>c</sub> mV/decade	b <sub>a</sub> mV/decade	LPR Ohmcm <sup>2</sup>	I <sub>corr</sub> A/cm <sup>2</sup>
Ni-Cr alloy in artificial sweat	-812	4.063	6.362	11693	356.7 x10 <sup>-8</sup>
Ni-Cr alloy in artificial sweat + NaCl 50 ppm	-408	7.991	2.740	3718782	1.090 x10 <sup>-8</sup>

It is well known that when corrosion resistance decreases, LPR value decreases and corrosion current increases (Figure 2).



**Figure 2 Correlation among Corrosion Parameters of Polarization Study**

**Ni-Cr Alloy in Simulated Sweat System**

When Ni-Cr alloy is immersed in Simulated Sweat (SS) system (Figure1) the corrosion potential is -812 mV vs SCE. The LPR value is 11693Ohmcm<sup>2</sup> and the corrosion current is 356.7x10<sup>-8</sup>A/ cm<sup>2</sup>.

**Ni-Cr Alloy in Simulated Sweat + 100 ppm NaClSystem**

When Ni-Cr alloy is immersed in SS solution+ NaCl system (Figure 1) the corrosion potential is -408mV vs SCE. The LPR value is 3718782 Ohmcm<sup>2</sup> and the corrosion current is 1.090x10<sup>-8</sup>A/ cm<sup>2</sup>. There is increase in LPR value and decrease in corrosion current. This indicates that in presence of excess of chloride ions in the sweat, the corrosion resistance of Ni-Cr alloy increases.

**Implication**

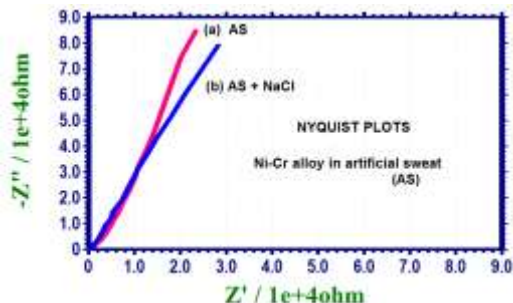
People wearing ornaments or watches made of Ni-Cr alloy need not worry about the sodium chloride level in their sweat.

**Analysis of AC Impedance Spectra**

The AC impedance spectra are shown in Figure 3. The corrosion parameters are given in Table 2. Bearing in mind that in AC impedance spectral analysis, when corrosion resistance increases, charge transfer resistance increases, impedance value increases, and double layer capacitance decreases (Figure 4), it is inferred that when Ni-Cr alloy comes in contact with sweat containing sodium chloride, the corrosion resistance of Ni-Cr alloy increases.

**Implication**

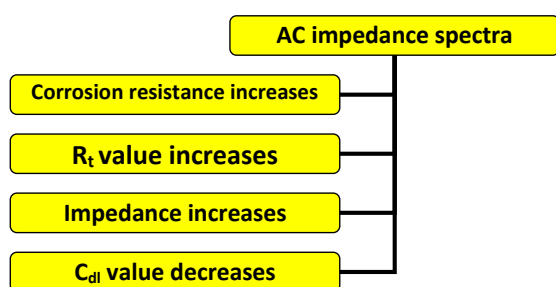
People wearing ornaments or watches made of Ni-Cr alloy need not worry about the sodium chloride level in their sweat.



**Figure 3 AC Impedance Spectra of Ni-Cr Alloy in Various Test Solutions. (a) Artificial Sweat (b) AS + NaCl**

**Table 2 Corrosion Parameters of Ni-Cr alloy Immersed in Sea Water in the Absence and Presence of Inhibitor Systems Obtained from AC Impedance Spectra**

System	$R_t$ Ohm $cm^2$	impedance log (Z/ohm)	$C_{dl}$ F/ $cm^2$
Ni-Cr alloy in artificial sweat	23820	4.933	2.141x $10^{-10}$
Ni-Cr alloy in artificial sweat + NaCl 50 ppm	28850	4.947	1.768x $10^{-10}$



**Figure 4 Correlation among Corrosion Parameters of AC Impedance Spectra**

### Conclusion

- The corrosion resistance of Ni-Cr alloy in artificial sweat in the absence and presence of 100 ppm of sodium chloride has been evaluated by electrochemical studies such as polarization technique and AC impedance spectra (EIS – electrochemical impedance spectra).
- The study reveals that in the presence of excess of chloride ions in the sweat, the corrosion resistance of Ni-Cr alloy increases.
- It implies that people wearing ornaments or watches made of Ni-Cr alloy need not worry about the sodium chloride level in their sweat.

### Acknowledgement

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# CORROSION RESISTANCE ALUMINIUM IN ARTIFICIAL SWEAT IN THE PRESENCE OF SODIUM CHLORIDE

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## Abstract

The corrosion resistance of aluminium in artificial sweat in the absence and presence of 100 ppm of sodium chloride has been analyzed by electrochemical study such as polarization technique and AC impedance spectra (EIS – electrochemical impedance spectra). The study reveals that in the presence of excess of chloride ions in the sweat, the corrosion resistance of **aluminium** decreases. **It implies that** people wearing ornaments or watches made of aluminium must be careful about the sodium chloride level in their sweat.

**Keywords:** Corrosion resistance, aluminium, artificial sweat, electrochemical studies, sodium chloride influence

## Introduction

Human perspiration (sweat) comes in contact with a number of consumer products. Contact can cause a variety of undesirable effects. Dyes can bleed or discolour, components can corrode and/or malfunction, residues can be unsightly. The problem of metal corrosion resulting from contamination by palmar sweat is common to many industrial occupations. Constant handling of metal parts by some individuals causes an accumulation of rust. In the manufacture of highly finished metal products, for example ball-bearings, and also in subsequent assembling and packing processes, serious consideration must be given to this effect [1-15]. The present investigation is undertaken to study the corrosion resistance of aluminium in artificial sweat in the absence and presence of 100 ppm of sodium chloride by electrochemical studies such as

polarization technique and AC impedance spectra (EIS – electrochemical impedance spectra).

## Experimental

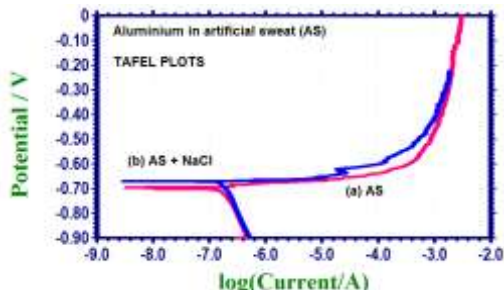
Electrochemical studies such as polarization studies and AC impedance spectra are employed to study the corrosion resistance of very pure aluminium.

The metal specimens were immersed in artificial sweat (the ISO standard ISO 3160-2), whose composition is: 20g/l NaCl, 17.5 g/l NH<sub>4</sub>Cl, 5g/l acetic acid and 15 g/l d,l lactic acid with the pH adjusted to 4.7 by NaOH. In electrochemical studies, aluminium is used as working electrode. Artificial Sweat (AS) is used as the electrolyte. The temperature is maintained at 37 ± 0.1°C.

## Results and Discussion

The polarization curves of aluminium in simulated (artificial) sweat in presence of sodium chloride and is

shown in Figure 1. The corrosion parameters, namely, corrosion potential ( $E_{corr}$ ), Tafel slopes ( $b_c$  = cathodic;  $b_a$  = anodic), linear polarization resistance (LPR) and corrosion current ( $I_{corr}$ ) are given in Table 1.

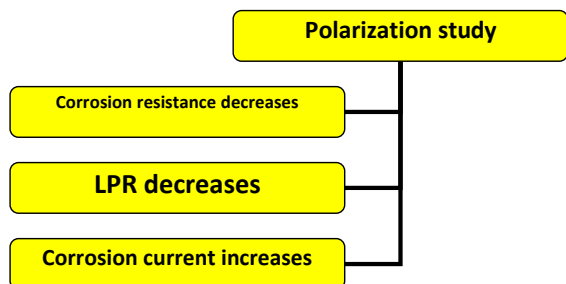


**Figure 1** Polarization Curves of Aluminium in Various Test Solutions. (a) Artificial Sweat (b) AS + NaCl

**Table 1** Corrosion Parameters of Aluminium Dipped in Artificial Sweat in the Absence and Presence of 50 ppm of NaCl Obtained from Polarization Study

System	$E_{corr}$ mV vs SCE	$b_c$ mV/decade	$b_a$ mV/decade	LPR Ohm $mcm^2$	$I_{corr}$ A/ $cm^2$
aluminium in artificial sweat	-696	443	20	46658	$1.741 \times 10^{-7}$
aluminium in artificial sweat + NaCl 50 ppm	-671	551	114	4122	$99.65 \times 10^{-7}$

It is well known that when corrosion resistance decreases, LPR value decreases and corrosion current increases (Figure 2).



**Figure 2** Correlation among Corrosion Parameters of Polarization Study

**Aluminium in Simulated Sweat System**

When aluminium is immersed in Simulated Sweat (SS) system (Figure 1) the corrosion potential is -696mV vs SCE. The LPR value is 46658 Ohm  $mcm^2$  and the corrosion current is  $1.741 \times 10^{-7}$  A/ $cm^2$ .

**Aluminium in Simulated Sweat + 100 ppm NaCl System**

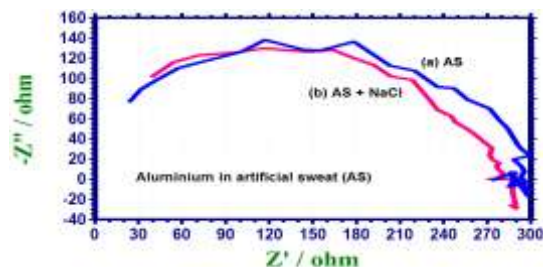
When **Aluminium** is immersed in SS solution+ NaCl system (Figure 1) the corrosion potential is -671mV vs SCE. The LPR value is 4122 Ohm  $mcm^2$  and the corrosion current is  $99.65 \times 10^{-7}$  A/ $cm^2$ . There is decrease in LPR value and increase in corrosion current. This indicates that in presence of excess of chloride ions in the sweat, the corrosion resistance of **aluminium** decreases.

**Analysis of AC Impedance Spectra**

The AC impedance spectra are shown in Figure 3. The corrosion parameters are given in Table 2. Bearing in mind that in AC impedance spectral analysis, when corrosion resistance decreases, charge transfer resistance decreases, impedance value decreases, phase angle decreases and double layer capacitance increases (Figure 4), it is inferred that when aluminium comes in contact with sweat containing sodium chloride, the corrosion resistance of aluminium decreases.

**Implication**

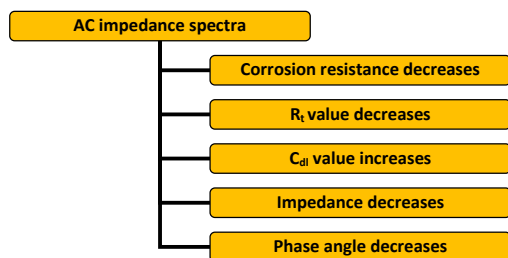
People wearing ornaments or watches made of aluminium must be careful about the sodium chloride level in their sweat.



**Figure 3** AC Impedance Spectra of Aluminium in Various Test Solutions. (a) Artificial sweat (b) AS + NaCl

**Table 2 Corrosion Parameters of Aluminium Immersed in Sea Water in the Absence and Presence of Inhibitor Systems obtained from AC Impedance Spectra**

System	$R_t$ Ohm $cm^2$	impedance log(Z/ohm)	Phase angle °	$C_{dl}$ F/ $cm^2$
aluminium in artificial sweat	295	2.503	70.04	$1.73 \times 10^{-8}$
aluminium in artificial sweat + NaCl 50 ppm	253	2.458	70.00	$2.02 \times 10^{-8}$



**Figure 4 Correlation among Corrosion Parameters of AC Impedance Spectra**

## Conclusion

- The corrosion resistance of aluminium in artificial sweat in the absence and presence of 100 ppm of sodium chloride by electrochemical studies such as polarization technique and AC impedance spectra (EIS – electrochemical impedance spectra).
- The study reveals that in the presence of excess of chloride ions in the sweat, the corrosion resistance of aluminium decreases.
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# A STUDY OF THE IMPACT OF THE HOSPITAL AND SEWAGE WATER DUE TO THE PERCOLATION INTO THE GROUND WATER IN THE RESIDENTIAL AREA

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## Abstract

The effect of the hospital and sewage water due to the percolation into the ground water in and around Pillayarpallayam residential area, Dindigul has been chosen for the present study. Water samples have been collected and the physicochemical parameters of water samples have been analyzed. The reverse osmosis technique has been suggested for the treatment of polluted water. This study aims to wastewater management related research in order to highlight the present situation of the ground water quality in this area.

**Keywords:** Sewage, water quality parameters, ground water

## Introduction

A continuous availability of uncontaminated water is essential for the human daily life. However, most water around the world gets polluted by liquid and solid wastes produced by human activities. Much research has been done for wastewater management on various perspectives [2].

Sewage treatment is the process of removing contaminants from wastewater. It includes physical, chemical, and biological processes to remove these contaminants and produce environmentally safe treated wastewater. A by-product of sewage treatment is generally a semisolid waste that has to undergo further treatment before the disposal process. The population growth is one of the important issues for the contamination of water. Sewage treatment process is essential in order to protect the environment and public health [2]-[5].

## Materials and Methods

The physical parameters include color, taste, odor, temperature, turbidity, solids, and electrical conductivity. On the other hand, chemical parameters can include pH, acidity, alkalinity, chlorine, hardness, dissolved oxygen, and biological oxygen demand. The third type of parameter involves

biological parameters, which include bacteria, algae, and viruses [7].

Ground water samples were collected from (two polluted sites), Pillayarpalayam, behind the St. Joseph's Hospital, Dindigul. All two locations comprises of hospital and sewage waste water, which drains the majority of their pollutants into the ground water. The ground water resource was used for domestic purposes. Water samples from all the sites were collected in sterile glass bottles, brought to the laboratory, processed within 1-3 hrs, and stored at -20°C for further analysis [8]-[10].

Following physico-chemical properties were studied. Total dissolved solid (TDS) of water and fixed residue was measured by evaporation method. Dissolved oxygen (DO) and biochemical oxygen demand (BOD) of water was measured by sodium thiosulphate titration method. Chemical oxygen demand (COD) was measured by titration of potassium dichromate and sodium thiosulphate [11]-[13].

## Result and Discussion

The water samples were analyzed for physico-chemical characteristics. The following physical parameters were analyzed namely, Appearance, Colour, Odour, Turbidity NT units, TDS (mg/l)



Electrical Conductivity (Micro mhos/cm) and the results are shown in the Table1 and Table 2.

**Table 1 Physical Examination of the Ground Water Sample 1**

S.No	Parameter	Values of Ground water sample 1	Permissible limit
1	Appearance	Liquid	-
2	Colour	Colourless	-
3	Odour	Nil	-
4	Turbidity NT units	2	2.5
5	TDS(mg/l)	1750	500
6	Electrical Conductivity Micro mhos/cm	2500	-

**Table 2 Physical Examination of the Ground Water Sample 2**

S.No	Parameter	Values of Ground water sample 2	Permissible limit
1	Appearance	Liquid	-
2	Colour	Colourless	-
3	Odour	Nil	-
4	Turbidity NT units	2	2.5
5	TDS(mg/l)	1505	500
6	Electrical Conductivity Micro mhos/cm	2150	-

The following chemical parameters were analyzed namely, pH, Alkalinity, CaCO<sub>3</sub>(mg/l), Total hardness(mg/l), Calcium(mg/l), Magnesium (mg/l), Iron(mg/l), Manganese(mg/l), Ammonia (mg/l), Nitrite(mg/l), Chloride(mg/l), Nitrate(mg/l), Fluoride(mg/l), Sulphate(mg/l), Phosphate(mg/l) and the values are listed in the Table 3 and Table 4.

**Table 3 Chemical examination of Ground water Sample 1**

S.No	Parameter	Values of Ground water sample 1	Permissible limit
1	pH	8.14	7-8.5
2	Alkalinity	-	-
3	CaCO <sub>3</sub> (mg/l)	408	200
4	Total hardness (mg/l)	720	200
5	Calcium (mg/l)	160	75
6	Magnesium (mg/l)	77	30
7	Iron (mg/l)	-	0.1
8	Manganese (mg/l)	-	0.05
9	Ammonia (mg/l)	-	-
10	Nitrite (mg/l)	0.14	-
11	Chloride (mg/l)	5	45
12	Nitrate (mg/l)	464	200
13	Fluoride (mg/l)	1.4	1.0
14	Sulphate (mg/l)	226	200
15	Phosphate (mg/l)	0.23	-

**Table 4 Chemical examination of Ground Water Sample 2**

S.No	Parameter	Values of Ground Water Sample 2	Permissible Limit
1	pH	7.69	7-8.5
2	Alkalinity	-	-
3	CaCO <sub>3</sub> (mg/l)	380	200
4	Total hardness(mg/l)	540	200
5	Calcium(mg/l)	120	75
6	Magnesium(mg/l)	58	30
7	Iron(mg/l)	-	0.1
8	Manganese(mg/l)	-	0.05
9	Ammonia(mg/l)	-	-
10	Nitrite(mg/l)	0.2	-
11	Chloride(mg/l)	6	45
12	Nitrate(mg/l)	320	200
13	Fluoride(mg/l)	0.4	1.0
14	Sulphate(mg/l)	224	200
15	Phosphate(mg/l)	0.14	-

### Conclusion

The ground water samples were found to be high hardness and contaminated by sewage and hospital waste water. The ground water samples quality parameters reveal that it cannot be suitable for drinking purpose. People living in and around the present study area can be used the ground water for drinking purpose after the proper water treatment process such as reverse osmosis and boiling.

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# INFLUENCE OF HALLS HONEY LEMON ON CORROSION RESISTANCE OF Ni – Ti ALLOY IN ARTIFICIAL SALIVA

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## Abstract

An arch wire in orthodontics is a wire conforming to the alveolar or dental arch that can be used with dental braces as a source of force in correcting irregularities in the position of the teeth. An arch wire can also be used to maintain existing dental positions; in this case it has a retentive purpose. Nickel- and titanium-based alloys are promising materials for dental orthodontic wires due to their superior mechanical properties and corrosion resistance. Influence of Halls Honey Lemon (HHL) on corrosion resistance of orthodontic wire made of Ni-Ti alloy in artificial saliva has been evaluated by electrochemical study such as polarization technique. Corrosion resistance of Ni-Ti alloy in artificial saliva increases in presence of presence of 1000 ppm of Halls Honey Lemon (HHL) increases. Hence people clipped with orthodontic wire made Ni-Ti alloy need not hesitate take 1000 ppm of Halls Honey Lemon (HHL) orally.

## Introduction

Several research works have been carried out to study the corrosion resistance of alloys in artificial saliva [1-10]. The present work is undertaken to study the corrosion resistance of Halls Honey Lemon (HHL) in Artificialsaliva. Electro chemical studies such as Polarization study has been used in the present study.

## Materials and Methods

Influence of Halls Honey Lemon (HHL) on corrosion resistance of orthodontic Wiremadeof Ni-Ti alloyin artificial saliva hasbeen evaluatedby electrochemical study such as Polarization technique.

## Composition of The Artificial Saliva

The metal specimens were immersed in Fusayama Meyer Artificial Saliva [1-5] whose composition is given in Table 1.

**Table1 Composition of Artificial Saliva**

Chemicals	Gram/liter
Na H <sub>2</sub> PO <sub>4</sub> 2H <sub>2</sub> O	0.690
Na <sub>2</sub> S.9H <sub>2</sub> O	0.005

NH <sub>2</sub> CONH <sub>2</sub>	1
CaCl <sub>2</sub> 2H <sub>2</sub> O	0.906
KCl	0.4
NaCl	0.4

## Polarization Study

In the present investigation Tafelplots were recorded in a CHI Electro chemical work station/ analyzer, model 660A. It was provided with automatic IR compensation facility. A three-electrode cell assembly was used.

## Result and Discussion

Influence of Halls Honey Lemon (HHL) on corrosion resistance ofNi-Tialloy in artificial aliva, has been investigated by polarization technique. The working electrode was Ni-Ti alloy. A SCE (Saturated Calomel Electrode) was thereference electrode. Platinum was the counter electrode. A time interval of 5 to 10 min was given for the system to attain a steady state open circuit potential. The electrodes were immersed in artificial saliva (AS), in the absence and presence of Halls Honey Lemon (HHL). From polarization study, corrosion parameters such as corrosion potential (E<sub>corr</sub>), corrosion current

( $I_{corr}$ ), Tafelslopes anodic =  $b_a$  and cathodic =  $b_c$  and LPR (Linear Polarization Resistance) were calculated. In polarization technique, in case of Halls honey lemon LPR increases and corrosion current decreases.

### Influence of 1000 ppm of Halls Honey Lemon (HHL) on corrosion resistance of Ni-Tialloy immersed in Artificial Saliva (AS)

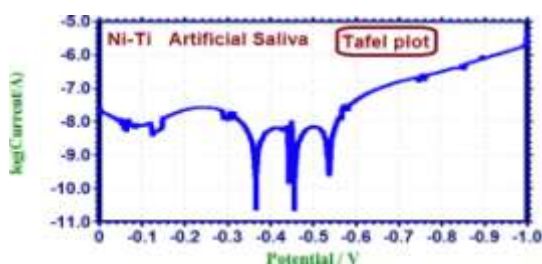
It is observed from Table 2, that in presence of 1000 ppm of Halls Honey Lemon (HHL), the corrosion resistance of Ni-Ti alloy in AS increases. This is revealed by the fact that, in presence of 1000 ppm of Halls Honey Lemon (HHL), LPR value of Ni-Ti alloy increases (Figure 1-2) and corrosion current decreases. Halls Honey Lemon (HHL) behaves as a mixed type of inhibitor. This is due to the fact that in presence of Halls Honey Lemon (HHL), the shift in corrosion potential is very small (from -535 to -537) mV vs SCE).

### Implication

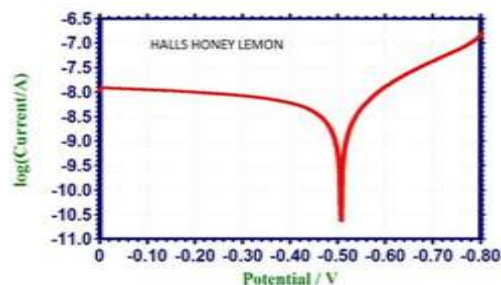
Corrosion resistance of Ni-Ti alloy in artificial saliva increases in presence of 1000 ppm of Halls Honey Lemon (HHL). Hence people clipped with orthodontic wire made Ni-Ti alloy need not take 1000 ppm of Halls Honey Lemon (HHL) orally.

**Table 2 Corrosion parameters of Ni-Ti alloy in AS in the absence and presence of 1000 ppm each of Halls Honey Lemon (HHL) obtained from polarization Study**

System	$E_{corr}$ V vs SCE	$b_{cm}$ V/decade	$b_{am}$ V/decade	LPR $\Omega\text{cm}^2$	$I_{corr}$ A/cm <sup>2</sup>
AS	-535	147	306	10497489	$4.117 \times 10^{-9}$
AS+HHL	-545	144	324	13194458	$3.276 \times 10^{-9}$



**Figure 1 Polarization curve of Ni-Ti alloy immersed in Artificial Saliva (AS)**



**Figure 2 Polarization curve of Ni-Ti alloy immersed in Artificial Saliva (AS) + Halls Honey Lemon**

### Summary and Conclusion

Influence of Halls Honey Lemon (HHL) on corrosion resistance of orthodontic wire made of Ni-Ti alloy in artificial saliva has been evaluated by electrochemical study such as polarization technique.

Corrosion resistance of Ni-Ti alloy in artificial saliva increases in presence of 1000 ppm of Halls Honey Lemon (HHL). Hence people clipped with orthodontic wire made Ni-Ti alloy need not take 1000 ppm of Halls Honey Lemon (HHL).

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## RECENT TRENDS OF OPERATIONS RESEARCH IN HUMAN RESOURCE MANAGEMENT

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### Abstract

*In this exploration paper, we pointed toward figuring out the utilization of functional examination in the field of human asset the board. It has forever been a well established reality that people are known to commit errors on the off chance that work is managed without the assistance of any logical device. With point by point research in Human Asset the board, it came as far as anyone is concerned that the preparation, choice, enrollment and different cycles in different associations depend on predisposition and fractional perspectives. Additionally, we understood that normal capital that is being put resources into the preparation and advancement programs is a lot higher than it ought to be.*

*This made us want to connect the concept of organizational research in human resource management. e to maximize the satisfaction with minimum cost. With this motive, we aimed at reading the past articles where we gained information about how organizations are already using Operations Research techniques like Linear Programming and Assignment Problem, for the process of training.*

*Finally, our exploration felt total when we gave genuine ramifications and it was demonstrated to us that Tasks Exploration procedures helps the associations in coming to conclusions about how they ought to go about with their HR strategies really at least expense.*

### Introduction

“Facebook accused over of gender bias, allowing jobads that discriminate against women” (Press, 2018). Due to the growing exposure in the organizational culture and efficiency today, each person wants equal rights, be it a manor a woman. The focus is now on the knowledge and skills possessed rather than the gender, political reach etc. The entire process of HRM is now evolving into affair and transparent one. At the same time, markets are turning morecompetitive and hence organizations need the bestof theTalent Pool. They aim at finding the right person at the rightprice for the right job at the right time. As both the demandand supply side of the process of HRM are now focusing on the productivity, we felt the need to have a systematic mathematical model to measure and evaluate the process right from hiring to retention to compensation of the employees.

Very much like any administration choice, human asset the executives choices include involving hierarchical assets with expectations of influencing

representative efficiency. Similarly as we can break down an interest in another device or plant regarding the consumptions fundamental and the normal Change in productivity that results, so we can analyses investments in human resources in terms of the expenditures necessary to develop and implement programs, and the expected resulting effect on work force value. (Boudreau J.W., Cornel University, 1990).

Hence, we need to regularly monitor and evaluate ifour HRM processes are profitable to our organizations ornot. There are a lot of manual errors which could happen unintentionally /intentionally which would hamper the growth of the organization like–

- Gender Bias
- Ego Clashes
- Favoritism
- HALO effect
- First Impression Errorsetc.

Operations Research (OR) are an analytical method ofproblem-solving and decision-making that

is useful in the management of organizations. In operations research, problems are broken down into basic components and then solved in defined steps by mathematical analysis. (Rouse, 2011).

Tasks Exploration is the fate of independent direction. Functional exploration assumes what is happening consequently expanding administrative efficiency and ensuring the alarm assets are overseen all the more really. The present status of the workmanship as rehearsed I India is analyzed opposite the expected with regards to the monetary motivators and disincentives; social, culture and political variables; PC accessibility and utilization; accessibility of OR faculty and current administration styles.

### Industry Overview

Listen randomly to 10 interviews of Global Fortune 500 CEOs and you will hear them say, "it is all about the people" when accounting for the success of their respective companies (Abhijit Bradbury). As of today, 2018, names like MERCER, Kelly Industries and AON have created their importance in the Indian sustainable eco system. Had this same statement been made any time before 2008, it would have sounded too crazy for huge industries like these to sustain here. There wasn't even much of any statistical evidence, but yet the Indian market evolved an industry, today known as 'The People's Industry'

It was before viewed as a sluggish regulatory faculty division however is presently viewed as "HR" that recognizes the worth of representatives as a hierarchical asset. This change has pushed HRs to turn into a vital accomplice to business pioneers, adding to huge business choices, prompting on basic changes, fostering the worth of the representatives, making a hierarchical culture - to put it plainly, they presently grab a chair at the table.

HR personnel today also handle the heavy burden of recruitment, payroll, training and development, retention, performance management and ensure a safe and healthy work place environment to work in.

If you ask why the industry has grown then these are the following reasons why:

- Increasing globalization
- Rapid technological change
- Tougher competition
- New structures and hierarchies
- New organizational alliances
- New ways of assigning work
- Changes in employees' priorities, capabilities and demographic characteristics (India Today, 2016).

Within these and many such pressures, there is a need for, or we can say, there is an opportunity for the human resource function to play a critical role in helping organizations sail through these transitions.

With these needs comes great responsibilities like:

- Hiring and retaining talent,
- Lowering labor costs
- Winning the war for talent
- Aligning technology
- Adapting, engaging and retaining the rapidly changing worker profile
- Understanding the intricacies of workers' qualifications
- Understanding skill gaps and developing employees to match the requirement
- Dealing with the risks of a global operation (India Today, 2016)

### Attrition and Loyalty

Gone are the days when employees worked for decades for the same corporation. Today's businesses have learned to live with employee churn, while evolving to minimize the impact of attrition on the overall health of the business (Abhijit Bradbury). While some businesses, such as insurance sales and business process outsourcing, are known for their high attrition, many other businesses also suffer regularly from attrition, especially in key leadership roles.

HR needs predictions, as well as decisions to take advantage of the questions pertaining to employee behavior. Once the appropriated at assets, business rules, etc. a regathered, predictive analytics can answer the what, when and why questions, and



operations research can answer the how and what-if questions for HR. Loyalty is the flip side of this coin. Similar methodologies can enable forward-looking decisions with respect to which incentives – and it doesn't always have to be money – will generate loyalty from which employee and for how long.

### **Learning and Development**

This learning and improvement a piece of the association kicks in to connect the capacity holes that the enlisting group can't close. Individuals foster their abilities from various encounters, communications and connections. Formal improvement plans attempt to abbreviate the time required for fostering these skills.

Predictive decisions would help customize this methodology per employee per competency gap (Abhijit Bradbury). So, the individual development plan for Employee A would not only state that the development gap for Employee A is “decision-making,” it will also suggest having Employee X mentor A because that is the most effective mentor-mentee relationship for this particular skill. The plan may go on to say that Employee A should, however, learn about building “financial acumen” by watching a video tutorial.

### **Talent the Executives**

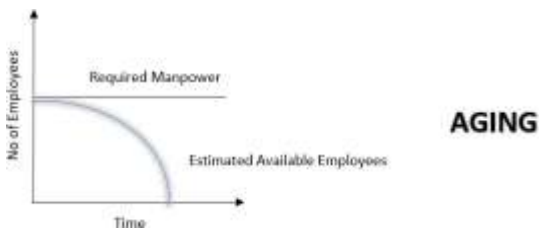
Numerous associations that have a conventional methodology toward ability ID utilize a presentation versus likely lattice by characterizing their workers into high-medium-low entertainers and with high-medium-low potential (Abhijit Bradbury). The supposition that will be that previous execution is a precise indicator of progress in ongoing jobs. To aid possible recognizable proof, the organizations use evaluation focuses to recreate situations that decide progress in the following job. In a world that is quickly changing, the presumptions about future jobs that don't stay up with the outer movements won't foresee which worker to wager on.

Most progression arranging processes today expect that a pattern area of strength for of is the best indicator of outcome in a future job, regardless of

how different the previous jobs are from the future job. Versatile calculations that produce refreshed forecasts, and related choices, as more (and better) information opens up can help.

### **Literature Review**

In the field of Human Resource Management, there are chances of many challenges that will soon enough force the field to take up more of quantitative techniques than qualitative for the various processes like Recruitment, Selection and Training. The HR Department of any organization is usually seen as the department of ‘soft discipline’ and thus the total human capital invested in the same is not calculated properly. Operational Research will help the Human Resource Department to construct systematic models and measures that will help that keep a track of the actual human capital invested in the same. One of the challenges that has been identified in the previous studies is Aging. This means that the organization will have to face consequences of the fall in population growth. The impact of this will be that the gap between the available and required work force will increase because of the above stated issue. This will lead to an increase in the rate of employees being recruited yearly. Any operational research problem starts by analyzing the current situation and the current impact of aging. It is believed that OR can help HR managers to forecast what kind of population growth and aging problems they might face in the future. Previous studies show that using the Markov Theory, techniques for better workforce planning and development can be modeled. These models are based on the probabilities where either the employees are pulled towards the development of their career or they are pushed towards the advancement. These probabilities are assessed from the past presentation. The mix of these Back and forth systems will assist the HR with figuring out and assess the principles and quality better, individually. It has been noted, before, that this strategy is as of now being utilized in military preparation and carriers. (Popular, 2008)



There are various techniques in Operational Research which will help the HR departments in effective and efficient workforce planning. Based on the studies made in past, there are 4 major theories that aim at different dimensions of Human Resource Planning i.e. Markov Chain, Computer Simulation, System Dynamics, Optimization. The first three models of the above stated focus on predicting the future result in the case where the already existing policies are being followed and the latter one focuses on developing new policies for already existing goals. All four models come in with their set of limitations, but System Dynamics is the best suitable as it is affected by the feedback and non linearity. (Wang, 2005)

### Significance

There are different business choices to be made including specific variables by each money manager. It is many times seen that these variables are fairly obscure to the leaders and choices consequently taken depend on instinct and experience which might end up being correct. Tasks Exploration is a device that assists entrepreneurs with running their organizations better by considering the different raw numbers which help in accomplishing ideal choices.

At the point when we discuss human asset the board, there are numerous essential capabilities performed by this division like staffing, enlistment, preparing and so forth. There are different procedures used to carry out these roles however since it includes the executives of individuals inclination can't be overlooked.

In spite of elevated degree of knowledge and complexity, choices are made from different predisposition. After all we are just human. Numerous errors in our reasoning like Securing predisposition, fad impact, tendency to look for predictable answers, bunching deception lead us to

go with problematic choices and obstruct our sane direction.

This causes us to understand a requirement for a deliberate strategy to tackle the above issue. This need is happy with the utilization of Tasks research. It is a scientific strategy wherein issues will be separated in little parts and afterward will be addressed utilizing characterized advances.

There are different procedures like Task issue, direct programming issue which can be utilized. Markov Chain is an other technique which will help since it considers probabilities.

All these techniques provide a one stop solution to the various problems that might occur for management of people on a day to day basis. Thus, we can say that operation research is highly useful and significant in human resource management.

### Methodology

While concentrating regarding the matter Human Asset The executives, we came to know how there are times when there are a ton of inclinations during the most common way of Preparing, determination and so on with a ton of added cost. Fields like HR The board and Promoting, where significant task is finished by the people, have a significant degree for mistake. Consequently, there should be a component of science too to build the effectiveness. We needed to search for ways of making it more pleasant and more efficient. This made us consider concentrating on the use of Functional Exploration in Human Asset The board as OR targets improving the arrangement while limiting the expense and furthermore, it is one of the most solid numerical devices that anyone could hope to find to humankind in the current day.

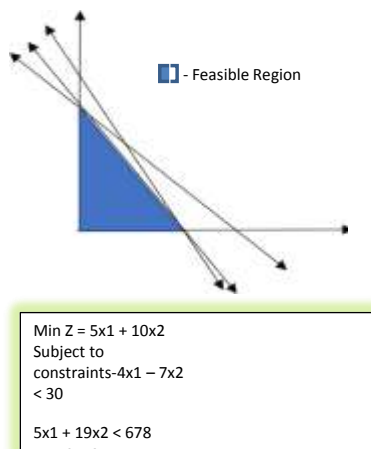
The information will be gathered through auxiliary exploration as the idea of the examination doesn't fit essential sources. Through optional examination we will recognize the use of Tasks Exploration in Human Asset The board and its effect.

### A.Linear Programming Problem

A linear programming problem may be defined as the problem of maximizing or minimizing a linear function subject to linear constraints. The constraints

may be equalities or inequalities. (Ferguson, 2000). We have a Minimization/ Maximization Function known as the Objective Function along with a few constraints and we then plot the monograph to find out the best possible combination to satisfy the Objective Function.

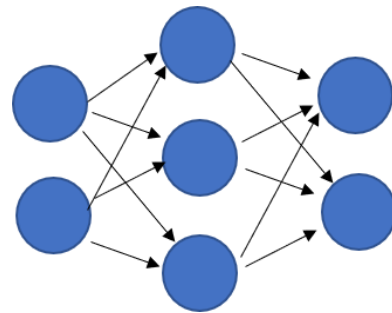
For example, let's take a company ABC Ltd. The Objective function could be to minimize the cost or the labor hours of x department swart constraints relating to different labor categories, work timings etc. They can then plot these numbers on the graph as in how many employees should each department have in order to minimize the cost or maximize the productivity. The sample LPP problem model looks like-



## B. Network Optimization

Representing a problem as a graph can provide a different point of view and could make it easier to solve and Network Theory provides a set of techniques for analyzing these graphs. (CICam, 2000)

For example- ABC Ltd is a company which serves as an online portal for job search. It has to take various requirements from the companies (demand centers) and provide them with the right employees after selecting them from the online portal (demand center). It could be shown by a basic network model as-



Here, the Input can be the various resumes submitted by the applicants, hidden could be the company's operations and the output can be the selection suggestions given to different companies.

## C. Simulation

**Systems simulation** is a set of techniques that use computers to imitate the operations of various real-world tasks or processes through **simulation**. (Wikipedia, 2018) Simulation in HRM could be done in the following ways-

- Simulation Training can be undertaken for risky jobs where on the job training can prove to be dangerous.
- It can also be used in the fields where live training is costlier than simulation training. It gives a real life like experience.
- It is possible to simulate the organizational performance under various hypothetical situations like recession, strikes etc.
- Few companies who follow simulation training are AIIMS, Train 4 Trade Skills, Lloyds, Banking Group etc.

## D. Assignment Problems

The assignment method is used to determine what resources are assigned to which department, machine, or center of operation in the production process. The resource would be monetary, personnel, technological or another type of resource. (Investopedia, 2018)

For example-ABC Ltd has different jobs for different employees with a time constraints or has different promotion packages for different employees, assignment model can solve it by converting the issue into a mathematical problem. Steps to do so-

- Step 1 - Balance the AP by adding dummy rows/columns. Step
- 2-Row minima
- Step 3- Column Minima Step 4-Alloting to the 0s Step5-Final Assignment

An assignment model looks like this-

	A	B	C	D
W	3	2	4	8
X	5	8	1	4
Y	7	4	3	2
Z	4	6	9	1

### E. Queuing Hypothesis

Lining hypothesis is the numerical investigation of the clog and postponements of stalling in line. Lining hypothesis (or "queuing hypothesis") analyzes each part of stalling in line to be served, including the appearance cycle, administration process, number of servers, number of framework places and the quantity of "clients" (which may be individuals, information parcels, vehicles, and so on) (Investopedia, 2018)

For instance ABC Ltd is a call community. In a call place around 70% costs are that of HR and the significant issue is defers in broadcast communications line and developing client pausing. In such cases, firms can utilize queuing hypothesis to track down the right number of servers (representatives) and the quantity of clients per server.

### Conclusion

As has been laid out beforehand, Tasks The board (OM) and Human Asset The executives (HRM) have since days of yore been exceptionally un mistakable fields running lined up with one another however rarely meeting.

By and by, the previously mentioned fields cooperate on events of regulatory issues rotating around finance frameworks and other such comparative issues. While in principle, the two subjects are attempted by disjoint gatherings of researchers, who work in totally different disciplines. As times have advanced, the scarce difference of qualification between the scholarly community and

practice of HRM and OM have continually been ebbing ceaselessly. This obscuring out of the discussed qualification can essentially be credited to Globalization, Labor force Variety, Dynamism in the Political, Monetary and Lawful Climate and above all the unrests in innovation.

Of extensive significance is the Money saving advantage Examination's utilization in HM. This approach is an exceptionally all encompassing methodology that not just considers expenses and advantages related to a financial worth, yet additionally represents non-financial factors, for example, proficiency, wastage of time, representative fulfillment, professional stability and so on. This empowers the administration to think about every one of the elements (financial and non-money related) while showing up at a choice, hence guaranteeing the most ideal utilization of assets. Considering how restricted our assets are, and in lieu of rising worldwide expansion, it becomes basic for associations to utilize assets deftly to amplify their benefits and limit their misfortunes.

Another significant viewpoint is the enlistment, choice preparation of an organization's labor force - which is helped by the quantitative models of OM. It helps in recognizing and enhancing specific ranges of abilities of representatives and other faculty that should be furnished with specific abilities and characteristics.

It is in many cases said that the progress of an association or any functioning body still up in the air by the capacities of the people who are a piece of its everyday work cycle. Also, since representatives are the abovementioned and are all viewed as an association's greatest resource, this OM Cycle frames a necessary and vital piece of the manageability of an association's development and future possibilities.

### Limitations

1. Lack of essential information. Essential information gives the contemporary news and private belief. Yet, because of the absence of mindfulness about OR and its significance in the overall population, we needed to depend on Auxiliary information.
2. As we have depended significantly on the discoveries of past exploration papers, there could be predispositions and misrepresentation

in a couple of discoveries. Additionally, the legitimacy of the Web is problematic.

3. Due to absence of profundity in the subject, we have explored on the outline of the whole point. We have given the extent of HRM in OR utilizing various procedures yet couldn't present a legitimate numerical model.
4. Hence, this exploration paper has a restricted profundity however high extension.

### Future Research

1. The extent of OR in HRM could be concentrated on top to bottom utilizing a strategy with definite model and computations.
2. Checking the achievability of every strategy for various HRM rehearses.
3. The ideal approach to coordinating the customary HRM with the forthcoming OR models.
4. New strategies in OR which could improve on the course of HRM to make it more worker amicable and supportable.
5. A different model to distinguish just the delicate parts (human part) of the productivity and working of the business worker relationship.

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## INDEPENDENT DOMINATION IN REGULAR GRAPHS

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### Abstract

Let  $G$  be an easy graph with  $n$  nodes.  $S$  is an independent dominating set of  $G$  if  $S$  is an independent set and every vertex not in  $S$  is adjacent to a vertex in  $S$ . The independent domination number  $i(G)$  is defined as the smallest cardinality among the maximal independent sets of vertices of a set  $S$  in a graph. We discuss concerns concerning independent domination in regular graphs in this study. We study the maximum value of the product of the independent domination numbers of a graph and its complement, as a function of  $n$ , in light of the work of Cockayne et al. (1991) and Cockayne and Mynhardt (1989). We specifically demonstrate that if  $G$  is regular, then  $i(G) \cdot i(\bar{G}) < (n + 14)^2/12.68$ .

**Keywords:** Upper boundaries, regular graph, minimal domination set, independent domination number

### Introduction

Let  $G$  be a simple graph of order  $n$ . [1]The independent domination number  $i(G)$  is defined to be the minimum cardinality among all maximal independent sets of vertices of  $G$ . [3]We investigate the maximum value of the product of the independent domination numbers of a graph and its complement, as a function of  $n$ . In particular we prove that if  $G$  is regular then  $i(G) \cdot i(\bar{G}) < (n+14)^2/12.68$ . [4]Our main theorem gives an upper bound on  $i(G) \cdot i(\bar{G})$ , as a function of  $n$ , for regular graphs  $G$ . [2] This study was prompted by observing the irregular structure typical of graphs attaining known or conjectured upper bounds for  $i(G)$  and  $i(\bar{G}) \cdot i(\bar{G})$  in earlier research. Prior to this we consider the same problem for general graphs. [5]In what follows, the open neighbourhood of a vertex  $u$  will be denoted by  $\Gamma(u) = \{u \in V : uv \in E\}$ , and that of a set of vertices  $X$  by  $\Gamma(X) = \bigcup_{S \in X} \Gamma(x) \cap (V - X)$ . [6]We abbreviate  $i(G)$  to  $i$  and  $i(\bar{G})$  to  $\bar{i}$  where it is unambiguous, and without loss of generality assume  $i \geq \bar{i}$

### Definition

Let  $G = (V, E)$  be a graph. A set  $S \subseteq V$  is called a dominating set if every vertex  $v \in V - S$  there exists a vertex  $u$  in  $S$  such that  $u$  and  $v$  are adjacent.

### Example

In the graph,  $S = \{v_2, v_4\}$  is a dominating set.  $V(G) - S = \{v_1, v_3, v_5\}$  and every vertex in  $V(G) - S$  is adjacent to vertex of  $S$ .

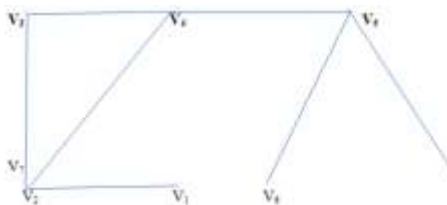


### Definition

A dominating set of minimum cardinality denoted by  $\gamma(G)$  is called a minimum dominating set. A dominating set  $S$  is called a minimal domination set if no subset of  $S$  is a dominating set.

### Example

From this graph minimum dominating set =  $\{v_2, v_5\}$  and minimal dominating set =  $\{v_6, v_7, v_4\}$



## Results

### Lemma

Let  $G$  be a graph with a minimum maximal independent set  $I$ , and let  $k = \max_{x \in V - I} |\Gamma(x) \cap I|$ . Then  $V - I$  contains an independent set of order at least  $k$ .

### Proof

Choose  $x \in V - I$  such that  $k = |\Gamma(x) \cap I|$  is maximum, and let  $K = \Gamma(x) \cap I$ . Form the set  $X = \{v \in V - I : \Gamma(v) \cap I \subseteq K\}$ , and let  $R$  be a maximal independent set of  $G[X]$  containing  $x$ . Then  $R \cup (I - K)$  is maximal independent for  $G$ , so  $|R| + (i - k) \geq i$ , i.e.  $|R| \geq k$ . Thus  $R$  is the required independent set of  $V - I$ . Let  $\bar{I}$  be a minimum maximal independent set of  $\bar{G}$ , and set  $\bar{k} = \max_{x \in V - \bar{I}} |\Gamma(\bar{x}) \cap \bar{I}|$ .

### Lemma

Any graph of order  $n$  satisfies  $i + \bar{i} + k + \bar{k} \leq n + 4$ .

### Proof

By Lemma 2.1, the graph  $G$  contains two disjoint independent sets, one of order at least  $i$ , and the other of order at least  $k$ . These two independent sets correspond to two cliques in  $\bar{G}$ . Since any independent set of  $\bar{G}$  can contain at most one vertex from each clique of  $\bar{G}$ , this is true for  $\bar{I}$  so we deduce that  $V - \bar{I}$  contains disjoint cliques of orders at least  $i - 1$  and  $k - 1$  in  $\bar{G}$ . With  $\bar{K}$  defined as above, Lemma 2.1 additionally implies that  $V - \bar{I}$  contains an independent set of order at least  $\bar{K}$  in  $\bar{G}$ . Obviously an independent set of  $V - \bar{I}$  can have at most one vertex in common with a clique of  $V - \bar{I}$  so  $(i - 1) + (k - 1) + (\bar{k} - 2) \leq n - \bar{i}$ , which proves the Lemma.

### Theorem

If a graph of order  $n$  satisfies  $\min\{k/i, \bar{k}/\bar{i}\} \leq 1/2$  or  $\max\{k/i, \bar{k}/\bar{i}\} = 1$  then  $i \cdot \bar{i} \leq (n + 4)^2/12$ .

### Proof

First suppose  $k \leq i/2$ . All vertices appear in an independent set of order at least  $\bar{i}$  in  $\bar{G}$  and hence in a clique of order at least  $\bar{i}$  in  $\bar{G}$ . Now  $G[I \cup R]$  is

bipartite, so any clique of  $G$  contains at most two vertices from this set; consequently each vertex of  $I$  has at least  $\bar{i} - 2$  neighbours in  $V - (I \cup R)$ .

Meanwhile, each vertex of  $V - I$  has degree at most  $k$  in  $I$ , implying  $i(\bar{i} - 2)/(n - i - k) \leq k$ . Solving this inequality for  $k$  gives  $((n - i) - [(n - i)2 - 4i\bar{i} + 8i]^{1/2})/2 \leq k$ . Using the upper and lower bounds on  $k$  and solving the resultant quadratic expression for  $i\bar{i}$  yields  $i\bar{i} \leq i(2n - 3i + 8)/4$ , and it is easily verified that the maximum value of the right-hand side of this last inequality is  $(n + 4)^2/12$ . Clearly a similar argument applies for  $\bar{k} \leq \bar{i}/2$ . To complete the proof, it remains to dispose of the case where  $\bar{k} = \bar{i}$  and  $k > i/2$ . Applying Lemma 2.2,  $3i/2 + 2\bar{i} < i < \bar{i} + k + \bar{k} \leq n + 4$ , so  $i\bar{i} < 2\bar{i}(n - 2\bar{i} + 4)/3 \leq (n + 4)^2/12$ , as required.

### Theorem

Any regular graph of order  $n$  satisfies  $i \cdot \bar{i} < (n + 14)^2/12.68$ .

### Proof

Let  $G$  be regular of degree  $\delta$ . If both  $k = i$  and  $\bar{k} = \bar{i}$ , Lemma 2.2 gives  $i + \bar{i} \leq (n + 4)/2$  and thus  $i \cdot \bar{i} \leq (n + 4)^2/16$ . Henceforth assume without loss of generality that  $k \neq i$ . Furthermore write  $i + \bar{i} = \alpha(n + 14)$ ,  $\alpha \in Q$ ; then  $i\bar{i} \leq \alpha^2(n + 14)^2/4$ . (1)

We obtain another upper bound for  $i\bar{i}$  as follows. Each vertex of  $V - I$  has degree at most  $k$  in  $I$ , whilst each vertex of  $I$  has degree  $\delta$  in  $V - I$ , so  $k(n - i)/i \geq \delta$ . (2)

As shown in the proof of Theorem 2.3 (If a graph of order  $n$  satisfies  $\min\{k/i, \bar{k}/\bar{i}\} \leq 1/2$  or  $\max\{k/i, \bar{k}/\bar{i}\} = 1$  then  $i\bar{i} \leq (n + 4)^2/12$ ), each vertex of  $G$  appears in a clique of order at least  $\bar{i}$  containing at most two vertices from  $I \cup R$ . Thus each vertex of  $I \cup R$  has degree at least  $\bar{i} - 2$  in  $V - (I \cup R)$ , whilst each vertex of  $V - (I \cup R)$  has degree at least  $\bar{i} - 3$  therein. We conclude that some  $x' \in V - (I \cup R)$  satisfies  $\delta = |\Gamma(x') \cap (V - (I \cup R))| + |\Gamma(x') \cap (I \cup R)| \geq \bar{i} - 3 + (i + k)(\bar{i} - 2)/(n - i - k)$ , so  $\delta \geq n(\bar{i} - 3)/(n - i - k)$ . (3)

Eliminating  $\delta$  between (2) and (3) and rearranging gives  $i\bar{i} \leq [k(n - i - k)(n - i) + 3ni]/n$ . (4)

As a function of  $k$ , the right-hand side of (2.4) is maximised at  $k = (n - i)/2$ . However, the vertex  $x \in R$  satisfies  $|\Gamma(x) \cap I| = k$ , whilst as a vertex of  $I \cup R$  it has degree at least  $\bar{i} - 2$  in  $V - (I \cup R)$ , so the regularity of  $G$  implies  $\delta = |\Gamma(x) \cap I| + |\Gamma(x) \cap (V - (I \cup R))| \geq k + \bar{i} - 2$ . (5)

Now  $I - K \neq \emptyset$ , so  $\Gamma(I - K) \subseteq V - (I \cup X) \subseteq V - (I \cup R)$  with  $|\Gamma(I - K)| \geq \delta$ , giving  $n - ik \geq |V - (I \cup R)| \geq |\Gamma(I - K)| \geq \delta$ . (6)

Eliminating  $\delta$  between (5) and (6) and rearranging gives  $k \leq (n+2-i-\bar{i})/2$ . Hence in fact the right-hand side of (4) is maximised at  $k = (n + 2 - i - \bar{i})/2$ , yielding  $i \cdot \bar{i} \leq [(n + 2 - i - \bar{i})(n - 2 - i + \bar{i})(n - i) + 12ni]/4n \leq [(n + 2 - i - \bar{i})n(n - i) + 12ni]/4n \leq (n + 14 - i - \bar{i})(n - i)/4$  as  $i \leq n - i \leq (n + 14 - i - \bar{i})(n + 14 - i)/4$ , so  $i \cdot \bar{i} \leq (n + 14)^2 (1 - \alpha)(2 - \alpha)/8$  since  $i + \bar{i} = \alpha(n + 14)$  and  $i \geq \bar{i}$ . (7)

Finally, from (1) and (7) we have that  $i \cdot \bar{i} \leq \max_{\alpha > 0} (\min\{f(\alpha), g(\alpha)\})(n + 14)^2$ , where  $f(\alpha) = \alpha^2/4$  and  $g(\alpha) = (1 - \alpha)(2 - \alpha)/8$ . Thus it remains to solve the quadratic equation  $2\alpha^2 = (1 - \alpha)(2 - \alpha)$ , which has positive root  $\alpha = (\sqrt{17} - 3)/2 = 0.5615 \dots$ , whence  $i \cdot \bar{i} \leq (n + 14)^2 (13 - 3\sqrt{17})/8 < (n + 14)^2/12.68$ .

## Conclusion

In this paper discussed with demonstrate that the maximum value of the product of the independent domination numbers of a graph and its complement, as a function of  $n$ . Then, we demonstrate that if  $G$  is regular then  $i(G) \cdot i(\bar{G}) < (n + 14)^2/12.68$ .

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## SURVEY OF STOCK FRAMEWORKS WITH WEAKENING

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### Abstract

*This paper presents an exceptional audit of the advances made in the field of stock control of short-lived things (falling apart stock) [ 1 ]. The keep going broad survey on this subject traces all the way back to 2001 (Goyal S.K. also, Giri B.C) [4]., Ongoing patterns in demonstrating of disintegrating stock, European Diary of Functional Exploration, From that point forward, north of 200 articles regarding this matter have been distributed in the significant diaries on stock control, showing the requirement for another survey[3]. We utilize the arrangement of Goyal and Giri in view of timeframe of realistic usability attributes and request qualities. Commitments are featured by examining fundamental framework qualities, including cost limits, putting in a rain check or lost deals, single or different things, a couple of distribution centers, single or multi-echelon, normal expense or limited income, and installment delay.*

**Keywords:** *Decay of stock, survey, models, deals*

### Introduction

► Survey of stock frameworks with decay. ► Arrangement of Goyal and Giri (EJOR, 2001) utilized. ► North of 200 articles 2001-2011 explored. ► Commitments featured by framework attributes.

### Presentation

In the numerical demonstrating of stock control that began with the old style Financial Request Amount (EOQ) model of Harris , the certain supposition that was that supplied things have limitless timeframes of realistic usability. Crumbling was first represented by Whitin, who considered design things decaying after an endorsed stockpiling period. Ghare and Schrader first displayed negative outstanding rotting stock. Very nearly 50 years after the fact, numerous varieties exist that vary in presumptions on the lifetime of a thing, yet in addition on the sort of interest, the presence of cost limits, permitting deficiencies and putting in a raincheck, single or different things, a couple of distribution centers, single or multi-echelon demonstrating, normal expense or limited incomes, and whether a defer in installment is passable.

About 10 years prior, Goyal and Giri made a differentiation between three general classes of stock in their magnificent survey on disintegrating stock models, which included 130 references. They arranged models in light of the presence of oldness,

disintegration, or not one or the other. Things are dependent upon out of date quality in the event that they lose their worth over the long haul in light of fast changes of innovation or the presentation of another item by a contender, or in light of the fact that they leave style. Weakening is characterized as the harm, decay, vaporization, dryness and so forth of things. Like our audit, the one by Goyal and Giri is confined to weakening since, as they contended, "significant consideration has not yet been given on displaying of such a stock framework simply because once the things become old they are not reordered". Over a long time back, the primary surveys showed up. Prastacosgave a study of blood stock administration. Raafat did an overview confining his review to consistently crumbling stock models just, as he had been gone before by Nahmias who had proactively given a broad survey on fixed-lifetime models. As of late, a few survey commitments have showed up. Some of them center around unambiguous regions, for example, Pierskalla, who examines blood stock and production network the board. Nahmias distributed a book that gives an outline of the demonstrating approaches utilized in the field of transitory stock frameworks. Pahl et al., Akkerman et al., and Karaesman et al. Centeraround the issue of decay underway and circulation arranging, particularly of food supply chains. At last, Li et al. give an outline of about 100 late papers on weakening stock administration, including

25 distributions that have showed up in Chinese administration diaries. This multitude of surveys don't mean to give an outline like Goyal and Giri, who shrouded the fundamental commitments in displaying weakening stock issues in the logical diaries in the field of stock hypothesis.

The target of our article is consequently to give a far reaching writing survey of models for stock control with decaying things that have been distributed since the audit of Goyal and Giri. The grouping is steady with that of Goyal and Giri to work with examination.

The extent of this paper is restricted to decaying stock and does exclude writing on out of date quality (unexpected passing) to keep the length of this article to a containable size. The attention isn't on the subtleties of numerical inductions, yet on the suppositions and particulars of the models. Segment 2 depicts the strategy that has been applied for the assortment of writing for this audit. Segment 3 depicts the arrangement of disintegrating stock models, including the assignment of inspected writing to these classes and appropriate extra model qualities. Segment 4 gives an outline of the outcomes. The end is given in Segment 5.

### Area Bits

#### Decay

1. Models for weakening stock can be comprehensively classified by the lifetime of items and qualities of interest. Three classifications are recognized in light of timeframe of realistic usability qualities:
2. Fixed lifetime, for example foreordained deterministic lifetime of for example two days or one season.
3. Age subordinate crumbling rate (which infers a probabilistic dispersed lifetime, for example Weibull).
4. Time or stock (yet not age) subordinate weakening rate.
5. Note that models with a steady decay

#### Introductory Stage

Our review means to track down papers on decaying stock control that have been distributed between January 2001 and December 2011. In like that, it can act as a development of the survey of Goyal and Giri which included papers till 2000. We initially began

with a watchword search in a determination of significant diaries that distribute regarding this matter. Four unique sets of catchphrases were placed in this manner, utilizing the special case image \* in addition to 'AND stock'. The catchphrases are

#### Examination

The choice cycle portrayed in the past segment prompted 227 important papers that have been distributed between January 2001 and December 2011. Note that some of them were still in press right now of composing this original copy, yet these papers were at that point accessible on the web. In Table 2, we show the quantity of papers distributed by every diary. In Table 3 the papers are grouped by the displaying of the disintegration (lifetime) and of the interest, key measures that were talked about in

#### Conclusion

In this paper we have given an exceptional audit of decaying stock writing succeeding crafted by Goyal and Giri [85]. It is prominent that falling apart stock models with time-ward or time-differing request are all around addressed in the ongoing writing. An incredible greater part of models expecta deterministic setting. From a pragmatic perspective, this makes these models less promptly relevant in a business climate.

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## APPLICATONS OF QUEUEING HYPOTHESIS IN MEDICAL CONSIDERATION

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### Abstract

*Functional exploration epitomizes many methods that can further develop the manner in which we plan and sort out wellbeing administrations. Activity research (O.R) centers around the use of scientific strategies to work with better independent direction. This paper is an endeavour to dissect the hypothesis (Lining) and occasions of purpose of lining hypothesis in medical care associations all over the planet and advantages obtained from the same.*

### Introduction

Activity Exploration existed as a logical discipline since 1930's. It is a discipline of applying suitable scientific strategies for navigation. Or then again has been concentrated on in medical services settings beginning around 1952. One of the significant purposes of functional examination in medical services is as Lining hypothesis. Lines or Lining hypothesis was first dissected by A.K Erlang in 1913 in the setting of phone offices. It is widely polished or used in modern setting or retail area tasks the executives, and falls under the domain of choice Sciences. The rising cost of medical services can be ascribed not exclusively to maturing populace and new costly and high level treatment modalities yet additionally to failures in wellbeing conveyance. Lining hypothesis application is an endeavour to limit the expense through minimization of shortcomings and deferral.

### Wellbeing Administration Scope Organization

It is normal for medical services supervisors to extend responsibility for actual framework and labour arranging. This might be finished at various offices, emergency clinics or even public level. It is a typical strategy to see past patterns, gauge the verifiable year-on - year development and extrapolate this development rate to what's in store. Anyway there are two likely issues. First and foremost, we only occasionally see a conclusive pattern and the assessment of "development rate" is exceptionally reliant upon the begin and end points of time spans.

Besides, the supposition of a durable pattern is moreover unreasonable. A medical services use is many times firmly connected with age, a more vigorous method for anticipating is to utilize populace based drivers. We can initially drive the age explicit usage rate, which is the quantity of experiences (For example crisis or patient attendances, emergency clinic affirmations) according to populace intended for each age bunch. With quick change and realignment of medical care framework, new lines of administrations and offices to render something very similar, server monetary tension on the medical care associations and broad use of extended administrative abilities in medical care setting, utilization of lining models has become very predominant in it. Lining models are utilized to accomplish an equilibrium or trade-off among limit and administration delays. For use of lining models to any circumstance we ought to initially depict the "Information Cycle" also "yield Cycle". A Model is displayed underneath with a short depiction of both interaction:

### Costs Related with Patients or Clients Sitting Tight for the Administration

- Loss of business to HCO, as certain patients probably won't sit tight for the help and may choose to go to the contending associations.
- Costs brought about by society for instance expanded mediations and cost because of postpone in care or on the other hand the worth of patients time.
- Diminished patient fulfilment and nature of care.

### Costs of Offering the Assistance (Limit Expenses)

- Compensations paid to workers.

### Lining Hypothesis and Medical Care

The wellbeing frameworks ought to have a capacity to convey protected, effective and smooth administrations to the patients. A few key repayment changes, expanding investigations and cost pressures on the framework and expanding request of value and adequacy from exceptionally mindful and instructed patients because of advances in innovation and media communications have begun coming down on the medical services supervisors to answer these worries. Lining hypothesis is an illustration of these in medical services. It basically manages patient move through the framework, assuming patient stream is great then, at that point, patient lining is limited, on the off chance that it is awful, the framework might endure loss of business and patients might experience significant lining delays. Medical services framework can be envisioned as a complex lining network in which postponements can be decreased through the accompanying ways:

- Synchronization of work among administration stages (e.g., coordination of tests, medicines, release processes)
- Planning of assets (e.g., specialists and attendants) to match examples of appearance
- Consistent framework checking (e.g., following number of patients holding up by area, indicative gathering and sharpness) connected to prompt activities.

Lining hypothesis is currently reasonably broadly utilized in the accompanying settings:

### Emergency Clinic Drug Store and Drug Store Stores

The examples of utilization of lining hypothesis in drug store practice are not many. Various drug stores in the branch of safeguard utilize computerized Lining Innovation (AQT). AQT is likewise used by numerous other large medical clinic frameworks with

critical caseloads, for example, College of Virginia emergency clinic frameworks. In Drug store, Lining hypothesis can be utilized to evaluate a huge number of elements, for example, solution occupy time, patient holding up time, patient advising time and staffing levels. The use of lining hypothesis might be of specific advantage in drug stores with high-volume short-term responsibilities or potentially those that give numerous customer facing interactions. By better understanding lining hypothesis, administration chiefs can pursue choices that increment the fulfillment of all applicable gatherings Clients, Representatives and the executives Medical care asset and framework anticipating calamity the board Any kind of catastrophe he cause critical human and financial harm and they all interest an emergency reaction. It requests prompt salvage of individuals, arrangement of clinical benefits required and control of the harm to individuals and property. In such situations, lining models are every now and again utilized related to recreation to answer the "imagine a scenario where" questions, to design, sort out and be ready for the disasters. For Model, assuming H5N1 bird influenza spreads to US and causes a pandemic, it would be significant emergency.

### Conclusion

Lining hypothesis, is "The numerical way to deal with the examination of stalling lines in Medical services setting". Its utilization has been approved in modern setting, retail area and in help settings such as broadcast communications however its reception and use in medical care setting is lingering behind other areas. In wellbeing area it is predominantly utilized in ED stand by line and staffing studies, examination of lines in short term and mobile consideration settings and for catastrophe the board. Anyway it has scope for involves in any setting where there exist stand by lines or there is the potential for the equivalent. It can be utilized in long term, short term, Doctor office, general wellbeing, office and asset arranging.

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# APPLICATION OF GEOGEBRA FOR TEACHING MATHEMATICS

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## Abstract

*Advancements came to alter the educating of specialized plan; they brought assets that empowered 3D and 2D realistic reproduction. The target of this examination is to grasp how the execution of the powerful programming GeoGebra on the subject of round and hollow segments can work on 3D spatial perception in understudies as a result of the difficulties in grasping the 3D portrayals and moving them to the 2D sheet. This is a semi-trial contextual analysis in a blended subjective and quantitative methodology which was directed in a grade 12 class regarding the matter of clear math. The instruments utilized were a pre-test, post-test and St Nick Barbara Solids Test. The understudies of the trial bunch involved GeoGebra and got improved brings about the post-test than the understudies in the benchmark group, which recommends an improvement in learning; nonetheless, the St Nick Barbara Solids Experimental outcomes showed that the hardships in imagining perspectives on the anticipated solids in a two-layered plane persevered. This review is likewise expected to test programming in a study hall with understudies who have never encountered a 3D innovation in their instructive practices and direct future exploration in the perplexing substance of illustrative math with the assistance of programming.*

**Keywords:** 3D portrayals, 3D spatial, software geogebra.

## Introduction

Data and Correspondence Innovations (ICTs) have supported present day types of learning in specialized regions, considering ideal 3D realistic portrayal in variety with numerous benefits, of which the closeness to the real world, the quick execution of activities, intelligence, perception of 2D and 3D portrayals of a similar strong and the low cost for project execution stick out. In a concentrate by Garganté et al. [1] (p. 11), they express that: proposes a scientific categorization of ICT affordances that incorporates classifications, for example, information openness and promptness, quick data trade, variety of learning encounters, broad correspondence and cooperation innovations, reflection through composed talk investigation, and multimodal or non-straight access to data. These orders by and large mirror the materialness of ICT in daily existence in any logical region. In the educating of specialized drawing (TD), explicitly in the subject of enlightening calculation (DG), the scientific classifications of ICT have enormous significance since they permit the portrayal of conceptual hypothetical substance in 2D and 3D realistic analyses. The understudies group DG as a subject

with complex substance, and it is hard for them to spatially picture the state of the strong in 3D, form a similar strong in 3D to turn intellectually and transport to the sheet in 2D. For Wahab et al. [2] (p. 1006), "the trouble in learning calculation isn't extraordinary to Malaysian understudies, however it rather happens worldwide". Similar creators add that the trouble for understudies is associating the 2D picture to 3D. These hardships are introduced in the writing by various writers [3-15]. Previously the mechanical upheaval, this whole growing experience was depleting for DG instructor intervention since instructing was customary/manual and utilized chalk, a board, rulers, set squares, protractors and compasses. The activities used to require hours to settle and a portion of the ideas stayed dynamic. The conventional model didn't drive clear, quick and cooperative learning. The restricted encounters in math didn't give amazing open doors for understudies to foster their visual spatial abilities, in this way forestalling the advancement of thinking while learning math [16]. Presently, ICT considers the utilization of Innovative Assets (TRs) that improve instructive practices with dynamic 3D encounters. Making an opening for future changes

in the school educational program corresponding to the time and the number of activities of viable classes (on the off chance that they are mimicked in TRs) accounts for more encounters quicker than expected. These offices that innovation brings to the study hall don't supplant educator intervention in the instructing and educational experience, particularly in learning the generally perplexing substance of DG. In this unique circumstance, the school system should have educators who are ready to answer these new requests and train their understudies in these key abilities [17]. Subsequently, this study presents the examination question: How might the unique programming GeoGebra advance spatial perception in the investigation of distinct calculation?

The GeoGebra highlight was considered and created by Markus Hohenwarter in 2001 to be utilized in a study hall. The spatial representation advanced by the unique programming GeoGebra can work with the tackling of DG issues. For Baranová and Katrenicová [8] (p. 22), "in our idea, the spatial capacity is the expertise in taking care of outwardly relegated issue as a main priority. The part of calculation which permits the portrayal of 3D articles in two aspects is Engaging calculation". The advancement of spatial perception abilities can be created through monotonous reproductions. These recreations give educators and instructors a way to work with discovering that prompts expanded understudy accomplishment [18] in an interactive way because of the effortlessness of graphical development of the DG components that the programming empowers. DG is a specialized region that spatially concentrates on the connections of 3D and 2D shapes by seeing subtleties precisely in any position [19]. It is likewise a technique for concentrating on 3D calculation through 2D pictures. It gives knowledge into the design and metric properties of spatial items and cycles [7]. DG is the fundamental point for the preparation of specialists, modelers and planners.

### Technological Resources

The innovation is made out of TRs, which are electronic and interactive media gadgets that have in short order acquired improvement 3D portrayal in designing. 3D innovation is creating and advancing quickly, and these advancements are likewise striking in the field of schooling and have carried huge developments to the homeroom climate [20]. Right now, educators of DG have a few systems to help the intercession of complex what's more, long happy in a basic and quick manner for all understudy levels. Advances give quick and exact designing plans at all levels, empowering quick yet quality learning in an intuitive and cooperative way [11]. For Sheep et al. [18] (p. 158), "explicitly, strategy producers frequently accept that all innovation configurations like programming, PCs, tablets, and different advancements are similarly viable at arriving at understudies in the study hall".

Being dynamic programming, GeoGebra, as well as introducing all components for the investigation of DG, permits the speedy reiteration of activities, their recording and sharing for different applications. In this way, it is critical to distinguish a reasonable methodology in educating and figuring out how to boost the opportunity for growth. Empowering understudies to have more chance to lead different examinations is one of the learning strategies [22]. Anbenefit of applying TRs in the homeroom is the utilization of the very devices that understudies use in their day to day routines (PCs, cell phones and tablets) and these understudies, who are advanced locals, advance effectively with inspiration and a clear constructivist information coming from TR control.

### 3D Spatial Representation

3D Spatial representation (SV) is the capacity to spatially consolidate every one of the subtleties related to the state of the solids and their situation. For the under study to address the practices in DG, it is important to intellectually turn the solids in the projection planes, in this way there is a need for three abilities: the capacity to turn intellectually the solids

in the projection plane, the capacity to imagine everything about the state of the strong and the capacity to understand the relationship of the components that will collaborate with the strong. This thinking considers the making. Portrayal of a chamber in the unique programming GeoGebra. reason for seeing the theoretical fields of DG. The thinking related with calculation is called spatial thinking, which is the best trouble for auxiliary school understudies [9]. To quantify SV capacity, a few tests from mental brain science are utilized, like the Psychological Revolution Test, Spatial Representation Test, Mental Cut Test, Minnesota Paper Structure Board Test, Paper Collapsing, Surface Turn of events, Shape Test and St Nick Barbara Solids Test (SBST). The SV tests measure different abilities, for example, visual memory limit, view of shape figures, shape position in space, variety retention, visual engine coordination, and connections of components that form with shapes spatially.

### Sections Produced in Cylinders

Segments of solids is one of the subjects of DG. The part delivered in a strong is the figure that outcomes from the cut made by the cutting plane. The state of the subsequent figure relies upon the place of the cutting plane. The states of the part figure delivered in chambers are procured relying upon the place of the cutting plane in two unmistakable circumstances: while the slicing plane is lined up with the surface pivot and while the cutting plane isn't resemble to the surface hub. The figure can have four outcomes. On the off chance that the principal result is a periphery, it is on the grounds that the slicing plane is lined up with the bases. On the off chance that the subsequent outcome is an oval, it is a result of utilizing a diagonal slicing plane to cut the bases. If the Science 2022, 10, 3034 5 of 15 third outcome is a quadruplet, it is on the grounds that the slicing plane is lined up with the generatrixes. The fourth outcome comes from two circumstances: in the event that it is a circle curve and a straight section, it is on the grounds that the

part is of a slanted plane to the bases; and assuming they are two fragments of line and two oval curves.

### Materials and Methods

In this work the procedure utilized was the practically exploratory contextual analysis on the grounds that it doesn't incorporate every one of the qualities of a genuine trial [24]. This examination portrays furthermore, breaks down exhaustively the analysis directed, which zeroed in on the utilization of dynamic programming, GeoGebra rendition 5.0.721.0 (to learn more [WWW.Geogebra.org](http://WWW.Geogebra.org)), in understudies of an overall optional school class in Southern Mozambique. The review is made out of a test of 25 understudies addressing the subject of DG in a grade 12 class of a government funded school in the city of Maputo. An educator and five learner understudies from the Visual Training degree course of the Educational College of Maputo were additionally important for the members. The disposition of the review lies in the way that it encounters the unique TR Geo Gebra in showing the subject of chamber areas. Furthermore, this examination is spearheading in Mozambique since it was reproduced on cell phones, which are not yet permitted to be utilized in Mozambican study halls. Timbane et al. [25] (p. 770) feature in their review that "in the Mozambican setting, the utilization of a wireless in the study hall, in the school climate, is precluded by regulation". The methodology is blended, being quantitative for introducing and examining the quantifiable information of the connections, causes and outcomes of the peculiarities that happened in the study hall climate and subjective for gathering information from the understudies through their way of behaving, thoughts, sensations, assessments and impression of contrasts and similitudes of similar parts of encounters in the study hall. Fully intent on getting more noteworthy veracity of exploration results, the proper instruments for information assortment were: a pre-test, post-test and SBST applied to understudies in the accompanying arrangement.



### Santa Barbara Solids Test

The SBST was applied after the post-test and was directed in a 15 min time span. This instrument expected to quantify the understudies' degree of SV in concentrating on segments in chambers. Understudies needed to translate 3 figure shape decisions coming about because of a cut brought about by 3 unique planes in 3 chambers. The SBST likewise contained 3 unique levels: The principal low-level activity introduced a part brought about by a level plane. The second mid-level activity highlighted a cut coming about because of a diagonal plane separating, situated to enter the top base. The last complex-level activity likewise contained a sideways plane yet separated.

### Conclusions

The implementation of the dynamic software GeoGebra in the study of sections in cylinders can promote spatial visualization in students. These spatial skills are developed through simulations of practical exercises in the dynamic software GeoGebra by allowing 3D graphical representation. This 3D representation generated great interest and motivation for the students in the practical activities and facilitated the understanding of spatial visualization. This study guides future investigations around the complex content of DG with the goal of facilitating the learning process in an interactive way.

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# GRAPH THEORY USING IN COMPUTER APPLICATION

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## Abstract

Diagrams are considered as a fantastic demonstrating instrument which is utilized to display many sort of relations among any actual circumstance. Numerous issues of genuine world can be addressed by diagrams. This paper investigates various ideas engaged with diagram hypothesis and their applications in software engineering to exhibit the utility of chart hypothesis. These applications are introduced particularly to extend diagram hypothesis and to exhibit its goal and significance in software engineering designing.

**Keywords:** Charts, network, limitations, diagram shading, chart drawing.

## Introduction

Diagram hypothesis is a part of discrete math. In arithmetic and software engineering, chart hypothesis is the investigation of diagrams which are numerical designs used to show pair wise relations between objects. There is wide utilization of charts in giving critical thinking procedures, since it gives a natural way before introducing formal definition. To dissect the diagram hypothesis application two pain points are thought of.

1. Classical issue
2. Problems from application the traditional issue are characterized with the assistance of the chart hypothesis as availability, cuts, ways and streams, shading issues and hypothetical part of diagram drawing. Though issues from application especially accentuation on trial research and the execution of the chart hypothesis calculations. Chart drawing [1] is a vital subject in execution perspective, in light of the fact that the programmed age of attracting diagram has significant applications key software engineering innovations, for example, information base plan, computer programming, circuit planning, network planning and visual connection points.

## Graphs

Diagrams give a helpful method for addressing different sorts of numerical items. Basically, any diagram is comprised of two sets:

1. A set of vertices
2. A Set of edges.

Contingent upon the specific circumstance, limitations are forced on the kind of edges we permit. For certain issues coordinated edges are applied and for other issue undirected edges are applied from one vertex to other. So charts give us numerous strategies and adaptability while characterizing and taking care of a genuine issue. Charts has many highlights, some of them are:

- gives preoccupied view
- lays out relationship among objects
- adjusting
- demonstrating
- choice - making skill
- underlying course of action of different articles
- simple alteration or change in the current framework

## Application in Computer Science

### Data Base Planning

In information base planning diagrams are utilized as chart information bases [2]. Chart information base purposes diagram portrayal with hubs, edges, and properties to address and store information. This diagram structure plays key part in planning data set, since it gives quick execution process utilizing different usefulness and properties of chart structure. Chart data set utilizes as:

- Capacity framework that gives record free nearness
- Examining apparatus for interconnection
- Useful asset for chart like-inquiry
- Useful asset for chart like-inquiry

Diagram data sets are frequently quicker for cooperative informational collections that map all the more straightforwardly to the design of article situated applications.

Chart has numerous applications in programming. For instance: during Necessities Particular, Information Stream outlines are utilized where vertices address changes and edges addresses the information streams. During Configuration stage, graphical plan is utilized for portraying relations among modules; while during Testing, the control stream of a program related with McCabe's intricacy measure which utilizes coordinated diagrams for tending to the succession of executed guidelines and so on. Indeed, even Programming Interaction The board has likewise uses of organization charts which includes diagram calculations.

### Network System

Diagram hypothesis has wide application in the field of systems administration. To dissect the chart hypothesis application in systems administration two regions are thought of: diagram-based portrayal and organization hypothesis. Diagram based portrayal enjoys many benefits, for example, it gives different perspective; it makes issue a lot simpler and give more exact definition. Though network hypothesis gives a bunch of procedures to breaking down a diagram and applying network hypothesis utilizing a chart portrayal. The term diagram and organization are equivalent. Both allude to a kind of construction where there exist vertices (for example hubs, specks) and edges (for example joins, lines). There are various sorts of charts and organizations which yield pretty much design. These two terms can be separating based on their utility. The term diagram is utilized in math though the term network is utilized in material science.

### Purpose of a Chart in Science

1. Mathematicians are worried about the theoretical design of a diagram.
2. Mathematician's define activities to examine and control diagrams.
3. They foster hypotheses in light of primary adages.

### Purpose of an Organization in Material Science

- Physicists are worried about displaying true designs with networks.
- Physicist's define calculations that pack the data in an organization to additional basic qualities (for example factual examination).

Diagram hypothetical ideas are applied in a few basic issues in organization, for example, network, information gathering, directing, versatility, energy productivity, geography control, traffic examination, finding most brief way and burden adjusting [11]

### Computer Equipment

In PC equipment chart hypothesis ideas are utilized to demonstrate the restriction of the actual layer.

Chart hypothesis ideas are utilized in equipment world to give:

- Register designation by chart shading
- Portrayal of guidance arrangements by charts by contiguousness network
- In guidance equal handling
- Interaction of distribution scheduling [3]

### Data Construction

Information might be coordinated a wide range of ways. The intelligent or numerical model of a specific association of information is known as a "information structure". The selection of information model relies upon two contemplations:

1. It should be rich enough in design to reflect genuine relationship of information in genuine world.
2. The construction ought to be basic enough that one can successfully handle information when vital.

These two contemplations are satisfied by the chart hypothetical ideas. Erratic connection among information can likewise be addressed by a chart and its grids, tasks performed on these measurements are further helpful for determining relations and information affiliation and is valuable to comprehend how this information might be put away in memory [4][5].

### Image Handling

Picture Examination is the strategy by which data from pictures is removed. Picture examination is predominantly performed on advanced picture handling methods. The picture handling methods can be further developed utilizing a diagram hypothetical methodology. The utilizations of diagrams in picture handling are: to find edge limits utilizing diagram search calculations in division.

- To ascertain the arrangement of the image
- Finding numerical limitations, for example, entropy by utilizing least traversing tree.
- Finding distance changes of the pixels and works out the distance between the inside pixels by utilizing briefest way calculations.

### Data Mining

Diagram mining is the fundamental application area of chart hypothesis in information mining. Diagram mining addresses the social part of information. There are five hypothetical based approaches of diagram based information mining. They are sub diagram classifications, sub chart isomorphism, diagram invariants, mining measures and arrangement techniques.

### Operating Framework

A diagram is an information construction of limited set of matches, called edges or vertices. Numerous down to earth issues can be addressed with the

assistance of chart in the field of working framework, for example, work booking and asset allotment issues. For instance chart shading idea can be applied in work planning issues of computer processor, occupations are expected as vertices of the diagram and there will be an edge between two positions that can't be executed all the while and there will be balanced connection between practical booking of diagrams [10].

### Graph Reason in Working Framework

- Framework processes are addressed in diagram structure.
- Diagram extraction strategies are utilized in occasion following.
- Fantastic testing apparatus in execution assessment as a result of simple approval and change.

### Website Planning

Site planning can be demonstrated as a chart, where the website pages are addressed by vertices and the hyper joins between them are addressed by edges in the diagram. This idea is known as web chart. Which find the fascinating data? Other application areas of charts are in web local area. Where the vertices address classes of items, and every vertex addressing one sort of items, and every vertex addressing a kind of article is associated with each vertex addressing other sort of items. In diagram hypothesis such a chart is known as a total bipartite chart. There are many benefits of involving chart portrayal in site improvement, for example, Looking and local area revelation.

- Diagram portrayal (coordinated chart) in site utility assessment and connection structure.
- Tracking down undeniably associated part and give simple discovery.

**Table 1 Application of Graph Theory in Computer Science**

<b>Application Field</b>	<b>Property and concepts of graph theory</b>	<b>Applications Area</b>	<b>Uses</b>
Database designing	Record free contiguousness	Diagram information base	Analyzing interconnection, Direct mapping and Natural scaling to large data sets.
Software engineering	Connectivity and Data flow, Directed graph, and cyclomatic complexity	DFD, Control flow graph, ER-diagram, process sequencing and software quality[12]	Transformations, Capturing requirements, Describing relations among modules, Designing system and In testing process.
Computer hardware	Graph coloring and Matrix representation	Coloring algorithms Fine-grain parallelism analysis, Data dependence matrix	Compilers utilizes chart shading calculations for Register distribution to factors , Compute parallelism degree, Extremely valuable in scientific modelling [3], Tending to the succession of guidance execution , Asset assignment and Streamlining the memory space(file association).
Network design	Connectivity, Traversing, Adjacency, Vertex cover algorithms and Different graph representation	Topological control and Weighted graph, Butterfly network and 2-D array	Finding shortest path, Searching and Arrangement of nodes in network designing, Modeling communication networks [7], Traffic analysis and in Network security.
Data Structure	Directed graphs , Matrices and Matrices operation	Array, Tree, Linked list, Pointers , Stacks, and Queues	Efficient organization of data, Finding minimum cost tree, Minimizing data retrieval times, Minimizing page swapping in data structure paging system and Provides link structure in websites
Image processing	Edge connectivity, Regions, Spanning tree	Edge boundaries, Entropy, Shortest path algorithms and Search algorithms	Segmentation and registration, Distance transform and Center line extraction
Data mining	Sub graphs, Isomorphism	Graph mining	Sub structure matching, Reducing search space.
Operation system	Graph coloring, Directed graph	Job scheduling problems and Simultaneous execution of job	Provide feasible solution to job scheduling and Efficient resource(processor) allocation in solving simultaneous job execution problems.[8] and In process representation
Web site designing	Coordinated diagram, Undirected chart, In degree and out degree, Search calculations and Bipartite diagram	Web graph, Web pages and Hyperlinks	Community discovery, Searching and Website evaluation

## Conclusion

This paper is intended to help the understudies of software engineering to acquire profundity information on diagram hypothesis and its pertinence with different subjects like working frameworks, Organizations, Data sets, computer programming and so on this paper zeroed in on the different utilizations of significant chart hypothesis that have significance to the field of software engineering and applications.

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## CUBIC BI - IDEALS IN CUBIC NEAR - RINGS

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### Abstract

We discuss the concept of cubic bi-ideals of cubic near-rings in this paper. We investigated a few of its characteristics using example.

**Keywords:** Cubic near-ring, Cubic bi-ideal.

### Introduction

The notion of fuzzy sets initiated by Zadeh [8] in 1965. This theory has a vast range of application in set theory, group theory, semi group theory, measure theory and topology. After ten years, the notion of interval-valued fuzzy set was introduced by Zadeh [9]. Jun et al [3] coined the concept of cubic set. The idea of fuzzy ideals of near-rings was proposed by Kim et al [4]. Thillaigovindan et al [7] introduced the idea of interval-valued fuzzy ideals in near-rings. Furthermore, Lenin Muthukumar et al [5] studied about cubic ideals in near-rings. We defined cubic bi-ideals in cubic near-rings and a few of their properties with examples in this paper.

### 1. Preliminaries

In this section, we list basic definitions used in this paper.

#### Definition 2.1 [6]

A near-ring  $N$  is a system with two binary operations '+' and '.' such that

1.  $(N, +)$  is a group not necessarily abelian;
2.  $(N, \cdot)$  is a semigroup;
3.  $(x + y)z = xz + yz$  for all  $x, y, z \in N$ . We will use the word "near-ring" to mean "right distributive near-ring". We denote  $xy$  instead of  $x \cdot y$ .

#### Definition 2.2 [9]

Let  $X$  be a non-empty set. A mapping  $\bar{\mu} : X \rightarrow D[0, 1]$  is called interval-valued fuzzy set, where  $D[0, 1]$  denote the family of all closed subintervals of  $[0, 1]$ .

#### Definition 2.3 [2]

Let  $X$  be a non-empty set. A cubic set  $\mathcal{A}$  of  $X$  is a structure  $\mathcal{A} = \{(x, \bar{\mu}_A(x), \gamma_A(x)) : x \in X\}$  which is briefly denoted by  $\mathcal{A} = (\bar{\mu}_A, \gamma_A)$  where  $\bar{\mu}_A = [\mu_A^-, \mu_A^+]$  is an interval-valued fuzzy subset of  $X$  and  $\gamma$  is a fuzzy set in  $X$ .

#### Definition 2.4 [1]

Let  $N$  be a near-ring,  $(N, \bar{\mu})$  be an interval-valued fuzzy near-ring and  $(N, \gamma)$  be a fuzzy near-ring. A cubic set  $\mathcal{A} = (\bar{\mu}, \gamma)$  is called a cubic near-ring of  $N$  if it satisfies the following conditions,

1.  $\bar{\mu}(x - y) \geq \min\{\bar{\mu}(x), \bar{\mu}(y)\}$ ,
2.  $\bar{\mu}(xy) \geq \min\{\bar{\mu}(x), \bar{\mu}(y)\}$ ,
3.  $\gamma(x - y) \leq \max\{\gamma(x), \gamma(y)\}$ ,
4.  $\gamma(xy) \leq \max\{\gamma(x), \gamma(y)\}$ ,  $\forall x, y \in N$

### Main Results

#### Definition 3.1.

A cubic subgroup  $\mathcal{A} = (\bar{\mu}, \lambda)$  of a cubic near-ring  $N$  is called a cubic bi-ideal of  $N$ , if for all  $x, y, z \in N$  it satisfies the following conditions:

1.  $\bar{\mu}(x - y) \geq \min\{\bar{\mu}(x), \bar{\mu}(y)\}$ ,
2.  $\lambda(x - y) \leq \max\{\lambda(x), \lambda(y)\}$ ,
3.  $\bar{\mu}(xyz) \geq \min\{\bar{\mu}(x), \bar{\mu}(z)\}$ ,
4.  $\lambda(xyz) \geq \max\{\lambda(x), \lambda(z)\}$ ,  $\forall x, y, z \in N$ .

#### Example 3.2

Let  $N = \{0, a, b, c\}$  be a near ring with  $(N, +)$  as the Klein's four group and  $(N, \cdot)$  as defined below (Scheme 13: (0,7,13,9) see [28] P. 408).

+	0	a	b	c	·	0	a	b	c
0	0	a	b	c	0	0	0	0	0



$$\begin{array}{cccc|cccc} a & a & 0 & c & b & a & 0 & a & b & c \\ b & b & c & 0 & a & b & 0 & 0 & 0 & 0 \\ c & c & b & a & 0 & c & 0 & a & b & c \end{array}$$

Then  $(N, +, \cdot)$  is a cubic near - ring.

Let  $\bar{\mu} : N \rightarrow D[0, 1]$  be an interval-valued fuzzy subset with  $\bar{\mu}(0) = [0.4, 0.5], \bar{\mu}(a) = [0.2, 0.3] = \bar{\mu}(c)$  and  $\bar{\mu}(b) = [0.3, 0.4]$ . Then  $\bar{\mu}$  is an interval-valued fuzzy bi-ideal of  $N$ .

Let  $\lambda : N \rightarrow [0, 1]$  be a fuzzy subset with  $\lambda(0) = 0.1, \lambda(a) = 0.4 = \lambda(c)$  and  $\lambda(b) = 0.35$ . Then  $\lambda$  is a fuzzy bi-ideal of  $N$ .

Hence  $\mathcal{A} = (\bar{\mu}, \lambda)$  is a cubic bi-ideal of  $N$ .

### Proposition 3.3.

Let  $N$  be a cubic near-ring with strongly regular. Then  $\bar{\mu}(x) = \bar{\mu}(x^2)$  and  $\lambda(x) = \lambda(x^2)$  for every  $x \in N$  if  $\mathcal{A} = (\bar{\mu}, \lambda)$  is a cubic bi-ideal in  $N$ .

#### Proof:

Consider  $\mathcal{A} = (\bar{\mu}, \lambda)$  is a cubic bi-ideal of  $N$  and  $x \in N$ . Although  $N$  is strongly regular, there exist  $y \in N$  such that  $x = x^2y x^2$ . Then

$$\begin{aligned} \bar{\mu}(x) &= \bar{\mu}(x^2y x^2) \\ &\geq \min\{\bar{\mu}(x^2), \bar{\mu}(x^2)\} \\ &= \bar{\mu}(x^2) \\ &\geq \min\{\bar{\mu}(x), \bar{\mu}(x)\} \\ &= \bar{\mu}(x) \end{aligned}$$

$$\begin{aligned} \lambda(x) &= \lambda(x^2y x^2) \\ &\leq \max\{\lambda(x^2), \lambda(x^2)\} \\ &= \lambda(x^2) \\ &\leq \max\{\lambda(x), \lambda(x)\} \\ &= \lambda(x) \end{aligned}$$

Hence  $\bar{\mu}(x) = \bar{\mu}(x^2)$  and  $\lambda(x) = \lambda(x^2)$ .

### Theorem 3.4.

Let  $N$  be a distributive cubic near-ring. Every cubic bi-ideal of  $N$  is a constant on  $N/\{0\}$  if  $N$  is regular and B- simple.

#### Proof.

Let  $\mathcal{A} = (\bar{\mu}, \lambda)$  be a cubic bi-ideal in  $N$ . Suppose that  $N$  is regular and B-simple. Assume the set  $L = \{d = d^2/d \in N \text{ and } d \neq 0\}$ . Let  $g(\neq 0) \in N$ . Since  $N$  is regular, there exist  $x \in N$ , such that  $g = gxg$ .

Then  $gx = (gxg)x = (gx)^2$  and  $xg = x(gxg) = (xg)^2$ . Hence  $gx, xg \in L$  and  $L$  is not empty. Let  $h \in L$ . We show that  $\bar{\mu}(h) = \bar{\mu}(d)$  and  $\lambda(h) = \lambda(d)$  for all  $d \in L$ . Choose  $d$  in  $L$ . If  $N$  is B-simple,  $Nh = N$  and  $hN = N$  for all  $h(\neq 0) \in N$ . If  $d \in N, d \in Nh = hN$ . Therefore  $d = hx = yh$  for some  $x(\neq 0), y(\neq 0) \in N$ . Hence  $d^2 = h(xy)h$ . Since  $\mathcal{A} = (\bar{\mu}, \lambda)$  is a cubic bi-ideal of  $N$ ,

$$\begin{aligned} \bar{\mu}(d^2) &= \bar{\mu}(h(xy)h) \\ &\geq \min\{\bar{\mu}(h), \bar{\mu}(h)\} \\ &= \bar{\mu}(h) \\ \lambda(d^2) &= \lambda(h(xy)h) \\ &\leq \max\{\lambda(h), \lambda(h)\} \\ &= \lambda(h) \end{aligned}$$

Since  $d \in L, d = d^2$ . Hence  $\bar{\mu}(d^2) = \bar{\mu}(d)$  and  $\lambda(d^2) = \lambda(d)$ . Therefore  $\bar{\mu}(d) \geq \bar{\mu}(h)$  and  $\lambda(d) \leq \lambda(h)$ .

Since  $Nd = N = dN$  by a similar argument to the one proved above, we get  $\bar{\mu}(d)\bar{\mu}(h)$  and  $\lambda(d) \geq \lambda(h)$ . This shows that  $\mathcal{A} = (\bar{\mu}, \lambda)$  is a constant on  $L$ . Since  $gx, xg \in L$  as previous arguments, we get  $\bar{\mu}(gx) = \bar{\mu}(h) = \bar{\mu}(xg)$  and  $\lambda(gx) = \lambda(h) = \lambda(xg)$ .

If  $(gx)g(xg) = (gxg)yg = gxg = g$ .

$$\begin{aligned} \bar{\mu}(g) &= \bar{\mu}((gx)g(xg)) \\ &\geq \min\{\bar{\mu}(gx), \bar{\mu}(xg)\} \\ &\geq \min\{\bar{\mu}(h), \bar{\mu}(h)\} \\ &= \bar{\mu}(h) \\ \lambda(g) &= \lambda((gx)g(xg)) \\ &\leq \max\{\lambda(gx), \lambda(xg)\} \\ &\leq \max\{\lambda(h), \lambda(h)\} \\ &= \lambda(h) \end{aligned}$$

If  $h = Ng = gN, h = xg = gy$  for some  $x(\neq 0), y(\neq 0) \in N$ . Therefore  $h^2 = g(yx)g$ .

Hence

$$\begin{aligned} \bar{\mu}(h^2) &= \bar{\mu}(g(yx)g) \\ &\geq \min\{\bar{\mu}(g), \bar{\mu}(g)\} \\ &= \bar{\mu}(g) \end{aligned}$$

$$\begin{aligned} \lambda(h^2) &= \lambda(g(yx)g) \\ &\leq \max\{\lambda(g), \lambda(g)\} \\ &= \lambda(g) \end{aligned}$$

Since  $h \in L$ , we get  $h = h^2$ . Then it follows that  $\bar{\mu}(h) = \bar{\mu}(h^2) = \bar{\mu}(g)$  and  $\lambda(h) = \lambda(h^2) = \lambda(g)$ .

Hence  $\mathcal{A} = (\bar{\mu}, \lambda)$  is a constant on  $N/\{0\}$ .

### Theorem 3.5.

If  $\mathcal{A} = (\bar{\mu}, \lambda)$  is a cubic bi-ideal in  $N$ , then  $\mathcal{A}^c = (\bar{\mu}^c, \lambda^c)$  is a cubic bi-ideal of  $N$  as well.

### Proof.

Let  $x, y, z \in N$  and  $\mathcal{A} = (\bar{\mu}, \lambda)$  is a cubic bi-ideal of  $N$ . Then

$$\begin{aligned}\bar{\mu}^c(x - y) &= 1 - \bar{\mu}(x - y) \\ &\leq 1 - \min\{\bar{\mu}(x), \bar{\mu}(y)\} \\ &= \max\{1 - \bar{\mu}(x), 1 - \bar{\mu}(y)\} \\ &= \max\{\bar{\mu}^c(x), \bar{\mu}^c(y)\}\end{aligned}$$

$$\begin{aligned}\lambda^c(x - y) &= 1 - \lambda(x - y) \\ &\geq 1 - \max\{\lambda(x), \lambda(y)\} \\ &= \min\{1 - \lambda(x), 1 - \lambda(y)\} \\ &= \min\{\lambda^c(x), \lambda^c(y)\}\end{aligned}$$

$$\begin{aligned}\bar{\mu}^c(xyz) &= 1 - \bar{\mu}(xyz) \\ &\leq 1 - \min\{\bar{\mu}(x), \bar{\mu}(z)\} \\ &= \max\{1 - \bar{\mu}(x), 1 - \bar{\mu}(z)\} \\ &= \max\{\bar{\mu}^c(x), \bar{\mu}^c(z)\}\end{aligned}$$

$$\begin{aligned}\lambda^c(xyz) &= 1 - \lambda(xyz) \\ &\geq 1 - \max\{\lambda(x), \lambda(z)\} \\ &= \min\{1 - \lambda(x), 1 - \lambda(z)\} \\ &= \min\{\lambda^c(x), \lambda^c(z)\}\end{aligned}$$

Therefore  $\mathcal{A}^c = (\bar{\mu}^c, \lambda^c)$  is a cubic bi-ideal of  $N$ .

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# STOCK HYPOTHESIS AND THE LORDS OF OLYMPUS

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## Abstract

*In stock hypothesis, the normal model accepts the presence of negligible cost information for requesting, holding, and deficiencies of stock. This paper questions the legitimacy of stock hypothesis, since it gives off an impression of being difficult to gauge any of these expenses. We reason that peripheral costs would be unessential in a more experimental hypothesis, which ought to focus on macrolevel strategy examination as opposed to microlevel cost minimization.*

## Introduction

The executives Researchers have customarily been defenders of logic in the approval of hypothesis. In the pragmatist reasoning, hypothetical legitimacy frequently depends upon premises which are underestimated as obvious insights. Immanuel Kant called these suspicions engineered deduced premises: In the approval of hypothesis. In the pragmatist reasoning, hypothetical legitimacy frequently depends upon premises which are underestimated as undeniable bits of insight. Immanuel Kant called these presumptions manufactured deduced premises: The realist reasoning is especially significant in the field of stock hypothesis, where the normal model is intended to limit the amount of negligible requesting, holding, and deficiency costs for everything in the stock, without determining how these expenses are to be estimated. The reason that important expense data would be become way or another be gotten from the association's bookkeeping framework seems, by all accounts, to be nearly universally acknowledged, based on the exemplary texts in the field [Hadley and Whitin, 1963; Wagner, 1962; Whitin, 1953], the standard Tasks Exploration texts [Hillier and Lieberman, 1974; Wagner, 1975], and the mind-boggling number of papers on neoconservatives distributed as of late. This article urges re-examination of the pragmatist reasoning. The book keeping proof shows that the negligible expense boundaries accepted in the hypothesis are practically difficult to quantify. Hence, we ought to address stock hypothesis on observational, if not

common sense, grounds. After a survey of the book keeping proof on every classification of stock expenses, we presume that minimal costs would be superfluous in a more exact hypothesis, which ought to be dedicated to macrolevel strategy investigation instead of microlevel cost minimization.

## Requesting Expenses

In putting in a renewal request for a stock thing, no less than four particular steps are involved, every one of which might bring about various expense components:

1. It is important to Confirm that a request
2. Putting in the request with a provider
3. Getting, assessing, and putting the thing away
4. Paying the provider.

The hypothesis normally expects that there is some exceptional minor expense related with every renewal request [Hadley and Whitin, 1963; Hillier and Lieberman, 1974; Wagner, 1962 and 1975]. This cost is accepted to consolidate every one of the means above and to be the gradual expansion to add up to costs, communicated as one or the other a personal use or a lost an open door for benefit. On the off chance that a given expense will happen no matter what the recharging choice, it ought not be viewed as in the stock model. The estimation of requesting costs which fit these presumptions presents grievous challenges to the bookkeeping local area. The significant deterrent is that requesting costs will generally be imbedded in like manner costs for a few divisions or exercises of the firm, and may have little connection with the

quantity of stock renewal orders. A model is given by the buying capability. Scarcely any organizations keep up with buying offices gave exclusively to stock securing. All the more frequently these divisions are likewise answerable for the obtainment of office hardware and supplies, processing plant apparatus and hardware, and various different materials. Segregating that part of the expense of keeping a buying division to the stock procurement capability might be incomprehensible, particularly on a negligible premise. The equivalent issue applies to the book keeping and information handling offices, where the expenses related with stock obtaining are typically converged with numerous different capabilities. Regardless of whether we could separate the very part of complete expenses inferable from the stock securing capability, it is hard to distinguish any costs which differ significantly with the requesting rate. A large portion of these expenses are limit related and will generally be fixed as opposed to variable [Gardner, 1978; Vollman, 1973; Wight, 1974; Ziegler, 1973]. Models remember deterioration and rent or rental charges for materials handling gear, office and warehousing space, and PC frame works. Work force costs are basically semi fixed as a rule, particularly when the faculty involved in stock obtaining work parttime on different capabilities. Subsequently the very idea of a minor requesting cost might be deceptive. The consequence of these issues is that every one of the recommended ways to deal with requesting cost estimation in the book keeping writing produce normal, not peripheral, costs [Ziegler, 1973]. Cost minimization models that utilize normal expenses can surely lead to choices that are not even close to ideal. This shortcoming in requesting expenses may still be OK, not with standing, on the off chance that different expenses could be estimated with a sensible level of exactness. Tragically, there are likewise critical issues in estimating stock holding and lack costs.

### **Holding Expenses**

A few parts of stock holding costs are genuinely easy to gauge on a minor premise, for example, administration costs for protection and expenses. However, the major component of complete holding

costs is the expense of capital, an exceptionally emotional measure, which relies upon the gamble climate of the firm and the board objectives for paces of return on venture. The suitable expense of capital for any firm is an issue that is a long way from gotten comfortable the money writing. Johnson [1971], for instance, expresses that the expense of capital is never a refined factual measure, yet is enveloped by an expansive scope of conceivable outcomes in any circumstance. Lambert's study [1975] of six organizations delineates the significance of the expense of capital in absolute stock holding costs. More than 85% of the normal holding costs for the organizations in the review depended on leader decisions on the expense of capital. Complete holding costs went from 14 to 43% of the worth of inventories.

### **Deficiency Expenses**

Deficiency costs present maybe the most questionable estimation issues. To start with, some understanding should be arrived at on the proper meaning of a stock deficiency. A portion of the conceivable outcomes that have been proposed for deficiency measures include: the times that a lack condition happens, paying little mind to esteem or term; the dollar worth of deals which are lost or delay purchased; the quantity of client orders which can't be filled quickly from stock and result in lost deals or delay purchases; the length of lack conditions; and an assortment of weighted measures, for example, the quantity of demands delay purchased weighted by the span of each rain check. The second issue with deficiency costs is that, given an emotional decision for the most proper lack measure in a stock, there is still no reasonable approach to connect a dollar cost to a lack. The bookkeeping writing contains little direction on this point [Ziegler, 1973]. Hansmann [1962] summarizes this issue well: "It shows up that there isn't anything reasonable to be said about potential misfortunes because of client aggravation." Ends Bertrand Russell's point of view on hypothetical legitimacy is valuable in assessing stock

hypothesis:

As time went on, my universe turned out to be less lush. Progressively, Occam's razor gave me an all the more clean-cut image of the real world. I don't imply that it could demonstrate the non-reality of elements which it demonstrated to be pointless; I mean just that it nullified contentions in favour of their existence. I actually figure it difficult to discredit the presence of numbers or focuses or moments or the Divine forces of Olympus. For should I know these may be generally genuine, however there isn't the slightest motivation to think so [Russell, 1959]. Russell's initial years were committed to populating the universe with incredible quantities of supernatural elements; he spent the rest of his vocation efficiently annihilating the supernatural populace by Occam's razor, which rejects speculations based upon premises which can't be laid out by an assessment of the proof. For the situation of stock hypothesis, the proof can't be extended to legitimize the mystical substances of minor requesting, holding and lack costs. Like the Divine forces of Olympus, these substances might exist, however there isn't the slightest motivation to think so. One solution to this situation is to reclassify the stock choice issue in the hypothesis. Albeit most hypothesis manages microlevel examination [Hadley and Whitin, 1963; Hillier and Lieberman, 1974; Wagner, 1962 and 1975; Whitin, 1953], or the investigation of individual things in the stock, the essential issue by and by is truly one of macrolevel examination [Brown, 1975; Gardner, 1978; Gardner and Dannenbring, 1979; Wight, 1974], where minimal expenses are to a great extent superfluous. Top administration's task is to discover some adequate compromise among no less than three total stock factors. These remember the singular amount speculation for inventories on the equilibrium sheet, the general degree of client care (the quantity of stock deficiencies anyway characterized), and the complete reordering responsibility as it influences changes in capacity. Due to the uncertain idea of the expense of capital and any expenses or advantages inferable from various degrees of client support,

choice of the most suitable compromise is a complicated strategy choice, not an expense minimization issue. Cost surely impact this choice, yet the main goal cost information accessible are administration costs on stock venture and the decent expenses related with various degrees of limit. These expenses are best considered at the total level. We reason that the focal point of stock hypothesis ought to move from microlevel cost minimization models to macrolevel strategy examination. For instance, models which could make efficient, ideal compromises among total stock factors would probably be of impressive advantage practically speaking. Such models ought to likewise change over top administration targets for total factors into working level choice standards for individual request amounts and wellbeing stocks. One unassuming move toward this heading is tracked down in Gardner and Dannenbring [1979], which incorporates a straight forward, without cost agricultural stock model that profits ideal upsides of stock deficiencies for contributions of different mixes of limitations on speculation and reordering responsibility. The rich assortment of useful stock choice issues gives an immense opportunity for more exact exploration at the macrolevel. Diary editors could contribute to the advancement of observational hypothesis by specifying that stock papers which accept the presence of some expense construction ought to determine how those expenses are to be estimated.

### Conclusion

In paper we discussed with the topic of financial stock hypothesis, the normal model accepts the presence of negligible cost information for requesting, holding, and deficiencies of stock of microlevel cost minimization.

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## FOSTERING A META-STOCK OF HUMAN QUALITIES

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### Abstract

*Human qualities are progressively being utilized as an idea in an extensive variety of fields including brain science, social science, humanities, science and innovation studies, and data science. Notwithstanding, the utilization of this idea changes broadly in these various fields, and a few unique instruments have been grown independently to quantify values. This paper surveys an examination to date on values on the whole of these fields to foster a meaning of values, and afterward surveys 12 worth inventories to make a meta-stock.*

**Keywords:** *Human values, value inventories, meta-analysis.*

### Introduction

All things considered, human qualities have been significant variables for social researchers investigating different social, mental, financial, and political peculiarities (Hitlin, 2003). Since they create and develop in a social setting, values can be considered as a connection among self and society (Rokeach, 1973), and subsequently, values are a remarkable mental build that are noticeable forerunners to direction what's more, conduct at the individual and cultural degrees of investigation. Values can be evaluated through different means. One of the well known approaches for estimating values is to overview people with respect to how they would rank or rate the relative significance of things in a given rundown of values. In this sense, endeavors toward classifying values into specific types are significant for analysts as they insert esteem inventories into experimental tests that serve research needs.

Content investigation is likewise a successful methodology for considering human qualities. It gives an unpretentious investigation of recorded correspondence like addresses and declarations that coders could recognize values an individual was deliberately or subliminally communicated in literary materials while might not have any desire to communicate in an overview (Fleischmann, Oard, Cheng, Wang, and Ishita, 2009). As text based information are arranged into a coding plan by

scientists while directing substance investigation, deduced, content-explicit or on the other hand deduced, a substance touchy worth stock is required for performing such order work. The writing to date incorporates a few worth inventories.

They were either intended for researching general individual qualities or zeroed in on a particular item at issue for example, work values in a business setting. Existing worth inventories, be that as it may, are intended for overview research. Just not many of them have been applied to content investigation. By investigating 12 worth inventories that record for various levels of examination got from different areas, our objective for this paper is to create a meta-stock of human values that can be custom fitted to serve analysts' requirements when leading overviews or content investigation. For the accompanying segments, we start with the meaning of values and the significance of significant worth examination. We then, at that point, examine esteem characterizations and survey 12 existing worth inventories. In view of our meta-examination of these 12 worth inventories, we create a meta-stock of human qualities. We close by examining the ramifications of the metainventory and bearings for future examination.

### What are Values?

In sociology research, "the term 'values' has been utilized differently to allude to interests, joys, likes,

inclinations, obligations, ethical constraints, wants, needs, objectives, needs, abhorrence's and attractions, and numerous different sorts of particular directions" (Williams, 1979, p.16). In any case, the deliberation and absence of refined experimental help have made values be understudied in sociology research (Spates, 1983). Rokeach (1973) noticed the disarray of wording, that values were many times arising in different disciplines under various terms, making the problem the field. By conceptualizing values as unique essential organizers of conduct and recognize values from other sociopsychological develops, he laid out the hypothetical association among values and conduct and brought agreement to the field. He additionally operationalized his applied meaning of values and caught the various leveled association of values through the rank ordering of values by respondents in Rokeach's Worth Overview (Rokeach, 1973). Scientists have various ways of conceptualizing values.

### **The Significance of Values Exploration**

Values have been a significant socio-mental build in sociology research. The view that qualities rouse and make sense of individual dynamic has been generally acknowledged and esteems have been recognized as a key prescient and illustrative calculate examining human and social elements (Schwartz, 2007). Writing from brain science, humanism, authoritative way of behaving, and political theory has recommended that values might underlie and make sense of different individual and authoritative ways of behaving.

In the area of brain research, values have been viewed as connected with character types (Allport, Vernon, and Lindzey, 1960). In social science, values have been believed to be helpful for depicting society's shared awareness (Durkheim, 1960). In authoritative way of behaving, values impact corporate choices on system (Britain, 1967) and hierarchical responsibility (Ponser and Schmidt, 1993). In political theory, values act as critical indicators of perspectives toward legislative approaches, ideological groups, furthermore, establishments (Schwartz, 2007). To summarize, the

significance of values in human and social elements is ideal outlined by the accompanying proclamations: Values are determinants of essentially a wide range of conduct that could be called social way of behaving or social activity, perspectives and philosophy, assessments, moral decisions and defenses of self to other people, and endeavors to impact others (Rokeach, 1973, p. 5).

### **Esteem Arrangements**

Many exploration endeavors on values have been committed to figure out the construction and order of values. Rokeach (1973) distinguished 36 qualities which are coordinated into terminal and instrumental qualities. Schwartz (1994) indicates 56 essential human qualities that can be gathered into 10 esteem types. In this sense, the ways used to describe values incorporate "endeavors toward listing the hypothetically predetermined number of values that exist on the planet and endeavors toward sorting those qualities into specific kinds" (Henry and Reyna, 2007, p. 274).

Esteem groupings can be drawn nearer from different viewpoints. As Rescher (1969) contended, thought of various parts of characterizations can reveal further insight into figuring out the idea of values. He proposed six standards as measures for grouping values. These standards demonstrate the way that esteem orders can be drawn closer from numerous bearings. He separated values by,

1. The subscribership to the worth, in which values can be assembled as private qualities, expert or work values, public values, and so forth;
2. The articles at issue, wherein values can be arranged regarding their proper gathering of items for example, thing values, ecological qualities, individual or individual qualities, bunch values, and cultural qualities;
3. The kind of advantages at issue, in which values can be anticipated into a relating grouping like material and physical, monetary, moral, social, political, stylish, strict (profound), scholarly, proficient, and nostalgic;



4. The kind of purposes at issue, wherein values can be grouped by the particular kind of reason served by acknowledgment of the esteemed setting, for example, the haggling worth of a specific asset, or the convincing worth of a contention;
5. The connection between supporter and recipient, in which values can be delegated self-situated (or egocentric) values and otheroriented (or impartial) values;
6. The relationship of the worth to different qualities. In this approach specific qualities are seen as subordinate to different qualities. The subordinate values might be delegated instrumental or mean qualities.

Independent qualities, which are not considered subordinate, can be named inborn or end values. Since our definition specifies that qualities "act as directing standards of what individuals think about significant throughout everyday life," this concentrate just centered around "the kind of advantages at issue," in which values are characterized by human needs, needs, and interests that are served by their acknowledgment.

#### **Meta-Examination of Significant Worth Inventories**

Looking at the 12 worth inventories introduced in past segment, three methodologies of planning esteem inventories can be distinguished: (1) judicious hypothetical inventories, (2) observational based inventories, and (3) hypothetical exact inventories.

- Reasonable hypothetical inventories could be conceptualized in view of simply judicious or deduced inventories. For model, Bernthal's (1962) work on esteem order for the executives choices, the PVQ (Britain, 1967), the RVS (Rokeach, 1973), the LOV (Kahle et al., 1988), and Jurkiewicz and Giacalone's (2004) esteem system of work environment otherworldliness are judicious hypothetical inventories.
- Observational based inventories infer that esteem things are straightforwardly got from observational information in light of review,

interview, or content examination. For instance, the PVS (Scott, 1965), the CES (Ravlin and Meglino, 1987), and Bird and Waters' (1987) administrative moral guidelines are exact based inventories.

- Hypothetical exact inventories are created through an underlying judicious or hypothetical determination of things that can be placed into an experimental test to come by results. For instance, McDonald and Gandz's (1991) shared values in associations, the SVS (Schwartz, 1994), the LVI (Crace & Brown, 1995), and the VSD (Friedman et al., 2006) are hypothetical observational inventories.

Among these three methodologies of significant worth stock plan, researchers express worry about the subjectivity that a sane hypothetical stock could have in recognizing the esteem things and the quantity of values to be remembered for the stock. Hofstede (1980) noticed that "examination of number of instruments intended to gauge human qualities clarifies that the universe of all human qualities isn't characterized and that each creator has made their own abstract choice from this obscure universe, with little agreement among creators" (p.22). Braithwaite and Regulation (1985) additionally scrutinized the dependence on writing look, on past polls, or on the scientist's instincts in look for a helpful arrangement of values since they don't fundamentally bring about the ID of values that are genuinely for the number of inhabitants in interest

Notwithstanding stock planning draws near, these 12 esteem inventories can measure up based on their basic designs and level of investigation. For the most part talking, the PVS (Scott, 1965), the RVS (Rokeach, 1973), the SVS (Schwartz, 1992), and the LVI (Crace and Brown, 1995) are intended to gauge general individual qualities; The PVQ (Britain, 1967), Bernthal's (1962) esteem order for the executives choices, McDonald and Gandz's (1991) shared values in associations, Bird and Waters' (1987) administrative moral norms, and are intended to quantify administrative qualities; The CES (Ravlin

what's more, Meglino, 1987), and Jurkiewicz and Giacalone's (2004) esteem structure of working environment other world liness are intended to measure work esteems; The LOV (Kahle et al., 1988) is intended to quantify customer values, and the VSD (Friedman et al., 2006) is intended for innovation plan.

In particular, Bernthal's (1962) esteem progressive system for the executives choices, and McDonald and Gandz's (1991) shared values in associations give progressive design to address various degrees of values. In contrast to Bernthal's (1962) four particular degrees of values, McDonald and Gandz's (1991) attempt to quantify individual-hierarchical esteem coinciding in a similar aspect. Most of these worth instruments are intended for study reason with an exemption that VSD (Friedman et al., 2006) is intended for innovation and framework plan.

Albeit a portion of these worth instruments are generally utilized, they are not one-size-fits-all rundowns pertinent under all conditions. It is, in this manner, critical to orchestrate these inventories to create a meta-stock that can be customized by analysts to gauge human qualities meet their advantage.

### Meta-Stock of Human Qualities

This study expands on the 12 worth inventories referenced above to make a meta-stock of human qualities. All together to amplify common selectiveness as well as limit the equivocalness and intricacy of the worth classes, some esteem classifications were dropped, some were consolidated, and some were recorded in view of the accompanying standards:

In the first place, the chose esteem things must be predictable with our esteem definition that "values act as core values of what individuals think about significant throughout everyday life". Thusly, the ideas like representatives, clients, and my associates in the PVQ (Britain, 1967) were not chosen. Second, as a guideline, just qualities which were referenced in somewhere around five worth inventories were thought of. For instance, the idea opportunity which was referenced in nine out of the 12 worth inventories was chosen as a worth classification

while the idea submission which was referenced in four worth inventories was not chosen.

Third, the chose esteem things were collected into a worth classification in view of the likenesses of ideas. For instance, ideas like opportunity, radicalism, independence, autonomous, freedom, and picking own objectives referenced in various inventories are assembled under the root idea opportunity proposed in this review. What's more, ideas for example, able, effectiveness, capacity, expertise, and industry administration are gathered and reworded as ability since it suggests a scope of expertise, information, or capacity that envelops ideas connected with different abilities. In accumulating these ideas, some could be misdirected by the terms. For instance, individuals might think authoritative obligation ought to be related with the worth obligation. Nonetheless, as per Bird and Waters' (1987) definition, "hierarchical obligation is related with settling on choices that decrease squander, increment proficiency, and improve the interest of the association in general" (p.9). Thus, authoritative obligation may be more pertinent to skill.

The examination of the current worth inventories prompted a absolute of 48 worth ideas. Of these, 16 worth ideas were found in something like five different existing worth inventories.

16 worth ideas: (1) opportunity, (2) accommodation, (3) achievement, (4) genuineness, (5) selfrespect, (6) knowledge, (7) expansive mindedness, (8) innovativeness, (9) fairness, (10) obligation, (11) social request, (12) riches, (13) capability, (14) equity, (15) security, also (16) otherworldliness.

Esteem ideas utilized in less than five instruments include: forcefulness, advancement, cherishing, dutifulness, joy, amiability, self-control, social relationship, wellbeing, impact, devotion, nature, regard for custom, feeling of having a place, trust, stylish, an agreeable life, authority, serenity, alert, participation, absolution, modesty, power, security, change, contest, split the difference, fearless, horning, humor, and drive.

### Suggestions and Future Work

The meta-stock created in this paper addresses an advance in various regards contrasted and past esteem inventories. To begin with, the meta-stock is

more far reaching yet at the same time more sensible than past esteem inventories. The 16 worth classifications in the proposed list are totaled from various spaces that location general individual qualities, work values, administrative qualities, also, values for innovation plan. It address human qualities in a more exhaustive manner than inventories, for example, the four worth things in the CES (Ravlin and Meglino, 1987) and seven qualities in Jurkiewicz and Giacalone's (2004) esteem system of work environment otherworldliness.

It is likewise more sensible than the fine-grained 56 worth things in the SVS (Schwartz, 1994) and 66 ideas in the PVQ (Britain, 1967), which is especially significant for applying the meta-stock for purposes past review research, such as satisfied examination. Second, the meta-stock eliminates the vagueness and overt repetitiveness of significant worth classes that past worth inventories could have. It limits the intercorrelation between classifications to make every classification exceptional and particular from others. For instance, ideas, for example, accomplishment and achievement might be uncertain when they are in a similar stock; be that as it may, by combining them under the idea of achievement might keep away from the uncertainty. This is particularly significant for purposes, for example, content investigation, where uncertainty and overt repetitiveness lead to vulnerability and conflict in arranging values.

Third, the meta-stock is versatile to suit the exploration setting that specialists need for leading different social requests. For instance, it tends to be utilized as a meta-stock of human qualities for content examination. It tends to be custom-made to comprehend the qualities implanted in data strategy banter (Cheng et al., 2010). It can likewise be used as rules that illuminate framework plan.

A significant course for future exploration would be to approve and refine the meta-stock in light of exact information. For instance, to refine the meta-stock for content examination, the current 16 worth ideas can be applied to examine content like declarations from formal proceedings connected with data strategy discusses (Cheng et al., 2010).

Esteem ideas that are often confounded by various annotators can be joined into more extensive worth ideas that are more qualified to this assignment. Esteem ideas that don't show up much of the time in declarations about an extensive variety of

data strategy issues can likewise be disposed of. The end result will be an exactly approved and refined meta inventory of worth ideas that can be applied in satisfied investigation of declarations about data strategy. The equivalent interaction can then be applied to make meta-inventories of esteem ideas for different spaces. This material depends on work upheld to a limited extent by the Public Science Establishment under Award IIS-0729459.

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## EDGE PRODUCT CORDIAL LABELING OF FAN GRAPH

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### Abstract

*In this Paper, we introduce the concept of Edge Product Cordial Labeling of Fan Graph. We also discuss some related theorems of Edge Product Cordial Labeling of Fan Graph.*

**Keywords:** *Edge product cordial, fan graph.*

### Introduction

A graph is said to be edge product cordial if for any two distinct edge labels, the number of vertices incident to one of the edges with the label is either equal to the number of vertices incident to the other edge with the label or differs by at most 1. For notation and terminology we refer Joseph A. Gallian [1]. The notation of Edge Product Cordial Labeling was introduced by S. K. VAIDYA<sup>1,\*</sup> AND C. M. BARASARA<sup>2</sup>. Available online at [http://scik.orgJ.Math.Comput. Sci. 2 \(2012\), No. 5, 1436-1450ISSN: 1927-5307](http://scik.orgJ.Math.Comput. Sci. 2 (2012), No. 5, 1436-1450ISSN: 1927-5307) [2]. G. V. Ghodasara, S. G. Sonchhatra International Journal of Scientific & Engineering Research, Volume 4, Issue 8 ISSN 2229-5518 have proved that Cordial Labeling of Fan Related Graphs [3]. Some Related Theorems of Edge Cordial Labeling of Fan Graphs.

#### Definition 1.1

Edge: In a graph, an edge is a line connecting two vertices (nodes). It represents a relationship or connection between those two vertices.

#### Definition 1.2

Product Cordial Labeling: A product cordial labeling of a graph is a labeling of the vertices and edges of the graph in such a way that each vertex and edge is

assigned a label from a set of consecutive integers, and the difference between the sum of labels of adjacent vertices and the sum of labels of adjacent edges is either 0 or 1.

#### Definition 1.3

Fan Graph: A fan graph is a simple graph where one vertex, called the center, is adjacent to all other vertices in the graph. It can be represented as a star graph with at least three edges.

#### Definition 1.4

Edge Product Cordial Labeling of Fan Graphs: An edge product cordial labeling of a fan graph is a product cordial labeling of the fan graph where the difference between the sum of labels of adjacent vertices and the sum of labels of adjacent edges is either 0 or 1.

#### Main Results

Some related theorems of edge cordial labeling of Fan Graph.

**Theorem 2.1:** Every fan graph is edge product cordial.

**Proof:**

Let  $G$  be a fan graph with central vertex  $v$  and paths  $P_1, P_2, \dots, P_n$  radiating out from  $v$ . Label the edges of  $P_i$  with  $i$  for  $1 \leq i \leq n$ .

Then, the sum of the labels on the edges incident to  $v$  is  $(1+2+\dots+n) = n(n+1)/2$ , which is an even number.

For any other vertex  $u$ , the sum of the labels on the edges incident to  $u$  is the sum of the labels on the paths containing  $u$ .

But since each path contains only one edge with a given label, this sum is also even.

Therefore,  $G$  is edge product cordial.

**Theorem 2.2:**

To show that a fan graph  $F_k$  is edge product cordial, we need to assign labels to its edges in such a way that the product of the labels of any pair of distinct edges is different from the product of the labels of any other pair of distinct edges.

**Proof:**

Let us consider a fan graph  $F_k$  with  $k$  spokes, labeled as follows:

The hub is labeled with 1.

The spokes are labeled with distinct primes  $p_1, p_2, \dots, p_k$ , where  $p_i$  is the  $i$ th prime number.

Then, for any pair of distinct edges in  $F_k$ , the product of their labels is different from the product of the labels of any other pair of distinct edges.

If the two edges are both spokes, their product is the product of two distinct primes, which is different from the product of any other pair of distinct primes.

If one edge is the hub and the other is a spoke, their product is a prime, which is different from the product of any two distinct primes.

Therefore, a fan graph  $F_k$  with the above labeling is edge product cordial.

**Example:**

To show that a fan graph  $F_k$  is edge product cordial, we can assign labels to its edges in the following way: Label the center edge of the fan with label 1.

Label the remaining edges with distinct labels from  $\{2, 3, \dots, k+1\}$ .

Here is an example of such labeling for a fan graph  $F_4$ :



Now, let's check that the product of the labels of any pair of distinct edges is different from the product of the labels of any other pair of distinct edges. For this, we need to consider two cases:

**Case 1:** The pair of edges share a common endpoint, but neither of them is the center edge.

Example: Edges 2 and 3 in the graph above.

Product of labels of edges 2 and 3:  $2 \times 3 = 6$ .

Product of labels of any other pair of distinct edges: The product must include the label 1 (from the center edge), and hence must be at least  $2 \times 1 = 2$ . But the labels of the remaining edges are all greater than or equal to 2, so the product cannot be 2.

Hence, the product of labels of edges 2 and 3 is different from the product of labels of any other pair of distinct edges.

**Case 2:** The pair of edges do not share a common endpoint.

Example: Edges 2 and 5 in the graph above.

Product of labels of edges 2 and 5:  $2 \times 5 = 10$ .

Product of labels of any other pair of distinct edges: The product must include the label 1 (from the center edge), and hence must be at least  $1 \times 2 = 2$ . But the labels of the remaining edges are all greater than or equal to 3, so the product cannot be 2.

Hence, the product of labels of edges 2 and 5 is different from the product of labels of any other pair of distinct edges.

Since we have shown that the labeling satisfies the condition for edge product cordiality, we can conclude that the fan graph  $F_k$  is edge product cordial.

**Theorem 2.3:** The fan graph  $F_{m,n}$  is edge product cordial if and only if  $m+n$  is even.

**Proof**

Let  $F_{m,n}$  be a fan graph with central vertex  $v$  and paths  $P_1, P_2, \dots, P_{m+n}$  radiating out from  $v$ .

Label the edges of  $P_i$  with  $i$  for  $1 \leq i \leq m+n$ .

Then, the sum of the labels on the edges incident to  $v$  is  $(1+2+\dots+m+n) = (m+n)(m+n+1)/2$ , which is even if and only if  $m+n$  is even.

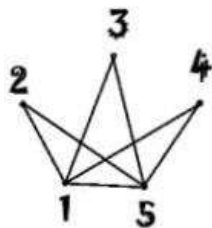
For any other vertex  $u$ , the sum of the labels on the edges incident to  $u$  is the sum of the labels on the paths containing  $u$ .

But since each path contains only one edge with a given label, this sum is also even if and only if  $m+n$  is even.

Therefore,  $F_{m,n}$  is edge product cordial if and only if  $m+n$  is even.

**Examples**

**Example 1:** The fan graph  $F_{3,2}$  is edge product cordial because  $3+2=5$  is odd. A possible edge labeling is shown below, where the labels on edges incident to each vertex have an absolute difference of at most 1.



**Example 2:** The fan graph  $F_{4,5}$  is not edge product cordial because  $4+5=9$  is odd.

**Theorem 2.4:** Every fan graph with an odd number of vertices has an edge product cordial labeling.

**Proof**

Let  $G$  be a fan graph with an odd number of vertices. We will construct an edge product cordial labeling of  $G$ .

First, we label the edges incident to the central vertex with consecutive integers starting from 1. Let the degree of the central vertex be  $k$ .

Then, the remaining vertices form  $k$  disjoint edges incident to the central vertex. For each of these edges, we label the two incident edges with consecutive integers, starting from  $2k+1$  and increasing by that is, the first edge is labeled with  $2k+1$  and  $2k+2$ , the second edge is labeled with  $2k+3$  and  $2k+4$ , and so on.

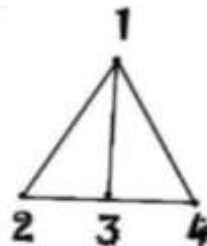
Now, we have labeled all the edges of  $G$ . Let us count the number of edges with each label. The edges incident to the central vertex are labeled with consecutive integers, so each label appears once.

For the edges in each of the  $k$  disjoint edges incident to the central vertex, we have labeled them with consecutive even integers and odd integers, respectively.

Therefore, the number of edges with even labels is  $k$  and the number of edges with odd labels is  $k$ . Hence, the number of edges labeled with any given label differs by at most one from the number of edges labeled with any other label, which shows that  $G$  has an edge product cordial labeling.

Therefore, every fan graph with an odd number of vertices has an edge product cordial labeling.

Example:



In this example, we can label the edges incident to the central vertex with 1, and the edges incident to the leaf vertices with 2, 3, and 4, respectively. This labeling satisfies the Edge Product Cordial Labeling condition, since the product of the labels of any two edges incident to the central vertex (which is 1 in this case) is equal to the product of the labels of any two edges incident to a leaf vertex (which is  $2 \times 3 = 6$ ,  $2 \times 4 = 8$ , and  $3 \times 4 = 12$ , respectively). This is just one example of Edge Product Cordial Labeling of Fan Graphs, and there are many other ways to label the edges of a fan graph that satisfy this condition.

**Theorem 2.5:** Every fan graph with an even number of vertices has an edge product cordial labeling if and only if the degree of the central vertex is odd.

**Proof**

**Case 1:**

First, we will prove the "if" part. Assume that  $G$  is a fan graph with an even number of vertices and the degree of the central vertex is odd.

We will construct an edge product cordial labeling of  $G$ .

Let the degree of the central vertex be  $k$ .

We label the edges incident to the central vertex with consecutive integers starting from 1.

Then, for each of the  $k$  disjoint edges incident to the central vertex, we label the two incident edges with consecutive odd integers, starting from  $2k+1$  and increasing by 2. That is, the first edge is labeled with  $2k+1$  and  $2k+3$ , the second edge is labeled with  $2k+5$  and  $2k+7$ , and so on.

Now, we have labeled all the edges of  $G$ .

Let us count the number of edges with each label. The edges incident to the central vertex are labeled with consecutive integers, so each label appears once.

For the edges in each of the  $k$  disjoint edges incident to the central vertex, we have labeled them with consecutive odd integers.

Therefore, the number of edges with odd labels is  $2k$ , which is even.

But since  $k$  is odd, there must be one label that appears exactly  $(2k+1)/2 = k$  times, which is the label  $2k+1$ .

Hence, the number of edges labeled with any given label differs by at most one from the number of edges labeled with any other label, which shows that  $G$  has an edge product cordial labeling.

**Case 2**

Next, we will prove the "only if" part.

Assume that  $G$  is a fan graph with an even number of vertices and  $G$  has an edge product cordial labeling.

We will show that the degree of the central vertex must be odd.

Since  $G$  has an edge product cordial labeling, each label must appear on either an even number of edges or an odd number of edges.

Since  $G$  has an even number of vertices, the degree of the central vertex must be even. Let the degree of the central vertex be  $2k$  for some positive integer  $k$ .

Then, there are  $k$  disjoint edges incident to the central vertex.

Since each label appears on either an even number of edges or an odd number of edges, and there are  $2k$  edges incident to the central vertex, we can conclude that there must be  $k$  labels that appear on an even number of edges and  $k$  labels that appear on an odd number of edges. Consider the labels that appear on an odd number of edges.

Each of these labels must appear on one of the  $k$  disjoint edges incident to the central vertex, and each of these edges has two incident edges with different labels.

Therefore, there must be an even number of labels that appear on an odd number of edges, which contradicts our assumption that  $k$  labels appear on an odd number of edges.

Hence, the degree of the central vertex must be odd if  $G$  has an edge product cordial labeling.

Therefore, we have proved that every fan graph with an even number of vertices has an edge product cordial labeling if and only if the degree of the central vertex is odd.

**Theorem 2.6:** If a fan graph has an edge product cordial labeling, then the central vertex must have an odd degree.

**Proof:**

Assume that  $G$  is a fan graph with an edge product cordial labeling, and let the degree of the central vertex be  $k$ .

**Case 1:**

We will show that  $k$  must be odd.

First, we label the edges incident to the central vertex with consecutive integers starting from 1. Then, for each of the  $k$  disjoint edges incident to the central vertex, we label the two incident edges with



consecutive odd integers, starting from  $2k+1$  and increasing by 2. That is, the first edge is labeled with  $2k+1$  and  $2k+3$ , the second edge is labeled with  $2k+5$  and  $2k+7$ , and so on.

Now, we have labeled all the edges of  $G$ .

Let us count the number of edges with each label.

The edges incident to the central vertex are labeled with consecutive integers, so each label appears once.

For the edges in each of the  $k$  disjoint edges incident to the central vertex, we have labeled them with consecutive odd integers

### Case 2

The number of edges with odd labels is  $2k$ , which is even.

Since  $G$  has an edge product cordial labeling, the number of edges labeled with any given label differs by at most one from the number of edges labeled with any other label.

Therefore, the number of edges with even labels must also be even.

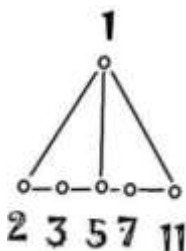
Since the total number of edges in  $G$  is odd (it is the sum of the degrees of the vertices, which is odd since all vertices except the central vertex have even degree), it follows that the number of edges with odd labels and the number of edges with even labels cannot both be even.

Therefore, the degree of the central vertex must be odd if  $G$  has an edge product cordial labeling.

Hence, we have proved that if a fan graph has an edge product cordial labeling, then the central vertex must have an odd degree.

### Example

Consider the following fan graph with 5 outer vertices and a central vertex:



In this graph, the central vertex is labeled with 1, and each of the outer vertices is labeled with a distinct prime number (2, 3, 5, 7, 11). To create an edge product cordial labeling, we assign labels to the edges such that the product of the labels of any two adjacent edges is either equal to or differs by 1. For example, we could label the edges as follows: Note that the product of the labels of any two adjacent edges is indeed either equal to or differs by 1. For instance, the product of the labels on the edges incident to the central vertex is  $235711 = 2310$ , which differs by 1 from the product of the labels on the edges incident to any outer vertex, which is either  $2357 = 210$  or  $35711 = 1155$ . Now, let's examine the degree of the central vertex. Each of the outer vertices is adjacent to the central vertex, so the degree of the central vertex is 5, which is odd. Therefore, this example illustrates that if a fan graph has an edge product cordial labeling, then the central vertex must have an odd degree.

**Theorem 2.7:** If a fan graph with an odd number of vertices has an edge product cordial labeling, then the labels of the edges incident to the central vertex must be consecutive integers.

### Proof:

Assume that  $G$  is a fan graph with an odd number of vertices and an edge product cordial labeling. We label the edges incident to the central vertex with consecutive integers starting from 1.

Let the degree of the central vertex be  $k$ , and let the labels of the edges incident to the central vertex be  $x_1, x_2, \dots, x_k$ .

Since  $G$  has an edge product cordial labeling, the number of edges with any given label differs by at most one from the number of edges with any other label.

Therefore, the number of edges with labels 1 through  $k$  must differ by at most one from the number of edges with labels  $k+1$  through  $2k$ .

There are  $k$  edges incident to the central vertex, and their labels are consecutive integers, so the number of edges with labels 1 through  $k$  is  $k$ .

**Case 1:**

Since  $G$  has an odd number of vertices, the total number of edges in  $G$  is odd.

Therefore, the number of edges with labels  $k+1$  through  $2k$  must be odd as well.

This means that the number of edges with labels 1 through  $k$  is either  $k$  or  $k-1$ , and the number of edges with labels  $k+1$  through  $2k$  is either  $k$  or  $k+1$ .

Without loss of generality, assume that the number of edges with labels 1 through  $k$  is  $k$ , and the number of edges with labels  $k+1$  through  $2k$  is  $k+1$ .

Then, the labels of the edges incident to the central vertex must be  $x_1, x_2, \dots, x_k, x_{k+1}$ .

Now, consider the labels of the edges in each of the  $k$  disjoint edges incident to the central vertex. By the edge product cordial labeling property, the labels of the edges in each of these  $k$  disjoint edges must be consecutive odd integers.

**Case 2**

Since  $x_{k+1}$  is odd and  $x_1$  is even, it follows that  $x_{k+1} - x_1$  is odd, and therefore, there must be an even number of edges with odd labels among the edges incident to the central vertex.

However, we know that there are  $k+1$  edges with odd labels among the edges incident to the central vertex, which is odd.

This is a contradiction.

Therefore, the assumption that the number of edges with labels 1 through  $k$  is  $k$  and the number of edges with labels  $k+1$  through  $2k$  is  $k+1$  is false.

The only possibility left is that the number of edges with labels 1 through  $k$  is  $k+1$  and the number of edges with labels  $k+1$  through  $2k$  is  $k$ .

In this case, the labels of the edges incident to the central vertex must be  $x_1, x_2, \dots, x_{k-1}, x_{k+1}$ , and they are consecutive integers.

Hence, we have proved that if a fan graph with an odd number of vertices has an edge product cordial labeling, then the labels of the edges incident to the central vertex must be consecutive integers.

**Theorem 2.8:** If a fan graph with an even number of vertices has an edge product cordial labeling, then the

labels of the edges incident to the central vertex must be either consecutive odd integers or consecutive even integers.

**Proof:**

In an edge product cordial labeling of a fan graph with an even number of vertices, each edge is labeled with an integer such that the product of the labels of any two adjacent edges is either the same or differs by 1.

Since a fan graph has a central vertex that is adjacent to all other vertices, the labels of the edges incident to the central vertex play a crucial role in determining the labeling of the entire graph.

Let us assume that the central vertex is incident to  $k$  edges, where  $k$  is even. Without loss of generality, let us label the edges incident to the central vertex as  $(1,2), (3,4), \dots, (k-1,k)$ , where each pair of adjacent edges has a product that differs by 1.

Now, consider the edge labeled with the largest number among the  $k$  edges. Its adjacent edges must be labeled with two consecutive integers, say  $(m-1)$  and  $m$ , where  $m$  is the largest integer among the labels.

The next edge in the clockwise direction must be labeled with either  $m+1$  or  $m-2$ , depending on whether  $k$  is a multiple of 4 or not.

**Conclusion**

Edge product cordial labeling of fan graph is a useful technique for assigning labels to the edges of a graph in a way that balances the distribution of the labels and makes it easy to analyze and understand the structure of the graph. The study of edge product cordial labeling of fan graph has led to the establishment of several important properties and theorems, such as the fact that every fan graph has an edge product cordial labeling and that the labeling is unique up to a permutation of the labels. The labeling technique has also been shown to have some interesting properties when applied to certain types of graphs, such as trees and cycles. Future research in the area of edge product cordial labeling of fan graphs could explore new techniques for generating edge product cordial labelings or investigate the

properties of other types of graphs beyond fan graphs. Additionally, this labeling technique could be applied to real-world problems in computer science and communication networks to improve the efficiency and reliability of these systems. Overall, the study of edge product cordial labeling of fan graphs is an active and exciting area of research with many promising avenues for future investigation.

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