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**THE ELECTROLYTIC DEPOSITION OF CADMIUM.**

THE ELECTROLYTIC DEPOSITION OF CADMIUM.

A THESIS

SUBMITTED TO THE FACULTY OF

MICHIGAN STATE COLLEGE

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MASTER OF SCIENCE

BY

HERBERT WILLIAM SCHMIDT

1925.

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## INTRODUCTION.

The electrolytic deposition of cadmium is by no means a recent discovery. Smee appears to have been one of the first, if not the first, to deposit cadmium electrolytically. Since the publication of his results, the matter has received very little attention.

About this time, Woolrich and Russell were granted a patent in England in 1849, or nine years after the discovery of silver plating. Their solution was made by dissolving cadmium in  $\text{HNO}_3$ , precipitating  $\text{Cd CO}_3$ , with  $\text{Na}_2\text{CO}_3$ , washing with water, and redissolving in KCN.

Within the last few years, there has been a marked activity in the electrolytic deposition of cadmium. The reason for this is quite apparent when one considers that in cadmium, there is, to a very high degree, the protective value of zinc and the pleasing appearance of nickel.

It might be well at this time to review a few of the properties of this metal. Cadmium is always found in nature associated with zinc. In the extraction of the zinc, the cadmium distills first, since its boiling point ( $778^\circ\text{C}$ ) is considerably less than that of zinc ( $930^\circ\text{C}$ ). The distillate is collected, mixed with coke or charcoal, and distilled at about  $800^\circ\text{C}$ . In this way a metal of over 99.5% purity is obtained. The chief source of cadmium is America. It is estimated that production could be brought up to 500 tons or more a year if necessary to supply the

## QUESTION 1

1.1.1. The following table shows the number of people who visited the museum in each month from January to December.

Month	Number of people
January	120
February	150
March	180
April	200
May	220
June	250
July	280
August	300
September	280
October	250
November	220
December	180

1.1.2. The following table shows the number of people who visited the museum in each month from January to December.

Month	Number of people
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August	300
September	280
October	250
November	220
December	180

market.

Cadmium has a silver white color with a bluish tinge and a bright luster, which dulls somewhat on exposure to air. The cast metal is crystalline which when etched reveals polygonal crystals. It has a specific gravity of 8.65 at 20°C. Cadmium has a Brinnell hardness of 29.0. It can be easily cut with a knife and is very flexible, ductile, and malleable.

Cadmium is strongly electro-positive as shown by the following table of electrode potentials at 25°C.

Zinc -----	+ .758
Cadmium -----	+ .398
Iron -----	+ .441
Nickel -----	+ .220
Hydrogen -----	.000

The relative position of iron and cadmium are in question. Altho, according to the electromotive force, cadmium should be below iron in the series, its chemical and electrochemical behavior and its position in the periodic system would lead one to correctly place it above iron. Unless cadmium is above iron, it can hardly be expected to protect iron against corrosion. That it does protect iron has been shown by Blassett, (1).

However, since it lies so close to iron it cannot be expected to give as much intrinsic protection as zinc, and consequently will not protect as large areas as will zinc. It follows that a deposit of cadmium must be nearly impervious in order to furnish continued protection.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is crucial for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent data collection procedures and the use of advanced analytical techniques to derive meaningful insights from the data.

3. The third part of the document focuses on the implementation of data-driven strategies. It provides a detailed overview of the key steps involved in developing and executing these strategies, from identifying opportunities to monitoring and evaluating their performance.

- The first step is to identify the key areas where data can be used to drive performance improvements.
- The second step is to develop a clear and concise strategy that outlines the specific actions to be taken.
- The third step is to implement the strategy, ensuring that all relevant departments and individuals are involved.
- The fourth step is to monitor and evaluate the performance of the strategy, making adjustments as needed.
- The fifth step is to report on the results of the strategy, providing a clear and concise summary of the findings.

4. The fourth part of the document discusses the challenges and risks associated with data-driven decision-making. It highlights the need for a strong data governance framework and the importance of ensuring data privacy and security.

5. The fifth part of the document provides a detailed overview of the various data sources and tools used in the organization. It includes a list of the key data sources and the tools used to collect and analyze the data.

6. The sixth part of the document discusses the future of data-driven decision-making. It highlights the potential of emerging technologies such as artificial intelligence and machine learning to further enhance the organization's data-driven capabilities.

7. The seventh part of the document provides a detailed overview of the organization's data-driven strategy. It includes a list of the key objectives and the specific actions to be taken to achieve these objectives.

However, cadmium will not corrode as rapidly as zinc, will preserve a better appearance, and will protect the iron longer than will a similar plate of zinc, provided the iron is not exposed because of porosity or abrasion.

As the potential of cadmium is much closer to nickel than is zinc, it is more advisable to plate nickel over cadmium than zinc, since there would be less tendency to deposit nickel by immersion and if the cadmium is subsequently exposed, there would be less tendency for it to corrode and cause peeling of the nickel. By plating successively with cadmium and nickel it may be possible to materially increase the protective value of the nickel without sacrificing its desirable properties.

Whether the theoretical advantages of cadmium as compared with zinc can be realized commercially, and whether they will justify the added cost of the cadmium, can only be determined after more experience.

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry should be supported by a valid receipt or invoice. This ensures transparency and allows for easy verification of the data.

In addition, the document outlines the procedures for handling discrepancies. If there is a difference between the recorded amount and the actual amount received or paid, it is crucial to investigate the cause immediately. This could be due to a clerical error, a missing receipt, or a change in the terms of the agreement.

The second part of the document provides a detailed breakdown of the financial data for the period. It includes a table showing the total revenue, expenses, and net profit. Each item is categorized and described, providing a clear overview of the company's financial performance.

Finally, the document concludes with a summary of the key findings and recommendations. It suggests that the company should continue to focus on improving its record-keeping practices and ensuring that all transactions are properly documented. This will help to maintain the integrity of the financial data and support the overall success of the organization.

## REVIEW OF LITERATURE.

A review of the literature showed that altho there has been some investigation, the majority of this has been of an analytical nature only. In any investigation in electroanalysis, the problem is to remove all of the desired metal quantitatively, and in an adherent form. No reference to this kind of work will be made as it was deemed of little value in relation to electroplating. Mathers and Marble (2), give a complete abstract of the electrolytic deposition of cadmium. Mathers and Marble investigated cadmium deposition using a very low current density (0.4 amperes per square decimeter), and allowing the deposition to continue over a long period of time. Their work, consequently, was in reality one of the refining of cadmium rather than that of plating. They used a great number of different solutions among which were the sulphate, chloride, nitrate, acetate, ammoniacal, cyanide, bromide, iodide, fluosilicate, fluoborate, fluoride, and the perchlorate. In the case of the sulphate bath, they obtained only crystalline deposits after a few different addition agents had been used and so abandoned it as hopeless.

As far as could be determined the only bath in use at the present time for depositing cadmium is the cyanide solution.

The Udylite Process Company (3), covers the electrolysis of iron, steel, and other metals in a neutral or basic solution of cadmium cyanide with anodes of graphite, carbon, or other insoluable and non-polarizing materials.





The articles are then washed in water and baked for some hours at a temperature of 150°C to 200°C, or up to 250°C, if the plates are imbedded in  $\text{Ca}(\text{OH})_2$ . The electrolyte may contain from 1.25 to 15% cadmium and 1 - 25% Na CN. The cadmium is precipitated as  $\text{Cd}(\text{OH})_2$  and redissolved in NaCN or KCN. A slight excess of cyanide is allowable. Cadmium is added to the solution in the form of  $\text{Cd}(\text{OH})_2$ . With an electrolyte containing 10.5% cadmium, a current density of 25 - 100 amperes per square foot may be used.

Wm. A. Wissler and C. H. Humphreys (4), control a patent for practically the same process.

The Udylite Process Company, of Kokomo, Indiana, have developed a commercial method for depositing cadmium and are prepared to grant licenses for its industrial use.

The writer was of the opinion that cadmium could be deposited from a slightly acid solution of cadmium sulphate by means of suitable addition agents.

Blum and Hagaboom in their recent book, "Principles of Electroplating and Electroforming", say "It is possible to deposit cadmium from slightly acid chloride or sulphate solutions, but the deposits are coarsely crystalline and entirely unsuited for electroplating unless some suitable addition agents are present.

This investigation was undertaken to determine the effect of various addition agents on the electrolytic deposition of cadmium from a sulphate solution.



## THE PRINCIPLES OF ELECTRODEPOSITION.

It might be well to review some of the theoretical considerations in regard to the character of deposits as influenced by various factors. In electroplating as in other lines of work, there are a good many factors entering whose effects are not known.

There is no single case where one factor governing electrodeposition can be changed without changing quite a number of other factors. For instance, if we have a solution of a metallic salt in water and we add some acid, we now have changed the acidity, both actual and total, the conductivity, and the metal ion concentration slightly, as well as other factors. It can be readily seen that the problem of addition agents is a very complex one, and a consideration of principles, in so far as they are known, is of the utmost importance. These principles have as yet not been proven to be absolutely true in all cases but they are merely advanced as an aid to the electrodeposition of metals.

If the process of electrodepositing metals depends upon the formation of crystals, it seems reasonable that the principles of ordinary crystal growth must apply in some degree to the formation of crystals by electrodeposition. A consideration of these principles led W. D. Bancroft (5), to state certain "axioms" regarding the structure of electrodeposited metals.

These "axioms" were stated by Dr. Bancroft in the following terms:

1. Bad deposits are due to excessive admixtures of some compounds or to excessively large crystals.

2. Excessive admixture of any compound can be eliminated by changing the conditions so that the compound cannot precipitate.

3. Increasing the current density, increasing the potential difference at the cathode, or lowering the temperature, decreases the size of the crystals.

4. The crystal size is decreased when there are present, at the cathode surface, substances which are absorbed by the deposited metal.

5. If a given solution will give a good deposit at any current density, provided the conditions at the cathode surface are kept constant.

6. Treering is facilitated by a high potential drop thru the solution and by conditions favorable to the formation of large crystals.

No time will be taken for a discussion of these "axioms" but they will be referred to in the conclusion and discussion of the experimental work.

Wm. Blum, of the Bureau of Standards (6), discusses and gives experimental evidence of these axioms and also advances a theory of crystal formation.

Mathers and Marble in the discussion of their paper say, "that a good deposit is the result of the



additive properties of the acid ion and the additive substance. A stronger statement of the theory is that any metallic salt will give a good deposit for the proper addition agent is used." They attempt to prove this statement by the experimental work of their paper.

The above principles are just some of the theories concerning the character of electrolytic deposits and will be referred to later in this thesis.





METHOD OF PROCEDURE.

Solutions of various concentrations of Cd SO<sub>4</sub> were made and electrolytic deposits obtained from each of them at various conditions. Then to these solutions were added various salts at different concentrations and the results noted. Finally, the commonly called organic colloids and reducing agents were added and their effects noted.

After cleaning and washing, which method will be described in detail later, the specimen to be plated was placed in the solution under observation. The current was always on before any plate touched the solution; thereby preventing to a great degree any tendency to deposit by immersion. The voltage of the cell and amperage flowing thru the cell was regulated as desired by means of a rheostat. As a means of comparison a fixed time of 15 minutes was allowed for each plate. The current density was varied for different plates to observe that effect. Some plates were made to show the effect of agitating the solution with air or by stirring mechanically. The temperature was the same as room temperature and varied from 18° to 27° as maximum limits. After plating, the plates were rinsed in cold water and filed in a rack to dry. The crystal size and surface of the plates were compared by means of a microscope using a direct illumination from a 150 watt electric light. The magnification was set at

## Mathematical Induction

Let  $P(n)$  be a statement involving the natural number  $n$ . To prove that  $P(n)$  is true for all natural numbers  $n$ , we use the principle of mathematical induction. The principle consists of two steps: (1) *Base Case*: Prove that  $P(1)$  is true. (2) *Inductive Step*: Assume that  $P(k)$  is true for some natural number  $k$ . Prove that  $P(k+1)$  is true. If both steps are satisfied, then  $P(n)$  is true for all natural numbers  $n$ .

Example: Prove that the sum of the first  $n$  natural numbers is  $\frac{n(n+1)}{2}$ . Let  $P(n)$  be the statement that the sum of the first  $n$  natural numbers is  $\frac{n(n+1)}{2}$ . (1) *Base Case*: For  $n=1$ , the sum is  $1$  and  $\frac{1(1+1)}{2} = 1$ . So  $P(1)$  is true. (2) *Inductive Step*: Assume  $P(k)$  is true, i.e., the sum of the first  $k$  natural numbers is  $\frac{k(k+1)}{2}$ . We need to show that  $P(k+1)$  is true, i.e., the sum of the first  $k+1$  natural numbers is  $\frac{(k+1)(k+2)}{2}$ . The sum of the first  $k+1$  natural numbers is the sum of the first  $k$  natural numbers plus  $k+1$ . By the inductive hypothesis, this is  $\frac{k(k+1)}{2} + k+1 = \frac{k(k+1) + 2(k+1)}{2} = \frac{(k+1)(k+2)}{2}$ . So  $P(k+1)$  is true. Therefore, by the principle of mathematical induction,  $P(n)$  is true for all natural numbers  $n$ .

100 diameters. For the purpose of demonstration, photo micrographs of various plates were made but the method is included elsewhere in this thesis.

## APPARATUS AND MATERIALS.

### APPARATUS.

The apparatus used in this investigation consisted of a 250 cc beaker, two anodes of cadmium and a support for the cathode. All solutions used were made up to 250 cc volume.

### CHEMICALS.

All chemicals used were of the purity commonly called "C.P." except in the case of some of the organic addition agents.

### ANODES.

The anodes used were of cast cadmium in the form of rods and were of high purity.

### CATHODE MATERIALS.

Two different kinds of sheet metal were used. One was what is known as blue steel because of the blue scale on the surface and the other was known as Russian Iron. The former was 24 gauge in thickness and the latter was 20 gauge. Very little difference was noticed in plating with these two kinds of metal. The metal was cut



into strips approximately 4 cm. wide by 15 cm. long.  
All plates were numbered for record.

SOURCE OF CURRENT.

The current was obtained from a 6 - 12 volt motor generator set thru a switchboard provided with an ammeter and voltmeter. The current was varied by means of a resistance in series with the bath.

PRETREATMENT OF CATHODE MATERIAL.

The pretreatment of the cathode material is of very great importance since all oil, grease, rust or any other kind of foreign matter must be thoroughly removed before attempting to electroplate, or a complete failure will be the inevitable result.

All specimens, before plating, were given the following preliminary treatment:- If specimen was covered with a heavy layer of oil, this was removed by  $C Cl_4$  or  $CH Cl_3$ , then wiped with cloth. To remove the black scale, or in numerous cases to reuse plates previously plated with cadmium, the specimens were placed in a hot solution of the following composition:  $Sn Cl_2$ , 50 gm.; Tartaric Acid, 2 gm.;  $H_2O$ , 1000 cc. The specimens were allowed to remain in this solution until thoroughly cleaned, rinsed in cold water, and wiped dry with a cloth. This treatment was used to quite a number of plates at a time so that before they were finally used they became covered with rust again.

Just before plating the following procedure was used: The plates were first boiled in a strong alkaline solution to remove any remaining oil or grease, rinsed in hot water, and wiped dry. They were given a thorough cleaning with a fairly fine scratch brush on a motor driven buffing lathe to remove any rough spots and also any adhering loose material. The plates were immersed in a 10% solution of  $H_2SO_4$ , to remove the thin layer of rust

# THE HISTORY OF THE UNITED STATES

The history of the United States is a complex and multifaceted story that spans centuries. It begins with the early Native American civilizations, such as the Mayans, Aztecs, and Incas, who built sophisticated societies in the Americas. The arrival of European explorers in the late 15th and early 16th centuries marked the beginning of a new chapter in the continent's history. The Spanish, French, and British established colonies and fought wars for control of the land. The American Revolution (1775-1783) was a pivotal moment, leading to the birth of the United States as an independent nation. The Constitution was drafted in 1787, and the country grew through westward expansion, territorial acquisitions, and the Civil War (1861-1865), which resolved the issue of slavery. The late 19th and early 20th centuries saw industrialization, the rise of big business, and the Progressive Era, which aimed to reform society and government. The United States emerged as a global superpower after World War II, leading the world in the Cold War and playing a central role in the development of the modern world. Today, the United States continues to shape global events and remains a major power on the world stage.



accumulated, rinsed in cold water, and given a 10 second dip in the following bright dip solution;  $\text{HNO}_3$  conc.; 25% by volume;  $\text{H}_2\text{SO}_4$  conc.; 50% by volume; and  $\text{H}_2\text{O}$ , 25% by volume. The plates were washed clean in water. The surface of the metal then had a very bright color and was clean.

The plates were next placed in a hot alkaline solution for about 5 minutes, washed in hot water, cold water, and were then ready for plating. The alkaline solution was of the following composition:

$\text{Na}_2\text{CO}_3$ , 165 gms. per liter;  $\text{NaOH}$ , 15 gms. per liter.

1. The first step in the process of identifying a problem is to recognize that a problem exists. This is often done by comparing current performance with a desired state or goal. For example, a manager might notice that sales are declining or that customer satisfaction is low. Once a problem is identified, the next step is to define it more precisely. This involves determining the scope of the problem, its causes, and its effects. For instance, a manager might define a problem as "a 10% decrease in sales over the last quarter, primarily due to a loss of market share in the competitive market."

2. The second step in the process is to analyze the problem. This involves gathering information about the problem and its causes. This can be done through various methods, such as interviews, surveys, and data analysis. For example, a manager might conduct interviews with sales staff to identify common customer complaints or analyze sales data to identify trends. Once the information is gathered, the next step is to identify the root cause of the problem. This is often done using the "5 Whys" technique, which involves asking "why" five times to get to the root of the problem.

3. The third step in the process is to generate solutions. This involves brainstorming ideas for how to solve the problem. For example, a manager might brainstorm ideas for how to increase sales or improve customer satisfaction. Once a list of potential solutions is generated, the next step is to evaluate them. This involves comparing the solutions against various criteria, such as cost, feasibility, and potential impact. For example, a manager might evaluate a solution based on its cost, the resources required to implement it, and the potential impact on sales and customer satisfaction.

METHODS FOR MAKING PHOTOMICROGRAPHS.

The apparatus used was a Bosch and Lomb Photo-Micrographic camera. The illumination was obtained from a high power electric lamp focused directly on the plate rather than the usual method of using an illuminator. It was found that by using the direct method of illumination a better picture was obtained. A magnification of twenty diameters was used. All exposures were for 15 seconds, and developed for about 8 minutes.

### EXPERIMENTAL WORK.

In order that the experimental work of this thesis might be presented in as clear a manner as possible, the work has been divided into several parts, each of which will be presented and discussed separately. The photomicrographs found elsewhere are of value in getting a clearer insight into some of the subject matter. Whenever possible, concentrations have been expressed in terms of normality. In some cases, however, it was deemed advisable to express the additions in terms of the quantity added for bath of 250 cc. In the case of liquids, these additions are expressed in terms of cc of addition agent for 250 cc of solution.

In presenting the effects of a bath on the deposit, it should be remembered that the comparison is always drawn from a bath which does not contain the addition agent under consideration.

#### EFFECT OF ADDITION OF NON-METALLIC SALTS WITHOUT FREE ACID.

The standard for comparison was a bath containing simply  $\text{Cd SO}_4$  (1.0N). The deposit was coarsely crystalline. The color was fair; the cover poor; and the adhesion very poor. There was considerable treeing on the edges.

$(\text{NH}_4)_2 \text{SO}_4$  (0.25N). The deposit was coarsely crystalline with larger crystals than those of the  $\text{Cd SO}_4$  (1.0N). The color was improved some. The cover was poor, and adhesion was very poor. This bath was also tried

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3. The third part of the document focuses on the role of technology in data management and analysis. It discusses how modern software solutions can streamline data collection, storage, and reporting, thereby improving efficiency and accuracy.

4. The fourth part of the document addresses the challenges associated with data management, such as data quality, security, and privacy. It provides strategies to mitigate these risks and ensure that data is used responsibly and ethically.

5. The fifth part of the document concludes by summarizing the key findings and recommendations. It stresses the importance of ongoing monitoring and evaluation to ensure that data management practices remain effective and up-to-date.

6. The sixth part of the document provides a detailed overview of the data collection process, including the identification of data sources, the design of data collection instruments, and the implementation of data collection procedures.

7. The seventh part of the document discusses the importance of data quality and the various factors that can affect it. It provides practical tips for ensuring that data is accurate, complete, and consistent throughout the collection and analysis process.

8. The eighth part of the document focuses on data security and privacy, discussing the various risks and threats to data and the measures that can be taken to protect it. It emphasizes the need for robust security protocols and regular security audits.

9. The ninth part of the document discusses the role of data in decision-making and the various ways in which data can be used to inform organizational strategy and operations. It highlights the importance of data-driven insights in achieving organizational goals.

10. The tenth part of the document provides a final summary and conclusion, reiterating the key points and recommendations. It emphasizes the need for a data-driven culture and the ongoing commitment to data management excellence.

11. The eleventh part of the document discusses the importance of data governance and the various roles and responsibilities involved in ensuring that data is managed effectively and responsibly. It provides a framework for developing a data governance policy.

12. The twelfth part of the document discusses the importance of data literacy and the various ways in which it can be promoted and supported. It emphasizes the need for ongoing training and education to ensure that all employees are equipped with the skills and knowledge needed to work effectively with data.

13. The thirteenth part of the document discusses the importance of data ethics and the various ways in which it can be ensured. It provides a framework for developing a data ethics policy and ensuring that data is used in a fair, transparent, and responsible manner.

14. The fourteenth part of the document discusses the importance of data innovation and the various ways in which it can be fostered. It emphasizes the need for a culture of experimentation and innovation to drive the development of new data-driven solutions and services.

15. The fifteenth part of the document discusses the importance of data collaboration and the various ways in which it can be promoted. It emphasizes the need for open communication and shared data to enable organizations to work more effectively together and achieve their goals.

16. The sixteenth part of the document discusses the importance of data integration and the various ways in which it can be achieved. It emphasizes the need for a unified data architecture and the use of data integration tools to ensure that data is accessible and usable across the organization.

17. The seventeenth part of the document discusses the importance of data analytics and the various ways in which it can be used to gain insights into organizational performance and trends. It emphasizes the need for a data-driven approach to analytics and the use of advanced analytics tools to uncover hidden patterns and trends.

18. The eighteenth part of the document discusses the importance of data visualization and the various ways in which it can be used to communicate complex data in a clear and concise manner. It emphasizes the need for a data-driven approach to visualization and the use of data visualization tools to create compelling and informative visualizations.

giving the sample a preliminary dip for about 5 seconds in the following arsenic dip; 60 gms.  $As_2O_3$  per liter of concentrated HCl. The crystal size was decreased considerably. The color and cover were about the same as was the adhesion.

$(NH_4)_2 SO_4$  (0.50N). The crystal size was decreased somewhat. The color was darker; the cover and adhesion were poor. The amount of treeing was decreased considerable but there was still a tendency for the edges to get rough. There was also a decided tendency for the surface of the plate to become rough which was more pronounced if the time was increased to 30 minutes.

$(NH_4) Cl$  (0.25N). The deposit was crystalline with a slight increase in the size of the crystals. The color was darker; the cover and adhesion were poor. There was an excessive treeing on the edges.

$NH_4 Cl$  (0.50N). There was an increase in the crystal size. The color was darker than with (0.25N). The cover and adhesion were poor.

$Na_2 SO_4$  (0.25N). A crystalline deposit with practically no change in crystal size was obtained. The color was slightly darker; the cover was fair and the adhesion was improved. There was considerable treeing.

$Na_2 SO_4$  (0.50N). The crystal size was decreased slightly. The color was improved; the cover was fair and the adhesion was better but still poor. The treeing was only slight but the edges were rough.

$Na Cl$  (0.25N). The crystal size was increased



slightly. The color was darker; the cover was poorer, and the adhesion was also poor. Considerable treeing was observed.

Na Cl (0.50N). The crystal size was decreased slightly. The cover was poor; the color was slightly darker, and adhesion was poor.

K<sub>2</sub> SO<sub>4</sub> (0.25N). The crystal size appeared about the same; the color darker; the cover and adhesion were poor. There was a decided tendency to sponge. There was some treeing and the edges were rough.

K<sub>2</sub> SO<sub>4</sub> (0.50N). The crystal size decreased. The color was slightly darker; the cover and adhesion were poor. There was still a tendency to sponge, but there was no treeing.

K Cl (0.25N). The crystal size did not appear to be changed; the color was slightly darker; the cover was poor and the adhesion was poor. Treeing was excessive.

K Cl (0.50N). The crystals appeared to increase in size with a rougher surface. The cover was poor; the color slightly darker, and the adhesion was poor. A slight treeing was observed.

#### SUMMARY.

Practically all of the above addition agents gave treeing to a more or less degree. The crystal size was not changed to any great extent. The cover and adhesion were poor in all cases. It appeared that the SO<sub>4</sub>-ion is better



• The first step in the process of identifying a problem is to recognize that a problem exists. This is often done by comparing current performance to a desired state or goal. Once a problem is identified, the next step is to define the problem more precisely. This involves determining the scope of the problem, the resources available, and the constraints that may be affecting the problem. Once the problem is defined, the next step is to generate potential solutions. This is often done through brainstorming or other creative problem-solving techniques. Once potential solutions are generated, the next step is to evaluate the solutions. This involves comparing the solutions to the problem and determining which solution is most likely to be effective. Once a solution is chosen, the final step is to implement the solution. This involves putting the solution into action and monitoring its progress. The process of identifying and solving a problem is often iterative, meaning that it may be necessary to go back to an earlier step if the current solution is not working.

• The process of identifying and solving a problem is often iterative, meaning that it may be necessary to go back to an earlier step if the current solution is not working. This is because the initial definition of the problem may be incomplete or incorrect, or the initial solutions may not be effective. It is important to be flexible and open to change during the problem-solving process. Once a solution is implemented, it is important to monitor its progress and evaluate its effectiveness. If the solution is not working, it may be necessary to go back to an earlier step and re-evaluate the problem or generate new solutions. The process of identifying and solving a problem is a continuous process that requires ongoing evaluation and adjustment.

than the Cl-ion as an addition agent.  $\text{Na}_2 \text{SO}_4 + (\text{NH}_4)_2 \text{SO}_4$  are the best addition agents of this class.

### DISCUSSION.

In the first case without addition agents the deposit was crystalline with considerable treeing. Reasoning from Bancroft's sixth "Axiom" by increasing the conductivity we should decrease treeing. Altho the conductivity was increased by addition of the salts the tendency to tree was still quite pronounced. It is evident that treeing in this case must be greatly influenced by the second part of the sixth "axiom". We might further increase the concentration of the salts but this was thought inadvisable. However, we can increase the concentration of the  $\text{Cd SO}_4$ . This will be discussed later.

### EFFECT OF $\text{H}_2 \text{SO}_4$ AND NON-METALLIC SALTS.

With no non-metallic salt, as the acid was added gassing started at the cathode and increased with increased concentration of the acid. The tendency to tree, however, decreased with increased concentration. The crystal size appeared to decrease also. Sponginess was noticable on some of the plates. The color does not seem to stay constant as some plates are darker than others. The cover was about the same for all concentrations but only fair.

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The adhesion was fair, improving slightly with concentration. The maximum acid concentration appeared to be about 8 cc. conc.  $H_2 SO_4$  per 250 cc. solution as cadmium seems to redissolve as fast as it is plated out.

$(NH_4)_2 SO_4$  (0.25N). On increasing the concentration of acid, the crystal size appeared to decrease, but sponginess appeared. The adhesion improved with the concentration. The cover was fair. The color was about the same thruout. The treeing decreased with increased concentration of the acid. Cathode gassing increased with increase of acidity.

$(NH_4)_2 SO_4$  (0.50N). On increasing the concentration of the acid the crystal size appeared to decrease. The tendency to sponge was observed at concentrations over .2 cc. The tendency to tree decreased at the higher concentration until the edges were just rough. Adhesion improved with increase concentration of acid as did the color. Cathode gassing increased with increased concentration of acid.

$NH_4 Cl$  (0.25N). On increasing the concentration of acid, the crystal size decreased. In all cases the color was considerably darker than with the  $Cd SO_4$  alone or with  $(NH_4)_2 SO_4$ . The adhesion was fair, improving with the concentration of acid. The cover was poor, and the treeing decreased with increased concentration of acid. Rough edges were observed on all plates. Cathode gassing increased with acid concentration. Sponginess appeared at the higher concentrations of acid. The best condition appeared to be at an acid concentration of 1cc.

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$\text{NH}_4 \text{Cl}$  (0.50N). On increasing the acidity about the same results as above were noted. Increasing the concentration of  $\text{NH}_4 \text{Cl}$  appeared to have very little effect.

$\text{Na}_2 \text{SO}_4$  (0.25N). On increasing the acid concentration, the crystal size decreased. The color appeared to be slightly darker. Adhesion was fair, and treeing decreased with increasing concentration of acid. The edges were not very rough. The cover was poor without acid, but improved with concentration of acid. Maximum concentration of acid was less than 1 cc as deposit could be seen only on one side.

$\text{Na}_2 \text{SO}_4$  (0.50N). About the same effects as noted above were observed except that the maximum concentration was 2.00 cc. Increasing the concentration of  $\text{Na}_2 \text{SO}_4$  from (0.25 to 0.50N), decreased crystal size and as well as treeing.

$\text{NaCl}$  (0.25N). Increased concentration of acid decreased the crystal size. The color was darker and the cover was fair. Considerable treeing was observed without acid but this decreased with increased concentration of acid. The adhesion was poor but improved with acid concentration.

$\text{NaCl}$  (0.50N). Increased concentration of acid produced about the same effect as noted above except that the deposit appeared somewhat denser.

With  $\text{K}_2 \text{SO}_4$  (0.25N). Increasing the concentration of acid decreased the crystal size and improved the cover and adhesion. The color was darker. A slight treeing was

1. The first step in the process of identifying a problem is to recognize that a problem exists. This is often done by comparing current performance with a desired state or goal. For example, a manager might notice that sales are declining or that customer satisfaction is low. Once a problem is identified, the next step is to define it more precisely. This involves determining the scope of the problem, its causes, and its effects. A clear definition of the problem is essential for developing an effective solution.

2. The second step is to gather information about the problem. This can be done through a variety of methods, including interviews, surveys, and data analysis. The goal is to understand the problem from multiple perspectives and to identify the underlying causes. For example, a manager might interview employees to learn about their experiences with a particular process or analyze sales data to identify trends and patterns. Gathering information is a critical step because it provides the foundation for developing a solution.

3. The third step is to generate potential solutions. This involves brainstorming ideas and evaluating them based on their feasibility and effectiveness. A manager might consider different strategies, such as increasing marketing efforts, improving customer service, or streamlining operations. Each potential solution should be evaluated based on its ability to address the problem and its impact on the organization. This step is often the most challenging because it requires creative thinking and the ability to evaluate complex information.

4. The fourth step is to select a solution. This involves choosing the most appropriate solution based on the information gathered and the organization's resources. A manager might choose a solution that is most likely to succeed given the current situation and the organization's capabilities. For example, a manager might choose to invest in new technology if it is likely to improve efficiency and reduce costs. Selecting a solution is a critical decision that can have a significant impact on the organization's success.

5. The fifth step is to implement the solution. This involves putting the chosen solution into action and monitoring its progress. A manager might assign tasks to employees, allocate resources, and establish a timeline for implementation. It is important to monitor the progress of the solution to ensure that it is being implemented correctly and to make adjustments as needed. For example, a manager might track sales data to see if the new marketing strategy is having the desired effect. Implementation is a critical step because it is where the solution is put into practice and its effectiveness is tested.

6. The sixth and final step is to evaluate the results. This involves assessing the impact of the solution and determining whether it has effectively addressed the problem. A manager might compare current performance with the desired state and identify any remaining issues. For example, a manager might compare sales data before and after the implementation of a new marketing strategy to see if there has been an improvement. Evaluating the results is a critical step because it allows the manager to learn from the experience and make improvements for the future.

observed, decreasing with increased concentration of acid. The edges were rough, and sponginess was observed on some of the plates.

$K_2 SO_4$  (0.50N). Increased concentration of acid produced about the same effects as were noted above. The maximum concentration of acid was about 0.5 cc.

KCl (0.25N). Increasing the acidity decreased the crystal size but improved the adhesion and cover. The color was dark. Considerable treeing was noted but this decreased with increase of the acidity.

KCl (0.50N). Increased concentration of acid produced about the same effects as were noted above. The best concentration noted was .04 cc. Except for color, this was the best deposit in the series. Above this concentration there was a tendency to sponginess and rough edges.

#### SUMMARY.

In all cases, as soon as  $H_2 SO_4$  was added, cathode gassing started and increased with increase of the acidity. In nearly all cases the crystal size was increased with the addition of a salt. There appeared to be a definite acidity for this type of bath and was approximately 0.1 - 0.2 cc. The color with  $(NH_4)_2 SO_4$  was the best and with  $Na_2 SO_4$  second. KCl (0.50N) gave the finest crystals with .04 cc acid but the color was dark.



1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities related to the business. This includes keeping detailed ledgers for income, expenses, and assets, as well as maintaining up-to-date financial statements.

2. The second part of the document covers the various methods and techniques used for calculating the value of different types of assets, such as real estate, stocks, and bonds. It provides a detailed overview of the valuation process, including the use of market data and professional appraisals.

3. The third part of the document discusses the legal and regulatory requirements that apply to the valuation and reporting of assets. This includes a review of relevant tax laws, accounting standards, and disclosure requirements.

4. The fourth part of the document provides a detailed overview of the various valuation methods and techniques used in practice, including both traditional and modern approaches. It also discusses the challenges and limitations associated with each method, and provides guidance on how to choose the most appropriate method for a given situation.

## APPENDIX A

1. The first part of the appendix provides a detailed overview of the various valuation methods and techniques used in practice, including both traditional and modern approaches. It also discusses the challenges and limitations associated with each method, and provides guidance on how to choose the most appropriate method for a given situation.

## DISCUSSION.

The addition of acid decreased the hydrogen overvoltage at the cathode so that hydrogen was more easily released. Altho the addition of salts of this type deminished the tendency to tree, the crystal size did not appear to be affected to a very great degree. There was also a more pronounced tendency to produce a spongy deposit. The effect of the addition of the non-metallic compounds used appeared to be of a detrimental nature, either alone or with a slight acidity.

### ADDITIONS OF METALLIC COMPOUNDS WITH ADDITIONS OF H<sub>2</sub>SO<sub>4</sub> TO Cd SO<sub>4</sub> (1.0N).

Al<sub>2</sub> (SO<sub>4</sub>)<sub>3</sub> (0.25N). Without the addition of acid or with not over 0.1 cc, H<sub>2</sub>SO<sub>4</sub> was only slightly crystalline and of a fine texture. The adhesion was good and the color was very good with a high luster. Increasing the acidity the crystal size increased. Gassing started with an acid concentration above 0.1 cc. Treeing was observed but slightly without acid and gradually decreased with increased concentration of acid. The edges were slightly rough. With 5 cc of acid the deposit showed no marked attack by the acid.

Mg SO<sub>4</sub> (0.25N). The color was about the same as with Al<sub>2</sub> (SO<sub>4</sub>)<sub>3</sub>. The crystal size was slightly finer than

## • 2.1.1.1

•  $\text{H}_2\text{O}$  is a polar molecule. The oxygen atom is more electronegative than the hydrogen atoms, so it attracts the shared electrons in the  $\text{O-H}$  bonds more strongly. This creates a partial negative charge ( $\delta^-$ ) on the oxygen atom and a partial positive charge ( $\delta^+$ ) on the hydrogen atoms. The resulting dipole moment is represented by a red arrow pointing from the hydrogen atoms towards the oxygen atom.

• The partial positive charge on the hydrogen atoms of one water molecule is attracted to the partial negative charge on the oxygen atom of another water molecule. This attraction between the  $\delta^+$  of one molecule and the  $\delta^-$  of another is called a hydrogen bond.

• Hydrogen bonds are much weaker than covalent bonds, but they are strong enough to hold water molecules together in a network. This network is responsible for many of the unique properties of water, such as its high boiling point and its ability to form a solid structure (ice) that is less dense than its liquid form.

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## • 2.1.1.2

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• Hydrogen bonds are much weaker than covalent bonds, but they are strong enough to hold water molecules together in a network. This network is responsible for many of the unique properties of water, such as its high boiling point and its ability to form a solid structure (ice) that is less dense than its liquid form.

without  $Mg SO_4$ . The cover was not very good and there was a tendency for the surface to be rough with protruding crystals. There was a slight treeing and the adhesion was poor. On adding acid the crystal size decreased considerably for the first .04 cc. but then the decrease was slight. There was also an improvement in cover and a slight treeing. Increasing the concentration of acid above 1.0 cc, there was a tendency to produce sponginess and also an indication of excess acidity.

$Al_2 (SO_4)_3$  gave finer crystals than  $Mg SO_4$  and better cover.

$Mn SO_4$  (0.1N). The crystal size was decreased and the cover was improved. The color was slightly lighter, and a good adhesion was noted, but there was considerable treeing. Increasing the concentration of acid decreased the crystal size slightly, as well as decreasing the tendency to treeing.

$Cr_2 (SO_4)_3$  (0.1N). The crystal size was fine and the cover was good giving a more even deposit. The color was lighter and the adhesion was poor until the acid concentration was 0.2 cc. Increasing the acidity decreased the crystal size but appeared to give a less even deposit.

$Cr Cl_3$  (0.1N). The deposit was very finely crystallized. The cover was good but the deposit was uneven or rough with considerable voids. The color was about the same as without  $Cr Cl_3$  and the adhesion was good. Increasing the current density seemed to increase the

The text is extremely faint and mostly illegible. It appears to be a list or series of entries, possibly related to a collection or inventory. Some faint words are visible, such as 'The following', 'numbered', and 'items', but the majority of the content cannot be transcribed accurately.

The second section of text is also very faint and illegible. It continues the list or series of entries from the first section. The structure of the text suggests it might be a detailed catalog or a set of instructions, but the specific details are lost due to low contrast.

The final section of text on the page is equally faint and illegible. It appears to be the concluding part of a list or a summary section. Some faint words are visible, but they do not form any recognizable phrases or sentences.

roughness of the surface. Increasing the concentration of acid appeared to increase the crystal size. The cover was good in all cases but the surface appeared to get rougher and more uneven with increased acidity, while sponginess was observed on some plates.

Increasing the concentration of  $\text{Ce Cl}_3$  to (0.2N) tended to increase the crystal size slightly and gave a more uneven deposit.

Further increase of concentration to (0.4N) increased the crystal size more.

$\text{Fe SO}_4$  (0.1N). No change in the crystal size was observed. The color was considerably darker; the cover was poor; the surface was uneven, and the adhesion was poor. Increasing the acidity seemed to increase the crystal size but the adhesion was poor thruout and the surface was rough, with a fair cover. All deposits were somewhat spongy but this tendency increased with the acidity.

#### SUMMARY.

Arranging the addition agents in order of their increasing effect on the crystal size we get

$\text{Cr Cl}_3$      $\text{Cr}_2 (\text{SO}_4)_3$      $\text{Al}_2 (\text{SO}_4)_3$      $\text{Mg SO}_4$   
                    $\text{Mn SO}_4$      $\text{Fe SO}_4$ .

The cover was good with  $\text{Al}_2 (\text{SO}_4)_3$ , fair with  $\text{Cr}_2 (\text{SO}_4)_3$ , but poor in the rest. The color was excellent

with  $\text{Al}_2 (\text{SO}_4)_3$ , not as good with the chromium salts, and darker with  $\text{Fe SO}_4$ ,  $\text{Mg SO}_4$ , and  $\text{Mn SO}_4$ . The surface with the  $\text{Al}_2 (\text{SO}_4)_3$  and chromium salts was slightly rough but the rest are very rough with a tendency of grouping crystals. In all cases of the addition of acid, cathode gassing was evident, and the crystal size decreased. The color and cover remained about the same as noted above. The surface showed a marked improvement with Aluminum, and both chromium salts while the rest were rather rough, but the crystals were less grouped or rather there were more crystals.  $\text{Al}_2 (\text{SO}_4)_3$  appeared to be of some value as an addition agent.

#### DISCUSSION.

In using  $\text{Al}_2 (\text{SO}_4)_3$  after the salt has dissolved the usual apoleseence was observed, due to hydrolysis, but this disappeared upon standing, probably due to an equilibrium being established. The aluminum sulphate seemed to possess that additive property which when used with  $\text{Cd SO}_4$  produced more nearly the condition required for a good deposit.  $\text{Al}_2 (\text{SO}_4)_3$  is the first addition agent that appears to have any marked tendency to give a good deposit.

1. The first step in the process of identifying a potential problem is to define the problem. This involves identifying the symptoms and the context in which the problem is occurring. For example, if a company is experiencing a decline in sales, the problem might be defined as a decrease in revenue over a specific period.

2. The next step is to gather information about the problem. This can be done through a variety of methods, including interviews with employees, reviewing financial data, and conducting market research. The goal is to understand the underlying causes of the problem and to identify any trends or patterns that may be relevant.

3. Once the information has been gathered, the next step is to analyze the data. This involves looking for patterns and trends that may be related to the problem. For example, if sales are declining, it might be worth looking at changes in customer demographics or marketing strategies.

4. The final step in the process is to develop a solution. This involves identifying the root cause of the problem and developing a plan to address it. The solution should be based on the information gathered in the previous steps and should be designed to address the specific problem identified.

### Problem Solving

1. The first step in the problem-solving process is to identify the problem. This involves recognizing the symptoms and the context in which the problem is occurring. For example, if a machine is not working, the problem might be identified as a breakdown or a malfunction.

2. The next step is to gather information about the problem. This can be done through a variety of methods, including checking the machine's manual, asking for help from a technician, or conducting a visual inspection. The goal is to understand the underlying causes of the problem and to identify any potential solutions.

3. Once the information has been gathered, the next step is to analyze the data. This involves looking for patterns and trends that may be related to the problem. For example, if a machine is not working, it might be worth looking at the age of the machine or the frequency of use.

4. The final step in the process is to develop a solution. This involves identifying the root cause of the problem and developing a plan to address it. The solution should be based on the information gathered in the previous steps and should be designed to address the specific problem identified.



EFFECT OF CONCENTRATION OF Cd SO<sub>4</sub> WITH H<sub>2</sub>SO<sub>4</sub>.

Increasing the concentration of Cd SO<sub>4</sub> from (1.0N) to (2.0N), the crystal size was about the same, but the cover was improved and a denser deposit was obtained. The color was about the same but the adhesion was improved. Increasing the acidity to 0.1 cc the crystal size decreased but above 0.1 cc sponginess appeared.

In the case of Cd SO<sub>4</sub> 1.5N the crystal size was slightly smaller than with (1.0N). The cover was poor but the color and adhesion were fair. A slight treeing was observed, the edges were rough and there was a tendency to produce a spongy deposit.

DISCUSSION.

It is rather difficult to say at this time which concentration would be of the most value. The effect of addition agents seems to vary considerably with the concentration as will be shown later. However, a higher concentration of Cd SO<sub>4</sub> than (1.0N) is necessary in order to eliminate the tendency to give treeing.

# THE HISTORY OF THE UNITED STATES

The history of the United States is a story of growth, struggle, and achievement. From the first European settlers to the present day, the nation has evolved through various stages of development. The early years were marked by the search for a better life in a new world, followed by a period of colonial expansion and the fight for independence. The American Revolution led to the formation of a new government, which has since been shaped by the actions of many great leaders. The nation's growth was fueled by westward expansion, the industrial revolution, and the pursuit of a common dream. Despite the challenges and setbacks, the United States has emerged as a global superpower, a land of opportunity and freedom.

## THE AMERICAN DREAM

The American Dream is the belief that anyone can attain success and prosperity through hard work and determination. It is a dream of a better life, a dream of a future where everyone has the chance to succeed. The American Dream is a powerful force that has inspired generations of Americans to strive for greatness. It is a dream that has shaped the nation's identity and values. The American Dream is a dream of hope, a dream of possibility, a dream of a better tomorrow. It is a dream that has made the United States a land of opportunity and a land of hope.

MISCELLANEOUS ADDITIONS TO Cd SO<sub>4</sub> 1.0N.CHROMIC ACID (2 gms.)

With this bath the deposit became covered with a loose, black, spongy mass. This may have been due to excessive chromic acid so a bath was tried containing chromic acid (0.005 gms.). In this case the deposit was very rough and spongy and similar to the above.

BORIC ACID.

With 1 gm. Boric acid the crystal size decreased slightly but the cover was poor and the deposit contained some voids. The color was about the same as without the acid and the adhesion was fair.

Increasing the Boric acid content to 2 gms. the crystal size increased slightly but sponginess appeared. On adding H<sub>2</sub>SO<sub>4</sub> to this bath the sponginess disappeared, and with 0.1 cc a fairly fine crystalline deposit was obtained with no sponginess.

Increasing the boric acid in the same bath to 3 gms. the crystal size was further decreased. The voids were smaller while the color remained the same. Increasing the H<sub>2</sub>SO<sub>4</sub> to 0.2 cc decreased the crystal size but the deposit still contained considerable voids. With a further increase in acidity to 1.0 cc, the voids seemed to increase.

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DISCUSSION.

Apparently the chromic acid produced the conditions noted in Bancroft's first "axiom". Chromic acid has a detrimental effect on the deposit.

Boric acid did not seem to be of any particular value in the simple bath with acidity. Boric acid is used in plating solutions as a buffer to control the actual acidity. It may prove to be of value later.

ADDITIONS OF NON-METALLIC SALTS TO BATH OF Cd SO<sub>4</sub> 1.0N,  
AND Al<sub>2</sub> (SO<sub>4</sub>)<sub>3</sub> (0.25N).

(NH<sub>4</sub>)<sub>2</sub> SO<sub>4</sub> (0.25N). There was an increase in the crystal size due to the (NH<sub>4</sub>)<sub>2</sub> SO<sub>4</sub> but the deposit was very fine. The color was good but a little darker. The adhesion and cover were good but there was a slight treeing and some voids. Increasing the current density decreased the crystal size, improved the cover, but gave an excessive treeing.

Increasing the (NH<sub>4</sub>)<sub>2</sub> SO<sub>4</sub> concentration to (0.50N), there was no material change except that treeing was decreased.

Na<sub>2</sub> SO<sub>4</sub> (0.25N and 0.50N) gave about the same results as for (NH<sub>4</sub>)<sub>2</sub> SO<sub>4</sub>.

With NH<sub>4</sub> Cl (0.50N) the crystal size seemed larger than with either of the above. The color was slightly

## • 2012

• 2012年1月1日起，中国开始实施营业税改征增值税试点，即“营改增”。这一改革旨在减轻企业税负，促进服务业和制造业的发展。试点首先在上海市部分行业展开，随后逐步推广至全国。

• 2012年5月，中国启动新一轮的“四万亿”投资计划，以应对全球金融危机带来的经济挑战。这一计划重点支持基础设施建设和民生工程，旨在刺激内需，促进经济增长。

• 2012年6月，中国宣布将人民币纳入国际货币基金组织（IMF）的特别提款权（SDR）货币篮子。这是人民币国际化的重要一步，标志着人民币在国际金融体系中的地位日益提升。

• 2012年7月，中国启动新一轮的“宽带中国”战略，旨在加快宽带网络建设和普及，提升国家信息化水平。这一战略将重点支持农村地区和欠发达地区的网络建设。

• 2012年8月，中国宣布将人民币与美元挂钩，实行有管理的浮动汇率制度。这一举措旨在增强人民币的稳定性，促进国际贸易和投资。

• 2012年9月，中国启动新一轮的“节能减排”行动，旨在降低能源消耗，减少温室气体排放。这一行动将重点支持节能环保产业的发展，推动绿色经济转型。

• 2012年10月，中国宣布将人民币与美元挂钩，实行有管理的浮动汇率制度。这一举措旨在增强人民币的稳定性，促进国际贸易和投资。

• 2012年11月，中国启动新一轮的“宽带中国”战略，旨在加快宽带网络建设和普及，提升国家信息化水平。这一战略将重点支持农村地区和欠发达地区的网络建设。

• 2012年12月，中国宣布将人民币与美元挂钩，实行有管理的浮动汇率制度。这一举措旨在增强人民币的稳定性，促进国际贸易和投资。

darker, the cover was fair but the adhesion was poor.

### DISCUSSION.

As noted before, the addition of  $(\text{NH}_4)_2 \text{SO}_4$  or similar salts tend to increase crystal size but decrease treeing. Whether or not an adjustment of concentrations will be found so that this addition will be of any value remains to be seen.

### MISCELLANEOUS ADDITIONS TO 2.0N Cd SO<sub>4</sub>.

$\text{Cr}_2 (\text{SO}_4)_3$  (0.05N). The crystal size decreased but there were voids in the surface. The color and adhesion were good. There was no treeing but the edges were rough. Adding 0.1 Gr  $\text{H}_2\text{SO}_4$  decreased crystal size slightly with a less tendency to form voids. The cover and color were good. Increasing the current density increased the crystal size and more voids were observed.

$\text{Cr Cl}_3$  (0.1N). The crystal size decreased but the color was darker. Adhesion and cover were good but there were considerable voids and a slight treeing on the corners.

The addition of  $\text{H}_2\text{SO}_4$  decreased the crystal size slightly with but little change in the surface to decrease voids. The tendency to sponge was quite pronounced. The addition of 2.0 gms. Boric acid had very little effect on the deposit.

• Wiederholungsfragen sind die Fragen, die in den Vorlesungen und den Vorlesungsaufgaben gestellt wurden.

## • Zusammenfassung

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$(\text{NH}_4)_2 \text{SO}_4$  (0.50N). There was no appreciable change in the crystal size. The color was the same. The cover was good but the adhesion was poor. The surface was uneven but dense. The addition of  $\text{H}_2\text{SO}_4$  decreased the crystal size somewhat. In all cases there was a decided tendency to sponge. Increasing the concentration of  $(\text{NH}_4)_2 \text{SO}_4$  to (1.0N) did not affect the above condition to a very great degree, except that the adhesion was improved. In all the deposits with  $(\text{NH}_4)_2 \text{SO}_4$  the bath had a tendency to produce sponginess.

$\text{Al}_2 (\text{SO}_4)_3$  (.25N). The crystal size was fairly fine but there was a tendency to leave voids. The color and cover were good as was the adhesion. No treeing was observed but the edges were rough. Increasing the current density, decreased the crystal size and improved the cover so that a more uniform deposit was obtained. There was no tendency to sponge. Increasing the acidity tended to increase the crystal size but improved the cover. The adhesion was good.

$\text{Al}_2 (\text{SO}_4)_3$  (1.0N). The deposit was finer in texture and the color was very good. The cover was better than with the lower concentration of aluminum. Cohesion was good but there was a slight treeing and the edges were rough. Increased current density decreased the crystal size to a very fine uniform deposit but the tendency to treeing was excessive. Increasing the acidity decreased the crystal size but the deposit was not as good as without the acid.



With an acidity above 2.0 cc sponginess appeared. The concentration of aluminum was probably excessive.

$\text{Al}_2 (\text{SO}_4)_3$  (0.25N) and  $(\text{NH}_4)_2 \text{SO}_4$  (0.50N).

The crystal size was increased slightly due to  $(\text{NH}_4)_2 \text{SO}_4$ . The color and cover were good but there were some voids on the surface. There was no treeing but the edges were slightly rough. Increased current density decreased the crystal size but sponginess was observed.

$\text{Al}_2 (\text{SO}_4)_3$  (0.25N),  $(\text{NH}_4)_2 \text{SO}_4$  (1.0N). The crystal size was slightly larger. Otherwise, the effects were the same as noted above.

$\text{Al}_2 (\text{SO}_4)_3$  (0.50N),  $(\text{NH}_4)_2 \text{SO}_4$  (0.50N). The crystal size was slightly smaller than in the case of  $\text{Al}_2 (\text{SO}_4)_3$  (0.25N)  $(\text{NH}_4)_2 \text{SO}_4$  (0.50N). The other effects were about the same as noted above. No treeing was noted.

#### SUMMARY.

The most uniform deposit as well as having the best color was obtained by using only the  $\text{Al}_2 (\text{SO}_4)_3$  as an addition agent. The addition of  $(\text{NH}_4)_2 \text{SO}_4$  had the detrimental effect noted previously.

It appears that with  $\text{Cd SO}_4$  2.0N the best assition is  $\text{Al}_2 (\text{SO}_4)_3$  (0.50N).

• The first step in the process of creating a business plan is to conduct a market analysis. This involves identifying the target market, understanding the needs and preferences of customers, and assessing the competitive landscape. A thorough market analysis provides valuable insights into the potential size and growth of the market, as well as the strengths and weaknesses of existing competitors.

• Once the market analysis is complete, the next step is to define the business's mission and vision. The mission statement should clearly articulate the company's purpose and the value it aims to provide to its customers. The vision statement, on the other hand, should describe the long-term goals and aspirations of the business, providing a clear direction for the organization's future growth and success.

• The third step in the process is to develop a detailed financial plan. This involves estimating the costs of starting and operating the business, as well as projecting the revenue and profits over a period of time. A financial plan is essential for determining the feasibility of the business and for securing the necessary funding from investors or lenders.

• The fourth and final step is to create a marketing and sales strategy. This involves identifying the most effective ways to reach the target market, promote the business, and generate sales. A well-defined marketing and sales strategy is crucial for the success of the business, as it ensures that the company is able to attract and retain customers in a competitive market.

VARIOUS ADDITIONS TO Cd SO<sub>4</sub> (1.5N).

(NH<sub>4</sub>)<sub>2</sub> SO<sub>4</sub> (0.50N). The crystal size increased slightly. The color and cover were poor but the adhesion was improved. There was no tendency to tree except with the higher current densities.

Al<sub>2</sub> (SO<sub>4</sub>)<sub>3</sub> (0.25N). The crystal size was fine. The cover was good and the color very good with a high luster. The adhesion was good. There was no noticeable treeing except with the higher current densities but the edges were slightly rough. Increasing the current density decreased the size of the crystals and also decreased the formation of voids and gave a more even deposit.

Al<sub>2</sub> (SO<sub>4</sub>)<sub>3</sub> (0.50N). The deposit appeared denser but the surface was rougher in that more voids were observed.

Al<sub>2</sub> (SO<sub>4</sub>)<sub>3</sub> (0.25N), (NH<sub>4</sub>)<sub>2</sub> SO<sub>4</sub> (0.50N). The crystal size was increased. The cover and color were not as good and there was a slight tendency to give a spongy deposit.

Al<sub>2</sub> (SO<sub>4</sub>)<sub>3</sub> (0.25N), Cr Cl<sub>3</sub> (0.1N). The crystal size was decreased and a denser deposit was obtained. The color was slightly darker. The cover was fair but the adhesion was poor. Agitation with air decreased treeing.

Al<sub>2</sub> (SO<sub>4</sub>)<sub>3</sub> (0.25N), Fe Cl<sub>3</sub> (5 gms.). The crystal size increased considerable and the color was darker. The adhesion was poor but the cover was fair. There was no treeing but rough edges were observed.



$\text{Al}_2 (\text{SO}_4)_3$  (0.25N),  $\text{Na C}_2\text{H}_3\text{O}_2$  3 gm. The crystal size was fairly large with a tendency to exist as individual crystals. The color was darker and the cover was poor while the adhesion was fair.

#### SUMMARY.

The best deposit observed up to the present time was obtained from a bath containing  $\text{Cd SO}_4$  (1.5N), and  $\text{Al}_2 (\text{SO}_4)_3$  (0.25N).

#### EFFECT OF VARIOUS ACIDS..

The bath used for this observation was as follows:  $\text{Cd SO}_4$  (1.5N),  $(\text{NH}_4)_2 \text{SO}_4$  (0.50N),  $\text{Al}_2 (\text{SO}_4)_3$  (0.25N). The acids were added in very small quantities and the effects noted in each case.

$\text{H}_2\text{SO}_4$ . The crystal size was increased but was more uniform and there were less voids.

$\text{HC}_2\text{H}_3\text{O}_2$ . The crystal size increased considerable with increased concentration of acid. The cover was good but the color was darker. There was a tendency to produce sponginess.

$\text{HClO}_4$ . The crystal size increased considerably with increased concentration of acid. There was a decided tendency to produce sponginess.

$\text{H}_3\text{PO}_4$ . Crystal size was increased considerably with increased concentration of acid. The adhesion was poor,

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a decided tendency to produce sponginess. was observed.

$H_3PO_4$ . Crystal size was increased considerably with increased concentration of acid. The adhesion was poor and there was a decided tendency to produce sponginess.

$H_2C_2O_4$  (1 gm.). The crystal size was increased slightly. The cover was fair but there were considerable voids. There was no treeing but the adhesion was poor while the color was darker.

Citric Acid (1 gm.). The effects noted were the same as under  $H_2C_2O_4$ .

#### SUMMARY.

In all cases the addition of the acids had a very detrimental effect on the deposit. It would appear that the electrolytic deposition should be carried out in a neutral or very slightly acid solution.

#### EFFECT OF ORGANIC ADDITION AGENTS.

The bath used consisted of  $Cd SO_4$  (1.5N), and  $Al_2 (SO_4)_3$  0.25N to which was added the following organic compounds.

H CHO (0.1 cc). There was a decrease in the crystal size but the color was slightly darker. The adhesion

1. The first part of the document discusses the importance of maintaining accurate records of all transactions.

2. It also highlights the need for regular audits to ensure the integrity of the financial data.

3. The document further outlines the various methods used to collect and analyze financial information.

4. Finally, it provides a detailed overview of the reporting requirements and the consequences of non-compliance.

5. The document concludes by emphasizing the role of transparency and accountability in the financial reporting process.

6. It also discusses the challenges faced by organizations in implementing effective financial reporting systems.

7. The document provides a comprehensive guide for organizations looking to improve their financial reporting practices.

8. It includes a list of best practices and recommendations for ensuring the accuracy and reliability of financial data.

9. The document also addresses the role of technology in modern financial reporting and the benefits it offers.

10. Finally, it provides a summary of the key findings and conclusions of the study.

11. The document is intended to serve as a valuable resource for financial professionals and organizations alike.

12. It is hoped that this document will help to promote a greater understanding of the importance of financial reporting and the need for continuous improvement.

13. The document is a result of the collaborative efforts of many individuals and organizations who have shared their expertise and insights.

14. It is a testament to the power of teamwork and the pursuit of excellence in the field of financial reporting.

15. We believe that this document will be a valuable addition to the literature on financial reporting and will help to advance the field.

16. We would like to thank all those who have supported us throughout the process and who have helped to make this document possible.

17. We are confident that this document will provide a wealth of information and insights that will be helpful to all who read it.

and cover were fair. There was no treeing but the edges were rough and there was a decided tendency to form a streaked deposit. Increasing the concentration of HCHO to 0.5 cc increased the size of the crystals but did not appear to effect the other factors.

CH<sub>3</sub> CHO (0.1 cc). The deposit was rather coarsely crystalline. The color was darker and the adhesion poor. Agitation decreased treeing as well as the crystal size, but sponginess was more noticable.

CH<sub>3</sub> CHO (0.5cc). The deposit was coarsely crystalline even with agitation. The color was lighter than the above. Adhesion and cover were poor.

C<sub>2</sub>H<sub>5</sub> OH (1.00 cc). There was a decrease in crystal size but no other change was noticed. Increasing the concentration of C<sub>2</sub>H<sub>5</sub> OH to 5 cc increased the crystal size but this was decreased by adding H<sub>2</sub>SO<sub>4</sub> 0.5 cc. There was a noticable tendency to striate the deposit. Further additions of acid had little effect expect to increase cathode gassing.

Clove Oil (2 drops). The crystal size was decreased considerably so that a very fine deposit was obtained, except for some voids. The color was excellent. The cover was good but the adhesion was fair. There was no treeing but the edges were rough.

Clove Oil in alcohol ( $\frac{1}{2}$  drop oil to 1.0 cc alchhol).(1 cc There was no change observed. (2 cc). The crystal size decreased very slightly. There was a noticable tendency to

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give a striated deposit.

On adding  $\text{H}_2\text{SO}_4$  0.5 cc, the crystal size decreased slightly and there was no tendency to form a striated deposit.

Gelatin (0.1 gm.). A very fine deposit was obtained. The cover and adhesion were good. The color was about the same as that obtained from a cyanide bath. At low current densities there was no treeing and the edges were only slightly rough which was eliminated by agitation. At higher current densities the edges were rougher but the deposit was better.

Gelatin (0.02 gm.). The deposit was slightly rougher and the color and adhesion were not as good as above.

$\text{Cd SO}_4$  (1.5N)  $\text{Al}_2 (\text{SO}_4)_3$  (0.50N). The crystal size was fine and decreased with increased current density, but the edges became correspondingly rougher. The color was darker but the adhesion and cover were good. The deposit was finer but darker than with 0.02 gm. Gelatin was rougher than with 0.1 gm.

$\text{Cd SO}_4$  (2.0N),  $\text{Al}_2 (\text{SO}_4)_3$  (0.50N), Gelatin 0.05 gm. The deposit was about the same as noted just above.

Dextrose (0.02 gm.). This addition had very little effect, except to make the color slightly darker.

Dextrose (1.0 gm.). The crystal size was increased considerably even at relatively high current densities.

Peptone (0.1 gm.). The crystal size was very fine, but there were considerable voids. The color was darker

## • Protein synthesis:

• Primary structure: sequence of amino acids

• Secondary structure: local interactions between amino acids

• Tertiary structure:

• interactions between all amino acids

• Quaternary structure: interactions between subunits

• Polypeptide chain: amino acid chain

• Protein: polypeptide chain with its tertiary structure

• Polypeptide chain synthesis: occurs in ribosomes

• Protein synthesis: occurs in ribosomes

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and the adhesion and cover were fair. There was no treeing but the edges were slightly rough.

Blood Fibrin (0.1 gm.). The deposit was very coarsely crystalline and about the same as the simple salt solution with no additions.

Egg Albumin (0.1 gm.). The crystal size was very fine but the plate was pitted. The color was very dark but the cover and adhesion were good. The edges were slightly rough and the plate had a slight tendency to striate.

Egg Albumin (0.02 gm.). The crystal size increased some, but the color was much lighter, but as yet slightly dark. The adhesion and cover were good. The deposit was rough and had a pronounced tendency to striate.

Licorice Root (0.2 gm.). The root was cut into fine shreads and allowed to soak in the solution over night. The crystal size was very fine. The color was excellent. The cover was good and the adhesion was very good.

Gum Tragacanth (0.05 gm.) There was very little change in crystal size but the tendency to sponge was very pronounced. The cover was fair but the adhesion was poor. The color was slightly darker.

Gum Arbic. The crystal size was fairly fine but there was a decided tendency to give sponginess. The cover and adhesion were poor. Adding  $\text{Na H}_2 \text{PO}_4$  (10. gms.) increased the crystal size very much. The cover and adhesion were poor. The color was darker.

Glue (0.05 gm.). The crystal size was very fine, but there was a decided tendency to give sponginess. The

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cover and adhesion were poor and the color was darker.

Uric Acid (0.05 gm.). The crystal size was considerably increased. The cover was poor, the color darker; and the adhesion, fair.

B. Naphthol (0.05 gm.). As this solution was used it became slightly colored probably due to a reaction of the B. Naphthol. The deposit was very fine. The color, cover and adhesion were good. There was no treeing and the edges were smooth, except at the higher current densities. Excessive rough edges were eliminated by using mechanical agitation.

#### SUMMARY.

Reducing agents such as aldehydes did not produce a sufficiently good deposit. Of the addition agents used the most likely ones to be of any use were, gelatin, and B. Naphthol and Licorice Root. The other addition agents were more or less detrimental to the deposit. Agitation reduced or eliminated any tendency to form rough edges.

The first part of the report discusses the current state of the industry and the challenges it faces. It highlights the need for innovation and investment in research and development to maintain a competitive edge in the global market. The second part of the report focuses on the company's strategic vision and the key initiatives that will drive its growth over the next five years. This includes expanding into new markets, developing new products, and strengthening the company's financial position. The third part of the report provides a detailed financial forecast, including revenue projections, profit margins, and cash flow analysis. It also includes a risk assessment and a contingency plan to address potential uncertainties. The final part of the report concludes with a summary of the key findings and a call to action for the company's management and stakeholders.

### Conclusion

In conclusion, the report provides a comprehensive overview of the company's current performance and future prospects. It identifies the key challenges and opportunities that will shape the company's success in the coming years. The strategic vision and key initiatives outlined in the report provide a clear path forward for the company, and the financial forecast offers a detailed look at the expected outcomes. The risk assessment and contingency plan ensure that the company is prepared to navigate any uncertainties that may arise. The report concludes with a strong call to action, urging the company's management and stakeholders to work together to achieve the company's long-term goals and maintain its position as a leader in the industry.

GENERAL SUMMARY AND DISCUSSION.

The use of salts of the type of  $(\text{NH}_4)_2 \text{SO}_4$  appeared to be more of a detriment. Altho treeing was deminished to a great extent by their use the increase in crystal size outweighed any advantage. No combinations were found in which the addition of these salts would prove successful.

Of the various salts used  $\text{Al}_2 (\text{SO}_4)_3$  was deemed of the most value altho  $\text{Ce Cl}_3$  might be used to advantage. The color due to the presence of the  $\text{Al}_2 (\text{SO}_4)_3$  was very good and better than that of any others. Other than the organic compounds, no additions were found that would be advantageous to use in connection with  $\text{Al}_2 (\text{SO}_4)_3$ .

Of the organic compounds; Licorice Root, gelatin, and B. Naphthal were the only ones to produce a deposit that could be of any value. Of these, B. Naphthol and gelatin produced the highest color but the licorice root gave a slightly better deposit.

THE HISTORY OF THE UNITED STATES

The first part of the history of the United States is the period of discovery and settlement. The second part is the period of the American Revolution and the formation of the Constitution. The third part is the period of the expansion of the United States to the Pacific Ocean. The fourth part is the period of the Civil War and Reconstruction. The fifth part is the period of the Gilded Age and the Progressive Era. The sixth part is the period of the World Wars and the Cold War. The seventh part is the period of the Vietnam War and the Watergate scandal. The eighth part is the period of the 1960s and 1970s. The ninth part is the period of the 1980s and 1990s. The tenth part is the period of the 2000s and 2010s.

The history of the United States is a story of a young nation that grew from a small group of settlers on the eastern coast to a global superpower. The story is one of exploration, discovery, and the pursuit of a better life. It is a story of the American dream, of the belief that anyone can succeed through hard work and determination. The history of the United States is a story of the triumph of the individual over the state, of the power of the people to shape their own destiny. It is a story of the American spirit, of the courage and ingenuity of the American people.

The history of the United States is a story of a nation that has shaped the world. It is a story of a nation that has led the world in the arts, in science, in technology, and in the pursuit of a better life. The history of the United States is a story of a nation that has inspired the world. It is a story of a nation that has shown the world that a better life is possible. The history of the United States is a story of a nation that has made the world a better place.

RECOMMENDATIONS FOR A BATH.

The electrolytic deposition of cadmium can be accomplished to give satisfactory deposits. In any plating bath it is important that the solution be as simple as possible. In the case of cadmium, the bath should have the following composition:  $\text{Cd SO}_4$  1.5N,  $\text{Al}_2 (\text{SO}_4)_3$  0.25N, with an organic addition agent. Of the organic addition agents any one of the following should be used: Gelatin 0.1 gm., licorice root 0.2 gm., or B. Naphthol 0.05 gm.

A cathode current density of 1.5 - 2.2 amperes per square decimeter should be used. The anode area should be from 1.5 - 2.0 times as great as the cathode area. The temperature should be approximately that of ordinary room temperature. The solution should be agitated mechanically for successful operation.

## QUESTION 1

1. The following table shows the number of people who visited a museum in each month from January to December.
- | Month     | Number of Visitors |
|-----------|--------------------|
| January   | 120                |
| February  | 150                |
| March     | 180                |
| April     | 200                |
| May       | 220                |
| June      | 250                |
| July      | 280                |
| August    | 300                |
| September | 280                |
| October   | 250                |
| November  | 220                |
| December  | 180                |
2. The following table shows the number of people who visited a museum in each month from January to December.
- | Month     | Number of Visitors |
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KEY TO PHOTOMICROGRAPHS.

<u>FIGURE</u>	<u>BATH.</u>
1	Cd SO <sub>4</sub> 1.0N.
2	Cd SO <sub>4</sub> 1.5N.
3	Cd SO <sub>4</sub> 2.0N.
4	Cd SO <sub>4</sub> 1.5N, (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> 0.50N.
5	Cd SO <sub>4</sub> 1.5N, Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> 0.25N.
6	Cd SO <sub>4</sub> 1.5N, (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> 0.50N, Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> 0.25N.
7	Cd SO <sub>4</sub> 1.5N, Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> 0.25N, Gelatin 0.1 gm.
8	Cd SO <sub>4</sub> 1.5N, Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> 0.25N, B. Naphthol 0.05 gm.
9	Cd SO <sub>4</sub> 1.5N, Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> 0.25N, Licorice Root 0.2 gm.
10	Cd SO <sub>4</sub> 1.5N, Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> 0.25N, Egg Albumin 0.1 gm.
11	Cd SO <sub>4</sub> 1.5N, Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> 0.25N, Clove Oil 2 drops.

# Mathematical Induction

## Principle of Mathematical Induction

Let  $P(n)$  be a statement involving  $n$ .

1.  $P(1)$  is true.

2.  $P(k) \Rightarrow P(k+1)$  is true.

Then  $P(n)$  is true for all  $n \in \mathbb{N}$ .

Example: Prove that  $1 + 2 + 3 + \dots + n = \frac{n(n+1)}{2}$ .

Let  $P(n)$  be the statement  $1 + 2 + 3 + \dots + n = \frac{n(n+1)}{2}$ .

1.  $P(1)$  is true because  $1 = \frac{1(1+1)}{2} = 1$ .

2. Assume  $P(k)$  is true, i.e.,  $1 + 2 + 3 + \dots + k = \frac{k(k+1)}{2}$ .

We need to show  $P(k+1)$  is true, i.e.,  $1 + 2 + 3 + \dots + k + 1 = \frac{(k+1)(k+1+1)}{2}$ .

By the induction hypothesis,  $1 + 2 + 3 + \dots + k = \frac{k(k+1)}{2}$ .

Adding 1 to both sides, we get  $1 + 2 + 3 + \dots + k + 1 = \frac{k(k+1)}{2} + 1$ .

Q.E.D.

□





Figure 1.



Figure 2.

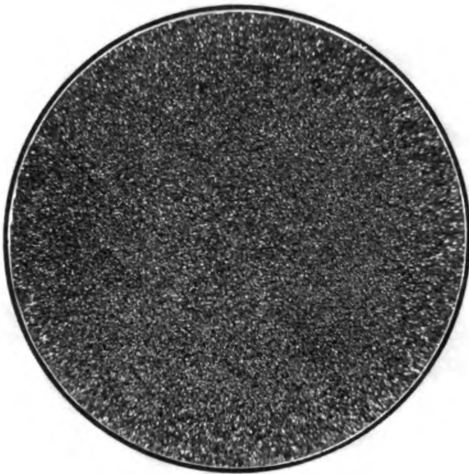


Figure 3.



Figure 4.



Figure 5.



Figure 6.



Figure 7.



Figure 8.



Figure 9.



Figure 10.



Figure 11.

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