(An Autonomous Institute Affiliated to Savitribai Phule University)

FY B Tech. Nano Project Report

APPLICATIONS OF CHEMISTRY IN MECHANICAL ENGINEERING

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1.MR. AMOL KAPSE SIR

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ABSTRACT:

Mechanical engineering, often perceived as a discipline solely focused on mechanics and machines, relies deeply on various scientific principles to design, innovate, and optimize mechanical systems. Among these foundational sciences, chemistry plays a pivotal and often understated role. It forms the bedrock upon which several critical aspects of mechanical engineering thrive, contributing significantly to the understanding, development, and improvement of mechanical systems.

Chemistry plays a central role in the understanding of material properties, their behavior under various conditions, and the selection of appropriate materials for mechanical components. From metals and alloys to composites and polymers, the composition, structure, and properties of materials are paramount in determining their suitability for diverse mechanical applications.

Understanding chemical reactions is crucial in combating corrosion, a pervasive challenge faced in mechanical systems. Chemistry aids in the development of effective surface treatments, coatings, and corrosion-resistant materials, prolonging the lifespan and reliability of mechanical components.

This report aims to explore these interconnections between chemistry and mechanical engineering, highlighting the critical role chemistry plays in advancing innovation, efficiency, and sustainability within this field.

MOTIVATIONS:

The motivation to undertake this study on applications of chemistry in mechanical engineering is to bridge the gap between seemingly distinct fields—chemistry and mechanical engineering—highlighting how the integration of chemical principles enriches and expands the horizons of mechanical engineering applications.

Understanding the chemical composition and behavior of materials is crucial for optimizing mechanical systems. The report seeks to emphasize how a deeper comprehension of materials at a molecular level can lead to the development of stronger, lighter, and more durable components.

By exploring the role of chemistry in mechanical systems, the report aims to showcase how leveraging chemical knowledge leads to innovations that enhance the efficiency and performance.

The report aims to offer solutions to practical challenges encountered in mechanical engineering by leveraging chemical insights. This can help engineers address issues such as material degradation, energy efficiency, pollution, and resource conservation.

Lastly : As an educational resource, the report can serve as a comprehensive guide for students, researchers, and professionals seeking a deeper understanding of how chemistry intertwines with various aspects of mechanical engineering.

PROBLEM STATEMENT

APPLICATIONS OF CHEMISTRY IN MECHANICAL ENGINEERING:

OBJECTIVES AND SCOPE

☐Standards for testing and material
☐Mechanical testing of materials
- Tensile testing
- Hardness testing
- Impact testing

☐Determining percentage composition of materials via spectroscopy
☐Corrosion testing
☐Chemical analysis of materials by wet chemical methods
- Experiment 1: Qualitative Analysis for Nickel in SS316
- Experiment 2: Qualitative Analysis for Iron in SS316
- Experiment 3: Qualitative Analysis for Mangenesel in SS316
- Experiment 4: Qualitative Analysis for Chromium in SS316

STANDARDS FOR MATERIALS AND TESTING:

Standards for materials and testing are crucial in various industries, including manufacturing, construction, aerospace, automotive, and more. These standards ensure quality, reliability, safety, and interoperability of materials and products.
They provide guidelines, specifications, and procedures for the selection, processing, testing, and use of materials in different applications.

There are several standards organizations that focus specifically on materials and testing standards across various industries .Here are some prominent international standards organizations:

- American Society for Testing and Materials(ASTM)
- International Organization for Standardization (ISO)
- American National Standards Institute (ANSI)
- British Standards Institution (BSI)
- Deutsches Institut für Normung (DIN)
- Japanese Industrial Standards (JIS)

These international standards organizations, among others, contribute significantly to the development and maintenance of standards that facilitate global trade, technological advancement, safety, and compatibility across diverse industries and sectors. They enable harmonization and cooperation among nations, industries, and stakeholders for the benefit of society.

MECHANICAL TESTING OF MATERIALS

Tensile Testing of Stainless Steel 316 (SS316)

Objective:

The objective of this experiment is to conduct a tensile test on SS316 to determine its mechanical properties, including ultimate tensile strength, yield strength, modulus of elasticity, and percentage elongation. The test aims to assess the material's behavior under axial loading and generate a stress-strain curve for analysis.

Materials Used:

- SS316 specimen (Stainless Steel 316)
- Tensile testing machine (Universal Testing Machine - UTM)
- Vernier caliper
- Extensometer (optional, for accurate strain measurement)
- Safety gloves and goggles

Procedure:

- <u>Specimen Preparation:</u>

  A SS316 specimen was obtained and prepared according to ASTM standards for tensile testing. The specimen was machined to have parallel ends and a reduced section for accurate test results.

- Setup and Calibration:

  The UTM was set up and calibrated following the manufacturer's instructions to ensure accurate readings.

  The SS316 specimen was securely placed in the UTM's grips, ensuring proper alignment and fixation.

- Tensile Test Execution:

  The tensile test was performed at room temperature.

  The UTM applied a uniaxial tensile load on the SS316 specimen at a constant crosshead speed of 5 mm/min.

  Load and extension were continuously recorded until failure occurred.

- Data Collection:

  Load and extension data were collected during the test to calculate stress and strain.

  Stress was determined by dividing the applied force by the original cross-sectional area of the SS316 specimen. Strain was calculated as the change in length divided by the original length.

- Analysis:

  A stress-strain curve was plotted using the collected data to analyze SS316's mechanical behavior.

Mechanical properties such as ultimate tensile strength (UTS), yield strength, modulus of elasticity, and percentage elongation were derived from the stress-strain curve.

Results:

- Max. Load (kN) : 96.855
- Tensile Strength (N/mm2) : 1230.68
- Yield Stress (N/mm2) : 768.787
- Youngs Modulus (N/mm2) : 99348.174
- YS/UTS : 0.737
- UTS/YS : 1.358

<u>Elongation and Area</u>

- Elongation % : 15.02
- Reductíon in Area % : 64.663,

Final CS. Area (mm2) : 27.81,

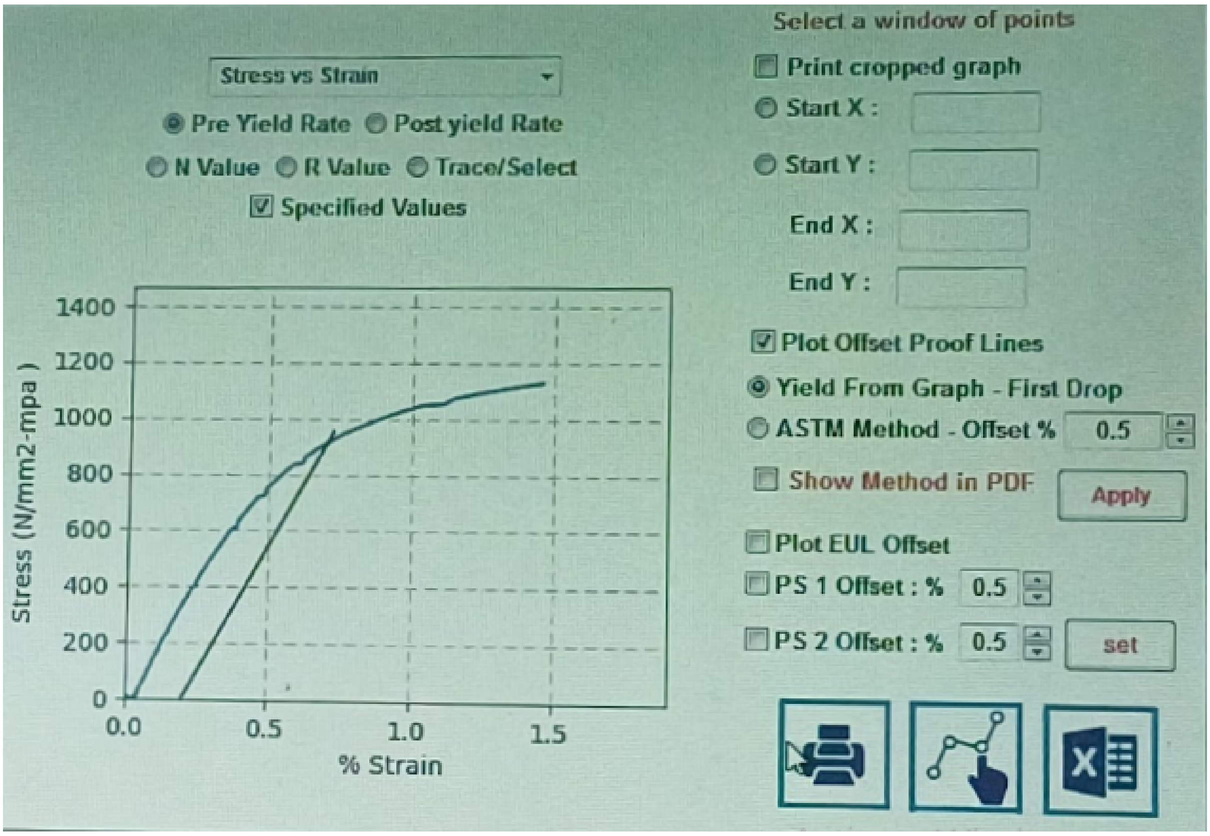
Final Gauge Length (mm) : 57,51,

<u>Input Fields</u> :

- Gauge Length (mm) : 50.0
- Outer Diameter (mm) : 10.01

<u>Stress- strain curve:</u>

The stress-strain curve displayed distinct regions representing elastic deformation, plastic deformation, and ultimate failure.



Conclusion:

The tensile test of SS316 provided valuable insights into its mechanical properties. The obtained stress-strain curve and calculated parameters contribute to a better understanding of SS316's behavior under tensile loading, aiding in material characterization for engineering applications.

Hardness Testing of Stainless Steel 316 (SS316)

Objective:

The objective of this experiment is to conduct hardness testing on SS316 to determine its hardness value using Brinell testing machine. The test aims to assess SS316's resistance to indentation and provide insights into its mechanical properties.

Materials Used:

- SS316 specimen (Stainless Steel 316)
- Hardness testing machine
- Brinell hardness tester
- Vernier caliper
- Safety gloves and goggles

Procedure:

- Specimen Preparation:

  A SS316 specimen was obtained and prepared according to ASTM standards for hardness testing. The specimen surface was cleaned and polished to remove any surface imperfections.

- Hardness Testing Methods:

  Brinell Hardness Test: The Brinell hardness test was conducted using a Brinell hardness tester, applying a predetermined load and measuring the diameter of the indentation.

- <u>Data Collection:</u>

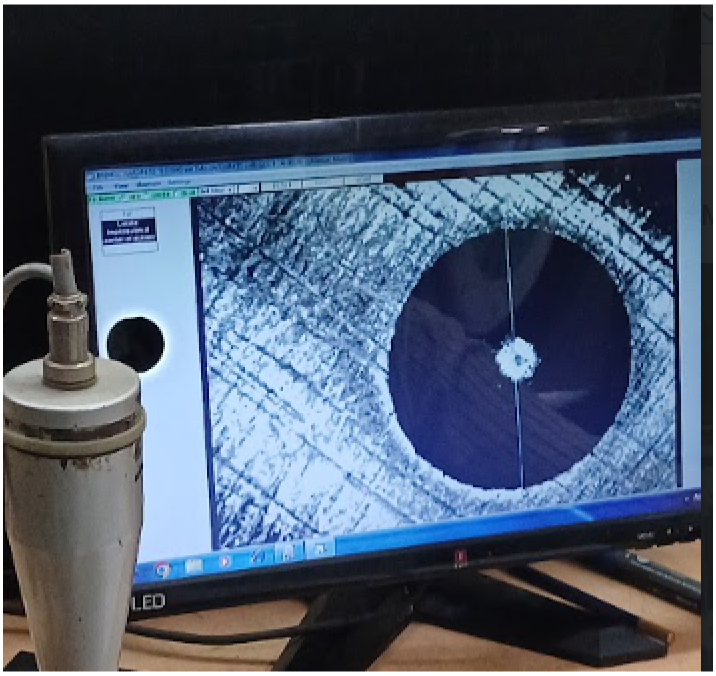
For the Brinell test, the Brinell hardness number (HB) was calculated.

Results:

- Brinell Hardness (HB): 200 HB

Conclusion:

The obtained hardness value provide insights into SS316's resistance to indentation under varying loads and indentation geometries. These values contribute to understanding SS316's mechanical properties, aiding in material assessment and suitability for different engineering applications.



SPECTROSCOPY(Working Principle)

A spectrophotometer is a versatile instrument widely used in material testing to analyze the concentration of substances, study the transmission and absorption of light through materials, and determine various material properties based on the interaction between light and matter. The working principle of a spectrophotometer involves several key components and processes:

1. Light Source:

- Principle: Provides a source of light across a range of wavelengths.
- Working: The spectrophotometer utilizes a light source, often a tungsten-halogen lamp or a deuterium lamp, emitting light across a broad range of wavelengths, including visible, ultraviolet (UV), and near-infrared (NIR) regions.

2. Monochromator:

- Principle: Selects specific wavelengths of light for analysis.
- Working: The emitted light passes through a monochromator, a component that separates the broad spectrum of light into individual wavelengths using prisms or diffraction gratings. It allows the selection of a specific wavelength to interact with the sample.

3. Sample Compartment:

- Principle: Where the sample interacts with the selected light wavelength.
- Working: The sample is placed in the spectrophotometer's sample compartment. The chosen

wavelength of light passes through or interacts with the sample. Depending on the material's properties, the sample may absorb, transmit, or scatter the incident light.

4. Detector:

- Principle: Measures the intensity of light transmitted through or absorbed by the sample.
- Working: After passing through the sample, the light enters a detector, typically a photodiode or a photomultiplier tube. The detector measures the intensity of light that has interacted with the sample. It converts this information into electrical signals.

5. Data Analysis and Display:

- Principle: Quantifies the sample's properties based on the detected light intensity.
- Working: The spectrophotometer's software analyzes the detected signals and compares them with a reference or blank sample. By measuring the difference in light intensity between the reference and sample, it calculates the sample's absorption, transmission, or reflection characteristics.

6. Calibration and Analysis:

- Principle: Ensures accuracy and reliability of measurements.
- Working: Spectrophotometers require calibration using standard samples of known properties to establish baseline measurements and accuracy. The obtained data is analyzed and compared against established reference values or standards to determine material properties such as concentration, absorbance.

Impact Testing of Stainless Steel 316 (SS316)

Objective:

The objective of this experiment is to conduct impact testing on SS316 to evaluate its toughness and resistance to sudden loading using the Charpy impact test method. The test aims to determine the material's ability to absorb energy and withstand impact loading.

Materials Used:

- SS316 specimens (Stainless Steel 316)
- Charpy impact testing machine
- Specimen notch cutter
- Vernier caliper
- Safety gloves and goggles

Procedure:

- Specimen Preparation:

SS316 specimens were obtained and prepared according to ASTM standards for impact testing. The specimens were machined to specific dimensions and notch configurations suitable for Charpy testing.

- Setup and Calibration:

The Charpy impact testing machine was set up and calibrated according to manufacturer specifications.

Specimens were securely placed in the Charpy machine's support and aligned for accurate testing.

- Impact Test Execution:

The Charpy impact test was performed at room temperature.

Specimens were subjected to a sudden impact using a pendulum-style striker with a specified energy at the notch.

The striker hit the notched section of the specimens, causing fracture and absorbing energy during the impact.

The machine recorded the energy absorbed and the fracture appearance.

- Data Collection:

Energy absorbed during fracture and the appearance of fracture surfaces were recorded.

The energy absorbed was measured in joules, representing the material's toughness.

Results:

Energy Absorbed (Charpy Impact Energy): 80 Joules

Conclusion:

The Charpy impact test demonstrated that SS316 absorbed 80 Joules of energy before fracturing under the sudden loading condition. This indicates a notable level of toughness and resistance to fracture when subjected to impact loading.

Percentage Composition Analysis of Stainless Steel 316 (SS316) by Spectroscopy

Objective:

The objective of this analysis is to determine the elemental composition of SS316, specifically the percentage composition of its constituent elements (such as iron, chromium, nickel, molybdenum, etc.), using spectroscopic methods. This analysis aims to assess the alloy's elemental composition for quality control and material characterization purposes.

Materials Used:

- SS316 sample (Stainless Steel 316)
- Spectroscopic analysis equipment (X-ray fluorescence (XRF) spectrometer, Optical Emission Spectroscopy (OES), or similar)
- Safety gloves and goggles

Procedure:

Sample Preparation:

The SS316 sample was prepared for spectroscopic analysis. Surface cleaning was performed to remove any contaminants or debris that could interfere with the analysis.

Spectroscopic Analysis:

The SS316 sample was subjected to spectroscopic analysis using the X-ray fluorescence (XRF) spectrometer or Optical Emission Spectroscopy (OES) method.

The spectroscopic equipment was calibrated and set up according to the manufacturer's instructions.

The sample was placed in the spectrometer, and the analysis was carried out to identify and quantify the elemental composition.

<u>Data Collection:</u>

The spectroscopic analysis generated data regarding the elemental composition of SS316.

The percentage composition of elements such as iron (Fe), chromium (Cr), nickel (Ni), molybdenum (Mo), manganese (Mn), and other trace elements was determined.

Results:

C	Mn	Si	S	P	Cr	Ni	Mo	Al	Co
0.041	1.428	0.451	0.017	0.023	17.62	10.78	1.440	0.015	0.233
Cu	**Nb**	**Ti**	**V**	**W**	**Sn**	**B**	**As**	**Fe**	
0.313	0.0037	0.170	0.069	0.073	0.012	0.0012	0.0077	67.30	

Conclusion:

The percentage composition analysis using spectroscopy revealed the elemental composition of SS316, indicating the presence and quantity of constituent elements in the alloy. This information is crucial for quality control, material identification, and ensuring the alloy's compliance with standards and specifications.

CORROSION TESTING:

Corrosion testing involves assessing the susceptibility of materials to degradation caused by various environmental factors, including moisture, chemicals, temperature, and other conditions. The testing aims to evaluate a material's resistance to corrosion, estimate its durability, and determine its suitability for specific applications.

Intergranular Corrosion Testing:

- Principle: Determines a material's susceptibility to intergranular corrosion along grain boundaries.
- Working: Materials are exposed to conditions promoting intergranular corrosion, such as sensitization to specific temperatures or environments. Testing assesses the material's resistance to this form of corrosion that attacks grain boundaries.
- It is a test for only Austenitic Stainless Steels
- Materials are used in foodprocessing , aircrafts etc.

Pitting Corrosion Testing:

- Principle: Assesses a material's resistance to localized pitting corrosion.
- Working: Samples are subjected to environments favoring pitting corrosion. The test evaluates the material's ability to resist the formation and propagation of pits on its surface.It is one of the toughest corrosion tests.
- It is a test for austenitic ferritic stainless steels
- Materials are used for pipe systems in sea water.

Streicher Test (ASTM A262 Method B) on Stainless Steel 304 (SS304)

Objective:

Evaluation of the material (SS304)through quantitative weight loss analysis to evaluate its susceptibility to intergranular corrosion.

Materials Used:

- Sample of SS304
- Ferric sulfate sulfuric acid.
- Testing equipment (beakers, heating apparatus, analytical balance, etc.)
- Safety gloves and goggles

Procedure:

<u>Sample Preparation:</u>

SS304 specimen were prepared according to ASTM standards for the Streicher test.

Specimen were cleaned, degreased, and properly marked for identification.

Weight the sample and note down.

<u>Testing Conditions:</u>

The test specimens were subjected to boiling in the ferric sulphate– Sulfuric acid for a predetermined duration, typically 24 to 72 hours.

The temperature was maintained within the specified range throughout the test.

Post-Test Examination:

After the test duration, specimens were removed from the solution and thoroughly cleaned.

Weigh the specimens and subtract the new weights from original weights

Results:

Initial mass of sample: 20.649 grams
Final mass of sample :19.8916 grams
Sample exhibits an acceptable mass loss of 0.7574 grams

Conclusion:

The Streicher test conducted on SS304 aimed to assess its susceptibility to intergranular corrosion, which can compromise material integrity in specific environments.

Chemical analysis of materials by wet chemical methods

1. Sample Preparation:

- Collection and Sampling: Obtain a representative sample of the material to be analyzed. The sample should be homogenized to ensure uniform composition.
- Drying and Grinding: Some samples may require drying or grinding to remove moisture or achieve a suitable particle size for analysis.

2. Digestion:

- The sample is digested using strong acids or a mixture of acids to dissolve the material and release the analytes of interest.

3. Titration or Spectroscopy:

- Titration: Involves the addition of a reagent of known concentration (titrant) to the digested sample until a specific endpoint is reached, typically indicated by a color change or other observable change. The volume or concentration of the titrant required for the reaction determines the concentration of the analyte.
- Spectroscopic Analysis: Utilizes spectrophotometers, such as UV-Vis, Atomic Absorption Spectroscopy (AAS), or Inductively Coupled Plasma (ICP), to measure the absorbance or emission of light by the sample. This data is used

to quantify the concentration of specific elements or compounds based on known calibration curves or standards.

4. Comparison with Standards:

- Calibration and Standards: Calibration curves or known standards of known concentrations are used for comparison. The measured values obtained from the analysis are compared to these standards to determine the concentration or composition of elements or compounds in the sample.
- Quality Control: Regular calibration and validation of instruments using certified reference materials ensure accuracy and reliability of the analysis.

5. Data Interpretation and Reporting:

- Data Analysis: Analyzed data is interpreted to determine the concentrations or presence of specific elements or compounds in the sample.
- Report Generation: Results, including the methodology used, raw data, calculations, and any observations or conclusions, are documented.

Importance:

- Wet chemical methods play a crucial role in material analysis, quality control, and research in various industries, ensuring compliance with standards, assessing purity, determining impurities, and characterizing materials.

Experiment 1: Qualitative Analysis for Nickel in SS316

Aim:
To determine the presence of nickel in SS316 stainless steel.

Materials:
SS316 stainless steel sample
Hydrochloric acid (concentrated)
Nitric acid (concentrated)
Distilled water
Dimethylglyoxime solution (5% w/v)
Ammonium hydroxide solution (10% w/v)
Filter paper
Safety goggles, gloves, and lab coat.

Procedure:
<u>Sample Preparation:</u>

a. Take a small piece of the SS316 stainless steel sample.
b. Clean the surface of the sample to remove any contaminants.
c. If the sample is not powdered, grind it into a fine powder using a mortar and pestle.

<u>Digestion of Sample:</u>

a. Place the powdered SS316 sample in a clean test tube.
b. Add a small amount of concentrated nitric acid (about 5 mL) to the test tube to dissolve the sample. Perform

this step in a fume hood due to potential acid fumes.
c. Gently heat the mixture on a hot plate until the sample dissolves completely. Avoid boiling.

<u>Formation of Nickel-Dimethylglyoxime Complex:</u>

a. To the dissolved sample, add a few drops of hydrochloric acid to ensure the pH is acidic.
b. Add a few drops of dimethylglyoxime solution to the test tube.
c. Allow the solution to stand for a few minutes. A pink or red precipitate indicates the presence of nickel.

<u>Confirmation Test for Nickel:</u>

a. Filter the solution to separate the precipitate from the solution.
b. Wash the precipitate with distilled water on the filter paper.
c. Transfer the precipitate into a clean test tube.
d. Add ammonium hydroxide solution to the precipitate. If the precipitate dissolves and forms a clear solution, it confirms the presence of nickel.

Observations:

Formation of a pink or red precipitate in the original solution after the addition of dimethylglyoxime.
Dissolving of the precipitate in ammonium hydroxide solution, forming a clear solution.

Conclusion:
If the observations align with the positive tests for nickel

presence as per the control experiment, it confirms the presence of nickel in the SS316 sample.

Experiment 2: Qualitative Analysis for Iron in SS316

Aim:
To determine the presence of iron in SS316 stainless steel.

Materials:

SS316 stainless steel sample
Hydrochloric acid (concentrated)
Nitric acid (concentrated)
Distilled water
Ammonium thiocyanate solution (10% w/v)
Potassium hexacyanoferrate(III) solution (known source of iron)
Filter paper
Sodium hydroxide solution (10% w/v)
Safety goggles, gloves, and lab coat

Procedure:

<u>Sample Preparation:</u>

a. Take a small piece of the SS316 stainless steel sample.
b. Ensure the surface of the sample is clean and free from contaminants.
c. If the sample is not powdered, grind it into a fine powder using a mortar and pestle.

Digestion of Sample:

a. Place the powdered SS316 sample in a clean test tube.
b. Add a small amount of concentrated nitric acid (about 5 mL) to the test tube to dissolve the sample. Be cautious and perform this step in a fume hood due to potential acid fumes.
c. Gently heat the mixture on a hot plate until the sample dissolves completely. Avoid boiling.

Formation of Iron(III) Ions:

a. To the dissolved sample, add a few drops of concentrated hydrochloric acid to ensure that all iron ions are in the ferric state (Fe^{3+}).
b. If the solution turns yellowish-brown, it indicates the presence of iron(III) ions.

Confirmation Test for Iron:

a. Prepare a control test with a known potassium hexacyanoferrate(III) solution in a separate test tube.
b. Place a drop of the SS316 solution and the potassium hexacyanoferrate(III) solution on separate filter papers.
c. Allow the drops to dry.
d. Add a drop of ammonium thiocyanate solution to each dried drop on the filter papers. If a reddish-brown color develops in the SS316 solution similar to the one formed in the potassium hexacyanoferrate(III) solution, it confirms the presence of iron.

Observations:

Yellowish-brown coloration in the solution after adding concentrated hydrochloric acid. Formation of a reddish-brown color with ammonium thiocyanate in the SS316 sample similar to the potassium hexacyanoferrate(III) solution.

Conclusion:

If the observations align with the positive tests for iron presence as per the control experiment, it confirms the presence of iron in the SS316 sample.

Experiment 3: Qualitative Analysis for Manganese in SS316

Aim:

To determine the presence of manganese in SS316 stainless steel.

Materials:

- SS316 stainless steel sample
- Hydrochloric acid (concentrated)
- Nitric acid (concentrated)
- Distilled water
- Ammonium sulfide solution
- Filter paper
- Safety goggles, gloves, and lab coat
-

Procedure:

Sample Preparation:
a. Take a small piece of the SS316 stainless steel sample.
b. Clean the surface of the sample to remove any contaminants.
c. If the sample is not powdered, grind it into a fine powder using a mortar and
Pestle.

Digestion of Sample:
a. Place the powdered SS316 sample in a clean test tube.
b. Add a small amount of concentrated nitric acid (about

5 mL) to the test tube to
dissolve the sample. Use caution and perform this step in a fume hood due to
potential acid fumes.
c. Gently heat the mixture on a hot plate until the sample dissolves completely. Avoid
Boiling.

Formation of Manganese Sulfide:
a. To the dissolved sample, add a few drops of hydrochloric acid to ensure the pH is
acidic.
b. Add a few drops of ammonium sulfide solution to the test tube.
c. Allow the solution to stand for a few minutes. A pink, red, or flesh-colored
precipitate indicates the presence of manganese.

Confirmation Test for Manganese:
a. Filter the solution to separate the precipitate from the solution.
b. Wash the precipitate with distilled water on the filter paper.
c. Dry the precipitate and perform additional confirmation tests if needed.

Observations:

Formation of a pink, red, or flesh-colored precipitate in the original solution after the
addition of ammonium sulfide.

Conclusion:

If the observations align with the formation of the characteristic precipitate for
manganese as per the control experiment, it confirms the presence of manganese in
the SS316 sample

Experiment 4: Qualitative Analysis for Chromium in SS316

Aim:
To determine the presence of chromium in SS316 stainless steel.

Materials:

- SS316 stainless steel sample
- Nitric acid (concentrated)
- Hydrochloric acid (concentrated)
- Distilled water
- Potassium chromate solution (known source of chromium)
- Filter paper
- Sodium hydroxide solution (10% w/v)
- Ammonium hydroxide solution (10% w/v)
- Safety goggles, gloves, and lab coat

Procedure:

<u>Sample Preparation:</u>
a. Cut a small piece of the SS316 stainless steel sample.
b. Clean the surface of the sample to remove any contaminants.
c. If the sample is in a non-powdered form, grind it into a fine powder using a mortar
and pestle.

<u>Digestion of Sample:</u>
a. Place the powdered SS316 sample in a clean test

tube.
b. Add a small amount of concentrated nitric acid (about 5 mL) to the test tube to
dissolve the sample. Use caution and perform this step in a fume hood due to
potential acid fumes.
c. Warm the mixture gently on a hot plate until the sample dissolves completely.
Avoid boiling.

Formation of Chromate Ion:
a. To the dissolved sample, add a few drops of concentrated hydrochloric acid to
ensure that all the chromium ions are in the hexavalent state (CrO4^2-).
b. If the solution turns yellow, it indicates the presence of chromium ions.

Confirmation Test for Chromium:
a. Prepare a control test with known potassium chromate solution in a separate test
tube.
b. Place a drop of the SS316 solution and the potassium chromate solution on
separate filter papers.
c. Allow the drops to dry.
d. Add a drop of sodium hydroxide solution to each dried drop on the filter papers. If
a yellow precipitate forms in the SS316 solution similar to the one formed in the
potassium chromate solution, it confirms the presence of chromium.

Additional Confirmation:
a. To the remaining solution of the SS316 sample, add excess ammonium hydroxide
solution.
b. If a gelatinous, green precipitate forms, it confirms the presence of chromium.

Observations:

Yellow coloration in the solution after adding concentrated hydrochloric acid.
Formation of a yellow precipitate with sodium hydroxide in the SS316 sample
similar to the potassium chromate solution.
Formation of a gelatinous, green precipitate upon the addition of excess
ammonium hydroxide.

Conclusion:

If the observations align with the positive tests for chromium presence as per the
control experiment, it confirms the presence of chromium in the SS316 sample

Challenges and Considerations of Wet Chemical Methods

1. Sensitivity and Selectivity:

- Challenge: Some wet chemical methods might lack sensitivity or specificity, making it challenging to detect low concentrations or distinguish between similar compounds accurately.
- Impact: This limitation can affect the reliability of quantitative results and lead to difficulties in identifying specific components in complex mixtures.

2. Interference and Matrix Effects:

- Challenge: Interfering substances or matrix effects within the sample can hinder accurate measurements, causing deviations from true values.
- Impact: These interferences can lead to inaccurate quantification, especially in complex matrices or when analyzing trace elements, impacting the precision of the results.

3. Sample Preparation Complexity:

- Challenge: Preparing samples for wet chemical analysis can be labor-intensive and time-consuming, especially when dealing with heterogeneous or challenging sample matrices.
- Impact: Inadequate sample preparation can result in non-representative samples, leading to biased or inconsistent results.

4. Accuracy and Precision:

- Challenge: Achieving high accuracy and precision in wet chemical analysis can be challenging due to variations in experimental conditions, human errors, or instrumental limitations.
- Impact: Inaccuracies and imprecisions in measurements may affect the reliability and validity of the obtained data, impacting decision-making based on the analysis.

5. Reaction Kinetics and Completeness:

- Challenge: Variations in reaction kinetics or incomplete reactions can lead to challenges in achieving complete and reliable chemical reactions.
- Impact: Incomplete reactions can affect the accuracy of quantification and hinder the extraction of accurate information from the sample.

6. Safety Concerns:

- Challenge: Working with corrosive, toxic, or hazardous reagents poses safety risks to personnel, requiring strict adherence to safety protocols and appropriate handling procedures.
- Impact: Inadequate safety measures can lead to health hazards or accidents, impacting personnel well-being and laboratory operations.

7. Cost and Time-Consuming Nature:

- Challenge: Wet chemical methods can be relatively time-consuming, involving multiple steps and requiring skilled personnel.

- Impact: The associated time and labor costs can be higher compared to instrumental techniques, potentially impacting the feasibility of routine analysis or large-scale studies.

8. Instrumentation and Expertise:

- Challenge: Availability and maintenance of specialized equipment and expertise in wet chemical techniques might be limited, especially in smaller or resource-constrained laboratories.
- Impact: Lack of access to equipment or skilled personnel can limit the implementation and reliability of these methods.

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