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Effect of Uric Acid on Mild Steel Tanks Used in Wastewater Treatment Plants

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Abstract
Mild steel (MS) tanks are widely used in wastewater treatment plants (WWTPs) due to their low cost and ease of fabrication. However, wastewater containing nitrogenous organic compounds such as uric acid can significantly accelerate corrosion of MS structures. This study investigates the effect of uric acid on the corrosion behavior of mild steel tanks used in a hospital sewage treatment plant. Field observations, wastewater characterization, and weight loss corrosion testing were conducted to evaluate material degradation. Comparative analysis of uncoated and coated MS samples was performed, and protective strategies including epoxy, FRP, and rubber linings were assessed based on cost and lifespan. Results indicate that uric acid promotes localized corrosion and increases corrosion rate, while FRP coating offers the best balance of durability and cost-effectiveness. The findings provide practical guidance for improving the service life and maintenance planning of MS tanks in wastewater treatment applications.
Keywords: *Mild steel, uric acid, wastewater treatment, corrosion, FRP coating*

I. Introduction

Wastewater from hospitals and residential areas contains nitrogen-rich organic compounds such as uric acid, which originates from human metabolic waste. Uric acid ($C_5H_4N_4O_3$) is weakly acidic in nature (pH 4–6) and alters the electrochemical environment inside wastewater tanks, promoting corrosion of metallic structures.

Mild steel tanks are commonly used in WWTPs due to their strength, availability, and economic advantage. However, continuous exposure to uric-acid-rich wastewater leads to accelerated corrosion, pitting, and reduced service life. Understanding this degradation mechanism and identifying suitable protective methods is essential for sustainable wastewater infrastructure.

II. Literature Review

Previous studies report that uric acid enhances anodic dissolution of iron and disrupts protective oxide layers on mild steel surfaces. Researchers have shown that the presence of uric acid along with ammonia and urea significantly increases localized corrosion in wastewater environments. Protective coatings such as epoxy and FRP linings have been reported to reduce corrosion rates by forming an effective barrier between the metal surface and corrosive media.

Despite extensive laboratory studies, limited field-based investigations are available for real wastewater treatment plants, particularly those handling hospital sewage. This study addresses this research gap.

III. Objectives of the Study

- To study the effect of uric acid on corrosion behavior of mild steel tanks
- To experimentally evaluate corrosion using the weight loss method
- To compare different protective coatings based on cost and lifespan
- To recommend an effective corrosion protection strategy for MS tanks

IV. Methodology

4.1 Description of the Wastewater Treatment Plant

The study was conducted at the sewage treatment plant of S. Nijalingappa Medical College and Hanagal Shri Kumareshwar Hospital, Bagalkot. The plant consists of screening chambers, aeration tanks, blowers, and multiple mild steel storage tanks of varying capacities. **Figure 1** shows the overall layout of the sewage water treatment plant.

Figure 1. *Sewage water treatment plant showing screening chamber and blower room*

4.2 Block Diagram of Treatment Process

The wastewater treatment process includes collection, filtration through carbon and dual media tanks, aeration, and storage. All major storage tanks are fabricated from mild steel, making them susceptible to corrosion due to uric acid.

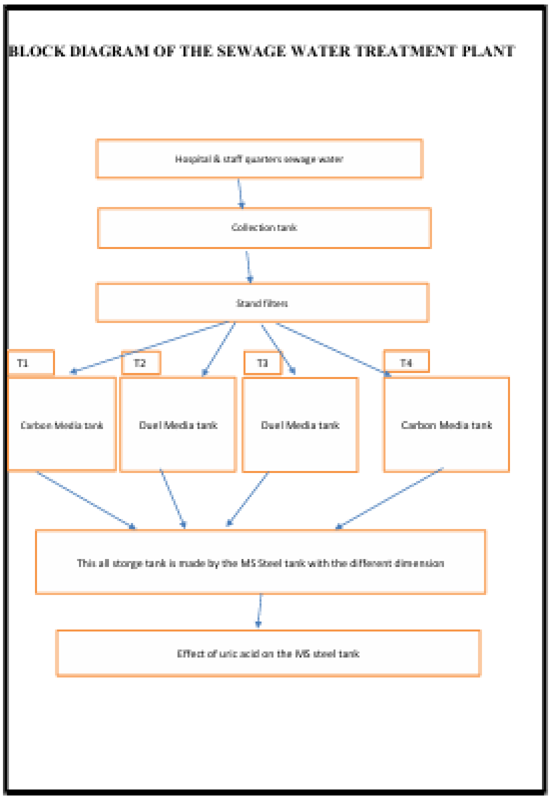


Figure 2. *Block diagram of sewage water treatment process using mild steel tanks*

4.3 Materials Considered

Three tank materials were evaluated:

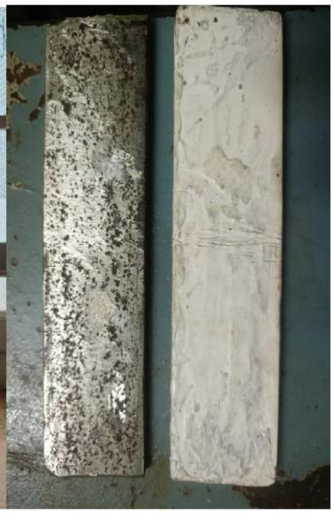
- Mild Steel (MS)
- Stainless Steel (SS)
- Fiber Reinforced Plastic (FRP)

Based on cost and life span analysis, mild steel was selected for detailed corrosion study.

4.4 Corrosion Testing Method
The weight loss method was employed for corrosion analysis. Mild steel samples were cleaned, weighed, immersed in wastewater containing uric acid, and reweighed after exposure.

Water sample with the PH test

Matel in the uric acid sampl



Metal sample without coating and with coating

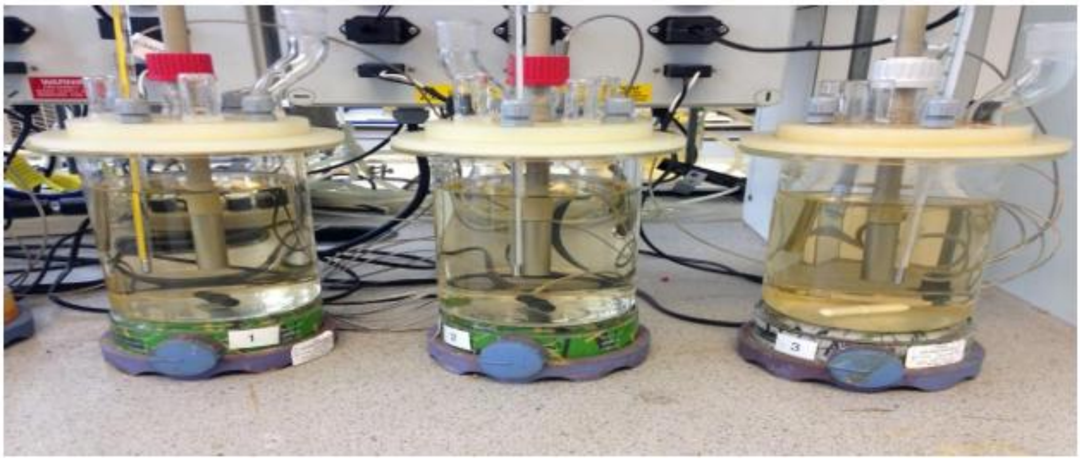


Figure 3. *Experimental setup for weight loss corrosion testing*

Corrosion rate was calculated using:

Corrosion Rate = Weight Loss / Area * Time
= W / A* T

Where,

W = weight loss (g),
A = surface area (cm^2),
T = exposure time (hours).

V. Results and Discussion

5.1 Visual Observation
Uncoated MS samples exhibited surface rust, pitting, and scale formation, while coated samples showed minimal degradation.

Sample	Initial Weight	Final Weight	Weight Loss	Corrosion Rate
FRP coated on mild steel	270.40	270.20	0.20	0.00000308
Without coated on mild steel	265.50	265.20	0.30	0.000005072

Figure 4. *Metal samples before and after exposure to uric-acid-rich wastewater*

5.2 Weight Loss Results

Experimental results show higher weight loss in uncoated mild steel compared to FRP-coated samples.
The FRP-coated sample demonstrated a significantly lower corrosion rate, confirming its superior protective performance.

5.3 Coating Cost and Lifespan Analysis

A comparative study of epoxy coating, FRP lining, and rubber lining was carried out considering material cost and average service life. FRP lining showed the best balance between cost efficiency and long-term durability.

VI. Advantages and Limitations

Advantages

- Provides practical insight into corrosion behavior in real WWTP conditions
- Helps select cost-effective corrosion protection methods
- Enhances tank durability and reduces maintenance cost

Limitations

- Long-term corrosion behavior was not studied
- Results are based on short-term exposure tests
- Continuous monitoring systems were not implemented

VII. Conclusions

The presence of uric acid in wastewater significantly accelerates corrosion of mild steel tanks, primarily due to acidic conditions and electrochemical reactions. Uncoated MS tanks experience higher corrosion rates, while protective coatings substantially improve performance. Among the coatings studied, FRP lining offers superior corrosion resistance, longer lifespan, and economic feasibility. Proper coating selection and regular monitoring are essential to ensure long-term reliability of wastewater treatment infrastructure.

VIII. Future Scope

Future studies may include long-term field exposure analysis, real-time corrosion monitoring using sensors, development of advanced eco-friendly coatings, and pre-treatment methods to reduce uric acid concentration before storage.

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