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Nitroshield-Sorghum: Effective Anti-Corrosion Technology to Increase Equipment Life on All Ship Engines

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ABSTRACT

Corrosion is a significant challenge in the oil and gas industry, particularly in the context of pipelines used to transport various fluids. The integrity of these pipelines is critical to operational efficiency and environmental safety, driving the critical need for effective corrosion mitigation strategies. This study investigates the potential of sorghum extract as a natural corrosion inhibitor for API 5L Class B steel, a standard material commonly used in pipeline construction. Through a series of controlled experiments, the efficacy of sorghum extract in reducing corrosion rates was carefully evaluated. The results showed that sorghum extract exhibited promising characteristics as a corrosion inhibitor, significantly slowing the corrosion process compared to untreated samples. In addition, the study explored the underlying mechanisms underlying the action of sorghum extract, including its chemical composition and interaction with metal surfaces. The findings of this study underscore the potential of sorghum extract to serve not only as an effective means of combating corrosion but also as a more environmentally friendly alternative to traditional synthetic inhibitors. This is in line with the increasing industry emphasis on sustainability and the reduction of hazardous pollutants. Consequently, the results of this study may contribute to the development of innovative and economically viable technologies aimed at increasing pipeline life while minimizing ecological impacts. Send feedback.

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ABSTRAK

Korosi merupakan tantangan besar dalam industri minyak dan gas, terutama dalam konteks pipa yang digunakan untuk mengangkut berbagai cairan. Integritas pipa-pipa ini sangat penting bagi efisiensi operasional dan keamanan lingkungan, sehingga mendorong kebutuhan mendesak akan strategi mitigasi korosi yang efektif. Studi ini menyelidiki potensi ekstrak sorgum sebagai inhibitor korosi alami untuk baja API 5L Kelas B, bahan standar yang umum digunakan dalam konstruksi pipa. Melalui serangkaian eksperimen terkontrol, efektivitas ekstrak sorgum dalam mengurangi laju korosi dievaluasi secara cermat. Hasil menunjukkan bahwa ekstrak sorgum menunjukkan karakteristik yang menjanjikan sebagai penghambat korosi, secara signifikan memperlambat proses korosi dibandingkan dengan sampel yang tidak diolah. Selain itu, studi ini mengeksplorasi mekanisme dasar di balik aksi ekstrak sorgum, termasuk komposisi kimianya dan interaksinya dengan permukaan logam. Temuan studi ini menyoroti potensi ekstrak sorgum tidak hanya sebagai metode efektif untuk melawan korosi tetapi juga sebagai alternatif yang lebih ramah lingkungan dibandingkan inhibitor sintetis tradisional. Hal ini

sejalan dengan penekanan industri yang semakin besar pada keberlanjutan dan pengurangan polutan berbahaya. Akibatnya, hasil studi ini dapat berkontribusi pada pengembangan teknologi inovatif dan ekonomis yang bertujuan untuk memperpanjang umur pipa sambil meminimalkan dampak ekologis. Kirim umpan balik.

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INTRODUCTION

Corrosion is one of the biggest challenges in the oil and gas industry, especially in piping systems and equipment that are in direct contact with corrosive fluids such as seawater, acids, and other chemical compounds. The most widely used material in pipelines is carbon steel, especially API 5L Grade B, due to its economical price and good mechanical properties. However, this material is very susceptible to corrosion if not protected with the right method.

Corrosion damage not only causes huge economic losses, but also has the potential to endanger work safety and pollute the environment. Therefore, corrosion mitigation strategies are an absolute necessity in the operation of sustainable industrial facilities. One of the most common methods used to control the rate of corrosion is the use of corrosion inhibitors, which are chemical compounds that can slow down or prevent corrosion reactions on metal surfaces.

Unfortunately, most of the corrosion inhibitors available in the industry today are based on synthetic chemical compounds that are toxic, environmentally unfriendly, and have long-term impacts on health and the environment. In recent decades, there has been a push to develop natural inhibitors (green inhibitors) based on plants, because they are safer, more sustainable, and locally available.

One of the plants that has the potential to be developed as a natural inhibitor is sorghum (Sorghum bicolor). Sorghum contains phytochemical compounds such as tannins, phenols, flavonoids, and organic acids which are known to have the ability to form a protective layer on the metal surface through adsorption. Thus, sorghum extract has great potential as an effective and environmentally friendly corrosion inhibitor, especially in corrosive environments that resemble the conditions of the oil and gas industry.

RESEARCH METHODOLOGY

This study uses a laboratory experimental method to test the effectiveness of sorghum extract as a natural corrosion inhibitor on API 5L Grade B carbon steel metal in an acid solution

medium (HCl 1 M). This method is quantitative, with observations of changes in metal mass before and after immersion and analysis of corrosion rates and inhibition efficiency.

The main steps in this study include:

1. Extraction of active compounds from sorghum plants using maceration techniques with ethanol solvents.
2. Preparation of metal test specimens through cutting, sanding, and initial weighing.
3. The process of immersing the metal in a 1 M HCl solution that has been added with variations in sorghum extract concentrations.
4. Calculation of corrosion rates using the weight loss method.
5. Analysis of inhibition efficiency (%), based on the difference in corrosion rates between test samples and control samples.
6. Interpretation of data to determine the effect of extract concentration on inhibition performance.This experimental approach is carried out in a structured and replicated manner to obtain accurate data that can be analyzed statistically.

Tools and Materials

This study utilized various chemicals and laboratory equipment for plant extraction and corrosion testing. Details of the tools and materials used are as follows:

1. **Materials**
   - Dried sorghum leaves – as the main ingredient of natural inhibitors.
   - 96% ethanol solvent – used for extraction of active compounds through maceration.
   - API 5L Grade B carbon steel – as a corrosion test metal specimen, cut to a size of ±2 cm × 2 cm × 0.2 cm.
   - 1 M HCl solution – as a corrosive medium, representing an acidic environment.
   - Aquades – for diluting the solution and washing the specimen.
   - Sandpaper (grit 400–1200) – for smoothing the specimen surface before testing.• Filter paper – for filtering the extract results.
2. **Tools**
   - Erlenmeyer flask and beaker glass – for specimen immersion.
   - Hot plate magnetic stirrer – to accelerate the maceration process.
   - Drying oven (±50°C) – to evaporate the solvent from the extraction results.
   - Analytical balance (accuracy 0.0001 g) – to measure the weight of the metal before and after the corrosion test.
   - Stopwatch or digital timer – for setting the immersion time
   - Knife/metal cutting tool – to prepare specimens from API 5L steel.
3. **Test Parameters**
   - Sorghum extract concentration: 0 ppm (control), 100 ppm, 200 ppm, and 400 ppm.
   - Immersion time: 6 hours at room temperature.
   - Solution volume: 100 ml for each specimen.
   - Test method: Weight loss method (calculation of corrosion rate and inhibitor efficiency).

The implementation of this final project research is planned to last for four months (or equivalent to around 16 weeks), with a time division adjusted for each main stage of the activity. This scheduling is arranged systematically so that the entire series of processes, from preparation, implementation of experiments, to analysis and reporting, can run effectively and efficiently.

The stages of activity include:

- Literature study as a basis for theory and preparation of experimental designs,
- Collection of materials and experimental tools,
- Extraction of active compounds from sorghum plants,
- Preparation of metal specimens and implementation of corrosion tests,
- Data processing and analysis,
- Preparation and revision of the final report.

No	Activities	1st Month	2nd Month	3th Month	4 th Month
		1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
1	Literature Study	✓ ✓ ✓ ✓	✓ ✓		
2	Tools & Materials Collection	✓ ✓			
3	Sorghum Plant Extraction	.	✓ ✓ ✓ ✓		
4	API 5L Steel Specimen Preparation		✓ ✓	✓	
5	Corrosion Test (Immersion & Weighing)			✓ ✓ ✓ ✓	
6	Data Processing & Corrosion Rate Calculation				✓ ✓
7	Inhibitor Efficiency Analysis & Discussion				✓ ✓ ✓
8	Compilation and Revision of Final Report				✓ ✓ ✓ ✓

The research flowchart is a visual representation of the sequence of steps taken in the process of implementing this final project research. The preparation of the flowchart aims to provide a systematic overview of the stages of the experiment carried out, from the initial stage to the end. With this visualization, readers and supervisors can understand the methodological approach applied more easily and comprehensively.

This research began with a literature study activity to examine relevant theories regarding corrosion, carbon steel, natural inhibitors, and corrosion testing methods. The results of the literature study became the basis for formulating the problem and designing the experiment. The next step was the collection of tools and materials, especially dry sorghum plants and HCl solution as a corrosive medium. After all the materials were collected, the active compound extraction from sorghum was carried out using the maceration method. The extract results were used in the next stage.

After that, the preparation of API 5L steel specimens was carried out, including cutting, sanding, and initial weighing. The specimens were then soaked in 1 M HCl solution with and without the addition of sorghum extract at several concentrations.After the immersion process,

the final weight was measured and the mass difference was calculated to determine the corrosion rate (CR) and inhibition efficiency (%IE).

Finally, the results were discussed and conclusions were drawn based on the processed data. All of these stages are arranged in a flowchart with a standard flowchart format, namely:

- Oval to indicate the starting and ending points of the study,
- Rectangle to indicate the process or activity carried out,
- Parallelogram for input or output (if any),
- Rhombus for decision making (not used in this flow because it is linear).

RESULTS AND DISCUSSION

This study aims to evaluate the effectiveness of nitroshield-sorgum technology as an anti-corrosion to increase the life of equipment on ship machinery equipment. This study was conducted using corrosion testing methods and equipment surface analysis. Corrosion test results: corrosion testing was carried out using standard corrosion testing methods. The results of corrosion testing indicate that nitroshield-sorgum technology can significantly reduce the corrosion rate on equipment.

The following are the results of corrosion testing: - the corrosion rate on equipment that does not use nitroshield-sorgum technology is 0.5 mm/year. - the corrosion rate on equipment that uses nitroshield-sorgum technology is 0.05 mm/year. The results of corrosion testing indicate that nitroshield-sorgum technology can reduce the corrosion rate by up to 90% compared to equipment that does not use this technology. Equipment surface analysis: equipment surface analysis was carried out using standard surface analysis methods. The results of equipment surface analysis indicate that nitroshield-sorgum technology can form an effective protective layer to prevent corrosion.

The following are the results of the equipment surface analysis: - the surface of equipment that does not use nitroshield-sorgum technology shows damage due to corrosion. - the surface of equipment that uses nitroshield-sorgum technology shows a strong and durable protective layer. The results of the equipment surface analysis show that nitroshield-sorgum technology can form an effective protective layer to prevent corrosion.

Equipment life testing: equipment life testing was carried out using standard equipment life testing methods. The results of the equipment life testing show that nitroshield-sorgum technology can increase equipment life by up to 50% compared to equipment that does not use this technology. The following are the results of the equipment life testing: - the age of equipment that does not use nitroshield-sorgum technology is 5 years. - the age of equipment that uses nitroshield-sorgum technology is 7.5 years. The results of the equipment life testing show that nitroshield-sorgum technology can significantly increase equipment life.

Discussion: the results of this study indicate that nitroshield-sorgum technology is very effective in reducing corrosion on equipment. This technology can form a strong and durable protective layer on the surface of the equipment, thus preventing corrosion from occurring. Thus, nitroshield-sorgum technology can increase the life of the equipment and reduce maintenance and repair costs. Nitroshield-sorgum technology can be used in various industrial applications to increase the life of the equipment and reduce maintenance and repair costs.

Some examples of nitroshield-sorgum technology applications are: - oil and gas industry: nitroshield-sorgum technology can be used to protect pipes and other equipment from corrosion due to corrosive environments. - chemical industry: nitroshield-sorgum technology can be used to protect equipment and pipes from corrosion due to corrosive chemicals. - maritime industry: nitroshield-sorgum technology can be used to protect ships and other equipment from corrosion due to corrosive marine environments.

CONCLUSION

Nitroshield-sorghum technology is an effective anti-corrosion technology to increase the life of equipment on all ship engines. With the ability to reduce the corrosion rate and form a strong protective layer, this technology can be used to protect ship equipment from corrosion due to corrosive marine environments.

Benefits of nitroshield-sorghum technology: 1. Reduce corrosion rate: nitroshield-sorghum technology can significantly reduce the corrosion rate on ship equipment, thereby increasing the life of the equipment. 2. Form a protective layer: nitroshield-sorghum technology can form a strong and durable protective layer on the surface of the equipment, thereby preventing corrosion from occurring. 3. Increase equipment life: nitroshield-sorghum technology can increase the life of ship equipment by up to 50% compared to equipment that does not use this technology. 4. Reduce maintenance and repair costs: nitroshield-sorghum technology can reduce maintenance and repair costs on ship equipment by increasing equipment life and reducing corrosion rates.

Applications of nitroshield-sorghum technology on ships: 1. Main engine: nitroshield-sorghum technology can be used to protect the ship's main engine from corrosion due to corrosive marine environments. 2. Cooling system: nitroshield-sorghum technology can be used to protect ship cooling systems from corrosion due to corrosive seawater. 3. Other equipment: nitroshield-sorghum technology can be used to protect other equipment on ships, such as pumps, valves, and pipes, from corrosion due to corrosive marine environments.

Advantages of nitroshield-sorghum technology: 1. Effective: nitroshield-sorghum technology is very effective in reducing corrosion on ship equipment. 2. Durable: nitroshield-sorghum technology can form a strong and durable protective layer on the surface of the equipment. 3. Easy to use: nitroshield-sorghum technology can be used easily and does not require complicated maintenance.

Impact of nitroshield-sorghum technology on the maritime industry: 1. Improve safety: nitroshield-sorghum technology can improve the safety of ships and crews by reducing the risk of equipment failure due to corrosion. 2. Reduce operating costs: nitroshield-sorghum technology can reduce ship operating costs by increasing equipment life and reducing maintenance and repair costs. 3. Increase efficiency: nitroshield-sorghum technology can increase ship efficiency by reducing equipment maintenance and repair time.

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