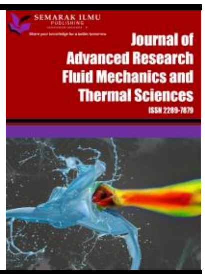
Journal of Advanced Research in Fluid Mechanics and Thermal Sciences

Journal homepage:
https://semarakilmu.com.my/journals/index.php/fluid_mechanics_thermal_sciences/index
ISSN: 2289-7879



A Study of the Thermal Behavior of Some Materials Used to Prevent Corrosion in Mechanical Parts

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ARTICLE INFO

Article history:
Received 5 November 2022
Received in revised form 9 February 2023
Accepted 16 February 2023
Available online 8 March 2023

Keywords:
Thermal process; machine; inhibitor; heat transfer

ABSTRACT

Thermal deterioration of Machines is the change in the properties of the basic material as a result of thermal reaction with its environment as a result of the presence of moisture in the bodies of machines such as the bodies of aircraft, cars, engineering equipment and related to the mechanics of the machines in the field of mechanical engineering, which is called the medium of deterioration and not as a result of a mechanical process such as friction in the machines as a result of work Continuous in these machines, according to this definition there is a possibility of corrosion not only in metals, but other materials such as concrete and containers that are in direct contact with moisture, air and environmental factors that are a catalyst for mechanical deterioration. Many researchers in mechanical engineering were interested in the thermal processes of machines, so the problem of corrosion and friction of machines and other important problems that have been studied extensively by finding engineering solutions to reduce or eliminate them. Corrosion of Machines be a limiting factor for various materials in many applications. Thus, it is necessary to have a better understanding of the deterioration processes, their prevention and reduction of the associated damage. In this research the preparation of some reagents and their use as deterioration inhibitors to reduce the deterioration process in engineering machinery by measuring the loss in weights resulting from the phenomenon of deterioration in engineering machinery. These thermal reagents were prepared as a thermal inhibitor painting, diagnosed in spectroscopic techniques, and then some thermal measurements were made to studying them as inhibitors of engineering corrosion in machines. The results appeared that the prepared reagents are good deterioration's inhibitors due to the inhibition efficiency of the selected thermal reagents increased with increasing of concentration, and decreased with increasing of temperature.

1. Introduction

Thermal deterioration process in machine is the destructive attack on a substance through interaction with its surrounding environment. The dangerous consequences of the erosion process have become a problem of prime importance worldwide. Deterioration engineering is a specialized

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https://doi.org/10.37934/arfmts.104.1.5564

branch concerned with applying scientific knowledge, natural laws and material resources in order to design deterioration inhibitors and inhibitors and design devices, systems and procedures aimed at dealing with the natural phenomenon known as deterioration [1-7].

Generally speaking, deterioration engineering is related to metallurgy as well as nonmetals including ceramics. Deterioration engineering often deals with other processes not completely related to deterioration, including (but not limited to) the cracking and shattering of structures, cracking, deterioration, erosion, and more [8-16]. Many researchers confuse deterioration with erosion. In fact, they are the same thing, but the way in which they occur is different. Deterioration is mainly caused by thermal process which may be an acid reaction on the machine (due to acid rain) or the presence of acids in the air [17-21]. But the process of erosion occurs due to chemical or physical forces [22-27]; for example, the erosion of rocks occurs due to rainwater falling on them. In short, the erosion process may occur as part of the erosion process but the erosion process cannot occur as a result of the erosion [28-32] as appearance in Figure 1.

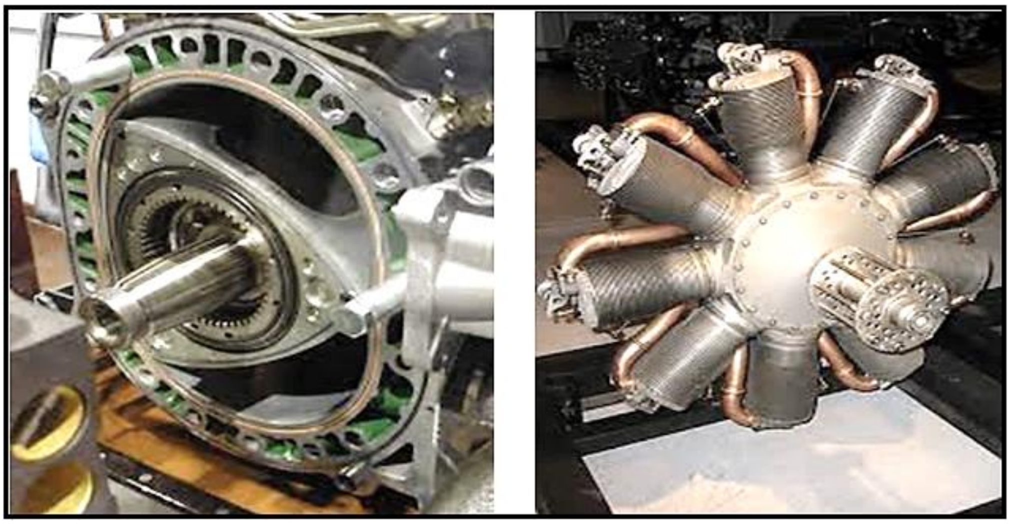

Fig. 1. Deterioration of Machines as a result of contacting with Environmental factors that stimulate erosion

2. Experimental Part

2.1 Thermal Deterioration Tests on Machines

The basic evaluation in the deterioration test of corroded surfaces of engineering machinery and metal objects is the test and analysis of weight loss for corroded surfaces, through the percentage of lost weight.

2.2 Preparation of Deterioration's Thermal Inhibitors

0.1 mole of p-formal benzaldehyde was liquifying in concentrated hydrochloric acid, then cooled at 0-5 ^{o}C, then added to solution of 0.01 mole sodium nitrite at 0-5 ^{o}C gradually with stirring and the temperature kept at -5 ^{o}C, flowed by addition of cooled solution of coupling 2,4-dichlorobenzoic acid 0.1 mole conferring to studies, the product was drinkable, desiccated, then 0.01 mole heated with pyrimidine-derivative for 4 hrs with glacial acid drops conferring to previous studies to produce reagent that acts inhibitor [1,2,4,9]. While, 0.1 mole of p-formal benzaldehyde was liquifying in concentrated hydrochloric acid, then cooled at 0-5 ^{o}C, then supplementary to solution of 0.01 mole sodium nitrite at 0-5 ^{o}C gradually with stirring and the temperature kept at -5

^{o}C, flowed by addition of cooled solution of coupling nitrobenzene 0.1 mole affording to studies, the product was drinkable, desiccated, then 0.01 mole refluxed with pyrimidine-derivative for 3 hrs with glacial acid 3 drops affording to studies to produce reagent that acts inhibitor, but reagent was prepared by liquifying of 0.1 mole of p-formal benzaldehyde in concentrated hydrochloric acid, then cooled at 0-5 ^{o}C, then added to solution of 0.01 mole sodium nitrite at 0-5 ^{o}C [2-4,9] gradually with stirring and the temperature kept at -5 ^{o}C, flowed by addition of cooled solution of coupling compound benzoic acid 0.1 mole affording to previous studies, the product was drinkable, desiccated, then 0.01 M refluxed with pyrimidine-derivative for 3 hrs with glacial acid 3 drops conferring to previous studies to crop thermal reagent that acts inhibitor [2-4,9].

2.3 Preparation of Aggressive Solution

Aggressive solution of 1M acid was prepared by dilution of the intense acid (98% acid) in distilled water. Gradually Inhibitor concentrations from $1x10^{-2}$ to $1x10^{-5}$ M were prepared in solution of 1M acid at 30 ^{o}C as a painted for corroded surfaces of machines in Figure 2.

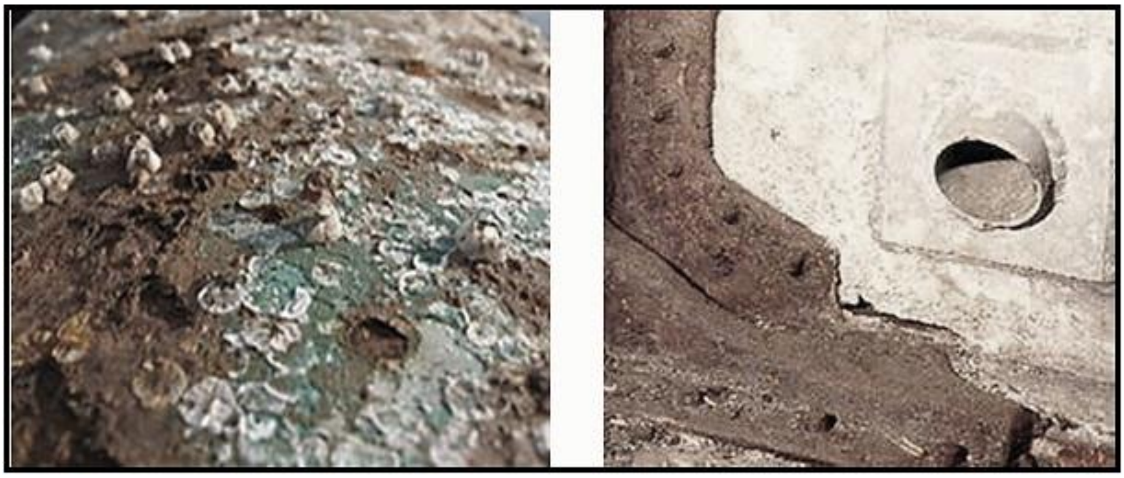

Fig. 2. Corroded Surfaces of Machine Parts

2.5 Weight Loss Analysis

The mild sheet was press-cut in a mechanic way into 2.5 cm diameter sheet disc. These sheet discs were emery polished ranging 110-410 grades for a smooth surface. Mild steel surface treatments; however, include absolute ethanol degreasing besides acetone drying. The specimens treated were then kept in a non-moisture desiccator before use in the deterioration studies [2,4,9]. Initially, specimens of mild steel were weighed in an electronic scale. Then they were suspended and immersed completely in beaker of 500 ml volume containing 1M sulphuric acid in presence of the inhibitors and absence for 10 hrs. The specimens were taken out after 10 hours 30 ^{o}C exposure period, washed with water out of deterioration products and eventually acetone-washed. Afterwards they were weighed again after being dried. Analysis of mass loss were conducted by method of ASTM explained previously [33-39]. The tests were conducted in duplicate in order to assure the results accuracy and the weight loss mean was reported. Weight loss permitted to calculate the rate of mean deterioration in mg cm^{-2} h^{-1}. The mild machine deterioration rate was designed via using the relation (1)

$$W = \Delta m / S \times T \quad (1)$$

where Δm is the mass loss (gm), s the area (cm^2) and t is the immersion period (h). While the percentage inhibition efficiency (E (%)) was calculated using the relationship (2)

$$E\% = Wcorr - Wcorr(inhib) / Wcorr \times 100 \quad (2)$$

The Wcorr and Wcorr (inhib) are the deterioration rates of mild in the absence and occurrence of inhibitor, correspondingly.

3. Results and Discussion

3.1 Weight Loss Measurements

The weight loss of surface in uninhibited acid solution and solutions containing different concentrations from the inhibitor was determined after hours (Table 1).

Table 1
Thermal deterioration rate, inhibition efficiency, surface coverage (θ) and free energy of adsorption on Machine through using weight loss measurements

Thermal process		Inhibitor concentration (M)			
Goads (kJ/mol)	Θ	E%		Deterioration rate (mg cm^{-2} h^{-1})	M(g)
	-	-	3.005	0.545	Uninhibited
-31.39 (Y=0.8013)			Inhibitor 1		
0.9745	77.34	0.6331		0.0097	1×10^{-2}
0.9683	73.52	0.6965		0.0133	1×10^{-3}
0.9004	69.33	1.1481		0.0427	1×10^{-4}
0.8706	58.01	1.4590		0.0794	1×10^{-5}
-33.63 (Y =0.8379)			Inhibitor 2		
0.7861	53.42	53.42		0.0121	1×10^{-2}
0.7707	47.70	47.70		0.0422	1×10^{-3}
0.7555	45.34	45.34		0.0732	1×10^{-4}
0.7100	40.00	40.00		0.0901	1×10^{-5}
-36.38 (Y =0.885)			Inhibitor 3		
0.5935	49.73	1.7019		0.0243	1×10^{-2}
0.5711	48.39	2.1476		0.0371	1×10^{-3}
0.5273	43.45	2.2904		0.0679	1×10^{-4}
0.4601	36.87	2.4003		0.0884	1×10^{-5}

Rendering to the current data in the consequences, reserve competence and deterioration proportion fact to analysis of weight injury of equipped inhibitors at diverse attentions after immersion for 8 hours at 30 ^{o}C are summarized in Table 1 and illustrated in Figure 3, and scheme 1 [1-3]. These ratios reveal that the mild deterioration of steel is lessened because of the inhibitors suggested in 1M acid at all concentrations of the recent study. However, there is notable decrement in the weight in the specimen of mild steel after 8 hours with no use of inhibitor. That could be justified by chemical reagents adsorption on the surface of mild steel that makes impairment to deterioration environment. The increasing of inhibition efficiency with concentration conceals that extra inhibitor particles are being adsorbed at higher attention on the metal surface, affecting larger surface coverage. A deterioration inhibitor is simply a substance that is smeared to environment to significantly reduction the corrosion rate in especially metals in special and materials that are in exposure to that environment [40-46]. It is labeled the first defense line against deterioration. In some deterioration types, there is almost no noticeable change or reduction of weight, nevertheless characteristics change and the material could probably unexpectedly fail as a result of some changes in the material. These changes may resist visual ordinary examination or determinations of weight change [47-52].

3.2 Mechanism of Deterioration Inhibition

Most applications of inhibitors in partly aqueous systems are related to four basic environment types

i. Aqueous acid solutions applied like in methods of machine-cleaning for instance pickling for mill scale or removal of corrodes in surface and machine fabrication or in the machine surfaces post service cleaning. The machine deterioration in acid solutions can possibly be inhibited by many substances, such as carbon monoxide, halide ions, and many other inhibitors.
ii. Supply waters, natural waters, and industrial cooling waters in the near-neutral pH range (5 to 9).

Deterioration takes place when the pipe metal reacts with oxygen in the water. Pipelines with low-mineral or stagnant water are mostly to be influenced by damage of deterioration. Standing water releases oxygen. It reacts with the iron wall of the pipe and leads to deterioration, (Figure 3) [53,54].

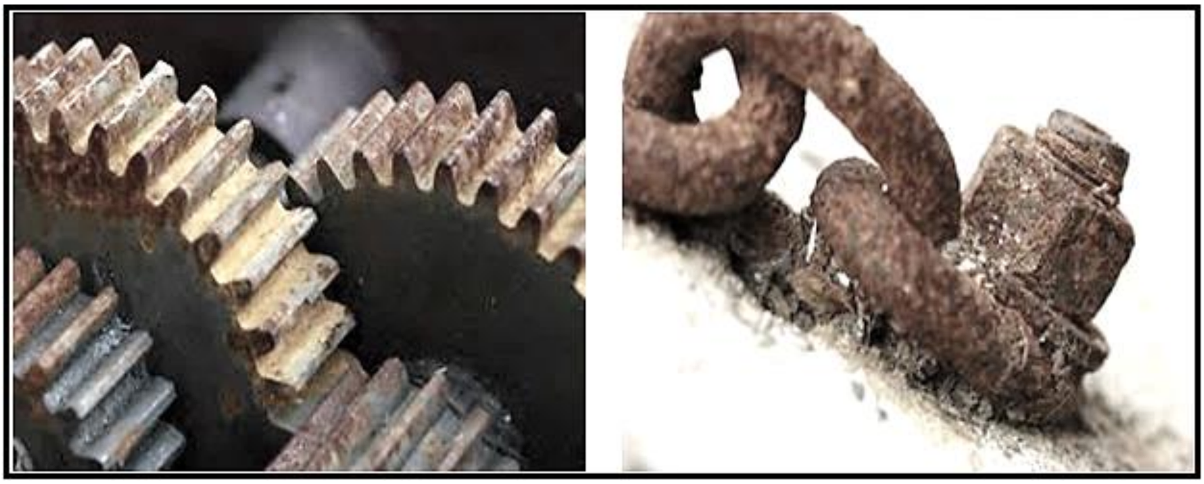

Fig. 3. Deterioration by thermal factors

3.3 Thermal Measurements

Through the following of the thermal curves, which showed great stability of the inhibitors prepared at high temperatures, through the use of temperatures graduated from the lowest to the most extreme temperatures, and thus these measurements give another proof that the prepared inhibitors are thermally stable and have proven good efficiency against the problem of deterioration occurring on the surfaces of the machines (Figure 4-6):

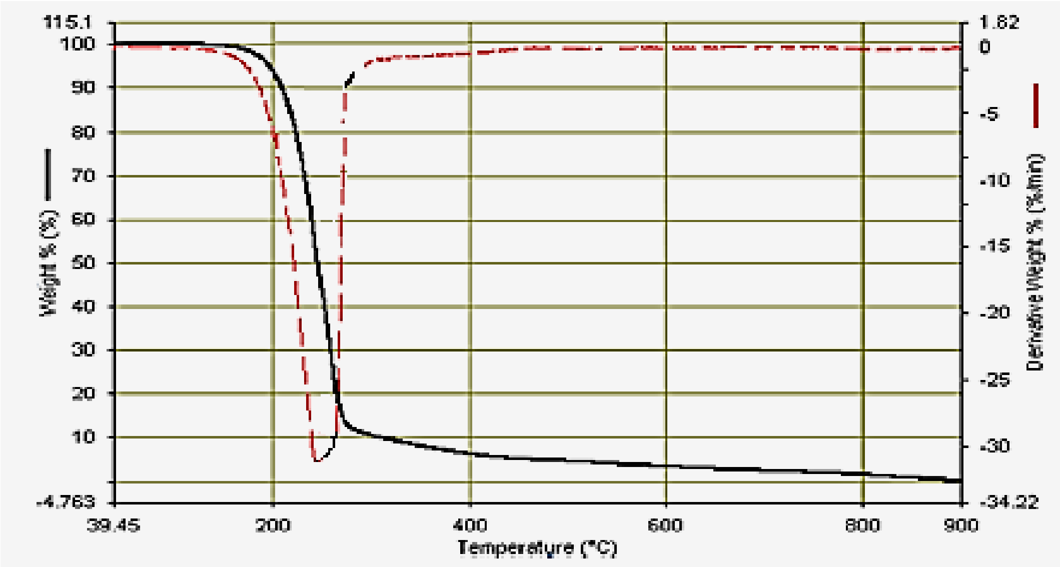

Fig. 4. Thermal curve of Thermo-Inhibitor [1]

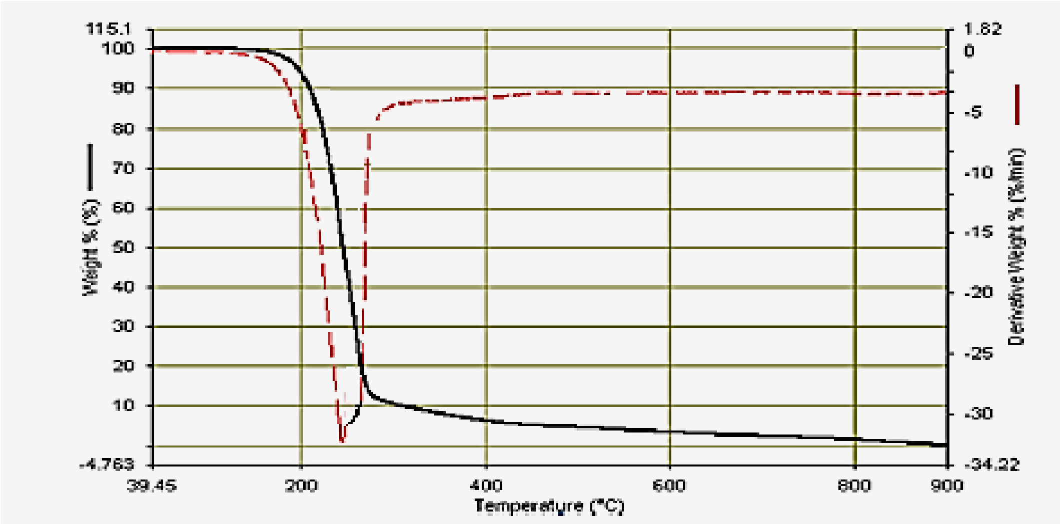

Fig. 5. Thermal curve of Thermo-Inhibitor [2]

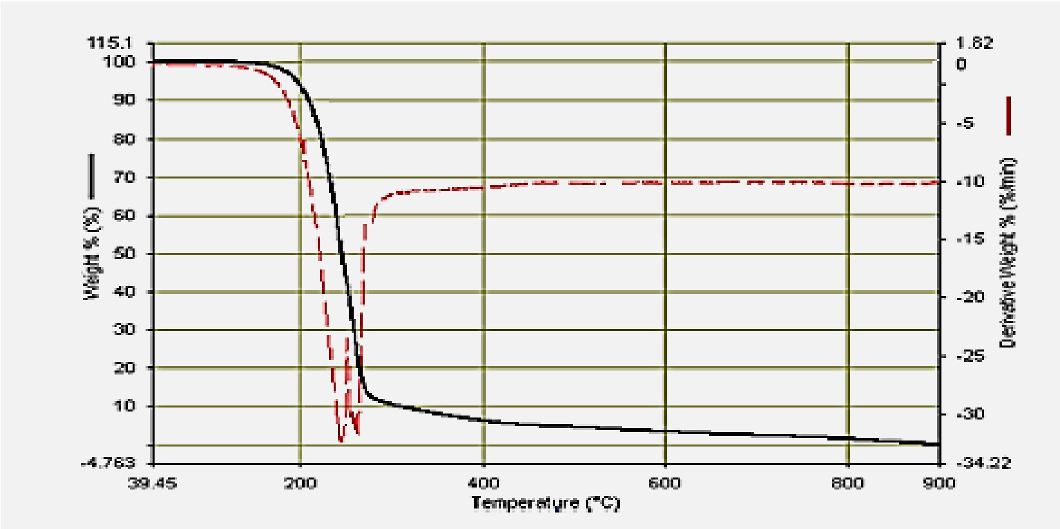

Fig. 6. Thermal curve of Thermo-Inhibitor [3]

4. Conclusions

One of the important basic reasons in any thermal corrosion position is conditions of the environment. For corrosion in aqueous media, two important variables, corrosion potential besides to pH. The prepared inhibitors were applied successfully as corrosion inhibitors on the surface in acid (1M H_2SO_4) solution at 30 ^oC [1-3]. The study found that the three prepared thermal painting gave good results for inhibition of corrosion by increasing the used concentrations of those reagents (inhibitors) that are directly related with the increase in the efficiency of inhibition of metal corrosion by the interaction between the surface of metal and the inhibitor (organic molecules), that is, the flattening efficiency increases with the increase in the concentration of the chemical reagent used. By decreasing the percentage of lost weight in the corrosion process and also increasing the efficiency of those chemical reagents to inhibit corrosion by decreasing temperatures, and thus it has proven good results and a significant efficiency against the problem of corrosion.

Data Availability Statement

The author contributed in this work in experiments, analysis of data, writing of manuscript.

Ethical Clearance

Ethics committee refer that there is no plagiarism and there is no mistakes or wrong results in this work, also there are no experiments on human or patients.

Conflict of Interest

The author declared that there is no conflict of interest.

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