International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 12 (2018) pp. 10972-10978

Case Study of Corrosion Resistance on New Roofing Screws in Corrosive Environments

[1]Bartolomeus Rante Allo, [2]Hadi Sutanto, [3]Isdaryanto Iskandar,
[1,2,3]Department of Mechanical Engineering, Atma Jaya Catholic University of Indonesia,
Jl.Jenderal Sudirman 51, Jakarta, 12930, Indonesia.
[1]ORCID :0000-0003-1852-3494

Abstract

The current problem with the roof screws is corrosion that can cause damage to the roof structure of the building. This study aims to obtain the level of corrosion resistance from various new roof screws on the market. There are 5 types of new roof screws, 3 types of environments, and 3 types of corrosion experimental models that have been done. The corrosive environmental composition of NPK and UREA is 2 kg then dissolved in 2 liters of pure water to show saturated condition. The results show that the new roofing type of SUS-304 has excellent corrosion resistance in 3 corrosive environments and 3 types of corrosion experiments but the roofing type H has a very high corrosion rate

Keywords: New Roof Screws, Corrosive Environment, Weight Loss, Weight Loss Rate.

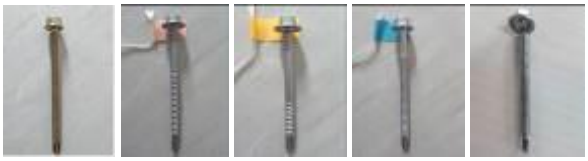
INTRODUCTION

Corrosion is defined as a result of the environmental influence of a material marked by the destruction or deterioration so that the material loses weight [1]. Root screws are very vital to the structure of the building houses, warehouses, office buildings. Determination of the type of metal roof screws can be based on shear strength, reaction to heat treatment, tensile strength, exposure to corrosive environments at various temperatures [2]. Several types of coatings on the new roof screws are: zinc coating, cadmium coating, aluminum coating, painting [3].

The new type of roof screws that many in the market require knowledge in the selection of new roofing screw type that suits the environment so that corrosion factors can be minimized.

Based on the above description, the authors made an accelerated corrosion model design to test and obtain the level of corrosion resistance on new roof screws in some corrosive environments especially in the chemical and offshore industrial environments.

The type of new roof screws used in this research that is:



(a) (b) (c) (d) (e)

Figure 1. Specimens of new type roof screws : (a) *Roofing code H*, (b) SDP – HWFTG, (c) *Envirocoat ITC*, (d) SS 410 – HR, (e) SUS 304.

EXPERIMENTAL METHOD

Material

Tabel 1. Chemical Composition of Specimens.

element	code H content wt %	SDP HWFTG content wt %	EC ITC content wt %	SS 410 HR content wt %	SUS 304 content wt %
Fe	94,8	76	49,2	74,7	67,4
C	< 1,00	3,14	> 4,50	> 4,50	0,31
Si	< 0,1	0,535	0,744	0,737	0,686
Mn	2	0,774	1,82	0,752	0,852
P	0,334	> 0,15	> 0,150	0,37	0,0594
Si	> 0,150	0	0	0	0
Cr	1,21	0,468	1,82	12,2	17,9
Mo	0,13	0,0643	0,664	1,84	0,196
Ni	0,312	7,45	11,3	1,98	8,85
S		0,208	0,342	> 0,150	0,0424
Al		> 1,50	> 1,50		0,0005
Co		0,0202	1,37		0,147
Cu		7,68	0,295		3,21
Nb		0,238	0,597		0,0964
Pb		0,0664	> 0,300		0
Ti		0,0412	0,253		0,0223
V		0,687	0,193		0,0816
W		0,27	1,72		0,0695
Sn					0,0378

Table of chemical composition of specimens obtained from laboratory Characteristics and Materials Atma Jaya Catholic University Jakarta Campus 3 BSD Cisauk Tangerang.

In the chemical composition table of the specimens there are several chemical elements that can minimize corrosion attacks against new roof screws ie: chromium, aluminum, cobalt, zinc, titanium.

Corrosive Environment

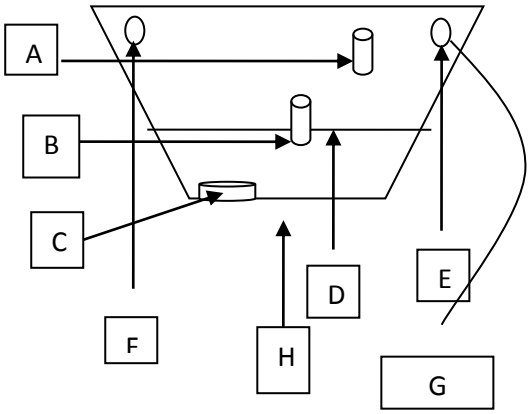


Figure 2. Accelerated corrosion model on roof specimens : (A) aerated specimens, (B) half-aerated specimens, (C) immersed specimens, (D) environmental limit of corrosive solution, (E) air pump inlet, (F) , (G) air pump ducts, (H) containers for corrosive environments.

Corrosive environment of NPK fertilizer and Urea fertilizer is produced by mixing 2 liters of pure water and 2 kilograms of the fertilizer so that the environment is saturated.

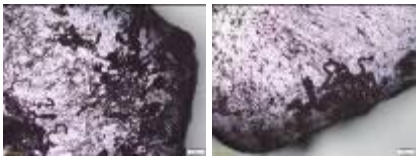
Procedure of cleaning corrosion product on chemical test specimen using liquid 100 mL nitric acid (HNO3, sp gr 1.42) + 20 mL hydrofluoric acid (HF, sp gr 1.198-48%) + 1000 mL pure water for 5 - 20 minutes with temperature 20 - 25 ^{0}C.

RESULT AND DISCUSSION

RESULT

A. Optical microscope of test specimen.

***Aeration test* in Corrosive Environment of NPK**



(a) (b)

(c) (d)

Figure 3. 5x optical photo magnification for NPK corrosive environment with aeration method on specimen of new roof spoon type : (a) Roofing code H, (b) SDP - HWFTG, (c) Envirocoat ITC, (d) SS 410 - HR, (e) SUS 304.

***Half immersed test* in Corrosive Environment of NPK**

(a) (b)

(c) (d)

(e)

Figure 4. 5x optical photo magnification for corrosive environments NPK with half immersed test method on specimens of new roof screw type (a) Roofing code H, (b) SDP - HWFTG, (c) Envirocoat ITC, (d) SS 410 - HR, (e) SUS 304.

***Immersed test* in Corrosive Environment of NPK**

(a) (b)

(c) (d)

Figure 5. 5x optical photo magnification for corrosive environment of NPK by immersed test method on specimen of new roof type roof (a) Roofing code H, (b) SDP - HWFTG, (c) Envirocoat ITC, (d) SS 410 - HR.

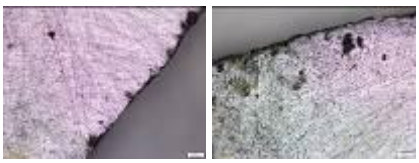
***Aeration test* in UREA Corrosive Environment**

(a) (b)

(c) (d)

Figure 6. 5x optical photo magnification for UREA corrosive environment with aeration method on specimen of new roofing type (a) Roofing code H, (b) SDP - HWFTG, (c) Envirocoat ITC, (d) SS 410 - HR.

***Half immersed test* in UREA Corrosive Environment.**



(a) (b)

(c) (d)

(e)

Figure 7. 5x optical photo magnification for UREA corrosive environment with half immersed test method on specimen of new roofing type (a) Roofing code H, (b) SDP - HWFTG, (c) Envirocoat ITC, (d) SS 410 - HR, (e) SUS 304.

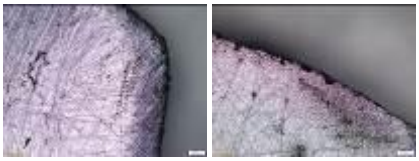
***Immersed test* in UREA corrosive environment**

(a) (b)

(c) (d)

Figure 8. 5x optical photo magnification for UREA corrosive environment with immersed test method on specimen of new roof screw type (a) Roofing code H, (b) SDP - HWFTG, (c) Envirocoat ITC, (d) SS 410 - HR,

***Aeration test* in corrosive environment of SEA WATER**

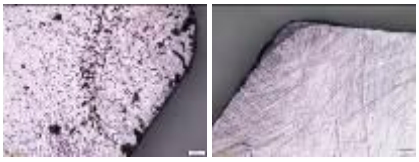


(a) (b)

(c) (d)

Figure 9. 5x optical photo magnification for corrosive environments WATER AIR with aeration method on specimen of new roof spoon type (a) Roofing code H, (b) SDP - HWFTG, (c) Envirocoat ITC, (d) SS 410 – HR.

***Half immersed test* in corrosive environment of SEA WATER**



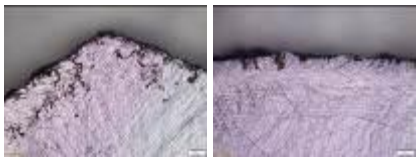
(a) (b)

(c) (d)

(e)

Figure 10. 5x optical photo magnification for corrosive environment of SEA WATER with half immersed test method on specimen of new roof type roof (a) Roofing code H, (b) SDP - HWFTG, (c) Envirocoat ITC, (d) SS 410 - HR, (e)) SUS 304.

***Immersed test* in corrosive environment of SEA WATER**



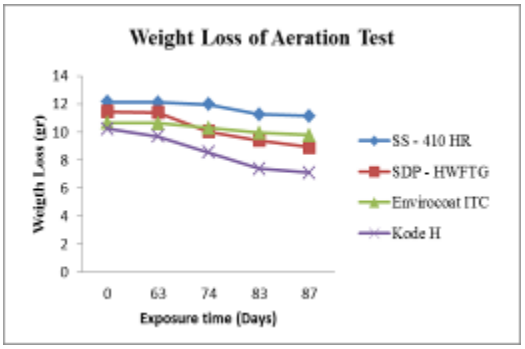
(a) (b)

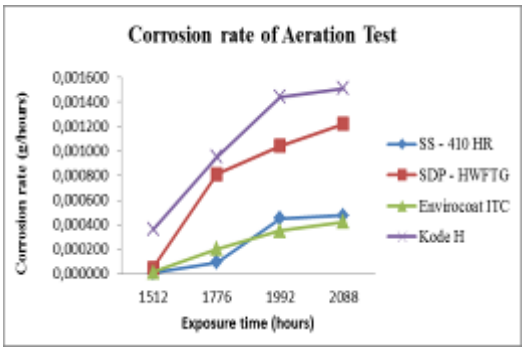
(c) (d)

Figure 11. 5x optical photo magnification for corrosive environments SEA WATER with immersed test method on specimen of new roof screw type (a) Roofing code H, (b) SDP - HWFTG, (c) Envirocoat ITC, (d) SS 410 - HR,

B. Result of weight loss of test specimen.

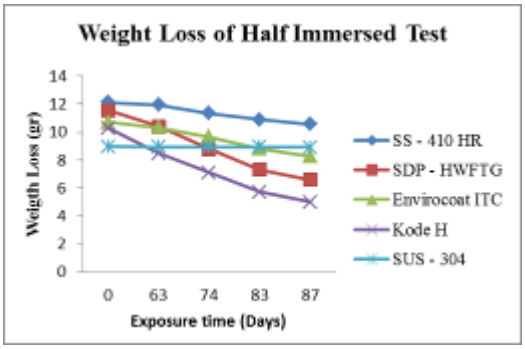
***Aeration test* in corrosive environment of NPK**

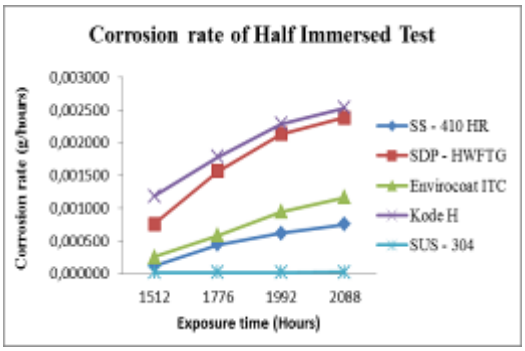




Graphic 1. Result of weight loss and corrosion rate of test specimen for aeration model.

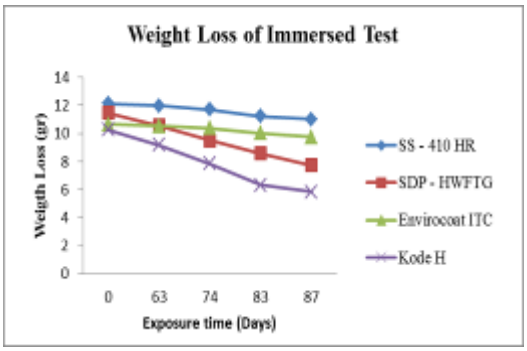
***Half immersed* test in corrosive NPK environment**

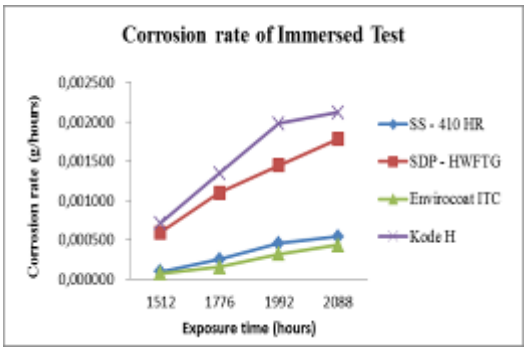




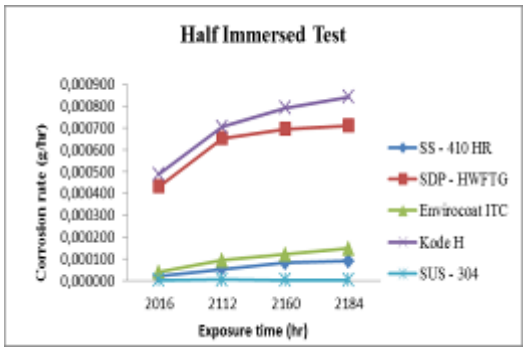
Graphic 2. Result of weight loss and corrosion rate of test specimens for half immersed test model.

***Immersed test* in corrosive environment of NPK**



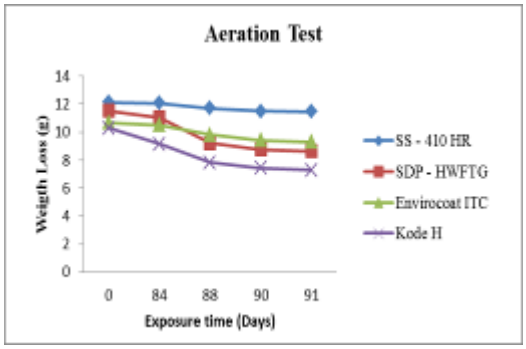


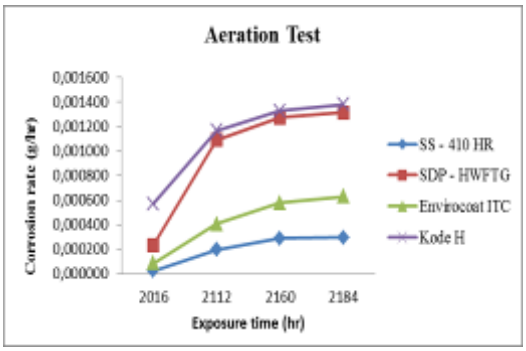
Graphic 3. Result of weight loss and corrosion rate of test specimens for immersed test model.



Graphic 5. Result of weight loss and corrosion rate of test specimens for half immersed test model.

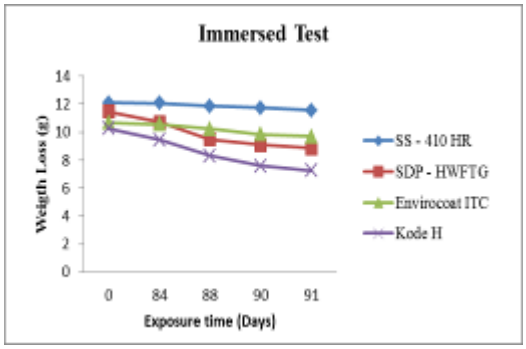
***Aerasion test in* UREA corrosive environment**

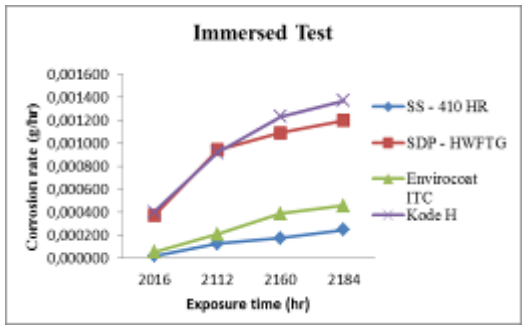




Graphic 4. Result of weight loss and corrosion rate of test specimen for Aerasion test model.

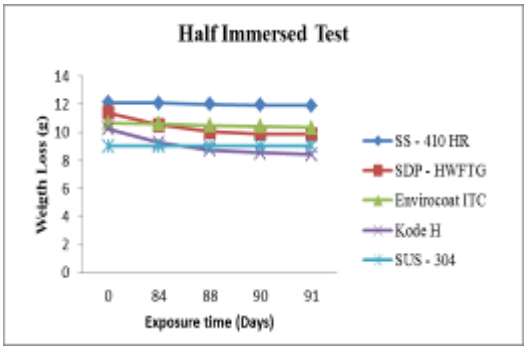
***Immersed test* in UREA corrosive environment**



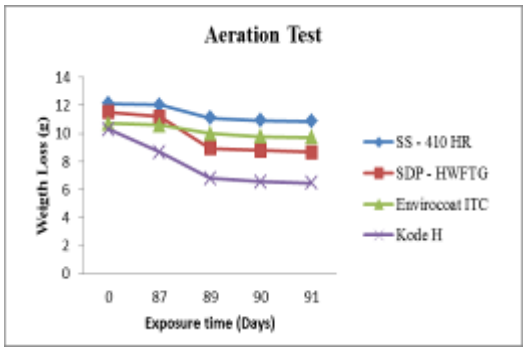


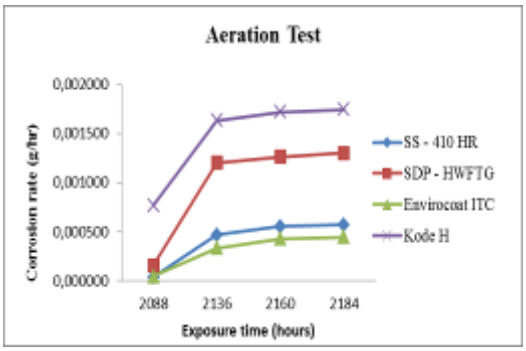
Graphic 6. Result of weight loss and corrosion rate of test specimens for immersed test model.

***Half immersed test* in UREA corrosive environment**

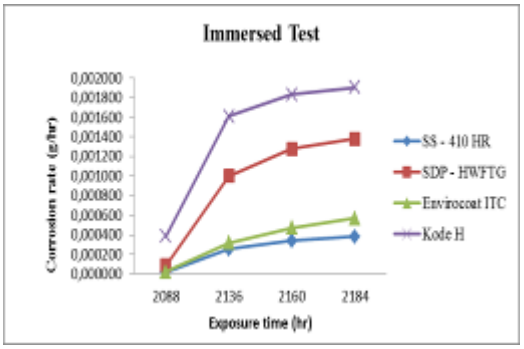


***Aerasion test* in corrosive environment of SEA WATER**



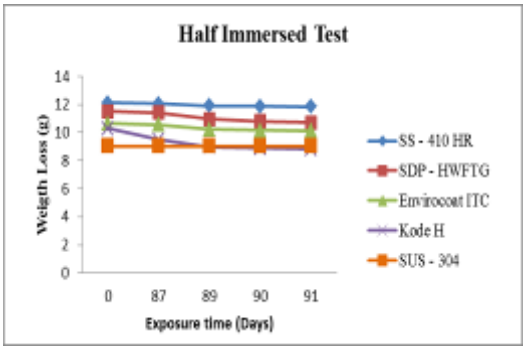


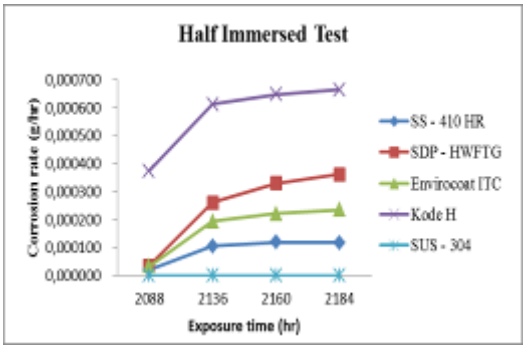
Graphic 7. Result of Weight Loss and Corrosion Rate of test specimen for Aerasion test model.



Graphic 9. Result of weight loss and corrosion rate of test specimens for immersed test model.

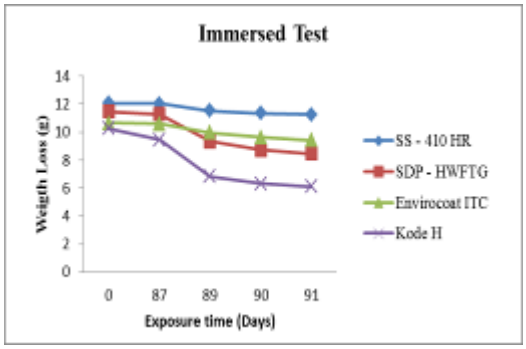
***Half immersed test* in Corrosive Environment of SEA WATER**





Graphic 8. Result of weight loss and corrosion rate of test specimens for half immersed test model.

***Immersed test* in corrosive environment of SEA WATER**



DISCUSSION

A.Optical microscope of test specimen.

Optical magnification microscope 5 x shows the surface state of the new roof screw test specimen after exposure for a certain time. The depth of the corrosion hole shows the corrosion performance of the material and the corrosion resistance of the material decreases [7].

The corrosive environment of NPK has a high corrosive impact on the material type of Roofing code H, SDP - HWFTG, Envirocoat ITC when compared to the corrosive environments of UREA and corrosive environments of SEA WATER.

B. Result of weight loss of test specimen.

The weight loss graph from the new roofing specimen test results indicates the corrosion resistance of new roof screws in a corrosive environment over a period of time and the corrosive impact of corrosive environments.

The corrosive environment of NPK provides a large corrosive impact on new roofing scales when compared to the corrosive environments of UREA and corrosive environments of SEA WATER.

The weight loss rate graph of the new roofing specimen test results shows the amount of weight loss from new roof screws by hour. Therefore it is necessary to check regularly in order to minimize the occurrence of damage to the roof structure of the building..

CONCLUSION

1. The corrosive environment of NPK has a significant impact on corrosion resistance of new roof screws when compared to the corrosive environment of UREA and SEA WATER.
2. The corrosive resistance of new SUS-304 type roof screws is excellent for all three corrosion models in NPK, UREA and SEA WATER. This is because it has a good chemical composition to corrosion.

3. The corrosion model design for this experiment was able to demonstrate the corrosive resistance of new roof screws in the corrosive environments of NPK, UREA, and SEA WATER.

REFERENCE

[1] Mars G. Fontana, *Corrosion Engineering Third Edition*, 1987

[2] ASM SPECIALTY HANDBOOK : *Stainless Steels*, edited by J.R.Davis, 1994.

[3] ASM SPECIALTY HANDBOOK : *Carbon and Alloy Steels*, edited by J.R.Davis, 1996.

[4] ASTM E 92 – 82 *Standart Test Method for Vickers Hardness of Metallic Materials*, 1997.

[5] ASTM G1 – 90, *Standard Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens*[1], 1999.

[6] ASTM G31 – 72, *Standard Practice for Laboratory Immersion Corrosion Testing of Metals*[1], 2004

[7] Mr. Syed Ali AfrazMaster's Thesis,*Mechanical,Microstructural and Corrosion performance for MIM materials based on coarse (-45μm) powders of ferritic stainless steel*.