Waste Landfill and the Waste Contamination Impact on the Corrosion Rate of Low Carbon Steel

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Abstract: ***Landfill is a method mostly used in many cities in Indonesia to accomodate the various kind of waste produced by the community in towns. The landfill contamination is penetrating the ground, the nearby water, the bad smells and the surrounding air. The contamination is convincely promote the increment of the corrosion rate of metals. The impact of the waste landfill contamination to the corrosion rate of steel is reported in this paper. The specimen of water was taken from the Palembang city waste landfill located at Sukawinatan area positioned on $2^0$55'02.6"S 104^{0}44'60.0"E The corrosion rate of low carbon steel (LCS) has already measured by the weight loss method. The low carbon steel is immersed at the site water of the landfill and compared to the corrosion of steel immersed in aquadest solution as reference. The corrosion rate of low carbon steel immersed 336 hours in waste contaminated water is 20.5836 mpy . The corrosion rate of LCS immersed in waste contaminated water in 504 hours is 12.5983 mpy . On the other hand, the corrosion rate of LCS immersed in aquadest for 336 hours is 16,5850 mpy and the corrosion rate of LCS immersed in aquadest 504 hours is 10.125 mpy. The results show the waste landfill contamination water ascend the corrosion rate of LCS by 25%. The experiments also show the tendency of corrosion rate descend from time to time, which shows the ability of LCS construct the passive layer on its surface, and it is convinced as the role of chromium. The galvanic couple of LCS to zinc indicates the corrosion rate reduction significantly.***

Keywords: Waste landfill contaminated water, corrosion rate, Low Carbon Stteel

1. Background

Waste management or waste disposal are all the activities and actions required to manage waste from its inception to its final disposal. This includes amongst other things, collection, transport, treatment and disposal of waste together with monitoring and regulation. There are eight major groups of waste management. Those include reuse and source reduction, animal feeding, recycling, composting, fermentation, landfills, inceneration and land application. Nearly all methods are applied in Indonesia, but most amount of rubbish and garbage are stacked at a site pointed as final disposal area. The contaminated environment including soil, water and air presumably promote the increment of corrosion rate of metal besides the promotion of greenhouse gases emissions such as methane [CH4][1]. It is important to know how the severity of the corrosion rate increment on metals regarding the contamination of landfill to water at the vicinity of waste landfill. This knowledge is to get fine anticipation and design the protection system of the underground constructions such as piping, tanks, cable etc. installed nearby.

Knowing the corrosion rate of metals at the site of waste landfill is supported to improve the management of waste disposal and to anticipate the impacts of water contamination to Low Carbon Steel (LCS) corrosion reaction.

Figure 1: Waste landfill at Sukawinatan in Palembang,South Sumatra, Indonesia.[2]

The experiments also carried out to find the effect of galvanic couple of LCS to Zinc in waste contaminated water.

2. Low Carbon Steel (LCS)

There are three groups of steel according to the content of carbon in it. High Carbon Steel contains 0.6-1.4 pecent carbon. Medium Carbon steel contains 0.3 – 0.6 pecent carbon. Low Carbon

Steel contains less than 0,3% carbon in it. Low Carbon Steel (LCS) is soft, though and good endurance in operation. Low Carbon Steel has good machinability and good weldability. The properties which make this steel has wide application in constructions and manufacturing activities. On the base of the consideration, the metal used in the experiment is Low Carbon Steel, which composition is as below.

Table 1: LCS Composition

Elements	*Contents (%)*
Fe	99.3
C	0.097
Si	0.047
Mn	0.389
Cr	0.078
Mo	0.003
Ni	0.005
Co	0.0067
Cu	0.020
Nb	0.011
Ti	0.0019
W	0.0025
Pb	0.0100

3. The landfill contaminated water

In order to find the fine results, the corrosion testing is conducted with the site solution of landfill. The quality of site solution is as below:

Table 2: The quality of water at the site of landfill

Testing parameters	Units	Test results Up-1578	Test methods
E-Coli bactery	Colony/ 100 ml	4	SNI 01.2897.1992
Chlorida(Cl)[a)]	mg/ L	1291	SNI 6989.19:2009
Oil and Grease[a)]	mg/ L	114,0	SNI 6989.10:2011
Sulphate (SO_4)[a)]	mg/ L	7,0	SNI 6989.20:2009
Nitrate	mg/ L	3,2	Spectrofotometri
Acidity	-	8,0	SNI 06.6989.3:2004

The table shows the severely contaminated water indicated mainly by the existence of e-coly bacteries, high content of corrosive agents such as chloride, sulphate and nitrate. On the other hand, there are also high oil and grease containants.[2]

4. Interface Potential Observation

An observation has done to observed the dynamic of electrochemical reaction on the surface of immersed metals in waste contaminated water.The method used is Luggin capillary tube.[5]

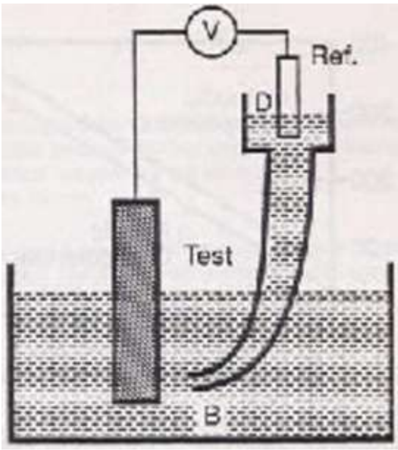

Figure 1: Luggin capillary tube [4]

Table 3: Interface potentials of LCS in waste landfill contaminated water.*)

No	Time (minutes)	Landfill Contaminated Solution (mV VS Cu/CuSo4)		Aquadest (mV VS Cu/CuSO4)	
		Zinc (Zn)	Low Carbon Steel	Zinc (Zn)	Low Carbon Steel
1	5	-867	-222	-973	-397
2	10	-866	-181	-971	-421
3	15	-867	-172	-969	-441
4	20	-948	-162	-968	-446
5	25	-954	-156	-969	-444
6	30	-953	-143	-969	-465
7	35	-952	-149	-971	-474
8	40	-952	-181	-972	-482
9	45	-948	-159	-973	-487
10	50	-955	-150	-973	-490
11	55	-950	-153	-973	-481
12	60	-952	-164	-972	-485

*) Reference electrode: $Cu/CuSO_4$, ambient temperature 31^0C) [3]

The measurements are conducted at room temperature of 31^0C. The results show the Zn and LCS metals tend to cathodic in waste contaminated water than in aquadest. This phenomenon is mainly caused by the high percentage of oil & grease content in the medium. The oil & grease content will deposited on the surface of metal and protect them from oxidation reaction and make the interface potential more cathodic than it should be. On the other hand the pH of 8 also support the tendency of metals to cathodic in it.

5. Corrosion Rate of LCS in Waste Contaminated Water

The corrosion rate is measured on the base of weight loss. The immersion is carried out in 336 hours and 504 hours in order to find the nearest average value oc corrosion rate. The corrosion rate of LCS found are as follows:

Table 4: Corrosion rate of LCS

Immersion time (Hours)	Protec tion	Aqua Dest (mpy)	Waste Landfill contaminated water (mpy)
336	No protection	16.5850	20.5836
	Couple to Zn	11.8512	5.9496
504	No protection	10.1250	12.5983
	Couple to Zn	8.3710	4.1807

The results show the corrosion rate of LCS in contaminated water higher than corrosion rate in aquadest. These indicate that hours after immersion, the corrosive agents such as Chloride, Sulphate and Nitrate penetrate the oil and grease film on the metal surface and corroding the steel.

The corrosion rate of LCS tend to decrease hours after.It shows that at 504 hours after immersion the corrosion rate decrease from 16.58 mpy to 10.12 mpy. LCS in aquadest also shows the same tendency, decrease from 20.58 mpy to 12.59 Its about fourty percent decrement. This indicates that the LCS able to built up the passive film on its surface and descend the corrosion reaction up to fourty pecents.

This is because the existence of Chromium of .078% and Cuprum inside the LCS which support it to built up the passive film on the surface.. It is likely probable that if the measurements applied on the weeks after, the passive film become stronger and descend corrosion reaction significantly.

The experiments also show that the corrosion rate reduced significantly when the LCS connected to a piece of Zn of one cubic centimeter. The corrosion rate in contaminated water reduce from 20.583 mpy to 5.959 mpy and at the immersion of 504 hours, the reduction become from 12.598 mpy to 4.180 mpy.

These reduction indicate how the passive film built more perfectly when the negatif electron flood the metal surface and put the metal into more cathodic. These facts are reflect that reduction of corrosion rate are created by the forming of passive film. The cathodic surface of metal strengthen the forming passive film on LCS. Again, we can conclude that the existence of chromium of 0.0783% in LCS play an important role in forming the passive film and control the corrosion rate of metal.

6. The impact of galvanic connection with Zn to corrosion rate

An experiment on the base of cathodic protection principle, already carried out to see the influence of zinc to the corrosion rate of LCS qualitatively. The ratio of surface area between LCS and Zn is 2.7. The test results show a significant reduction of corrosion rate in aquadest and in waste landfill contaminated water. The significant corrosion decrement found in the specimens immersed in contaminated water, which the decrement attain 50% along the immersion period. This indicates the electrons on the surface of LCS facilitating the protection of steel even in contaminated water.

7. Conclusions

1) The heavily contaminated water at the site of landfill increase the corrosion rate of LCS as much as 25%.
2) The corrosion rate of LCS tend to decrease by the growth of passive film on its surface from hours to hours.
3) A coupled connection to anodic metal such as Zn could reduce the corrosion rate of LCS as much as 50%.

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