Juniper Online Journal Material Science
ISSN: 2575-856X

Juniper Publishers
key to the Researchers

Short Communication
Volume 2 Issue 4 - September 2017
DOI: 10.19080/JOJMS.2017.02.555595

JOJ Material Sci

Corrosion Protection of Crude oil or Product Storage Tanks- Front End Designs (FEED)

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Submission: August 14, 2017; **Published:** September 11, 2017

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A Case Study

A skid mounted Formation water storage tank farm was set up in a remote marginal oil field in North East India. A Cathodic Protection system was installed in the tanks to protect them from Galvanic corrosion over 10 year service life. The tanks had the following design and process data.

Inside diam=6.0m. Height to eaves=4.5m Fixed cone type roof. Liquid capacity=100Kls (Cu.m). Nominal capacity=120Kls. Storage temp=Ambient. Storage pressure = Atmospheric. Max /Min temp (Amb)=38 /3 °C. Design temp = 65 °C. Material of construction = Carbon Steel. Corrosion allowance=3mm Salinity of water=8500ppm. pH=9.5.

System Design Approach

Design calculation for a single tank will be made

The terrain is hilly with heavy slush and mud during monsoon season which extends over April-Dec period every year. This makes the approach to the equipment difficult, requiring stand alone type with least maintenance and low capital investment. So a Sacrificial Anode system was installed.

Design life=10 years. Tank painted with 200 micron DFT Coal Tar Epoxy paint on both sides including structural skid which rests on ground. The system is shown in the above figure the tank steel structure is exposed to stored formation water zone inside, atmospheric zone outside and the base in soil zone.

Table1: Effective areas.

Current Density In Ma/ M^2	Bare Steel		Painted Steel	
	For Polarisation	For Maintenance	Polarisation	Maintenance
Water zone of 8500ppm salinity	120	45	30	8
Atmospheric zone	55	20	12	3
Soil zone	45	12	4	1

Calculation of steel areas in various zones Table 1

Atmospheric zone=3.142 x 6.01 x 4.5 + 3.142 /4 x 7^2=123 m^2

Water zone= 3.142 x 6 x 4.5=85“

Soil zone=3.142 x 6.8^2/4=36“

Table 2 Effective areas. Water zone (inside of tank) no painting damage=85 m^2

Atmospheric zone (outside of tank) 15% painting damage during installation=105 m^2

Table 2: Complete tank structure.

Water Zone		Cathodic Protection Current Required In Amps		Total Current Required In Amps	
		Polarisation	Maintenance	Polarisation	Maintenance
		10.0	4.0	10.0	4.00
Atmospheric zone	Bare steel	1.0	0.4	2.30	0.70
	Painted	1.3	0.3		
Soil zone	Bare steel	1.80	0.20	0.87	0.22
	Painted	0.7	0.02		
Complete tank structure				13.17	4.92

Soil zone (tank skid and bottom) 50% painting damage during installation=18 m^2

Assuming uniform 3% painting deterioration per year, the total deterioration during 10 year service life is 30 %

Painted area in water zone after 10 years = 60 m^2, Bare area=25 m^2

Painted area in Atmospheric zone=74m^2, Bare area=31m^2

Painted area in soil zone=13m^2, Bare area=5m^2.

Total current required for polarisation and maintenance after 10 years

Water zone = 60x38 /1000 + 60 x 25 /1000=3.8 Amps Atmospheric zone=74 x 15/1000+31 x 75/1000=3.5Amps. Soil zone=13 x 5/1000+57 x 5/1000=0.35Amps.

Therefore, total current required for the entire structure after 10 years=3.8+3.5+0.35=7.65Amps.

Design of anode

The anode must provide maintenance current over 10 year period. So, the current required is average of initial and final maintenance currents and=(4.92 + 7.65)/2=6.3Amps. The anode will be of high purity Zinc to stand 10 year service life. The weight of Zinc is given by

W=CR x L x Amp/n x u

Where W=Weight of Zinc in Kgs, CR is the consumption rate of zinc in Kg/Amp year. L=Service life, n=Efficiency factor and u=Utilization factor. In this case W= 10.7x10x6.3/0.9x0.8=936 kilograms.

Using 200mmx200mmx300mm long anodes, weight of each anode=0.2x0.2x0.3x7073kg/m^3=84.8kgs, 12nos anodes of this size will provide 1018 kilograms.

Energy capacity of the anodes@810A-hr per kilogram=810 x 1018=1,466,100 amps.

Figure 1: Tank Farm.

Energy required for initial polarisation and maintenance over 10 year period = (4.92 +7.65) x 365 x 24 x 10 +13.17 = 1,101,145.17 amps. Therefore, the anode system will be adequate Figure 1

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How to cite this article: Nirmalendu B. Corrosion Protection of Crude oil or Product Storage Tanks- Front End Designs (FEED). JOJ Material Sci. 2017; 2(4): 555595. DOI: 10.19080/JOJMS.2017.02.555595