Effect of Temperature and Pressure on Corrosion of Steel Casing in Water Based Drilling Mud

D. Pan[1], C. Vipulanandan[1], Ph.D., P.E. and D. Richardson[2]
[1]Center for Innovative Grouting Material and Technology (CIGMAT)
Department of Civil and Environmental Engineering
University of Houston, Houston, Texas 77204-4003
E-mail: dmpan1983@hotmail.com, cvipulanandan@uh.edu Phone: (713) 743-4278
[2]Program Manager – RPSEA, Sugar Land, Texas 77478

Abstract:
In this study, the corrosion behavior of mild steel 1018 immersed in water based drilling mud (WBM) contaminated by 5% of salt (sodium chloride) under room condition and high temperature and high pressure (100°C and 100 psi) was investigated. Based on laboratory investigation, the rate of initial corrosion of steel is water based drilling mud (WBDM) has been quantified.

1. Introduction

Casing completion is an extremely important part of the process of drilling and completion (Almisned 2008).Corrosion, the deterioration of a metal or its properties, attacks different component at various stages in the life of oil and gas field. Corrosion is a serious and well recognized issue throughout the oil and gas industry. Corrosion in a drilling fluid environment can range from a slow reduction in metal thickness to the rapid pitting or cracking of metal surfaces (McDonald et al., 2007). In drilling engineering, corrosion of drilling tool is a common phenomenon. This problem is becoming increasingly serious with the development of high speed and deep well drilling. Application of low solids, no solid phase, brine and MMH drilling fluid to meet the requirement of this advanced drilling technology poses a big challenge since drilling fluid must have a variety of additives with complex compositions. Drilling fluids usually tend to exhibit strong corrosive effect under high temperature and high pressure (Wang et al. 2013). Results showed corrosion fatigue failure of carbon steel was accelerated by Chloride ion (Cl^-) brought in by salt contamination in drilling mud (Chaoyang and Jiashen, 1998).

2. Objective

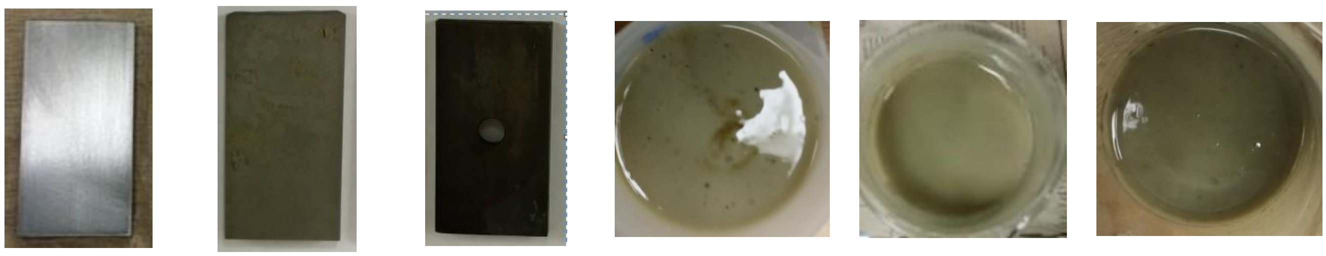
The objective was to quantify the short-term steel corrosion in salt contaminated water based drilling mud under high pressure and high temperature.

3. Material and experiment

Mild steel 1018 plate samples with average dimension of about 50 mm×25 mm×4.7 mm were used for this experiment. Corrosion rate under room condition and high pressure (100 psi) and high temperature (100°C) was investigated. Corrosion rate at the early stage was faster, as corrosion products formed, the corrosion rate tend to decrease. Water based drilling mud samples were prepared by mixing by water, bentonite, water and salt. The percentage of bentonite and salt were 4% and 5%, respectively.

4. Results

After 168 hours of testing, specimens were clean and weighted based on ASTM G31, and calculate the corrosion rate by weight loss. After one week, from observation, mixture of corrosion product and mud attached the surface of specimens. The color of specimens under HPHT was darker than that under room condition. Also, the mud has the same result as specimens (Figure 1). Weight loss of steel specimens under room condition and HPHT at most were 43.9 and 123.7 mg respectively (Figure 2).



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

Figure 1 steel specimens and drilling mud in this study (a) control specimens (b) specimens under room condition (c) specimens under HPHT (e) Mud before use (f) Mud with steel under room condition (g) Mud with steel under HPHT.

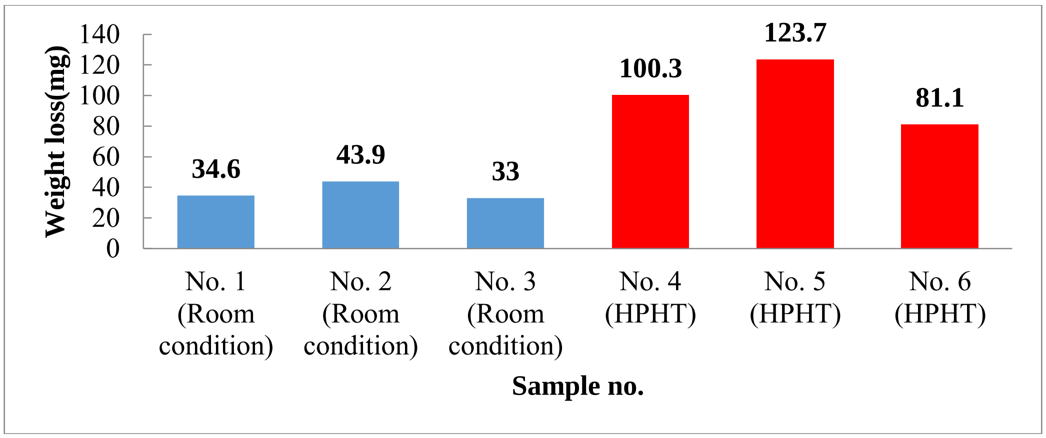


Figure 2 Weight loss of steel specimens under room condition and HPHT(ASTM G31)

Table 2. Evaluation of corrosion rate under room condition and HPHT

Corrosion Index (McDonald et al.,2007)	Corrosion Rate (mpy)	Corrosion rate (mpy, Room condition)	Corrosion rate (mpy, HPHT)
Low	0 to 5	3.02	-
Moderate	5 to 10	-	8.71

6. Conclusion

The corrosion of mild steel in water drilling mud contaminated by salt was accelerated under high pressure and high temperature compared to room temperature. The corrosion rate of steel under HPHT was almost three times of that under room condition. Also, the corrosion rate under room condition was evaluated as low level, but was moderate level under HPHT (Table 2).

7. Acknowledge

This study was supported by CIGMAT with partial funding from various industries.

8. Reference

1. ASTM G31 "Standard Practice for Laboratory Immersion Corrosion Testing of Metals"

F.Chaoyang and Z. Jiashen, (1998)"Corrosion fatigue behavior of carbon steel in drilling fluids", Corrosion, Vol.54, No.8, PP.651-656, 1998.

2. McDonald M., Barr, K. and Wadsworth G.(2007) "Use of silicate-based drilling fluids to mitigate metal corrosion", 2007 SPE international symposium on Oilfield Chemistry held in Houston, Texas, U.S.A, 28 February-2 March 2007.

3. Wang, Z.L., Yin, D., Luo, Y., Liang, H. J., Yang, L.L. and Lu, H., (2013), "Corrosion and Its Inhibition in Water-Based Drilling Fluid Used in Onshore oilfield", Natural Resources, Vol.4, PP.456-459.

4. Almisned, O.,(2008) "Assessing the corrosivity of drilling mud on well casings", Anti-Corrosion Methods and Materials, PP.278-282, 2008