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DRILL PIPE CORROSION COUPONS

Datasheet

Drilling Fluids Testing / Corrosion Monitoring Equipment

DRILL PIPE CORROSION COUPONS

Description

The placement of corrosion test rings in the drill string is one of the more common techniques used to evaluate the corrosiveness of drilling-fluid environments on the drill string and other steel equipment. Removal and examination of these rings after a period of exposure down-hole can be highly informative as to the corrosiveness of the drilling fluid, as well as to the type of corrosion encountered. An examination of scales and pits on the exposed rings gives clues as to the cause of the corrosion, thus aiding in choosing proper remedial action.

The ring technique is specifically designed for detection of the type of corrosion characterized by metal loss whether it is localized pitting or generalized attack. The test ring is not designed to give information relating to hydrogen embrittlement, stress corrosion cracking, or other forms of fracture formation, except in the manner in which pitting may relate to these failures.

Equipment

The following equipment is needed:

a. Ring construction: The ring-type drill string corrosion coupon, or corrosion ring, should be machined to fit in the tool box recess, at the end of the pin, and should have a bore the same as that of the tool joint to minimize turbulence.

b. Ring composition: To avoid galvanic corrosion, the ring should be made from steel identical to that of the tool joint in which it is placed. Such a requirement is impractical, and use of steel that is similar in chemical composition, such as AISI 4130, is recommended. The grade of steel used should be identified on the report form. The rings are normally cut from tubes that have not been quenched and tempered. The similarity in composition of the 4130 steel and the tool joint should be adequate to minimize galvanic effects and provide useful data.

c. Ring marking: The rings should be stenciled with a serial number for permanent identification.

d. Ring preparation: The rings should be scrubbed with a stiff fiber bristle brush and detergent solution, rinsed with clean water and with anhydrous acetone or methanol. The rings should be allowed to dry, weighed to nearest milligram, and this weight recorded on the report form. The ring should be stored in a dry container, such as a desiccator, to prevent corrosion. The corrosion rings should be shipped to the field in sealed envelopes or wrappers to minimize atmospheric corrosion.

Fann Drill Pipe Corrosion Coupons are made of Cold Drawn seamless mechanical tubing Type 4130 machine-finish steel.

Composition	%
C – Carbon	**.28 - .33**
Mn – Manganese	**.40 - .60**
P – Phosphorus	**.035**
S – Sulfur	**.040**
Si – Silicone	**.15 - .30**
Cr – Chrome	**.80 – 1.10**
Mo – Molybdenum	**.15 - .25**

Procedure

The drill pipe corrosion rings should be kept in the drill string for a minimum of 40 hours. A normal time for exposure is 100 hours. Exposure periods of less than 40 hours should not be used because initial corrosion rates may be unusually high and can give misleading data. The ring is usually placed in the tool joint at the top of the first stand above the drill collars and can be left in the drill string for more than one bit run. An additional ring can be placed in the Kelly saver sub to monitor corrosion at that point. Care should be taken to ensure that the box recess is clean to prevent interference with proper make-up of the joint and to avoid damage to the ring. In some instances specially manufactured subs have been used for the ring placement in the string. During installation, the ring should be handled with clean, dry gloves.

The drill pipe corrosion coupon form should be filled out completely. Each form should have a space for ring material, drilling fluid properties, type of corrosion, location of ring in the drill string, initial weight, time, depth in, depth out, ring number, color of scale, and any other information of significance in the specific test. The form may be printed on a mailing envelope for the ring or on a separate form to be enclosed with the ring.

The drilling-fluid residue should be removed from the coupon by wiping with a cloth when the ring is pulled from the drill string. The ring should be examined for severity of corrosion or mechanical damage. If severe corrosion is evident, the cause of the corrosion should be determined promptly so remedial action can be taken. Following visual observation, the coupon should be placed in the original envelope or wrapper containing a vapor phase corrosion inhibitor for return to the laboratory.

Before proceeding with a quantitative evaluation of corrosion of the ring, the ring should be rinsed with a suitable solvent, such as acetone or petroleum ether, to remove the oil applied to the ring on location. Prior to cleaning for weighing, a spot test should be made for corrosion by-products and mineral scale. For example, the surface can be examined qualitatively for sulfides by the acid arsenite test. The rings should be cleaned with a detergent solution and a stiff fiber bristle brush. It may be necessary to dip the ring for 5 seconds to 10 seconds in inhibited 10 percent to 15 percent hydrochloric acid one or more times to remove corrosion products. The ring should be scrubbed with the detergent solution after each acid dip, and rinsed thoroughly with clean water and then with anhydrous acetone or methanol. The ring should dry prior to weighing. Very abrasive materials or strong, uninhibited acids should not be used. An ultrasonic bath can be useful in cleaning the rings.

After the pre-weighed drill pipe corrosion coupon has been properly cleaned and the corrosion film and type of attack noted, the ring should be reweighed to the nearest milligram and the weight loss determined. If significant loss of metal due to mechanical damage is evident, it should be noted and taken into consideration in evaluation of the ring. The corrosion rate may be reported as kilograms per square meter per year, pounds per square foot per year, or mils per year.

NOTE: The re-weighing of Drill Pipe Corrosion Coupons is the user's responsibility.
This is usually done locally to obtain the weight loss information quickly.

Comments on Visual Examination

If visual corrosion is evident, it will normally be detectable as pitting corrosion. Uniform attack or general corrosion can best be determined by a weight loss measurement. Mechanical damage to the ring will most often be evidenced by cuts or dents on the outer surfaces of the ring. In some cases, the ring will exhibit a series of dents and worn spots, indicating considerable movement of the ring in the box recess.

In assessing the magnitude of the corrosion rates as calculated from weight loss measurements, it should be remembered that the rate is also influenced by the erosive effects of the drilling fluid. Since the bore of the ring is exposed to the mud pumped down the drill pipe, the loss of metal includes that removed by erosion as well as from corrosion. Loss from erosion can be substantial when the drilling fluid contains a high concentration of sand.

Examination of the ring may reveal a few deep pits with a relatively low weight loss. This condition would indicate a rather severe corrosion problem even though the calculated corrosion rate would be considered low.

Calculations

The following formulas apply to calculating the weight loss (wt. loss) corrosion rate:

a. For kilograms per square meters per year ($kg/m^2/yr$):

$$= \frac{[\textit{wt. loss, mg}]\;[10{,}000]\;[365]}{[1{,}000{,}000]\;[\textit{area}, cm^2{*}]\;[\textit{days exposure}]}$$

$$= \frac{87.60(\textit{wt. loss, mg})}{\text{area, } cm^2{*}(\textit{hours exposed}{**})}$$

$$= \frac{13.58\;(\textit{wt. loss, mg})}{\textit{area}, in^2{*}(\textit{hours exposed}{**})}$$

b. For pounds per square feet per year ($lb/ft^2/yr$):

$$= \frac{[(\textit{wt. loss, mg})]\;[144]\;[365]}{[453{,}600]\;[\textit{area}, in^2{*}]\;[\textit{days exposure}]}$$

$$= \frac{[2{,}781\;(\textit{wt. loss, mg})]}{[\textit{area}, in''(\textit{hours exposed}]}$$

c. For mils per year (mils/yr):

$$= \frac{\textit{wt. loss, mg}}{\left[\frac{16{,}387}{cm^3/in^3}\right]\left[\frac{\textit{specific gravity},}{g/cm^3}\right]\left[\frac{(\textit{area}}{in^2{*})}\right]\left[\frac{(\textit{year}}{\textit{days}/365}\right]}$$

For steel coupons with a specific gravity of 7.86, the formula can be reduced to the following:

$$\text{mils/yr} = \frac{68.33\;(\textit{wt. loss, mg})}{\textit{area}, in^2{*}(\textit{hours exposed}{**})}$$

*Total surface area of the ring is used in these calculations.
******Time used is based on total time in the drill string.

Following are the conversion rates between the units for steel coupons (specific gravity 7.86):

mils/yr = 24.62 ($lb/ft^2/yr$)

mils/yr = 5.03 ($kg/m^2/yr$)

$lb/ft^2/yr$ = 0.04 (mils/yr)

$lb/ft^2/yr$ = 0.20 (kg/m2/yr)

$kglm^2/yr$ = 0.20 (mils/yr)

$kg/m^2/yr$ = 4.90 ($lb/ft^2/yr$)

Fann Drill Pipe Corrosion Coupons

Drill Pipe Size & Type	Coupon Size	Legacy No.	Part No.
2-7/8 in. Internal Flush and 3-½ in. Slim Hole	2 1/2-in OD x 0.250-in wall	63618	**210091**
3-1/2 in. Extra Hole and 3-½ in. Full Hole	2 3/4-in OD x 0.188-in wall	63619	**210092**
3-1/2 in. Internal Flush and 3-½ in. Extra Hole	3-in OD x 0.313-in wall	63620	**210093**
4 in. Full Hole	3 1/4-in OD x 0.250-in wall	63621	**210094**
4 in. Internal Flush and 4-1/2 in. Extra Hole	3 3/4-in OD x 0.3125-in wall	63623	**210095**
4-1/2 in. Full Hole and 4-1/2 in. Extra Hole and 4 in. Internal Flush	3 5/8-in OD x 0.375-in wall	63624	**210096**
4-1/2 in. Internal Flush and 5 in. Extra Hole	4 1/2-in OD x 0.3125-in wall	63625	**210097**
5-9/16 in., 5-1/2 in. API Regular or Full Hole and 6-5/8 in. API Regular	4 5/8-in OD x 0.500-in wall	63626	**210098**
6-5/8 in. Full Hole K=202	4 11/16-in OD x 0.282-in wall	63627	**210099**
4-1/2 in. Extra Hole	3 13/16-in OD x 0.200-in wall	63629	**210100**
6-5/8 in. Full Hole K=123.3	5 3/4-in OD x 0.375-in wall	63630	**210101**
5 in. x H Tool Joint	4 3/16-in OD x 0.2185-in wall	63631	**210102**

Each coupon supplied by Fann is stamped with a serial number and packaged in a special corrosion-inhibitor envelope to prevent atmospheric corrosion. Serial number, initial weight, size, and the "K" factor (for calculating corrosion rate) are recorded on the coupon envelope.

The K factor is multiplication factor which includes the metal density and surface area of the ring. Thus, the weight loss divided by the exposure time need only be multiplied by the K factor to obtain the corrosion rate.

Fann offers a complete line of Corrosion Testing Equipment including:

- **Drill Pipe Coupons**
- **Flat and Rod Coupons**
- **Coupon Holders in various sizes and configurations**
- **Galvanic Corrosion Monitors**

Contact Fann for information on other Fluid Testing Instruments

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