

EROSION CORROSION PHENOMENA IN OIL AND GAS FACILITIES: EVALUATION AND MONITORING

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ABSTRACT

High flow velocity can have negative impact on the integrity of the oil and gas production equipment. This negative impact can influence the efficiency of Corrosion Inhibitor (CI). It is well established that the higher the flow velocity, the lower the CI efficiency. Another detrimental effect of flow velocity is the possible occurrence of erosion-corrosion phenomena, where the bare metal will be continuously exposed to the corrosive environment, and thus corroding much faster than in low flow velocity conditions.

The C-factor, as derived from API RP 14E equation, is used as criteria to limit the flow velocity to avoid such severe phenomena. This criterion is dependent on fluid corrosiveness, efficiency of the inhibition and the presence of solid particles. The Company uses a software, an in-house developed tool, to predict and evaluate the risk of erosion-corrosion for different oil and gas production equipment. Typical parameters influencing the corrosiveness of the fluid (water phase composition, CO₂ content in the associated gas, pressure, temperature), the production data (GOR, BSW) and the geometry of the equipment are considered when evaluate the likelihood of erosion-corrosion occurrence.

Two case studies are presented, both concerning multiphase subsea production pipelines in service on our offshore assets. As per COMPANY strategy this equipment is periodically inspected via In Line Inspection (ILI) Technology, with the aim of assessing its status. The results of these inspections are analyzed from a corrosion management point of view. Considering real production data and operating conditions, the in-house software was used to evaluate the corrosiveness of the produced fluid and the occurrence of erosion-corrosion phenomena. The predicted corrosion rates are then compared with the

ones measured by inspection tools (ILI & non-intrusive thickness monitoring). This analysis is used further on to re-define the corrosion mitigation program.

Key words: C factor, erosion-corrosion, inspection, multiphase, flow velocity

INTRODUCTION

High flow velocity can have negative impact on the integrity of the oil and gas production equipment. This negative impact can manifest by the reduction of Corrosion Inhibitor (CI) efficiency: the higher the flow velocity, the lower the CI efficiency. The negative impact can also manifest by the occurrence of liquid erosion corrosion phenomena.

The C-factor, as derived from API RP14E equation¹, is used as criteria to limit the flow velocity to avoid erosion corrosion phenomena. This criterion is dependent on fluid corrosiveness, potential corrosivity of the water, efficiency of the inhibition and the presence of particles. Company uses an internally developed software, PreCorr, to predict and evaluate the risk of corrosion and erosion-corrosion. The software is an electrochemical model that is using all oxidation and reduction reactions involved in a de-aerated water acidified by CO₂. The software has been up-dated by combining physico-chemical calculations and semi-empirical criteria established from more than 40 years of operational feed-back. The tool is providing a prediction of the corrosiveness of the fluid and a range of corrosion rates associated to the corrosiveness category, as presented in Table 1. The model is also providing a quantified output which is the 'Potential Corrosivity': the corrosion rate experienced by the bare steel surface in the corrosive environment and for on which corrosion reactions are well defined. The Potential Corrosivity does not consider any effects of scale formation nor wetting effect.

Table 1. Corrosiveness categories and associated corrosion rates

Corrosiveness	Corrosion rate (mm/y)
Very Low	<0.1
Low	0.1 to 0.3
Medium	0.3 to 1
High	1 to 3
Very High	>3

The tool also can assess the risk of the erosion-corrosion for the given operating conditions. Erosion-corrosion prediction is based on the comparison of the limiting flow velocity as provided by API RP 14E equation with the calculated flow velocity. The erosion-corrosion is considered as likely if the sum of liquid and gas superficial velocities is higher than the calculated limiting velocity.

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For a multiphase and free of solids fluid, the Company internal standards recommend limiting C-factor values as presented in Table 2. The distinction is made not only on the corrosiveness of the fluid, but also on the presence of good and reliable inhibition of the fluid. It is stressed out that these criteria are used only for a fluid free of solids. Should the produced fluid contain solids, the C-factor limitation is

dropping at 100 or even at 75 (US unit). Company internal standards, applicable to continuous service, is globally less conservative than API RP14E/ ISO 13703.

Table 2. C-factor (US Units) criteria as per internal standards

Corrosiveness	Non -inhibited fluid	Inhibited fluid
Very Low	130	160
Low	130	160
Medium	100	130
High	100	130
Very High	100	130

CASE STUDY # 1

The case study concerns a pipeline, named P30, of 10 km length, in carbon steel, of 0.2m diameter and with wall thickness of 13.6 mm. The produced fluid is multiphasic (oil, water and gas) at a temperature of about 60°C. Some sand production events were registered during the service. The internal corrosion of this fluid is mitigated by injection of corrosion inhibitor (CI). Typical production data for this pipeline are presented in Table 3.

During in-line internal inspection (ILI), corrosion indications were found as presented in Figure1. The internal inspection has shown an evolution of the corrosion indication since the previous ILI (6 years earlier) with severe metal loss particularly in the right branch, along the riser part (vertical section). The most severe corrosion indication was of 76% of wall thickness, corresponding to a corrosion rate of 1.7 mm/y.

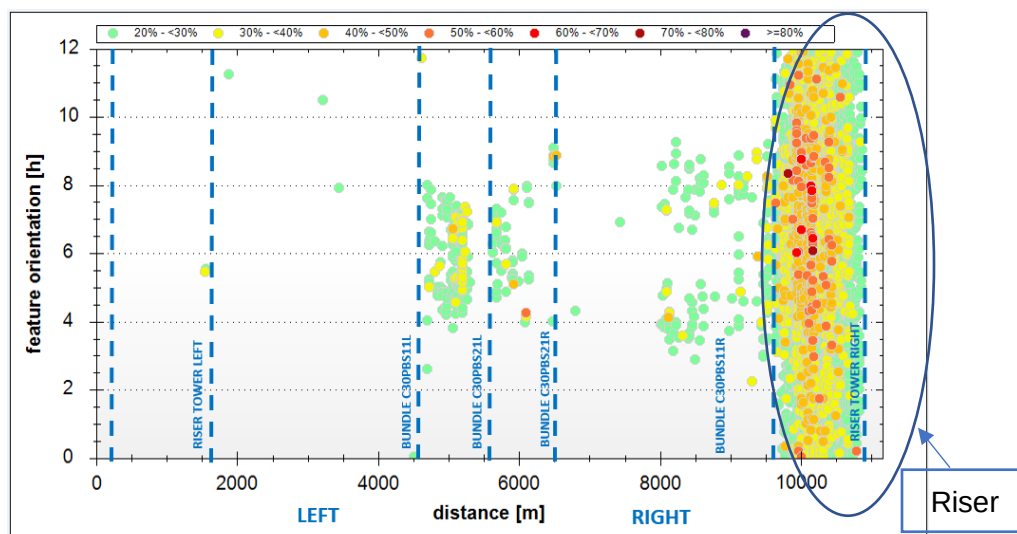


Figure 1. ILI results for Multiphasic Pipeline

In the next section, the corrosion assessment is performed in order to understand if the flow velocity is the main cause of these high corrosion rate and to find out what is the limitation value for C-factor.

Results

The corrosiveness of the fluid and associated Potential Corrosivity were calculated using PreCorr for different production data, as they occurred in the service-life of the pipeline. The production data are summarized in Table 3.