Destruction mechanisms and methods of laboratory autoclave tests of internal coatings of oil pipes

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Abstract. The main mechanisms of destruction of internal anticorrosive polymer coatings (IACPC) of the inner surface of tubing and fielding pipes are review in the article. They are divide into decompression peeling, substrate destruction under the corrosion of and natural aging of the polymeric basis. A critical analysis of the existing standards for the testing of internal anticorrosive coatings was made. The carrying out test on these documents does not allow obtaining the destructions identical to those found during the exploitation of pipelines. Investigations on the selection of optimal regimes of autoclave tests and the methodology for conduct research are describe. A comparison for the results of laboratory and experimental field tests of the coatings presented.

1 Introduction

Annual metal losses due to corrosion account for up to 12% of the total mass of the metal-fund, which corresponds to a loss of up to 30% of annual metal production in the Russian Federation [1]. The problem of corrosion is especially acute in the oil industry, where, according to various data, the share of oil pipeline failures due to corrosion is 25 to 95% of the total number of accidents [2]. The costs of corrosion in 2012 in the US exceeded $ 1 trillion that was about 6.2% of GDP [3, 4].

Only now in the extractive industry of the Russian Federation internal anticorrosive coatings are gaining increasing popularity for protection of the fielding pipes inner surface (usually epoxy and epoxy - Novolacs basis) despite the fact that the effectiveness of internal anticorrosion coatings was demonstrated 20 years ago [5]. All new capital construction takes place using this technology in most oil companies. Despite of the impressive economic effect an applicability of this technology for a long time has been limited to several aspects: the inability to conduct in-pipe diagnostics (due to the use of sleeves to protect the welded joint), the rapid process of corrosive destruction at the site of the defect, the inability to verify quality control and predict the resource.

Experience in the development of oil-fields in Western Siberia talk that the intensity of development by the corrosion damages to the internal surface of field pipelines is associated with an increase in the number of mechanical impurities in pumped product, changes in the ion composition of mining bedded water, flow regimes and significant bio-contamination of the oil-fields. This explains the growing need for corrosion protection methods for the internal surface of pipelines including the use of the IACPC. Along with the increase in the use of IACPC, there is a need to ensure and control the quality of the supplied products. Decision of this problem requires a complex approach, including the development of techniques for laboratory tests taking into account the specific exploitative conditions of the field pipelines. A complex approach to the test problem described in [6]. The authors analyzed a large number of causes of failures of the tubing and field pipelines and highlighted the main mechanisms of IACPC destruction during exploitation: decompression peeling of the coating, corrosive destruction of the substrate metal, aging of the polymeric basis, which confirms the conclusions made in work [7].

2 Decompression peeling of the coating

The essence of this destruction mechanism is the penetration of gas dissolved in the transported medium into the volume of the polymer through micropores and discontinuities, followed by the accumulation of gas in the pores or at the metal-coating interface. A multiple expansion of the compressed gas volume occurs with pressure drops. This accompanied by mechanical destruction of adhesive and cohesive bonds [8] and, as a result, the formation of swellings, exfoliations and cracking of the coating (Figure 1).

The main signs of decompression destruction include low (less than one year) time to failure (TtF); large damage area; no corrosion products under coating; high power of deformation of the coating. This type of destruction is more typical for tubing than for oilfield communication pipelines.

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