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Simulation of the Hydrodynamic Conditions of a Rotating Cage for Evaluating Corrosion Inhibitors.

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Abstract

The Rotating cage technique is used to evaluate corrosion inhibitors. The rotating cage holds 8 coupons containing corrosive liquid, which rotate within it. These coupons have a dynamic that simulates the conditions in a pipe through a corrosive fluid, in this case the material used in pipelines are analyzed oil. A study of the fluid dynamics through the ANSYS software shows that the velocity fields, contours, vectors and speed profiles for symmetric geometries arrangements 2, 4 and 8 embedded specimens with a corrosion inhibitor. The conditions are calculated velocity profiles are standard temperature and solution viscosity of 1.0 cp and 1.5 cp. The density is considered constant of 998 kg / m3 and three angular velocities (920, 460 and 230 rpm) were analyzed. Finally the results of these conditions have been analyzed, yielding values close to zero in the outside walls of the cylinder. The cylinder contain the coupons rotating speeds to ensure turbulence (1) and to analyze the rate of corrosion inhibitor.

I. INTRODUCTION

Corrosion may be defined as a destructive process that causes a deterioration of the material, as the result of a chemical attack caused by the environment. Corrosion, it occurs primarily in metals, therefore, a major problem is that the corrosion affects primarily these kind of items. This implies many types of problems, most of which are quite serious. This process in its various forms (among which may be present) will produce a considerable deterioration in the kinds of metals that affects them over time. If not treated, inducing complete destruction, implying also huge economic and production losses. For example: the costs caused by corrosion oscillate around 4% of GDP industrialized countries (the science and technology sector is only 0.47% of GDP compared to Mexico). Many of these costs could be avoided with more and better use of knowledge and techniques that are available today (2,3).

II. METHODOLOGY

A process of computer simulation was used to simulate the flow in pipelines in the laboratory samples by rotating ducts materials (steel) at different speeds. In doing rotate both being simulated corroded pipeline as it passes through a corrosive liquid with different inhibitors. Rotating cage geometry: To enter the simulation program geometry rotating cage is programmed into the software ICEM. In ICEM "draw" geometry and "meshing" was determined, as well defined boundary conditions. The geometry is drawn in 3D arrays 8, 4 and 2 flat test to determine the effects of the corrosion on the surfaces of the coupons. To determine a representative velocity profile of the fluid level, thus is reduced 2D geometry it identified. Each 2D geometries must have a mesh to be simulated in the software ANSYS FLUENT [4]. For each of the arrangements made with mesh boundary layer growth factor, this allows the calculation of the value to be right on the walls of the coupons. ANSYS FLUENT simulation: It made a total of 18 computer-assisted simulations, with arrangements of 2, 4 and 8 coupons with a time simulation of 4000 seconds, 20,000 iterations and each iteration with a time step of 0.2 (s). The conditions are calculated velocity profiles at standard temperature and solution viscosity of 1.0 cp and 1.5 cp. The density is 998 kg/m^3 and 3 angular velocities have been considered: 920 rpm, 460 rpm and 230 rpm for the calculations.

Experimental tests: To evaluate the inhibitory, experimental tests were made, through which the corrosion rate [5-7] was obtained. By performing these tests, the corrosion rate was determined in the typical material oil ducts [8]: steel with and without inhibitor and the inhibitor was also placed at 10, 25 and 50 ppm. The method usedin determiningthe corrosion ratewas theweight loss

III. RESULTS

With simulations contours [Fig.01], the vectors [Fig.02], and profiles of the fluid velocity obtained.

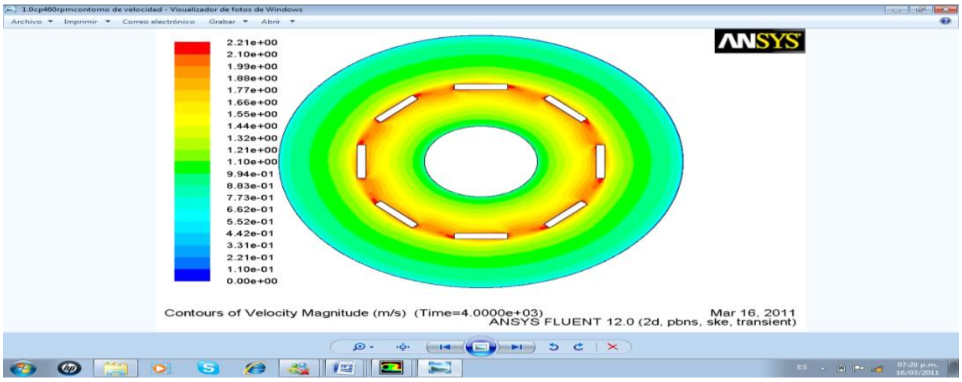

Figure 1.Contours of velocity, 460 rpm 1.0 cp for 8 coupons.

In the Figure1 it can be observed contours velocity simulation results at 460 rpm with a viscosity of 1.0 cp and 8 coupons. It is observed that the specimens have maximum speed and as it reaches the outer cylinder is stationary speed decreases to lowest value.

Figure 2 shows the velocity vectors and mark the ends of the coupons, at its maximum tangential speed.

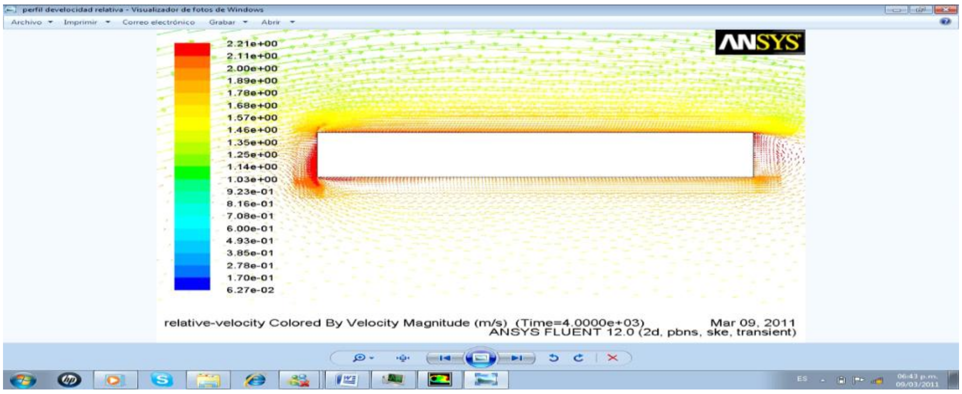

Figure2. Vectors velocity at 460 rpm 1.0 cp for 8 coupons

The following graphs velocity profiles are shown for each coupons at the speeds of 460 rpm, 920 rpm and 230 rpm.

The Figure 3 shows for 460 rpm the velocity profiles with different arrangements of coupons and viscosities are 1.0 cp and 1.5 cp well to 920 rpm [Figure 4] and 230 rpm [Figure 5].

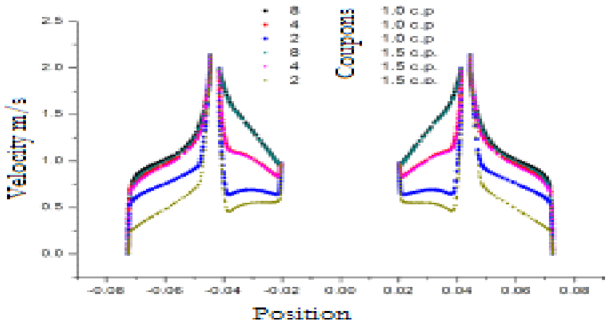

Figure 3. Velocity profiles at 460 rpm

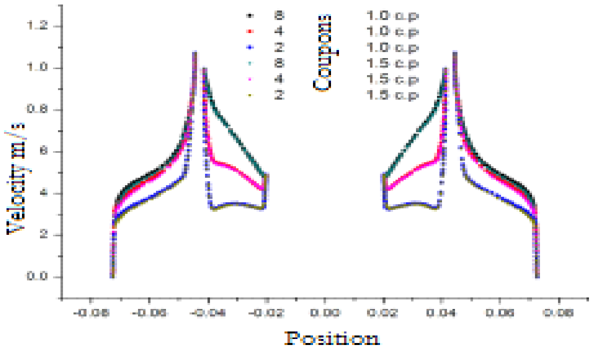

Figure 4.Velocity profiles at 920 rpm

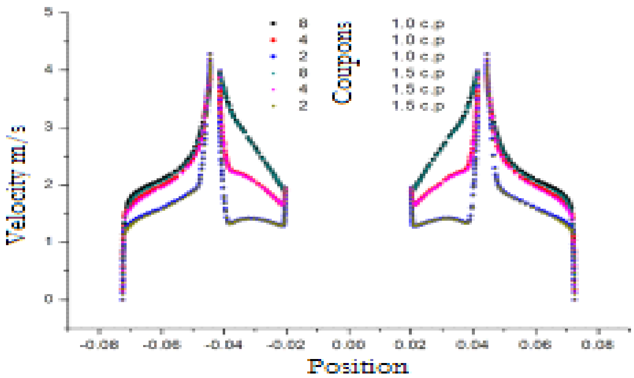

Figure 5. Velocity profiles at 230 rpm

The graphics can compare the simulations were made and note that changing the viscosity no difference in profiles with the maximum speed on the walls of the coupons and the minimum (zero) in the walls of the stationary cylinder (5). However, one can see a difference in behavior of the fluid when coupons are having different arrangements between it and the wall of the outer cylinder, but evaluating the behavior in this study would be irrelevant. With experimental results achieved to determine the coefficients of a function comprising 3 effects: the initial weight of a representative sample of 1 m^2, the function of weight loss per each square meter would affect the speed and finally the effect of inhibitor depending on the concentration of carboximidazolina expressed in ppm and positively affects each square meter of exposed metal. The inhibitor was evaluated at concentrations of 10, 25 and 50 ppm, which are regularly used to inhibit oil pipelines. Depending on the amount of inhibitor which the corrosive substance will be the result of the efficiency of the inhibitor is added, not because a greater amount is added can be inhibited more, in our case an amount of 10 ppm better inhibits corrosion to25 ppm, but 50 ppm inhibits better than 10 then the proper amount to inhibit the specimens of the device is 50 ppm.

IV. **CONCLUSIONS**

CFD study was done to see the difference in each of the simulations with different arrangements of coupons (2, 4, 8), different viscosities and speeds, then the conclusion is that: no matter the number of coupons surface of each coupon is exposed to the same corrosion conditions and weight loss technique is representative of any part of the coupon. The weight loss corresponds to the speed with which the cage has been rotated, faster more weight loss, and the higher concentration of inhibitor decreases the corrosive substance corrosion.

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