Modeling The Flow Inside A Cooling Jacket In Order To Prevent Corrosion Marks Problem

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Abstract

Corrosion marks were found in specific areas on the outer wall of a process container. The container is cooled by a spiral cooling jacket. The corrosion marks were found in the lower and upper circumference of the container and also in the areas adjacent to the water inlet and outlet. COMSOL Multiphysics® modeling software was used to model these phenomena. The laminar flow (CFD module) allows us to identify that the above-mentioned areas have very low water flow rates (close to zero water velocity). It is known from the literature that "standing water" (stagnation) can cause corrosion [1]. These findings are reasonable, because for the lower and upper circumference of the container, the space for the water flow (the gap between the outer wall of the container and the cooling jacket) is very narrow (3 mm), compared to the space available in the rest circumference of the container (3 cm). The narrow space for the flow, causes significant frictional forces and flow-rate resistance. Moreover, in the areas adjacent to the water inlet and outlet it was found that the water swirls in place creating vortices instead of moving up in the cooling jacket.

Thanks to the 3D model, it was possible to identify the root cause of the corrosion formation, suggest and test three different engineering solutions for solving the problem and as eventually to design a new cooling jacket based on the best solution.

Three different engineering solutions were tested in the simulation in order to encourage flow in the stagnant areas:

(a) Increasing the cooling water flow rate.

(b) Adding more outlets for the cooling water from the cooling jacket.

(c) Expanding the distance between the container and the jacket.

The simulation results show that for the first and second solutions there is no improvement in the flow in these areas, while for the third solution, a significant improvement of the flow rates in the problematic areas was obtained.

In addition, by using "Multiphysics" function, the influence of the heat transfer was examined as a function of the flow changes applied in the model.

COMSOL Multiphysics® capabilities allowed us to identify and study the source of the problem was found as well as a suitable solution which will be implemented on the new cooling jacket design. In the near future we are working on field-validation and further optimization.

[1] Marjan S., Robert C., Borut B., "The impact of stagnant water on the corrosion processes in pipeline", Materials ans technology 44 (2010) 6, 379-383.