Reinforcement of perfluoropolyethers coatings by ceramic oxides sol-gels for fouling mitigation on metal surfaces

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Concept

In this research we developed a coating formulation containing α,ω-substituted perfluoropolyethers (PFPE) and ceramic oxides sol-gels, for fouling mitigation on solid surfaces. Micrometer coatings where obtained on metal substrates by dip-coating procedure; they showed hydrophobic behavior (CA>130°) and low CA hysteresis. The coatings resistance against shear stresses and chemicals increased thanks to the high mechanical properties of the ceramic oxides, compared to a simple PFPE coating. The ability of the coatings to mitigate particulate fouling was preliminary confirmed in presence of $CaSO_4$ in an appropriate test rig.

Motivations and Objectives

One potential application of hydrophobic coatings concerns fouling mitigation. It has been demonstrated that low energy surfaces are able to influence the mechanism of deposition and removal of fouling particles on heat transfer surfaces, increasing the fouling induction period of the heat exchangers [1]. This research aims to develop a hydrophobic organic-inorganic coating, combining a PFPE with a sol-gel network obtained from the hydrolysis of tetraethylorthosilicate (OTES) or Zr-*n*-propoxide, in order to improve the mechanical properties of the final coatings [2]. The investigation focuses the attention on the important coatings parameters for a possible application on heat transfer surfaces, i.e., thickness, thermal resistance, surface roughness and chemical and physical resistance. Fouling mitigation ability of the coatings is assessed in particulate fouling conditions, in a specific test rig.

Results and Discussion

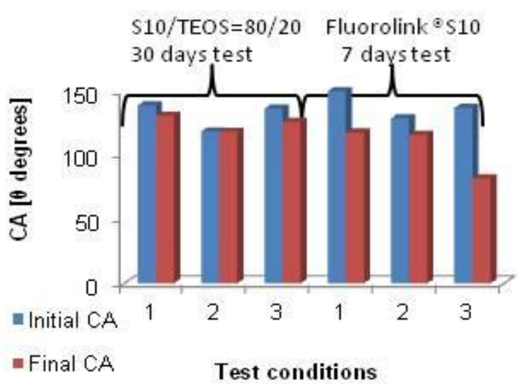

Figure 1. Resistance tests results. Legend: 1= shear stress (T=40°C, 2 m/s); 2= HCl (pH=2, T=50°C); 3=Seawater (pH=8, T=50°C)

Hydrophobic coatings were obtained by formulating in *iso*-propanol a commercial PFPE (Fluorolink®S10) with SiO_2 or ZrO_2 sol-gels, at different weight proportion (80/20, 1/05 and 1/1 respectively). The coatings resistance was investigated against erosion induced by liquid environments and shear stresses induced by a water flow. Compared to a simple PFPE coating, the resistance against shear stresses and aggressive environments increased of the 90% (Fig. 1a). Fouling mitigation ability of coatings deposited on the internal surfaces of a stainless steel tube, was assessed in presence of a $CaSO_4$ solution (4 g/L), flowed inside a coated tube (temperature=40°C, flowrate= 1.5 m/s). Thanks to the hydrophobic coating, the foulants deposition is 95% lower in respect to an uncoated surface.

References

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[2] R. B. Figueira, C. J. R. Silva, E. V. Pereira, Organic–inorganic hybrid sol–gel coatings for metal corrosion protection: a review of recent progress, *J. Coat. Technol. Res.* (2014) DOI 10.1007/s11998-014-9595-6.