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RELATE CRUDE OIL FOULING RESEARCH TO FIELD FOULING OBSERVATIONS

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EXTENDED ABSTRACT

Crude oil fouling research should be dircted to reflect the fouling behavior of operating exchangers. Current research focuses on data in small lab scale test sections such as heated rods and short tubular sections. For the results of this research to be useful to operating companies, it is essential to correlate the data to fouling trends and fouling mechanisms observed in the field.

Two important observations from the field will be shared in this paper. First, the relationship of tube side fouling rates to wall shear stress (and therefore to velocity) will be shown with data from six different crude preheat trains. Second, we will discuss the role of the heat transfer surface in the fouling mechanism.

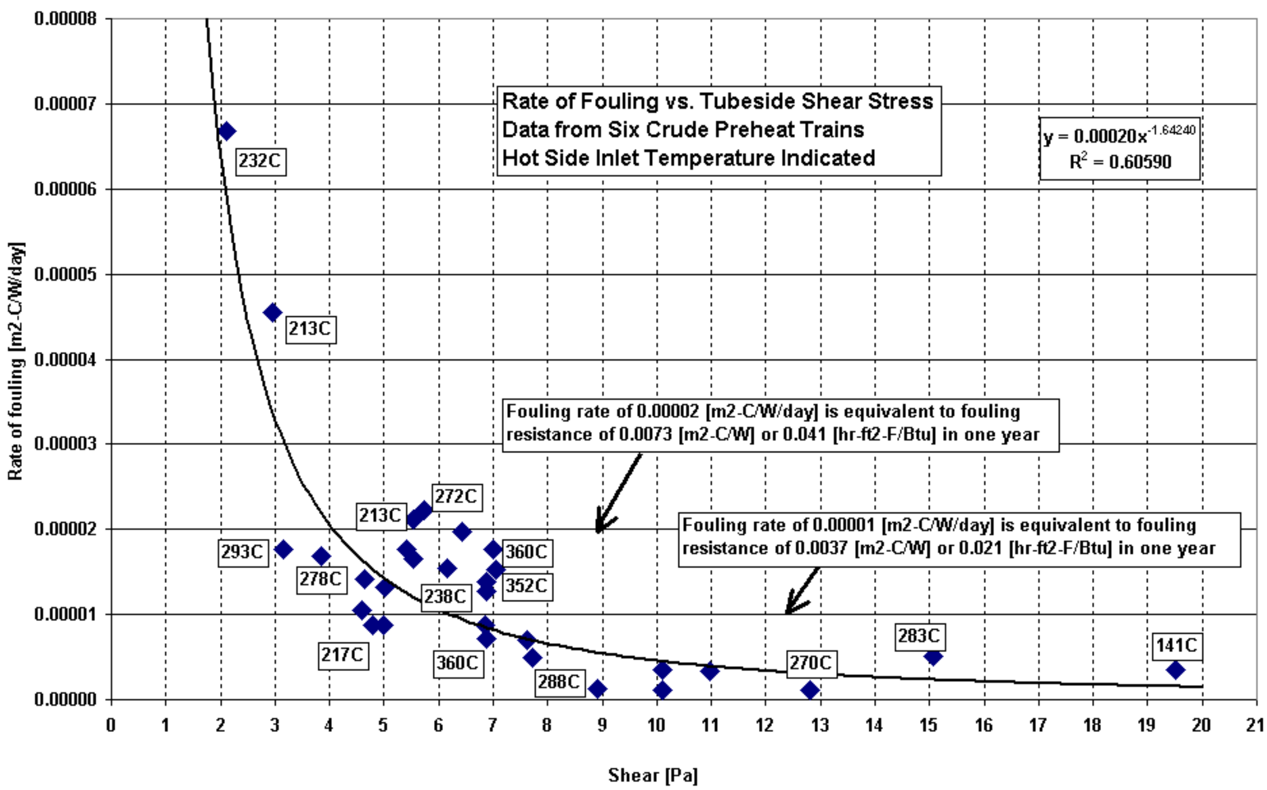

Fig. 1 Rate of Tubeside Fouling vs. Shear Stress and Velocity

Fig. 1 shows data for rates of fouling [m2-C/W/day] over several years of operation in six different crude preheat trains. This data is for many crude blends of varying densities, viscosities, and other properties. Additionally, it covers a wide range of velocities, from 0.9 to 2.7 m/s, with a majority being concentrated in the typical design range of 1.5-1.8 m/s, corresponding to 5-8 Pa shear stress. One major uncertainty in this data is the amount of shellside fouling, although based on visual observations we have assumed that it is minimal and that all fouling can be attributed to the tubeside. Noted on the plot are the hotside inlet temperatures (as a representation of the tube surface temperature in the exchanger) for some of the data points. The data shows that the rate of fouling diminishes approximately as shear stress (^ -1.6), without showing a clear relationship between these fouling rates and the hot side temperature.

Experience has shown that in many cases the rate of fouling can be lowered by reducing tube wall corrosion by changing metallurgy. This applies even when the base case rate of corrosion is otherwise acceptable from a tube failure perspective. Additionaly, fouling deposits from crude exchangers often contain a substantial (35+%) amount of iron sulfide. These two observations indicate that corrosion leads to a roughening of the tube surface (on a very small scale) and that roughening is responsible for promoting accumulation of fouling precursors, including the crude itself. The accumulated material thermally degrades over time, creating a foulant layer consisting of organic material, iron sulfide, and other inorganics like salts which are inherently present in the crude. Figures 2 and 3 [http://www.corrosioncenter.ohiou.edu] illustrate the nature of a corroded surface and the porosity available for trapping material. Note that these two figures are to illustrate the nature of the surface only and do not show actual corrosion from a tube surface.

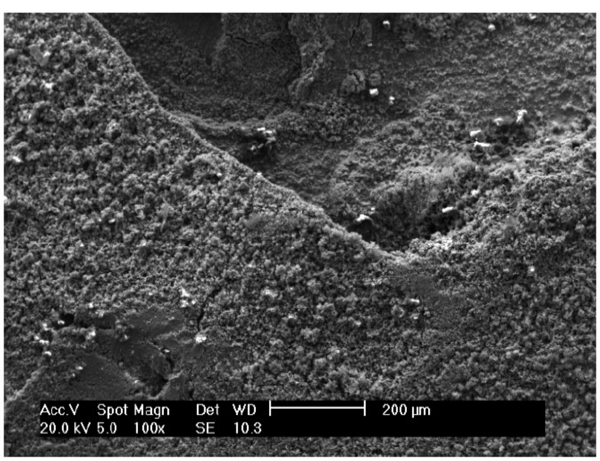

Fig. 2 Top view of a corroded surface

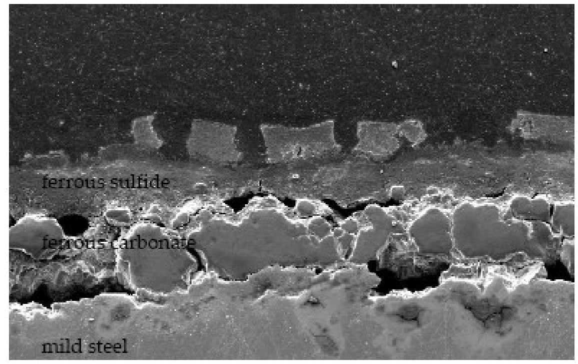

Fig. 3 Cross Section of a corroded surface

Crude oil fouling research needs to be directed to reflect the above two observations. The data generated in lab-scale tubular or annular test sections needs to be easily applied to real tubeside flow rates, shear stresses, and surface characteristics.

CONCLUSIONS

1. Operating fouling rates from six different crude preheat trains show a relationship to wall shear stress (which correlates with tubeside velocity), but not a clear relationship to hotside operating temperatures.
2. Experience has shown that tube surface roughness, typically resulting from corrosion, plays an important role in deposit accumulation.
3. Crude oil fouling research should account for the above observations and ensure that data from the research can be easily applied to operational velocities, shear stresses, and surface conditions.

REFERENCES

http://www.corrosioncenter.ohiou.edu