Fouling probe development for tubular heat exchangers

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Heat exchangers are used in a lot of industrial processes. Most heat transfer operations involve the deposition of unwanted residues on heat transfer surfaces. The interfering thermal resistance of such deposits leads to heat exchanger performance degradation. The response is an equipment oversizing, a money and energy expense resulting from decreasing heat transfer efficiency. So, it is necessary to be able to detect the onset of fouling and to follow its development over time in order to set up a cleaning programme.

Two types of method can be used to detect and control this deposit evolution. The first one consists of carrying out direct measurements at the exchanger limits. However, this process keeps the equipment off-line.

The second method, underdeveloped, consists in carrying out some measurements with a probe in sit u. We choose the second kind of method. The problem is limited to particulate fouling of cross flow tubular heat exchangers.

Therefore, we have chosen to apply a transient state method. The studied probe originality lies in the fact that it replaces one part or the totality of exchanger tube to be subject to the same thermohydraulic and fouling conditions as exchanger. This device can be described by a multilayered system where the temperature measurement is realised simultaneously and at the same place as the thermal excitation. A variation of temperature is generated by a reheater. A testing bench has been realised in which the sensor is laid in order to keep the same conditions (flow, fouling) as industrial ones.

The system is modelled by the thermal quadrupole formalism using integral transforms methods in cylindrical coordinates. A study of sensitivity is realised thanks to this direct model. The main data processing originality is to estimate not only the exchange coefficient but also the density variation of the fouling exposed outside layer.

Physical phenomena complexity (boundaries conditions validity, concept of exchange coefficient in transient state) compared with industrial conditions (measurement noise…) doesn't allow to use the previous model to estimate accurately such parameters.

Some results have been obtained from experimental study of sensibility which consit in deriving numerically experimental signals.