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ANALYSIS OF FOULING AND ITS IMPACTS ON HEAT EXCHANGER

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Abstract – *This article discusses the fouling and its effects on heat exchanger performance. In process industries the use of heat exchanger is up to 20 to 25% of the whole machineries. The functioning of the process industry depends mainly on the effective functioning of the heat exchanger. The major problem encountered in heat exchanger for its malfunctioning is due to the fouling of heat exchanger which directly affects the heat transfer rate and inturn affects the effectiveness of the heat exchanger. This article describes the types of fouling, fouling factor, fouling detection, effects of fouling and prevention of fouling.*

***Key Words*: Fouling, Heat Exchanger, Heat Transfer, Effectiveness, Fouling factor**.

1.INTRODUCTION

The deposition and accumulation of unwanted material such as scale, suspended solids, insoluble solids, and algae on the internal surfaces of the heat exchanger is called as fouling. There are different types of fouling. Chemical fouling, Biological fouling, Sedimentation fouling and Corrosion fouling. Preventing or Reducing fouling will be cheaper and more effective in maintaining the heat exchanger performance than removal or cleaning. The fouling accumulates in the heat exchanger reduces the cross sectional area of the tube and increases the resistance of the fluid passing over the surface. This inturn increase the pressure drop across the heat exchanger, reduce the flow rate of the fluid and greatly affects the heat transfer rate and the effectiveness of the heat exchanger. In the worst cases, the heat exchanger suddenly becomes block

2.FOULING TYPES

There are four types of fouling commonly found in heat exchanger. They are Chemical fouling, Biological Fouling, Sedimentation fouling and Corrosion fouling

2.1 CHEMICAL FOULING

Chemical fouling, or scaling, occurs when chemical changes within the fluid cause a fouling layer to be deposited onto the tube surface. The chances of scaling increases with rising temperature, concentration and pH levels. Such effects can be minimized by careful control of the tube wall temperature in contact with the fluid. Chemical fouling must be removed by either chemical treatment or mechanical descaling.

2.2 BIOLOGICAL FOULING

Biological fouling is caused by the growth of organisms, such as algae, within the fluid that deposit onto the surfaces of the heat exchanger. This type of fouling is removed by either chemical treatment or mechanical brushing processes.

2.3 SEDIMENTATION FOULING

Deposition fouling (also known as sedimentation fouling) occurs when particles contained within the fluid settle onto the surface, usually when the fluid's velocity falls below a critical level. The calculation of the critical velocity for any combination of fluids and particles should result in minimum working velocities above this critical level. Mounting the heat exchanger vertically can also minimize the effect as gravity pulls any particles out of the heat exchanger away from the heat transfer surface even at low velocity levels. Deposition fouling is usually removed mechanically by brushing or scraping.

2.4 CORROSION FOULING

Corrosion fouling occurs when a layer of corrosion products builds up on the surfaces of the tube. It forms an extra layer of material that has thermal resistance. The careful use of corrosion-resistant materials such as stainless steel is a key factor in preventing corrosion fouling.

3.FOULING FACTOR

Fouling factor is the reciprocal of heat transfer coefficient of the layer formed due to fouling. It is denoted by the symbol R_f. $R_f = 1/h$. normally the fouling factor is determined by testing the equipment in clean and scaling condition. Then by evaluating the heat transfer coefficient in both conditions the fouling factor is calculated as $R_f = (1/U_{scaling}) - (1/U_{clean})$.

Table -1: Fouling resistance for water

Water	Fouling resistance (m^2 K/ KW)
Hard water	0.043
Soft water	0.017
River water	0.043

Table -2: Typical Ranges of Overall Heat Transfer Coefficient U

Type of exchanger	U (W/m² C)
Water to Water	850 to 2500
Water to Oil	100 to 400
Gas to Gas	10 to 50
Gas to Water	10 to 250

4. FOULING DETECTION IN HEAT EXCHANGER

- Gradual decrease in flow meter reading indicates the accumulation of fouling materials in pipes.
- Increase in pressure drops between heat exchanger inlet and outlet sensed by the pressure transmitters.
- Drastic changes in the temperature of fluids passing through the heat exchanger indicated by temperature transmitters.

5. EFFECTS OF FOULING ON HEAT EXCHANGER

Fouling reduces the amount of heat exchange that can take place. This reduced heat exchange leads to other issues, including reduction in efficiency, diminished product quality, local hot spots, equipment breakdowns, safety concerns and increased frequency of maintenance and repairs. Fouling also causes issues with water flow. Because fouling tends to be much rougher than the smooth surfaces of pipes and metal components, it often impedes the movement of water. Blocked water flow can cause inefficiencies and pressure drops and reduce the heat exchangers performance.

6.PREVENTION OF FOULING IN HEAT EXCHANGER

Maintaining the heat exchanger free from fouling is essential for its longevity, efficiency, cost-effectiveness and overall performance. The fouling can be greatly reduced by

- Controlling materials causing fouling
- Proper selection of materials of the heat exchanger
- Proper protective coatings for the heat exchanger surfaces
- Periodic regular cleanings

Fig.1: Fouling in Shell and Tube Heat Exchanger

7. CONCLUSION

This paper concluded with proper design and selection of construction material for heat exchanger can greatly reduce the fouling effects. Proper analysis should be made for both the product and service fluids is essential for calculating the correct fouling factor and thereby the fouling effects can be reduced greatly. Design of heat exchanger should be in such a way to ensure the right fluid velocities, temperatures and other operating parameters. Frequent inspection and cleaning should be carried out to prevent fouling and to maintain the heat exchangers running effectively for many years.

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Teaching profession in Mechanical Engineering for past 20 years.