Fouling and Reduced Heat Transfer in Heat Exchangers | Fluid Heat Transfer: Fouling of Heat Exchanger Surfaces

Fouling and Reduced Heat Transfer in Heat Exchangers is a critical aspect of industrial operations, as it can significantly impact the efficiency and performance of heat exchangers. In this section, we will explore the concept of fouling, its causes, and methods to mitigate its effects.

### Fouling of Heat Exchanger Surfaces

Fouling occurs when unwanted materials accumulate on the surfaces of heat exchangers, reducing their effectiveness in transferring heat. Fouling can be caused by a variety of factors, including deposits from the process fluids, corrosion, and biofouling. It affects both the heat exchanger efficiency and the overall system performance.

### Causes of Fouling

1. **Deposition of Scale and Sludge**: Scale and sludge deposits can form due to calcium carbonate, silica, or other minerals in the feedwater or process fluids. These deposits can significantly reduce heat transfer rates.
2. **Biofouling**: Microorganisms, such as algae and bacteria, can proliferate on the heat exchanger surfaces, forming biofilms that reduce heat transfer.
3. **Corrosion**: Corrosion products can accumulate on the heat exchanger surfaces, affecting both the heat transfer efficiency and the structural integrity of the exchanger.

### Effects of Fouling

- **Increased Energy Costs**: Fouling reduces the heat transfer rate, requiring increased energy input to maintain the desired temperature difference between the fluids.
- **Reduced Productivity**: In industrial applications, such as power plants and chemical processes, increased energy costs can lead to reduced productivity.
- **Increased Maintenance Costs**: Fouling can lead to more frequent cleaning and maintenance, increasing downtime and associated costs.

### Mitigation Strategies

1. **Cleaning**: Regular cleaning of heat exchanger surfaces is essential to remove fouling deposits and restore heat transfer efficiency. Techniques include chemical cleaning and mechanical cleaning.
2. **Nano-Scale Materials**: Developing materials with inherent fouling resistance can help prevent fouling.
3. **Operational Adjustments**: Adjusting operating conditions, such as flow rates and temperatures, can help reduce fouling.

### Conclusion

Fouling is a complex phenomenon that can significantly impact the performance of heat exchangers. Understanding the causes and effects of fouling, as well as implementing effective mitigation strategies, is crucial for maintaining the efficiency and reliability of industrial systems.
Fouling is caused by deposits building up on the heat transfer surface adding a resistance to heat flow. Many process liquids can deposit sludge or scale on heating surfaces, and will do so at a faster rate at higher temperatures.

Example 5.2 Miniature Shell-and-Tube Heat Exchanger A miniature shell-and-tube heat exchanger is designed to cool engine oil in an engine with the engine coolant (50% ethylene glycol). The engine oil at a flow rate of 0.23 kg/s enters the exchanger at 120°C and leaves at 115°C. The 50% ethylene glycol at a rate of 0.47 kg/s enters at 90°C.

It is standard practice to add a fouling factor in the heat exchanger selection on the tube surfaces. A standard 0.0005 fouling factor will add 20 to 25% additional tube surface area. When the heat exchanger is new and the tubes are clean and shiny, the heat exchanger will operate at lower than design pressure even at full 16-16C. The most common type of fouling is the precipitation of solid deposits in a fluid on the heat transfer surfaces. Another form of fouling is corrosion and other chemical fouling. Heat exchangers may also be fouled by the growth of algae in warm fluids. This type of fouling is called the biological fouling.

Dec 02, 2021 In this paper, the fouling process was determined as a critical failure in the heat exchanger. Failure is an accelerated fouling layer across the heat exchanger tubes, which can be the reason for the clogging of tubes. Hence, a risk assessment was conducted using the Risk-Based Inspection (RBI) approach to estimate the probability of fouling in the standards of the Tubular Heat Exchanger Manufacturers Association (TEMA) are commonly used by the process industry for selecting the design fouling resistance for sizing shell-and-tube heat exchangers. Other standards with design fouling criteria are the Heat Exchanger Institute (HEI) and American Petroleum Institute (API).

Introduction to Heat Exchanger A heat exchanger is a device, which transfers thermal energy between two fluids at different temperatures. In most of the thermal engineering applications, both of the fluids are in motion and the main mode of heat transfer is convection.

These inhibitors can gel and foul, coating heat exchanger surfaces and reducing their efficiency. Silicates have also been shown to significantly reduce the lifespan of pump seals. While the wrong inhibitors can cause significant problems, the right inhibitors can prevent corrosion and significantly prolong the life of a liquid cooling loop.

Scale is an unwanted material that accumulates onto the internal surfaces of a heat exchanger — this deposition is otherwise known as fouling. If untreated, fouling will hinder and prevent the system from operating at its intended, energy-efficient state.

Extended surfaces have fins attached to the primary surface on one side of a two-fluid or a multifluid heat exchanger. Fins can be of a variety of geometry—plain, wavy or interrupted—and can be attached to the inside, outside or to both sides of an air-cooled heat exchanger. The purchaser shall supply the vendor with all environmental factors pertinent to the design of the exchanger as per Table 1. These factors shall be taken into account in the air-side design. 2. Air Coolers shall be designed for ...