

Fouling In Heat Exchangers

What is Fouling?

Fouling is generally defined as the accumulation of unwanted materials on the surfaces of processing equipment. It has been recognized as a nearly universal problem in design and operation and affects the operation of equipment in two ways:

- The fouling layer has a low thermal conductivity. This increases the resistance to heat transfer and reduces the effectiveness of heat exchangers – increasing temperature
- As deposition occurs, the cross-sectional area is reduced, which causes an increase in pressure drop across the apparatus

Cost Due to Fouling

Despite the enormous costs associated with fouling, only very limited research has been done on this subject. Reliable knowledge of fouling economics is important when evaluating the cost efficiency of various mitigation strategies. The total fouling-related cost can be broken down into four main areas:

- Capital expenditure, which includes excess surface area (10-50%, with an average around 35%), costs for stronger foundations, provisions for extra space, increased transport and installation costs.
- Extra fuel costs, which arise if fouling leads to extra fuel burning in furnaces or boilers or if more secondary energy such as electricity or process steam is needed to overcome the effects of fouling.
- Production losses during planned and unplanned plant shutdowns due to fouling.
- These are often considered to be the main costs of fouling and are very difficult to estimate.

According to Pritchard and Thackery (Harwell Laboratories), about 15% of the maintenance costs of a process plant can be attributed to heat exchangers and boilers, and of this, half is probably caused by fouling.

Fouling can be very costly in refinery and petrochemical plants since it increases fuel usage, results in interrupted operation and production losses, and increases maintenance costs. Panchal (Argonne National Laboratory), based on the study of Van Nostrand, re-estimated the energy and economic penalties associated with heat exchanger fouling for the US refineries, as more than \$2 billion per year. The maintenance costs in the USA were revised because they have increased significantly due to recent environmental regulations.

Typically, cleaning costs are in the range of \$40,000 to \$50,000 per heat exchanger per cleaning. Garrett-Price and Pritchard found that total heat exchanger fouling costs for highly industrialised

countries such as the US and the UK are about 0.25% of the countries' gross national product (GNP). Steinhagen et al found that the fouling costs for New Zealand are 0.15% of the New Zealand GNP, which is less than for industrialised countries. Using these percentages, Müller-Steinhagen lists total fouling related costs for various countries based on 1992 US\$.