

Monday, April 18, 2016

# Heat Exchanger Fouling Factors

One of the most misunderstood items in the heat exchanger schedule is the fouling factor. This week's Monday Morning Minutes post explores heat exchanger fouling factors and suggests a couple of rules of thumb to follow.

## Shell and Tube Heat Exchanger Fouling Factors

Engineers are often faced with interoffice scheduling traditions. While we were working with a local engineer on a heat exchanger application, she asked why the office always specified a .0005 fouling factor on Bell and Gossett series [SU heat exchangers](#). Let's look at what heat exchanger fouling factors are and what choices the engineer has regarding them.

## What Is a Fouling Factor in Shell and Tube Heat Exchangers?

Fouling factor is a numerical allowance for possible coating of the tubes by dirt or precipitate in the heated or cooled fluid. Fouling can occur inside the tubes or outside the tubes. It forms a very small coating that adds resistance to heat transfer. The fouling factor adds surface area to the heat exchanger so it can continue to meet the required capacity even though the tubes are coated or fouled.



## Why Are Fouling Factors Expressed in Thousandths or Ten Thousandths?

Let's look at basic heat transfer. In the Monday Morning Minutes post from March 28th, we wrote about swimming pool heat exchangers and offered the formula we all know well:

$$Q = U \text{ value} \times \text{Area} \times \text{LMTD}$$

The BTUH required (Q) and the log mean temperature difference (LMTD) are fixed by the design capacities. The variables are the U value and the surface area of the heat exchanger. As the U value becomes smaller, the surface area required to do the job goes up.

The U value is the inverse of the resistance in the heat exchanger to heat transfer. The U value is very dependent on the fluid type, the velocity, and the materials of construction. It is not unusual for the U value of a steam-to-water shell and tube heat exchanger for hydronic heating to be in the 500 to 1000 range before adding fouling. This is a high U value because condensing steam carries a higher temperature and a large BTU per pound. Let's assume the number is 800. The inverse, resistance, would be .00125. If we add a fouling factor of .0005 to it, the result is .00175 and the U value becomes 571. The surface area required goes up by 40%.

In a water-to-water shell and tube heat exchangers such as the Bell and Gossett WU series, the U value is more like 300 to 700.

## What Fouling Factors Should I Use?

In closed hydronic heating systems, dirt and poor water quality can affect many products other than the heat exchanger. For this reason, we go to great lengths to make sure those systems are clean. Clean systems promote less fouling in shell and tube heat exchangers.

The U value is also greatly affected by the fluid type and temperature. Glycols will lower the U value. Lower temperatures will lower the U value. Material of construction can change the U value.

In Michigan and Northern Ohio, R. L. Deppmann engineer sales representative can offer a specific recommendation for each opportunity. The recommendation will vary with the capacities, fluids, and selection. If a standard or starting point is needed, I would recommend .0003 fouling overall for steam-to-water shell and tube Bell and Gossett "SU" heat exchangers in closed hydronic heating systems with water as the fluid. For open hydronic systems, steam-to-glycol closed systems, and plumbing systems, I recommend .0005.

The old rules of thumb for .001 fouling factors is just too conservative for today's more precise methods of determining capacities. In addition, the larger fouling factor provides a solution with a larger heat exchanger that isn't "green." You could use .0008 for water-to-water series WU heat exchangers. This is a safe overall rule of thumb for liquid-to-liquid shell and tube selections with water. We may make a recommendation of different fouling factors for specific applications.

## What Fouling Factors Should I Use for Plate Heat Exchangers?

When using plate and frame style heat exchangers, don't specify any fouling! Plate type exchangers have very small passageways. The U values of this type of heat exchanger extend into the 2000 range most of the time. This U value is accomplished through high velocities. Those high velocities keep the plates clean. If we add fouling factors, the velocities are reduced because of the extra plates and we may start fouling. Once again, do not use fouling factors on plate style exchangers.

