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Well-designed heat exchangers can reduce maintenance cost: V Gokul Das, HRS Process Systems

The performance of heat exchangers has an impact not only on the capital cost but also on operating cost. Here are a few useful maintenance tips for trouble-free performance of heat exchangers.

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HRS Process Systems' V Gokul Das

Heat exchangers are the heart of any process industry and are equipment that perform the heating or cooling operations. Their performance and longevity has an impact not only on the capital cost but also on operating cost. We all know that breakdown maintenance is costly and annoying, thereby necessitating a regular maintenance schedule for process equipments like heat exchangers. A well designed heat exchanger will not only give a good performance but also have low maintenance requirement.

Shell and tube heat exchangers and plate type heat exchangers are two prominently used heat exchangers in the process industry. Over the years many units have been designed based on scale up of earlier design or a 'need to use' design, which can sometimes lead to improper performance and higher maintenance. The corrugated tube heat exchanger which is an advancement over these two heat exchangers and has many advantages, is a good choice, one of which is low maintenance. Understanding of the application where the heat exchanger is required enables one to design an efficient heat exchange solution.

Maintenance requirement

The heat exchangers normally have process fluids in liquid/vapour (gaseous) form as the primary fluid and the secondary fluid normally is a utility, viz, cooling water/hot water/chilled water (brine, steam, refrigerant gases or process fluids). The fluids or the process can have/can generate material that adheres to the heat transfer surface thereby impacting heat transfer. This is termed generically as 'fouling', which can be of the following types:

- Fouling due to high dissolved solid content
- Fouling due to suspended colloidal solids
- Localised precipitation of dissolved solid
- Biological fouling due to algae/fungi typically in cooling water
- Deposition due to chemical reaction
- Corrosion due to non-compatible material
- Solidification due to temperature or property of fluids, etc

Hence, in a process plant it is inevitable that some of the equipments would need servicing or maintenance.

Analysis/measuring aids

It is important to be able to measure the drop in performance of the heat exchanger or in other words the need for maintenance of heat exchanger. There are indicators which become handy at times:

- Monitoring the equipment with the help of temperature and pressure gauges helps to identify a drop in performance
- Reduction/elevation in temperature over design with no change in parameters like fluid flow rate and properties
- When the unit does not cool or heat as designed or specified (loss of heat transfer occurs)
- When pressure drop rises and exceeds original design, with no change in parameters like fluid flow rate and properties
- In some systems, choking of filter can also be an indication of these symptoms
- Some failures can be detected during regular visual checks through visible leaks or cross contamination between fluids

Evaluation of the type of indication can also give solution for maintenance.

Types of maintenance

Heat Exchangers; Source: HRS Process Systems

In chemical process and most of the other process industries, normally two types of maintenance problem are encountered with heat exchangers:

- Problems associated with various types of fouling in heat exchangers
- Problems associated with corrosion / leakage

In cases where there is failure of material due to corrosion or any other reason there are options for replacement of component (tubes or plates) to set right the equipment or attended to these by other methods like welding, brazing, etc.

Maintenance of heat exchangers with various types of fouling can be done by following methods such as manual cleaning, cleaning in place (CIP), combination of manual and CIP cleaning, and other special methods (as recommended by manufacturer).

In manual cleaning, one could use the simplest method of cleaning whereby the equipment needs to be opened/dismantled for cleaning. The tubes or plates are cleaned by scrubbing with a soft wire brush or by high pressure water jet (adjusted for the cleaning operation depending on fouling. In some cases, special tools like bullet/pig cleaning is also used. In cases where there is a hard scaling on the surface (especially in tubular heat exchanger), sometimes drill rods are also used.

CIP is a mechanism whereby one circulates a cleaning fluid which can soften/dissolve/dislodge/remove the fouling material without opening the heat exchanger. There are special chemicals (and temperature) to be used which will help in this cleaning process. The fluid is circulated at high velocity and preferably in reverse direction of process fluid.

In some cases, a combination of both the methods is used. In such a case, first CIP is done to soften the fouling material and then manual cleaning is done to clean the heat transfer surface.

It is very important to note that all these processes need to be done as per recommendation/instruction of the manufacturer since these are based on material of construction and design norms too.

Proactive measures

Prevention is better than cure, hence one must ensure the following when selecting or buying a heat exchanger:

- Design: The design of heat exchanger must take into consideration the fluid properties and the behaviour to enable a right heat exchanger selection (STHE, CTHE, PHE, SSHE, etc). A right type of heat exchanger selection would ensure proper performance with low maintenance. This is because each type of heat exchanger has some key advantages as well as limitations. Understanding these for the fluid is very critical to enable a good design and efficient operation.
- Material of construction (MOC): Selecting the right material, which is compatible with the fluid, enhances performance as it reduces corrosion/failure and expensive emergency maintenance. A good design can always work an effective configuration to reduce the cost of ownership whereby one can enhance the material say from carbon steel to stainless steel.
- Fluid Velocity: This is a critical parameter which can reduce fouling, enhance the running time between cleaning periods and, thus, needs careful analysis in heat exchanger design and selection. Although a part of heat exchanger design, many a times one tends to ignore the importance of this parameter.
- Use of chemicals for water treatment helps to reduce both biological and chemical fouling specially in cooling water systems. These can be monitored and corrective actions initiated automatically.
- Sacrificial material: In some cases if the above solutions do not help, or the process fluid so requires, one can also use sacrificial anodes or plates which get eaten away and the main equipment does not suffer. Periodic replacement of such material is required.

In conclusion, a well designed heat transfer solution for an application can not only reduce maintenance downtime and cost but also enhance efficiency and longevity of heat exchanger.

The writer is the Managing Director of HRS Process Systems Ltd (HRS PSL) - a wholly owned subsidiary of HRS International, UK - and the Director on Board of HRS International.