The heat

Two concerns for anyone in process heating are to save energy and reduce running costs. But how many organisations know how well, or badly, they are doing? Brian Wall finds out

Process pointers

- Check process time is no longer than needed
- See if the heating rate can be increased to reduce time spent at high temperature
- Ensure process is not running for too long and your product being over-treated
- Check the utilities are not left on when the process is not running
- Look into changing the schedule to allow more efficient use of process equipment

At least 40% of industrial energy in the UK is used in process heating, according to The Carbon Trust. The range of activities is vast, embracing everything from drying, to evaporation, separation, curing, heat treatment, melting and chemical processing – just as it's been for years. The good news is that there's nothing very revolutionary about most of the technology used – a tubular heat exchanger from the era of steam is not very different to a similar unit today. But the devil is in the detail.

So first, some basics: while steam remains the most widespread process heating medium, direct combustion also provides an efficient means of heat transfer – accepting the risk of contamination and its obvious limits with flammable products. Clearly, indirect combustion gets around the problems, but is less efficient, while direct electrical heating is efficient and clean – but expensive.

Whatever heat transfer approach is used, given that two key concerns are to save energy and reduce running costs, there's a range of precautionary measures – some well known, others less so. For example, in energy-hungry drying processes, online moisture content monitoring can help eliminate over- or under-cooking, but it's also worth investigating removing as much moisture as possible in the processes prior to drying. Then, self evidently, equipment should not be left running when not required, but also check your process is not operating at a higher temperature than necessary – which means accurate measurement.

Beyond these, energy losses are reduced by insulating the outer surfaces of process equipment and, where possible, covering the surfaces of liquids. Certainly, all steam pipework should be insulated: even a small leak results in waste. Also, on older steam distribution systems, where some pipework may be redundant, it should be isolated. And, since a major source of steam loss is sticking steam traps, these must be checked regularly.

Much of this is about good maintenance: for example, regular checks on the combustion air/fuel ratio on your boiler or furnace will avoid excessive fuel consumption and emissions. But it's also about sometimes thinking outside the box – looking at the possibility of recovering waste heat from the process to power the process itself or to provide space heating. Returning hot condensate to the boiler also saves energy and reduces maintenance.

Helpful starters

The Carbon Trust suggests a number of ways to increase efficiency and cut costs. Check the time the process is held at the processing temperature is no longer than needed. Check if the heating rate can be increased to reduce the overall time spent at a higher temperature. Check your process is not running for longer than necessary and the product being over-treated. Check utilities are not left on when the process is not running. And consider changes to scheduling, where possible, to allow more efficient use of the process equipment.

Think about installing variable speed fans. Air-flow control in dryers and furnaces is sometimes achieved by dampers interrupting the flow from a fan, which is usually working at full load. Variable speed fans can be much more energy efficient.

But what about efficiencies from prolonging the life of the heat transfer fluid and the system components themselves? As Petro-Canada America technical advisor Gaston Arseneault advises, the best approach is to prevent fluid degradation and solids formation from the start.

"Solids can be formed in the fluid through thermal breakdown, oxidative degradation, process leaks or when improperly transitioning between incompatible fluids. Thermal degradation can be greatly reduced by not operating the fluid beyond the temperature range and heat flux recommended by the manufacturer. It's not normally a problem in electrical immersion heaters, as long as a sufficient flow rate and adequate turbulence near the heating elements are maintained."

Clever stuff

A common form of fluid degradation in an electrical immersion system, however, is oxidative degradation. Some manufacturers offer an optional nitrogen blanket in the expansion reservoir to eliminate this threat. "Oxidative degradation results from the reaction of oxygen in the expansion tank vapour space with the fluid," explains Arseneault. "In addition to odours and increased acidity, these

is on

reactions form polymers or solids, resulting in an increase in fluid viscosity. A more viscous fluid is more difficult to pump, has poorer heat transfer characteristics and increases the chance of coking and sludging." He advises keeping the heat transfer fluid in the expansion tank below 65°C.

Gerry Christensen, technical chief at Arla Plast, one of Europe's leading suppliers of extruded plastic sheet, recalls how his company struggled with this problem. "Oil degraded very quickly and got very black. After six months, we had to put new bearings in the pumps … which cost a lot of money." Christensen experimented with 10 different heat transfer fluids before settling on Petro-Canada's Calflo HTF, a high temperature fluid for systems operating with bulk temperatures up to 326°C. "We have now been running without problems for three years," he concludes.

More fundamentally, though, achieving good value, low energy is first and foremost about choosing the right kit. Yes, little has changed with the fundamentals of shell and tubular heat exchangers, but the materials, construction and measurement and control technologies have certainly moved on. Consider plate heat exchangers (PHEs): reductions in size have gone hand in hand with improvements in performance

In the zone

Process heating and drying applications vary greatly, with individual industry sectors requiring different temperatures, conditions and plant types:

- Uses for low temperature process heating (30°C–100°C) include drying, curing, fermentation and laundering, harnessing warm air or water to provide the process heat – although, in the case of drying, higher temperatures may be needed for some applications.
- Uses for medium temperature process heating (100°C–250°C) include dyeing, sterilisation, cooking and baking, generally using warm air or water as the means of heating.
- Uses for high temperature process heating (250°C–1,200°C) include kilns, glass manufacture and metal foundries. These processes generally use heat provided by gas and oil burners, and electrical heating.

and efficiency, so that, whereas once they were limited to lower temperature and pressure duties, now they are far more capable.

Consider the AlfaNova, a PHE manufactured using a fusion-bonding technique. This enables it to withstand pressures to 20bar and temperatures from –50°C to +550°C, making it ideal for process cooling, but also hydraulic oil cooling, laser cooling, hygienic and sanitary duties, as well as water cooling and heating.

This is process intensification at its best. Another example is the ART (Alfa Laval plate reactor): essentially a reactor in a box, it's a heat exchanger that not only heats or cools a process, but provides the reactor vessel, too. The company claims that processes are accelerated and that mixing rates are higher, while dwell times are shorter. So product quality is improved, plant costs less to operate, in terms of energy and manpower, and downtime for servicing and cleaning is minimised. PE

Left: two semi-welded plate heat exchangers from Alfa Laval maintain constant process temperatures at Morrisons distribution centre at Burton Latimer Below: The right heat transfer fluid choice helps Arla Plast keep heating under control