Fluid thinking

Energy is consumed on a massive scale in process heating, but there are big savings to be made, particularly if you can conquer contamination, and oxidative and thermal degradation problems, writes Brian Wall

According to the Carbon Trust, UK industry spends around £9.5 billion on energy, with at least 40% of that consumed by process heating. "Using straightforward techniques, between 5% and 10% of this could be saved, reducing spending on energy by £280 million," it states. A sobering thought in an age when going green – and doing so for sound economic reasons – has never been higher up the corporate agenda.

Regardless of the application, there are a number of actions that can save money, energy and emissions. First, do not let processes operate at a higher temperature than necessary: rate of heat loss increases following a square law, so maintaining the lowest effective temperature saves significant energy. Second, check that utilities are not left running when processes are idle. Third, ensure that processes are not running for longer than necessary, and that products are not being over-treated.

Another area of frequent neglect, however, involves heat transfer fluids. These are designed to operate for long periods, provided they're properly maintained. Get that wrong and problems, such as contamination and oxidative or thermal degradation, soon raise their ugly heads. All will decrease the fluid's heat transfer capability, shortening its life, but also risking damage to plant, due to over-heating.

So what should you do? Along with initiating a schedule of fluid testing, there are a number of operations that must be performed regularly to ensure peak system performance and fluid life. We're not talking about anything onerous: they range from ensuring that moisture in the system is drained at start-up (and air or steam vented off), to continuing to circulate the fluid after shutdown until the temperature is 65°C (150°F) or lower, before turning the pump off. Failure to do so can easily lead to severe and early problems.

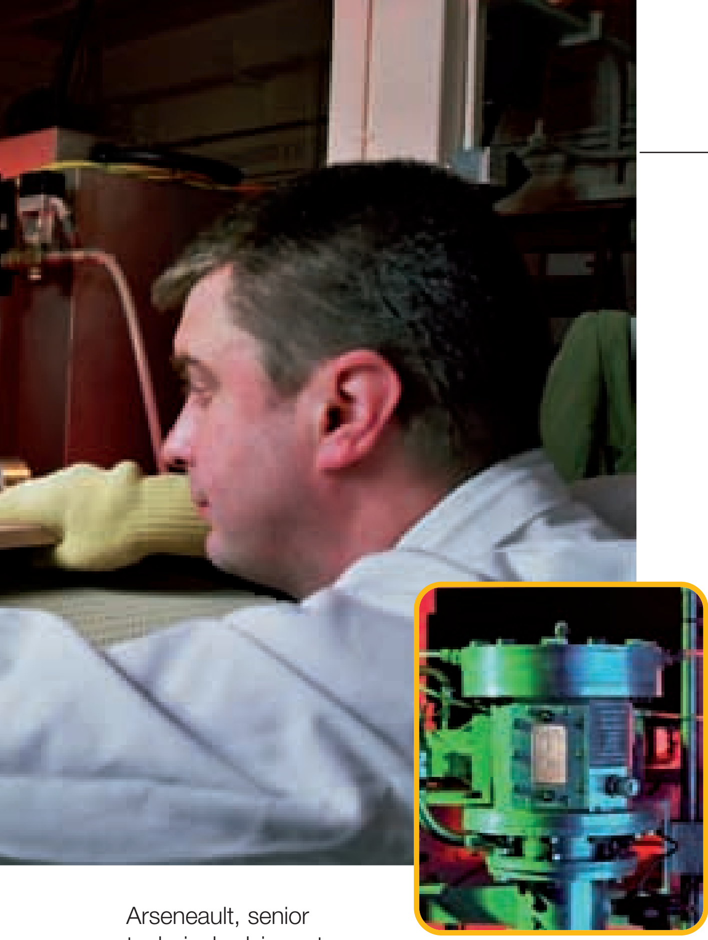
Plant engnieers should also establish a monitoring schedule and keep a daily record of performance, checking pressure values across the filters and at the expansion tank. Increased pressure can indicate the presence of water vapour. "The key to maintaining an efficient operating system – and to prolonging the life of the heat transfer fluid – is to prevent solids from forming," insists Gaston

Scaling up microwave plant

C-Tech Innovation, near Chester, specialises in large-scale microwave heating systems, including reactor scale-up projects, used, for example, in testing pilot plant.

The company has also built large-scale RF heating systems up to several hundred kW for both liquid and solid-state applications – such as a MAGF (microwave-assisted gas firing) kiln, which uses a combination of gas and microwave heating for firing ceramics. Its tunnel kiln version was developed to handle up to six tonnes of product, with a maximum operating temperature of 1,600°C.

Above and right: C-Tech Innovation process heating plant, using microwave technology



Arseneault, senior technical advisor at Canadian oil and gas giant Petro-Canada. "Solids can be formed in the fluid through thermal degradation, oxidative degradation and simple incompatibility, particularly if the system is not flushed out properly when changing from one fluid type to another."

Looking at these common problems in turn, though, he makes the point that thermal degradation can be minimised simply by not operating the fluid beyond the temperature range recommended by the fluid manufacturer. He also notes that such problems don't usually occur with electrical immersion heaters, as long as the flow rate and heat flux are carefully balanced.

Coking and sludging

As for oxidative degradation, which results from a reaction of the oxygen in the expansion tank vapour space with the fluid, he explains that the result is normally formation of polymers and solids, resulting in increasing fluid viscosity. "A more viscous fluid is more difficult to pump, has poorer heat transfer characteristics, and increases the chance of coking and sludging," warns Arseneault.

Minimising oxidation is about positioning the expansion tank so that the heat transfer fluid it contains is kept relatively cool. As a rule, the expansion tank should be "cool enough that one can comfortably touch the bare metal" – although this practice is not recommended, for obvious safety reasons. The fluid temperature should be warm and measured below 150°F or 65°C. It is also best, advises Arseneault, to choose a heat transfer fluid containing additives that resist oxidation.

So much for heat transfer fluids: what about the problems of process heaters operating within hazardous areas – where flammable gases, vapours or powders may be present in the atmosphere? Given that conventional heating plant is often riddled with ignition sources, making it safe can be a daunting prospect for any plant engineer. Yet, as Mark Jackson, of Ex-Solutions Consulting, a division of explosion protection firm Pyroban, says: "If an area has been classified under ATEX/DSEAR, then any equipment operating in the area must comply with the ATEX Directives to eliminate sources of ignition. This includes process heaters."

In 2007, Ex-Solutions provided Calder – a UK-based manufacturer of high pressure pumps – with a solution for a trailer-mounted hot oil boiler, required for operation in a Zone 2 area, where flammable hydrocarbons were present. The boiler was to be used to heat crude oil before re-injection into a production oil-well to melt wax build-up. The hot crude oil disperses the wax that chokes production, allowing flow rates to return to normal through improved viscosity.

Jackson explains that this particular boiler relied on diesel fuel to create an intense flame. The boiler also operated a large and constant breather (inducted and exhausted air flow), and incorporated a sophisticated control and instrumentation system to regulate burners and maintain thermodynamic balance. Further, the pumps were driven by a Volvo diesel engine – all aspects producing clear ignition hazards (pilot flame, hot surface, electrical spark, overspeed on the engine etc) which, when operated in hazardous areas without protection, could cause an explosion.

Ex-Solutions engineered a compact solution to protect the complete hot oil boiling unit for Zone 2. The unit incorporated several explosion protection technologies designed to reduce heat, static and sparking potential around surfaces. The company also installed its 3GP gas detection system.

Ultimately, whatever the application, understanding the precise heating, safety and environmental requirements of your process is the first requirement. Then, by establishing and ensuring best maintenance practice, maximum efficiency can be achieved, along with long-term compliance. PE

Pointers

- Do not let processes operate at excessively high temperatures
- Ensure that utilities don't run when processes are idle
- Check that product is not being over-treated
- Initiate a schedule of heat transfer fluid testing
- Ensure that moisture is drained from the heating system at start-up
- Circulate heating fluid after shutdown until it reaches 65°C
- Regularly check pressure values across filters and the expansion tank

Left inset: C-Tech Innovation's APNEP (atmospheric pressure non-equilibrium plasma) heater, which provides benefits formerly associated with vacuum plasmas

Simulation and modelling

Process heating equipment needs to be designed, commissioned and operated as an integrated component of the plant, if energy efficiency and product throughput and quality are to be achieved.

As Paul Brice, Honeywell Process Solutions' sales and consulting manager, says: "Process simulation is the most effective way to address this. Steady-state design tools provide the backbone for conceptual and detailed engineering design, enabling the development of integrated process heat exchange models with appropriately sized heating plant. Dynamic simulation then takes the initial model and provides a platform to prove operability – the capability to start up, shut down and transition between steady states – and develop and check effective control schemes, as well as develop instrumentation and process analyser strategies."

Brice makes the point that software models can be reused for developing everything from procedures, to control system checkout, operator training, scenario testing and design validation.