Steaming efficiency

Selecting the right flowmeter is key to boiler efficiency, says John Davison

Engineers know there are significant opportunities for improving energy efficiency in boiler houses – saving cost and reducing carbon footprint, while also helping users to be eligible for the Carbon Trust's Energy Efficiency Accreditation Scheme. Yet they also know they rarely attract the investment they need. And, even when they do, less than ideal instrumentation is too frequently chosen for the job.

Efficiency can be calculated by measuring energy in and out of the boiler, either manually or using a flow computer. But although most boiler houses do monitor steam flow to the process, few measure energy into the boiler. Also, accuracy is often questionable: in what is always a harsh environment, most flow instrumentation suffers from wear, corrosion and fatigue. Without frequent maintenance and repair, an orifice plate, for example, is likely to be so eroded that, possibly within months, its readings will be meaningless.

Limited options

However, measuring mass flow of saturated steam, which at the measuring point is invariably wet, is not easy. Indeed, the only useable flowmeter technologies are: orifice plate, averaging pitot, shedding vortex, variable area, venturi and nozzle.

Orifice plate, variable area, venturi and nozzles fall into the same category, all relying on pressure drop, caused by the increase in velocity as fluid passes through a restriction, to measure flow. Averaging pitot tubes, positioned across the pipe, measure the impact and suction pressure of the fluid: they induce a differential pressure, but without affecting steam velocity. Vortex meters have a similar profile to pitots, but rely on eddies shed by a non-streamlined body in the flow to sense velocity.

Given that pipe restrictions reduce movement, orifice plate devices that introduce an unrecoverable pressure drop are not good news. In contrast, vortex meters and pitot tubes create negligible line loss – less than 70mbar (1inch of water) on an equivalent 10 bar system (so less than 0.7%).

There are other limitations with fixed and variable orifice plates. In a wet steam environment, the sharp edge of the plate hole is soon eroded, compromising accuracy. Variable devices also suffer mechanical wear and some components may be affected by temperature. Although compensation can be built in, long-term accuracy is a problem.

And don't be misled by manufacturers' claims for variable orifice plates of, say, 100:1 turndown – the limitations of steam min/max flow, not to mention site conditions, rarely allow such a figure to be achieved. Calculate the maximum expected and minimum achievable flow: there's the real turndown.

Turning to vortex meters, these induce a negligible pressure drop, so are energy efficient. They also give a turndown of 30:1 – although they don't tolerate low flows. The units also offer long-term accuracy: although wear can take place, making vortices less defined, it's not a significant problem. However, mechanical noise is a limitation.

Finally, averaging pitot tubes also introduce negligible pressure drop. The only incursion into the pipe is a one inch weldolet into which the pitot is screwed – also meaning that installation is straightforward and quick. The one caveat: remember that shape matters. Only those with a square cross-section retain accuracy over the full measurement range. The accuracy of those with round bars is affected by changes in flow. Latest designs use a 'T' shape bar, which further increases accuracy and turndown.

Beyond that, there's no minimum flow velocity: pitots offer turndowns up to 100:1 and the critical component for low flow becomes the pressure transmitter. Turndown of the combined system is usually 10:1, which is more than enough for most applications.

Pointers

- Given that a steam flowmeter is a major investment, capable of providing long-term plant and downstream process information for energy saving and plant management, getting it right is important
- Averaging pitot tubes and shedding vortex devices have fixed characteristics, ensuring accurate measurement over a long period of time
- Overall, pitots give the best steam flow and long-term accuracy – and at an installed cost that is unbeatable.

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