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SINCE 1934
A HERITAGE OF STEAM INNOVATION

HYDROHEATER
TECHNOLOGY

Direct steam injection technology is ideal for heating liquids and slurries over a wide range of viscosities and solids content to precise temperatures.

Direct-contact steam injection technology has been used worldwide since the Industrial Revolution and the advent of steam boilers. This white paper details the basics of this often-overlooked heating technology. It explains the differences between direct and indirect heating, describes the direct steam injection spectrum, and details the advantages of Hydroheater technology.

STEAM HEATING METHODS

There are two basic types of exchangers used to transfer heat between process fluids — indirect and direct. Indirect heating is most commonly seen in the form of plate-and-frame or shell-and-tube heat exchangers. Any process that does not allow direct mixing of steam and fluid is indirect heating.

Indirect Heating

Indirect-contact heat exchangers have two or more fluid flow paths that do not allow for direct mixing of the fluids. They promote the transfer of heat from one fluid to another across a thermally conducting, but otherwise impermeable, barrier such as a tube wall or plate. With indirect heating, approximately 83% of the heat energy is transferred to the process fluid, while the remaining 17% of the energy has the potential to be lost in the condensate formed from the steam.

Direct Heating

Conversely, direct heating exchangers transfer heat by injecting steam from a plant's steam supply into the process fluid (liquid or slurry) that needs to be heated. Injecting steam directly into the process fluid results in more rapid heat transfer and more efficient energy use than indirect heat exchangers. Direct-contact steam heating can provide 100% thermal efficiency, because both the sensible and the latent heat of the steam are used. Energy savings can be considerable — reductions in the 20—25% range are not uncommon.

Because it requires less space than other methods of heat transfer, direct-contact heating allows for a reduction in both equipment expense and space requirements. In addition, this technology eliminates the need for condensate return systems, which are often required for indirect heat exchangers.

Hydroheater Technology

The Hydroheater technology (Figure 1) takes direct heating a step further by precisely metering the steam flow, which results in instantaneous condensation of the steam and provides temperature control within 1 degree Fahrenheit.

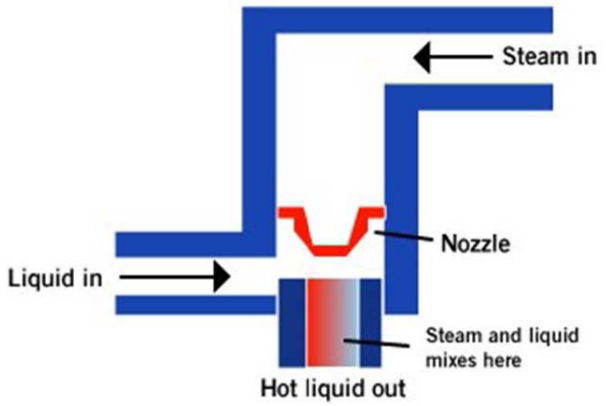

Figure 1: Hydroheater technology injects precise amounts of steam into the process fluid

A benefit of Hydroheater technology is rapid, uniform heating, which is important in the ability to handle difficult-to-heat fluids such as highly viscous fluids, fluids with the potential for bake-on, and abrasive slurries. In addition, Hydroheater technology is self-cleaning, which eliminates plugging and fouling of the heat transfer surface.

DIRECT STEAM INJECTION SPECTRUM

There are many forms of direct steam injection, including spargers, externally modulated heaters, and internally modulated heaters. Each method varies in its levels of complexity, with sparging being the simplest, and internally modulated having the greatest level of technology and control.

Sparging

Sparging is the oldest and least complicated technique of mixing steam with liquid or slurry to heat. Though considered simple and inexpensive, sparging is inefficient. The operation invariably results in poor heat injection economics due to steam energy escaping from vessels without condensing. Sparging is the least controllable direct steam injection heating method; it is basically injecting steam directly into a fluid- filled tank or pipe. When sparging equipment is operated outside of the design parameters, there is increased risk of equipment failure (both vessel and sparger pipes) due to the vibration associated with the steam hammer. Additionally, high maintenance costs for tanks, sensors, and piping are not uncommon with sparging.

External Modulation

Externally modulated direct steam heating (Figure 2) uses a steam control valve on the supply line to vary the pressure of the steam at the point of injection. Varying the pressure changes the steam density and velocity through the nozzle to control the amount of heating. Unfortunately, regulating steam pressure to control heating can result in unstable operation, hammering, and vibration when high or low steam flowrates are required. At low steam flow (such as trim heating), the differential between steam pressure and process can be very small, and a slight fluctuation in either pressure can cause an upset. Alternatively, at high steam flow requirements (maximum heating at startup), the orifice or nozzle size will allow more steam than can be condensed, and steam hammer will occur.

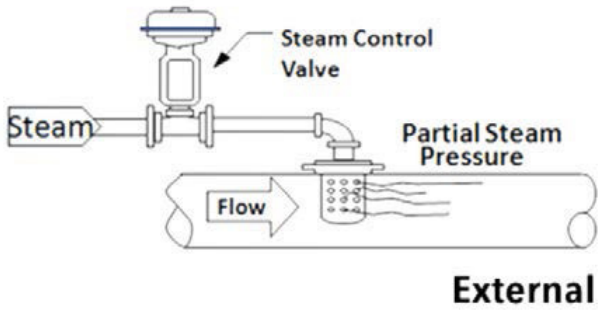

Figure 2: Externally modulated direct-contact steam heating

Internal Modulation

Internally modulated direct steam heating (Figure 3) controls the injection area rather than steam velocity and density to regulate the amount of heating. An internally modulated heater operates at higher steam velocities compared to an externally modulated heater. This higher velocity produces improved, often rapid-mixing and nearly instantaneous, condensation of the steam into the process fluid.

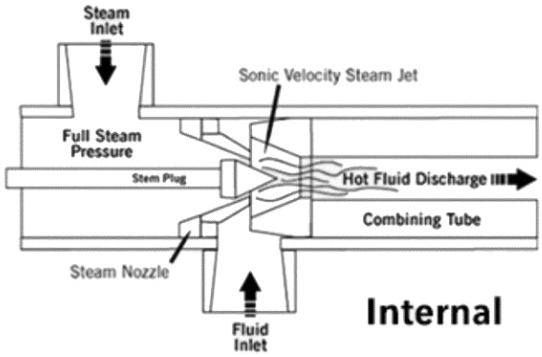

Figure 3: Internally modulated direct-contact steam heating

THE HYDROHEATER ADVANTAGE

Hydroheater technology uses only internal modulation and controls both steam flow and mixing turbulence by employing a modulating stem plug and nozzle assembly inside the heater. The precise mixing of metered amounts of high-velocity steam directly with a liquid or slurry provides instantaneous transfer of heat from steam to the liquid.

To accomplish this, a specifically engineered, variable-area steam nozzle meters the flow at the point of injection and contact with the fluid. The large pressure drop from full steam pressure to the process fluid pressure ensures high-velocity choked steam flow and instantaneous mixing of the two streams. When steam flow is choked, its velocity at the nozzle exit is constant regardless of the total mass flow injected. The internally modulated Hydro-Thermal heaters control the amount of injection area (cross-sectional area of the nozzle opening) to precisely regulate the heat load. The constant steam velocity results in consistent and stable operation across the full range of operation.

ADDITIONAL INFORMATION

Hydroheaters are not a one-size-fits-all solution. A potential limitation of direct steam injection heating is that the steam is injected directly into the process fluid. If the process fluid is sensitive and cannot tolerate this, steam injection cannot be used. The addition of the condensate to the process must be considered when specifying steam injection equipment.

Hydroheaters do, however, consistently outperform heat exchangers and other fluid heating systems. The reason for this is simple: Each Hydroheater is created in response to the input the client provides.

This input determines the custom design for the customer's specific needs and requirements. For more information, please visit Hydro-Thermal's website at http://www.hydro-thermal.com