

Application Profile

Key Words: Manure, Sludge Heating, Anaerobic Digester, Methane

Application: Agricultural Sludge (Manure) Heating

More and more Agricultural & Dairy Farms, Beef, Hog, and Poultry operations are considering the use of Anaerobic digestion for Biogas production. These operations typically produce a significant amount of organic matter in the form of manure. Anaerobic digestion is a biological process that breaks down for organic solids. Manure can be processed in anaerobic digesters and the byproduct is methane gas. The methane gas can be captured, stored, and used to run electrical generators and boilers for use in the farm operations. Heat exchangers can face the following challenges when heating sludge:

- Live steam used to provide heat for heat exchangers creates hot spots where sludge can burn and build-up plugging the heat exchanger tubes. This increases maintenance costs and an increase pressure drop across the heat exchanger
- Upgrading from mesophilic to thermophilic often require multiple Heat Exchangers in series to achieve the necessary temperature rise
- Increased pressure drop adds demand to the sludge pumps thus increasing energy usage.
- Temperature control problems can be present as there is a lag time from slurry entering and then being discharged.

To overcome these challenges, Direct Steam Injection (DSI) is a very good approach. There are some correct ways to apply DSI and some approaches that may not produce desirable results. One of the key factors to successful DSI is to inject steam at **sonic velocity** to achieve **choked flow**.

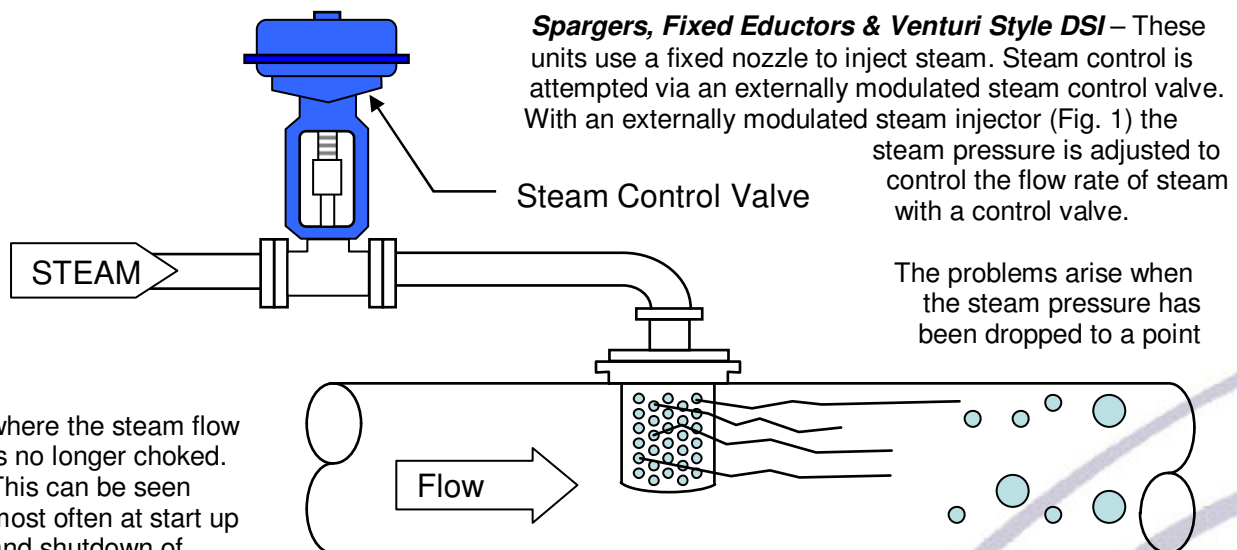


Figure 1 External Steam Control (Sparger)

The use of external steam control devices to control the steam flow by modulating the steam pressure can lead to **excessive steam hammer & vibration**. Steam hammer and vibration often result from poor mixing and condensing of the steam. As temperature demand drops, steam pressure drops, lowering the steam velocity and potentially causing instability. Uncondensed steam bubbles will typically collapse when they come in contact with a cold pipe wall in the liquid piping. When these bubbles collapse, the slurry rushes in to fill the void and impacts the pipe wall. In some cases this will result in some pinging noise and in severe cases, steam hammer & vibration.

PSX DSI Heater Solution

The PSX heater uses a unique method of steam injection via an integral steam control device. The key to efficient, safe, and predictable steam injection is to inject steam at sonic velocity to achieve choked flow. All steam injectors need to operate in a choked flow manner for good, non-violent mixing. The PSX heater is an internally modulated injection heater that varies the mass flow rate of steam by changing the area through which the steam may pass. This type of modulation allows the full steam pressure to always be present at the point of injection regardless of plug position. The PSX heater (fig. 2) has an integrated Pneumatic Actuator that allows the engineered steam diffuser opening to vary according to the temperature demand.

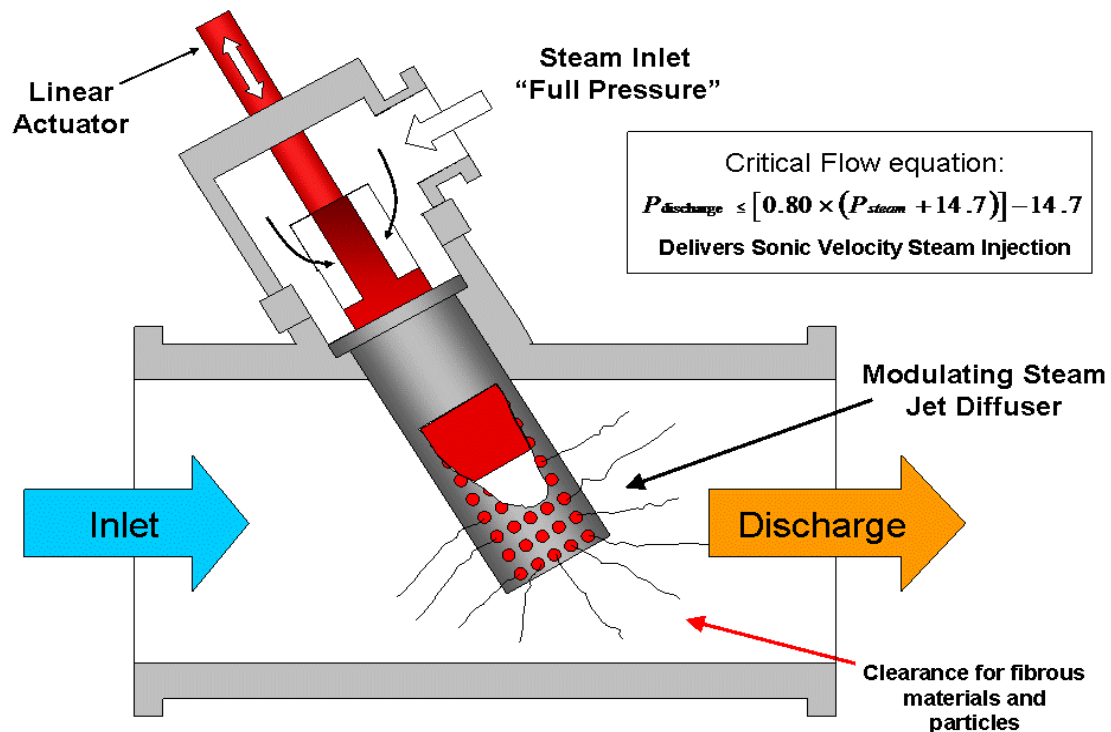


Figure 2 ProSonix Inline heater

Flow rates can range from 1 – 5,000 gpm. The PSX heater has a high heating capacity and can achieve a temperature rise of up to 250°F in a single pass through the heater.

Key PSX Heater Direct Steam Injection Benefits

- **Stable Operation** due to the internal steam modulation design which controls the steam mass flow and not the steam pressure thus eliminating steam hammer and vibration issues.
- **Low maintenance** due to the PSX heater's self cleaning design
- **Low Pressure Drop** reduces demand on the sludge pumps lowering energy costs
- **Better temperature control** allows for a more reliable heating process (typically +/- 1%)
- **Reduced installation and Operational Costs** from the elimination of condensate return system
- Direct mechanical control of the steam injector allows for linear process heating control
- Control is by the plant PLC/DCS or local controller with **no proprietary software** required
- PSX heater can be installed in the piping **requiring no floor space**