Tech Sheet #127
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BASICS OF CLOSED FEEDWATER HEATERS

TERMINOLOGY

A feedwater heater is a heat exchanger designed to preheat boiler feedwater by means of condensing steam extracted (or "bled") from a steam turbine. The heaters discussed here are classified as **closed**, since the tubeside fluid remains enclosed by the tubes and channel, and does not mix with the condensate, as is the case with **open** feedwater heaters. They are **unfired** since the heat transfer within the vessel does not occur by means of combustion, but by convection, and conduction.

The steam extraction process in a closed feedwater is referred to as **uncontrolled** extraction**.** The flow rate of steam into a feedwater heater is not limited by the amount of available steam (as opposed to a surface condenser, for instance). The shellside operating pressure in a feedwater heater is determined by the pressure of the steam supplied to it, not by the amount of heat transfer surface.

CONFIGURATION

Most feedwater heaters are of a standard shell-and-tube configuration, although some are of header type (mainly outside of the USA). A few employ straight tubes, although the majority uses U-tubes, which are relatively tolerant to the thermal expansion during operation.

RELATION TO POWERPLANT CYCLE

The heating process by means of extraction steam is referred to as being **regenerative.** The feedwater heaters are an integral portion of the power plant thermodynamic cycle. Normally, there are multiple stages of feedwater heating. Each stage corresponds to a turbine extraction point. These extraction points occur at various stages of the expansion of steam through the turbines. The presence of the heaters in the cycle enhances the thermal efficiency of the powerplant; the greater the number of extraction stages, the lower the amount of thermal energy required to generate a given amount of electrical energy. A beneficial by-product of the energy extracted by the heaters is the reduced rate of rejection of energy to the environment.

PRESSURE CLASSIFICATION

Low Pressure Heater: A heater located (with regard to feedwater flow) between the condensate pump and either the boiler feed pump or, if present, an intermediate pressure (booster) pump. It normally extracts steam from the low pressure turbine.

High Pressure Heater: A heater located downstream of the boiler feed pump. Typically, the tubeside design pressure is at least 1500 psig, and the steam source is the high pressure turbine.

Intermediate Pressure Heater: (if present). A heater located between the booster pump and the boiler feed pump. Usually the tubeside pressure is within 1000-1500 psi and the steam is extracted from an intermediate pressure turbine.

ORIENTATION

Horizontal**:** Most heaters are of this configuration. These are the most stable in regard to level control, although they occupy more floor space. Disassembly is by means of either shell or bundle removal. Most are floor mounted, although some are mounted in the condenser exhaust neck.

Vertical, Channel Down: Although these conserve floor space, the amount of control volume available for liquid
level fluctuation is less. Disassembly is by shell removal. Installation and removal may be more difficult than for horizontal heaters.

Vertical, Channel Up: These are the least frequently used. Disassembly is by means of bundle removal. If a subcooling zone is present, it must extend the full length of the bundle, since the water must enter the bottom and exit at the top end of the heater.

ZONES

Zones are separate areas within the shell in a feedwater heater.

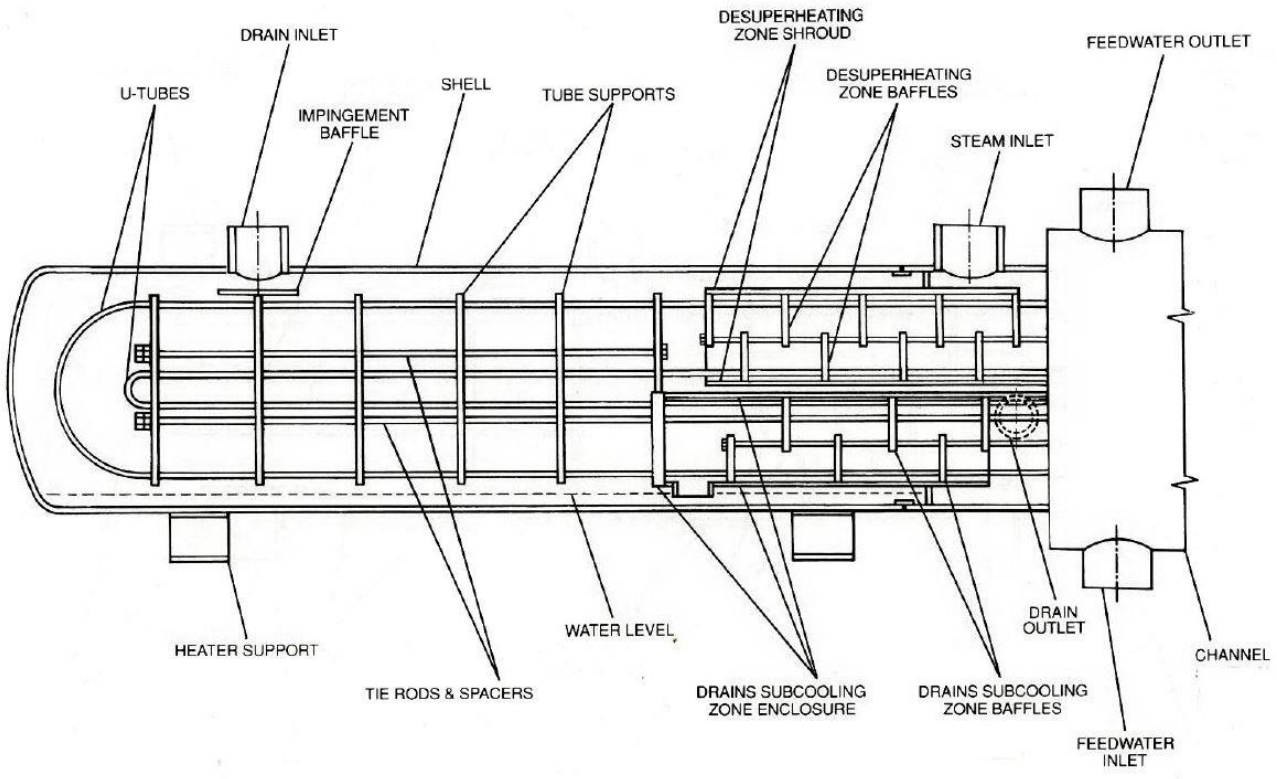
Condensing Zone: All feedwaters have this zone. All of the steam is condensed in this area, and any remaining non condensable gases must be removed. A large percentage of the energy added by the heater occurs here.

Subcooling Zone: (Optional) The condensed steam enters this zone at the saturation temperature and is cooled by convective heat transfer from the incoming feedwater.

Desuperheating Zone: (Optional) The incoming steam enters this zone, giving up most of its superheat to the feedwater exiting from the heater.

COMPONENTS

See figure below. (Typical 3 zone horizontal feedwater heater)



Typical 3 zone horizontal feedwater heater

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