Tech Sheet #136
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CONDENSER HOTWELLS

General:

Condenser hotwells have important functions within the condenser and also in the arrangement and performance of the overall power plant. Two primary functions are listed below.

Condensate Collection/Storage

First is the collection of condensate dripping off the condenser tubes. This collection and resultant reservoir provides system capacitance and insures the condensate pump is adequately supplied with condensate. Condensers operate at low absolute pressures and pumps are gravity fed. A loss of condensate or a reduction in net positive suction head (NPSH) may lead to pump cavitation, impeller damage and eventual plant shut down, therefore, hotwell levels are controlled and regulated. Low condensate levels are supplemented with emergency make up using demineralized water.

Condensate Reheating/Deaeration

Second is the reheating of condensation droplets as they fall from the tubes. Under ideal conditions the drops are at saturation temperature, however, longer droplet residence time (on tubes) can produce sub-cooled temperatures. When operating at or near full load, condensers will produce very little sub-cooling. In the event of sub-cooling there is a possibility of air re-absorption by the colder water drops leading to higher oxygen content. Both sub-cooling and higher oxygen are undesirable in condenser operation. The distance from normal to bottom tubes is normally recommended by the manufacture as a minimum that allows main exhaust steam to effectively reheat falling droplets, thereby returning their temperature to saturation conditions.

Design Features

Other features can be specified by the purchaser. All hotwell design features when specified and coordinated with the condenser manufacturer will produce a unit of high quality and superb performance. Some special features are:

> **Hotwell capacity** - Hotwell capacities typically range from 1 to 5 minutes of total condensate flow. The flow specified is converted into an equivalent volume that establishes the normal condensate level.

This Tech Sheet was developed by the members of the Heat Exchange Institute's (HEI) Condenser Section. HEI is a trade association comprising the leading manufacturers of heat exchange and vacuum equipment. HEI Tech Sheets are information tools and should not be used as substitutes for instructions from individual manufacturers. Always consult with individual manufacturers for specific instructions regarding their equipment.

Allowance for Service Connections – Condensers by virtue of low operating pressures and low elevation (within the power plant) become a convenient location for drips, drains, vents and an assortment of other discharges associated with a typical power cycle. Heat Exchange Institute standards for Steam Surface Condensers Chapter 5.0 SERVICE CONNECTIONS provide designers with guidelines for the safe dispersion of fluid energies at steady state operation without causing detrimental effects to the unit's internals, especially tubes. It is incumbent upon the purchaser to recognize and specify the need for extra hotwell "height" to accommodate large numbers of service connections located between the high condensate level and bottom tube.

Divided Hotwells – Divided hotwells are useful in locating tube leaks within divided (multiple bundle) condensers. The water can have a large range of dissolved solids anywhere from 500 ppm (fresh) to 35,000 ppm (sea) and leakage into the steam space can cause detrimental effects to the materials used in the construction of components located there. Hotwells are partitioned longitudinally with a vertical baffle that contains an opening at one end for condensate crossover. Sample points are positioned at crossover locations and conductivity measurements will help pin point the leaking tube bundle.

Multi-Pressure Units – Multi-pressure condenser designs are created using circulating water flow arranged in a series circuit. As the circulating water becomes hotter, it's condensing efficiency decreases, therefore, the steam side pressure in subsequent shells will be higher than that produced in the initial water shell. The Heat Exchange Institute Standards for Steam Surface Condensers Chapter 1.0 NOMENCLATURE provides illustrations of tube and shell circuit skematics. Also, Chapter 4.0 paragraph 4.6 provides some design particulars for multi-pressure hotwells.

By cascading condensate from the lowest to the highest pressure shell, it can be heated in the highest pressure hotwell to the saturated thermodynamic conditions of that shell. Cascading is accomplished through the use of a loop seal that overcomes shell differential pressures.

Heating Systems for Low Loads – During low load operation and cold circulating inlet, condensate subcooling may occur. Many condensers provide good droplet reheat even when operating at "low loads" and "low circulating water temperatures". However, it must be realized at these operating conditions, the ratio of air leakage to air removal capacity can mean that condenser absolute pressure is determined more by air leakage and air removal capacity than by steam condensing. Also at these conditions, air blanketing of the tubes can take place with resultant sub cool of dripping condensate. Although a very efficient hotwell can reheat this condensate to a remarkable degree, the condenser cannot normally be expected to handle this additional heating burden. These conditions may not allow manufacturers to provide oxygen guarantees as requested by specifications. Guarantees given on any surface condenser must be correlated with the parameters as specified in the latest issue of the Heat Exchange Institute Standards for Steam Surface Condensers paragraph 4.3 Oxygen Content Of Condensate. Briefly, the standard states, "under practical conditions of operation, the condenser can be expected to produce deaerated condensate with an oxygen content of the condensate not exceeding 42 ppb". This standard renders a set of conditions, which when met, could produce 7-14 ppb oxygen, part of the condition being that the condenser pressures are not lower than those provided in the standard. Special oxygen guarantees such as 14 ppb and less during low load conditions can be met and given by using direct steam injection into the condensate.

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Heating systems such as this will vary for individual units and manufactures. Purchasers must specify a range of load and temperatures so the condenser manufacturer can provide an appropriate system. Manufacturers in turn will advise the amount of heating steam required.

Condensate Retention – This design feature is rare and is typically associated with nuclear units. . A specified time is required between leak detection and operator corrective action. A labyrinth of hotwell baffles is necessary to provide the time delay.

Start Up Heating And Deaeration –Some power plant thermal cycles may requireheating and deaeration condensate in the hotwell prior to unit start up. When this feature is required, the purchaser must specify requirements such as: volume of water to be heated, time required, desired temperature, recirculation component (if any) and heating steam characteristics. The manufacturer will design a low pressure hotwell steam sparger to satisfy this request.

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