SUPERHEATER

A **superheater** is a device used to convert *saturated steam* or wet steam into *dry steam* usedinsteam engines or in processes, such assteam reforming.It is integral part of boiler and is placed in the path of hot flue gases from the furnace.

Theheat recovered from the flue gases is used in superheating the steam before entering into theturbine (i.e.,prime mover).Its main purpose is to increase the temperature of saturated steamwithout raising its pressure.Most of the modern boilers are having superheater and reheater arrangement.

Superheater is acomponent of a steam-generating unit in which steam, after it has left the boiler drum, isheated above its saturation temperature.

The amount of superheat added to the steam isinfluenced by the location, arrangement, and amount of superheater surface installed, as wellas the rating of the boiler. The superheater may consist of one or more stages of tube banksarranged to effectively transfer heat from the products of combustion. Superheaters areclassified as convection, radiant or combination of these.

Superheaters in packaged steam generators and HRSGs-general features.

Packaged steam generators generate up to 300,000 lb/h steam, while a few gas turbine HRSGs generate even more depending on the gas turbine size. Steam pressure in cogeneration and combined cycle plants typically ranges from 150 to 1,500 psig and temperature from saturation to 1,000°F Seamless alloy steel tubes are used in superheater construction. Tube sizes vary from 1.25 to 2.5 in.

Commonly used materials are shown . Allowable stress values depend on actual tube wall temperatures. Tube thickness is determined based on this using formulae discussed in the ASME Code, Sections 1 and 8. Different designs are available for super heaters depending on gas/steam parameters and space availability. The inverted loop design is widely used in packaged boilers, while the vertical finned tube design is common in HRSGs. The horizontal tube design with vertical headers is used in both.

Bare tubes are generally used in packaged steam generators, where gas temperatures are high (typically 1,500-2,200°F) and tube wall temperature is a concern. However, in gas turbine HRSGs, finned superheaters are used. Gas inlet temperature is generally low, on the order of 900-1,400'F, which requires a large surface area. Use of finned tubes makes their design compact. Superheaters can be of convective or radiant design or a combination of these in packaged boilers. Final steam temperature may or may not be controlled. In unfired and supplementary fired HRSGs, the superheaters are or convective design only.

Steam temperature control methods in superheaters.

Generally, steam temperature is maintained constant from about 60% to 100% load. Interstage attemperation or spray water injection is done to achieve the desired final steam temperature. Water injected should be demineralized since solids contained in feed water can get carried into the superheater and turbine and selective deposition can occur. Salt deposits in the superheater can result in tube overheating. Turbine blade deposition is a big concern with turbine maintenance engineers since it reduces power output, restricts flow passages, causes corrosion and can damage the blades. Hence, high steam purity on the order of 20-50 ppb is generally desired in high steam temperature applications. Good steam drum internals using a combination of baffles and Chevron separators can achieve the desired steam purity. In case demineralized water is not available for spray,

some of the steam may be condensed using a heat exchanger as shown , and the condensate is sprayed into the desuperheater. Steam flow through the exchanger and superheater should be balanced in the parallel paths either by using flow restrictions, control valves in each parallel path or by raising the exchanger level to provide additional head for control. Feed water from the economizer cools and condenses steam used for desuperheating (Fig. 4a). In Fig. 4b, the feed water is directly injected into the steam between the stages. Desuperheating beyond the superheater is not recommended since moisture can be carried to the steam turbine along with the steam if downstream mixing is not good.

Also, this method permits steam temperature in the superheater to increase beyond the desired final steam temperature and, hence, the premium on materials used for superheater construction will be high. There are several other methods used for steam temperature control such as varying excess air, tilting burners, recirculating flue gases, etc., but in packaged boilers and HRSGs, interstage attemperation is generally used. Superheaters in HRSGs.

The basic difference in superheater design used in steam generators and HRSGs is that in HRSGs, as mentioned earlier, finned tubes may be used to make the design compact. The large duty and large gas-to-steam flow ratio coupled with the low LMTD necessitates this.

However, while selecting finned tubes, a low fin density should be used conside ring the low steam side heat transfer coefficient inside the tubes. The heat transfer coefficient due to superheated steam flow is small, on the order of 150- 300 Btu/ft2h°F, depending on steam flow, pressure, temperature and tube size. A large fin area would only increase heat flux inside the tubes, tube wall temperature and possibly gas pressure drop as discussed in an earlier article.' Note that the gas side heat transfer coefficient is lower with higher fin density or surface area. Hence, it is misleading to evaluate finned superheater designs based on surface areas.' In large gas turbines, steam after expanding from the steam turbine is again reheated in the HRSG to generate additional power.

Applications of Superheater:

Superheaters are used for:

Power plants Steam engines

Locomotive use

Damper and shifting valve

Front-end throttle

Advantages and Disadvantages:

The main advantages of using a superheater are reduced fuel and water consumption but there is a price to pay in increased maintenance costs. In most cases the benefits outweighed the costs and superheaters were widely used. An exception was shunting locomotives(switchers). British shunting locomotives were rarely fitted with superheaters. In locomotivesused for mineral traffic the advantages seem to have been marginal. For example, the North Eastern Railway fitted superheaters to some of its NER Class P mineral locomotives but later began to remove them.

Without careful maintenance superheaters are prone to a particular type of hazardous failure in the tube bursting at the U-shaped turns in the superheater tube. This is difficult to both manufacture, and test when installed, and a rupture will cause the superheated high-pressur e steam to escape immediately into the large flues, then back to the fire and into the cab, to theextreme danger of the locomotive crew

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