Combustion performance

The Hitachi-Naka No.1 boiler is the first unit equipped with the newly developed Hitachi NR-3 burner. The NR-3 burner is the latest design in the NR series of rapid ignition low-NOx pulverized coal burners for large-scale commercial plants. The results of combustion testing are summarized

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Design Features of the Hitachi-Naka No.1 Boiler

The following are features that are incorporated into the design of the Hitachi-Naka boiler, in particular for once-through sliding pressure operation with supercritical steam parameters

Sliding pressure operation

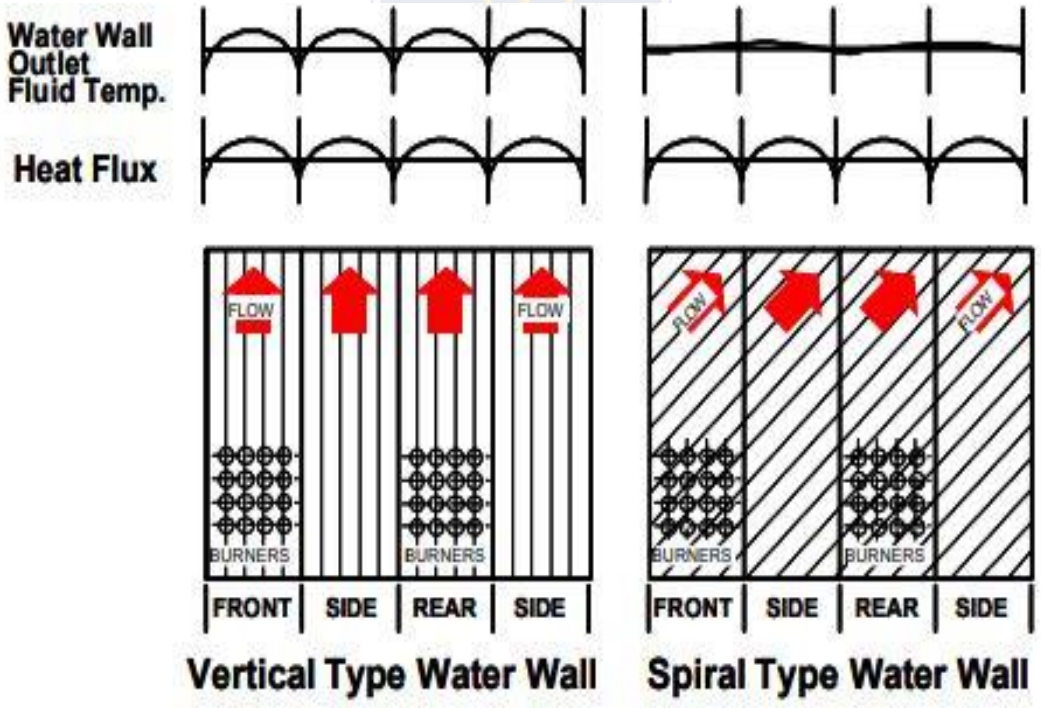
As the nuclear power has become the primary source for base load generation in Japan, coal-fired power plant equipment suppliers were challenged to design new supercritical coal-fired units with flexibility for frequent load cycling. By adopting the sliding pressure operation with lower boiler pressures at partial loads, the plant heat rate can be improved at partial loads due to

1) improvement of high pressure (HP) turbine efficiency,
2) reduced auxiliary power consumption by boiler feed pumps, and
3) higher steam temperature at the HP turbine outlet. In addition to the plant efficiency advantages, there are other benefits such as reduction in start-up time, increase in ramp rate and reduced erosion of bypass valves as described in Section 3 of this paper.

Spiral Waterwall

For sliding pressure boilers, maintaining uniform fluid conditions during low load / low pressure operation becomes critical to reduce the potential of tube damage caused by high metal temperatures. The lower part of the Hitachi-Naka boiler furnace is arranged in a spiral configuration such that the fluid path wraps around the boiler as it travels up the furnace.

A comparison of fluid temperature distribution between the conventional vertical wall and the spiral waterwall is shown. As a result of the uniform waterwall fluid temperature profile that is achieved across the full range of boiler loads, the spiral waterwall system does not require any flow adjusting devices to be installed at the furnace inlet.



Steam Separator

As the Hitachi-Naka boiler is a Benson type unit, a steam separator and a separator drain tank were installed to separate the steam and the water at the furnace outlet during a low-load recirculation operation. This design is different from that of a conventional NC boiler, for which a steam drum is installed to separate the water from the steam under all operating loads. The steam drum is designed to have sufficient water storage capacity, and usually contains complicated internal parts, such as steam cyclones, scrubbers, internal feed pipes, and baffles. Because of the complex internals, steam drums require a large amount of maintenance work during outage periods. However, the steam separator design of a Benson boiler is simple in configuration and has no internal, therefore significantly less maintenance work is required.

Boiler start-up systems

The Hitachi-Naka Boiler includes fully automatic start-up systems such as the turbine bypass system and the low load recirculation system. The turbine bypass system was designed to minimize the start-up time by controlling the main steam pressure and temperature before turbine rolling, and enabling the steam to flow through the superheater sections at a short time after light-off. The low-load recirculation system was designed to recover residual heat during start-up by circulation of the un-evaporated water from the furnace back to the economizer inlet, which also can assist in reducing start-up time. As this system is automatically operated, the start-up process is as simple as with a natural circulation (NC) boiler.

Advanced control systems

The latest developments in plant distributed control systems have led to a highly automated operation from boiler light-off to shutdown.

Advanced dynamic control from computerized calculation algorithms for the main control functions (e.g. steam temperature control) have been developed such that recently installed boilers can be controlled with reduced operator action.

Improved Design Features for PRB coal-fired Supercritical boilers

Council Bluffs Energy Center Unit 4

The new coal-fired boiler under construction at Council Bluffs Energy Centre Unit 4 (CBEC 4) shall be the first new generation coal-fired supercritical Benson boiler to be built in the U.S.A. The boiler shall include the latest in design features for advanced supercritical steam conditions.

The design and major engineering of the new plant is already complete, and the unit is currently under construction. CBEC 4 is on schedule to commence commercial operation in June 2007.