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FACULTY OF ENGINEERING &
TECHNOLOGY

BOILERS

Boiler is an apparatus to produce steam. Thermal energy released by combustion of fuel is transferred to water, which vaporizes and gets converted into steam at the desired temperature and pressure.

The steam produced is used for:

- Producing mechanical work by expanding it in steam engine or steam turbine.
- Heating the residential and industrial buildings.
- Performing certain processes in the sugar mills, chemical and textile industries.

Boiler is a closed vessel in which water is converted into steam by the application of heat. Usually boilers are coal or oil fired.

A boiler should fulfil the following requirements;

Classification of Boilers

The boilers can be classified according to the following criteria.

According to flow of water and hot gases.

- Water tube.
- Fire tube.

In water tube boilers, water circulates through the tubes and hot products of combustion flow over these tubes. In fire tube boiler the hot products of combustion pass through the tubes, which are surrounded, by water.

Introduction

The Hitachi-Naka Thermal Power Station Unit No.1 of the Tokyo Electric Power Company (TEPCO), whose “Benson” type boiler was designed and built by Babcock-Hitachi K. K. (BHK) is the latest supercritical coal-fired utility plant to commence commercial operation in Japan. State-of-the-art technologies such as high pressure, high temperature steam parameters of 3680 psig 1120°F/1115°F (604°C/602°C) and Hitachi’s advanced burner system for low NO_x combustion were integrated into the new design.

Flexible sliding pressure operation, advanced steam temperature control methods, and sophisticated computer control technologies make this unit an ideal plant for load demand following applications.

The sliding pressure supercritical Benson boiler technology has been fully established and has markedly surpassed drum type boilers in the areas of efficiency, flexibility in operation and availability, as proven by over 10 years operating experience in Japan. Supercritical technology was first developed in the U.S. in the 1950s. The early units however experienced problems related to reliability and operational flexibility. The technology was adopted in Japan in the 1960s, has been refined by members of the related industries and is now utilized for all new large capacity boilers.

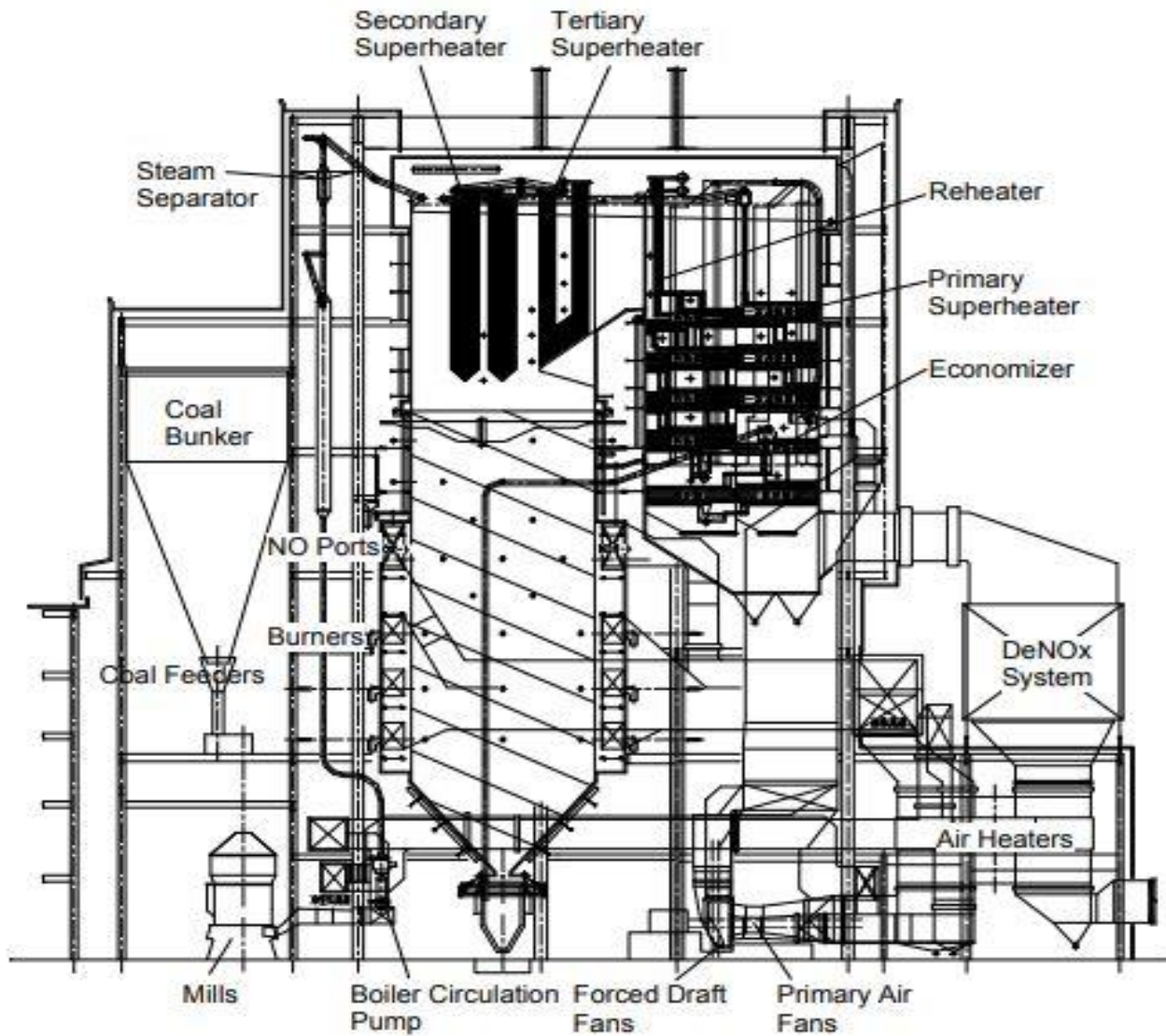
The continuing development of high strength pressure parts materials to be used for high temperature regions has enabled the technology to extend the steam temperatures to higher than 1100°F (593°C). Reflecting a strong desire of reduction in CO₂ emission by achieving high efficiency, recently constructed large capacity boilers in Japan have employed this technology unexceptionally.

Latest experience in supercritical boiler

The Hitachi-Naka Thermal Power Plant Unit 1 (1,000MW), which commenced commercial operation from December 2003, is the latest supercritical unit to be placed in operation in Japan. The plant is located in Ibaraki prefecture in Japan, approximately 60 miles from Tokyo city. The engineering and construction of the boiler, turbine and generator (BTG) power island was managed by Hitachi Ltd. The supercritical sliding-pressure Benson boiler was engineered and manufactured by Babcock-Hitachi K.K. (BHK), a subsidiary company of Hitachi Ltd group.

At the plant rated load, the boiler can supply the turbine generator with 6,327,000 lb/h of steam at supercritical steam conditions. The main steam parameters at the turbine inlet are 3,550 psig and 1,112°F, and the reheat steam temperature is 1,112 °F.

The plant was designed for load cycling operation, to follow the changing load demands throughout the operation day. As Japan does not have its own coal resources, coal-fired plants in Japan have to use imported coals. Therefore, utility companies must be flexible to purchase coal from a wide range of different sources from different countries, depending on the market price levels. The Hitachi-Naka boiler was designed to be able to burn a wide variety of imported coals, including those from Australia, Indonesia, China, U.S.A. and Canada



Operating experience Since the start-up period, the Hitachi-Naka boiler has been operating with stable and reliable performance parameters for both steady load and dynamic load operation modes. The main features of the boiler performance are summarized as follows.

Boiler performance The main steam and reheat steam temperatures have reliably achieved 1112 deg. F. The boiler efficiency was confirmed to be higher than the anticipated values at each tested load.

