Internal Recirculation
Circulating Fluidised-Bed Boilers
Improving your business is our business

Thermax offers products, systems and solutions in energy and environmental engineering to industrial and commercial establishments around the world. Its business expertise covers heating, cooling, waste heat recovery, captive power, water treatment and recycling, air pollution control and waste management and performance chemicals.

Thermax brings to customers extensive experience in industrial applications and expertise through technology partnerships and strategic alliances. Operating from its headquarters in Pune (Western India), Thermax has built an international sales and service network spread over South East Asia, Middle East, Africa, Russia, UK and the USA.

Boiler & Heater Group (B&H)

Thermax’s Boiler & Heater Group provides equipment and complete solutions for generating steam for process and power needs through combustion of various solid, liquid and gaseous fuels, as well as through heat recovery from turbine/engine exhaust and (waste) heat recovery from industrial processes. The Group also offers heaters for various applications in the Chemical, Petrochemical and Refinery segments. Its services arm offers renovation and modernization solutions for old boilers and heaters.

The major industry segments served by the Group in India and across the world are Steel, Refinery, Petrochemical, Power, Cement, Sugar, Fertilizer, Paper, Chemical, Non Ferrous Metal and Textile.

Our Green Business Philosophy & Activities

Thermax as an organisation is committed to sustainable development. Sustainability for us is not only a criterion applied to the energy and environment related solutions that we provide, but in fact pervades day-to-day activities, informs key decisions and guides new initiatives. In pursuit of achieving the Thermax vision of sustainable development for society, the Boiler & Heater Group has in the recent past delivered several breakthrough innovations through a combination of in-house R&D and global sourcing of the best available technologies.

Among these are spent wash-fired boiler for distilleries, municipal solid waste-fired boiler for urban waste disposal, waste heat recovery boiler for cement plants and internal-recirculation circulating fluidised bed boiler for power generation. The B&H Group is also working on a range of products for the emerging market for solar energy based heat recovery systems.
“When business organisations consider moving to decisions that are sustainable -- like saving electricity, recycling water, using renewable energy or putting up green buildings -- the big investments required upfront would certainly impact the balance sheet here and now. But, if we were to think of a longer time-frame, all these decisions would make a lot of sense when we consider the concept of life-cycle cost -- a higher capital cost, but with far lower operating costs such that it pays for itself over the life of the product. Long-term sustainability also goes hand in hand with the kind of decisions we make, processes we follow, policies we adopt and the values we propagate. Companies passionate about the cause of Sustainable Development will constantly come up with innovative solutions which, over time, will definitely add to the bottom line. If we were to redefine success of an organisation as achieving the triple bottom line -- economic, environmental and social -- it would be a sustainable model and we would be a far happier and healthier species on earth! So what can each one of us do? What can we do as an organisation to achieve this triple bottom line? These are questions we need to ask ourselves and act as quickly as possible since time is running out.”

Ms Meher Pudumjee
Chairperson
The Technology of Choice

Product Features

- Compact, economical design and construction
- Two stage separation for better bed inventory control
- Impact separation with ‘U-beam’ particle separators
- Best-in-class compliance with environmental norms
- Low auxiliary consumption
- Minimum refractory
- Bottom-ash cooler (wet and dry)
- No soot blowers
- Multifuel firing capability

Operating Range

Capacity: Upto 1000 Tons/hr
Design pressure: Upto 200 kg/cm² (g) i.e. 196 bar (g)
Steam temperature: Upto 560°C

Fuels:
Coal, Lignite, Petroleum coke (petcoke), Sludge, Oil pitches, Biomass, Agro-wastes, High-sulphur coal, Washery rejects, Mill rejects, Refused derived fuel, Char, Fly ash

Can be offered through following routes:
- Boiler island
- Boiler-Turbine-Generator (BTG) package
- Turnkey power plant (EPC)

Thermax IR-CFBC test facility (2 MWth) at Pune, India
IR-CFBC design offered to power / process plants seeking economy, reliability & flexibility
Internal Recirculation – Circulating Fluidised Bed
Boiler (IR-CFBC) – The Latest Design
Improves Performance, Reduces Costs, Minimises Maintenance

Two-Stage Particle Separation for Superior Combustion Efficiency

The unique IR-CFBC boiler design employs a patented two-stage particle separation system to provide high-solids loading and a uniform furnace temperature profile. The benefits of this technology include superior combustion efficiency, high operational thermal efficiency, low emissions, low maintenance, low pressure drop, and high turndown, resulting in improved overall plant performance. Our two-stage system includes a primary U-beam impact separator and a secondary multi-cyclone dust collector (MDC) which work together to provide a combined particle collection efficiency in excess of 99.8%. The U-beams, a staggered array of stainless steel channels at the furnace exit plane, capture nearly all of the solids suspended in the flue gas leaving the furnace and internally recirculate these solids to the lower furnace. The ceramic MDC, with small diameter 250 mm cyclones, captures the solids in second pass and returns this material to the lower furnace in a controlled manner. The ability to regulate the secondary recycle system provides the operator with unprecedented furnace temperature control, resulting in improved boiler performance and relatively faster load response.

The two-stage particle collection system provides improved performance, as well as a simplified, cost-effective boiler design.
Compact, Economical Design

The two-stage particle separation system results in a compact, simplified boiler arrangement. The entire U-beam particle separator is located at the furnace exit. Compared with hot cyclone-type CFBC designs, the IR-CFBC has significantly lower furnace exit gas velocity and requires significantly less building volume. By relying on internal recirculation, the IR-CFBC design eliminates J-valves, loop seals, high-pressure blowers, and soot blowers, which are required with other CFBC designs.

Higher Availability, Lower Maintenance

One goal of CFBC boiler manufacturers has been to eliminate thick, uncooled refractory and hot expansion joints from their designs to reduce the expense and lost time associated with refractory maintenance. This goal was achieved with the development of the IR-CFBC boiler. The furnace, U-beam separator, and superheater enclosures are constructed entirely of top-supported, gas-tight, all-welded membraned tube walls which do not require hot expansion joints. The small amount of refractory that is used in the IR-CFBC is applied to selected areas of the water-cooled enclosure surface in a thin layer which is only 16 mm thick in the lower furnace slightly thicker over the tube face elsewhere in the furnace. As a result, IR-CFBC requires only 10 to 25% of the total refractory found in a hot cyclone CFBC design and less than 50% of the refractory used in a water-cooled or steamcooled cyclone CFBC unit. This construction has significantly reduced the need for refractory maintenance in operating CFBC units.
No Interface Erosion

The patented reduced diameter zone (RDZ) tube section is another feature designed to reduce maintenance. The RDZ consists of a reduced diameter tube section mating to a specially-shaped ceramic tile. The reduced diameter tube section on each tube slopes away from the solids falling down the wall. This eliminates the solids material from building up and eroding the furnace tubes where the lower furnace refractory ends.

Low Flue Gas Velocities to Reduce Erosion

Erosion is a major cause of maintenance problems in CFBC boilers due to the high solids loading in the flue gas. The severity of this erosion is exponentially related to the velocity of the flue gas through the system. On hot cyclone CFBCs the particle separator depends upon an extremely high flue gas velocity to provide the energy needed to efficiently disengage the particles from the flue gas. By comparison, the U-beam particle separator is designed to operate efficiently with much lower flue gas velocity at full-load operating conditions. The particle capture efficiency actually increases as the flue gas velocity through the U-beam separator decreases. By operating at such a low gas velocity, the potential for erosion in the IR-CFBC is significantly reduced. To date, because of proper material selection and low flue gas velocities, the U-beam separators have not required any maintenance due to erosion throughout years of operation at design load conditions.
Fluidised-Bed Technologies to Meet Every Need

There is no substitute for actual operating experience. Thermax has that experience and a proven track record of high availability for all types of boiler technologies – including fluidised-bed combustion technologies such as – circulating (IR-CFBC) and bubbling (BFBC).

Bubbling Fluidised-Bed Combustion Technology

For fuels with high moisture contents and low heating values such as sludges and high moisture biomass, Thermax recommends the use of bubbling fluidised-bed combustion (BFBC) technology. Thermax offers an open hopper bottom BFBC design which is ideal for burning fuels containing large pieces of noncombustible material, such as rocks and metal pieces. BFBC technology also is well-suited for retrofit applications on stoker-fired or chemical recovery boilers.

Innovative Energy Solutions

Thermax is committed to the continuing advancement of its fluidised bed technologies. This commitment is demonstrated through continued research and development. In addition, field demonstrations and testing have led to many improvements that are now implemented into our design standards as well as our operating CFBC and BFBC boilers.
## Features and Benefits

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<th>IR-CFBC Design Features</th>
<th>IR-CFBC Design Benefits and Operating Results</th>
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| Two-stage particle separation system                        | ▪ Greater than 99.8% particle collection efficiency  
▪ Provides a means to control particle size distribution in furnace, which results in improved carbon burnout, limestone utilisation, emissions and heat transfer  
▪ Reduces operating costs                                                                                                           |
| All-internal primary solids recirculation (U-beams)         | ▪ Compact design requires 20-30% less building volume than cyclone-based CFBC boilers — critical for repowering projects  
▪ Lowers auxiliary power consumption compared with cyclone-based CFBC boilers                                                                                                           |
| Low, uniform velocities at the furnace exit U-beam separators, and the superheater | ▪ Significantly reduces erosion in upper furnace and superheater compared with cyclone designs  
▪ To date, no U-beam erosion maintenance required in any IR-CFBC unit  
▪ No high-maintenance vortex finders or hot expansion joints; therefore, no maintenance expenses for these items                                                             |
| No thick refractory due to elimination of hot cyclones and hot return legs | ▪ Thin, cooled refractory places no restriction on boiler start-up or shut–down rate  
▪ Significantly reduces need for refractory maintenance  
▪ Virtually eliminates forced outages due to refractory failures  
▪ Requires only 10 to 25% of the total refractory compared with hot cyclone CFBC designs                                                                                         |
| In-furnace heat transfer surface                             | ▪ Vertical, flat membraned tube panels within furnace perform evaporative or superheat duty  
▪ Proven reliability and low maintenance                                                                                                                                                |
| Unique primary air nozzles (bubble caps)                    | ▪ Reduces back sifting of solids during low-load operation  
▪ Reduces need for periodic cleaning of nozzles and primary air windbox  
▪ Minimises erosion inside nozzle caused by the re-entrainment of back-sifted solids                                                                                                    |
| Sootblowers not required upstream of MDC                    | ▪ Eliminates steam consumption, maintenance costs and forced outages typically associated with sootblowers                                                                                                                                  |
| Gravity fuel feed and fly ash recycle system                | ▪ Reduces maintenance, forced outages and auxiliary power requirements by eliminating the mechanical fuel injection and pneumatic fly ash recycle systems                                                                                      |
| High turndown (up to 5:1) without auxiliary fuel support   | ▪ Allows wider load swings  
▪ Reduces operating costs (no auxiliary fuel) during low–load operation                                                                                                                  |
Fuel Flexibility, Lower Emissions

Fuel Flexibility

One of the main advantages of CFBC technology is that it allows the owner to specify a wide variety of fuels to optimise the profitability of the facility. Thermax has the engineering expertise and operating experience needed to supply an IR-CFBC boiler that is capable of burning specified fuels, such as:

- Coal
- Lignite
- Petroleum Coke (petcoke)
- Washery Rejects
- Mill Rejects
- Agro-Waste
- Biomass
- Refuse Derived Fuel
- Char

Other fuels such as fly ash and sludge are also candidates, depending on their percentage of heat input, moisture content and emission requirements. The IR-CFBC boiler also can be designed to burn several specified fuels in the same unit. This provides the additional flexibility needed to respond to changes in the fuel markets.

Emissions Control

The IR-CFBC boiler can control SO₂ emissions by injecting limestone into the lower furnace. Relatively low NOx emissions are inherent in the IR-CFBC due to low and uniform furnace temperatures and staged combustion. NOx emissions can be further reduced by using a selective non-catalytic reduction (SNCR) system. In addition, the IR-CFBC’s patented secondary particle recycle system provides increased control, not found in other CFBC technologies, to maintain an optimum uniform furnace temperature which is essential for low SO₂ and NOx emissions and for better limestone utilisation.
Installations in 75 countries

Global Footprint of Boiler & Heater Group
For more details visit www.thermaxglobal.com or Write to bnhenquiry@thermaxglobal.com or enquiry@thermaxglobal.com