Atmospheric Fluidised Bed Combustion Boilers for Firing Solid Fuels
Advanced Technologies for Power Generation

Historically, Thermax has maintained an ongoing program to develop advanced technologies which offer the potential for more efficient, cost effective and reliable steam generation. One of these advanced technologies is Atmospheric Fluidised Bed Combustion (AFBC), which promises to provide a viable alternative to conventional coal fired and other solid fuel fired boilers for utility and industrial applications.

Thermax began investigating various aspects of the AFBC process in the mid-70s and has become the technological leader among boiler manufacturers in AFBC development for utility and industrial use.

Secondary overfire air is provided from both sides of furnace to ensure complete combustion, resulting in minimum unburnt, reduced carbon monoxide and improved efficiency.

Shop assembled, machine welded membrane panels allow for less refractory and make a gas tight enclosure resulting in less leakage and improved efficiency.
Salient Features of Thermax Atmospheric Fluidized Bed Combustion (AFBC)

B&W design two stage steam separating equipment inside the drum ensures turbine quality steam. Guaranteed 99.99 % steam purity even under conditions of rapid load changes.

In line, spaced bed evaporator tubes for better access to bed plate. Pin studs welded on inbed surfaces and furnace walls eliminate tube erosion.

Inclined airholes prevent bed material re-entry hence eliminating back shifting.

Stainless steel air (Bubble Cap) nozzles for primary air are designed for higher pressure drop to achieve higher turndown ratios for better operational flexibility.

Fluid bed ash coolers for cooling bed ash. Air is used to cool ash. Flue gas sent back to the air heater to recover sensible heat resulting in further improvement in efficiency.

Underbed fuel feed system using drag chain/rotary feeders for smooth flow of high moisture fuel to furnace. Hot air for transport of fuel inside combustor for smooth flow of fuel in the feed lines. No bends on fuel transport lines improves the availability.

Flow Modelled Fuel Feed System  Fuel Feed Mixing Nozzles  Boiler Control Room
Thermax Technology: High Availability & Efficiency

The challenge of the AFBC process is to burn fuel in an environmentally acceptable manner yet showing economic promise. The AFBC Boiler achieves this by carrying out combustion in a bed of crushed refractory/sand which is suspended by an upward stream of air, fluidising it and facilitating a significant higher degree of combustion completeness. In addition to this inherent advantage of the fluidised bed combustion process, design and operating characteristics of Thermax AFBC boilers offer a number of advantages for industrial steam and power generation.

Combustion temperatures of the AFBC process are maintained below the fuel ash softening temperature, so low-grade fuels can be burned without the risk of slagging and fouling in the boiler. The lower temperatures also limit the formation of nitrogen oxides. Fuels like coal, washery rejects, lignite (Kutch, Neyveli), petcoke, rice husk, DOB, bark, effluent sludge from paper mills, sludge from viscose plant, coffee waste etc. can be effectively burnt in Thermax AFBC Boilers.

Due to lower operating temperatures, the Thermax AFBC boiler design is less dependent on fuel and fuel ash characteristics than conventional boilers.

SOx control is achieved by limestone addition in the bed and FGD (Flue Gas Desulphurisation) is eliminated.

**Boiler Availability***

![Boiler Availability Graph](image)

**Load Vs Efficiency**

![Load Vs Efficiency Graph](image)

* Data from operating unit
Atmospheric Fluidized Bed Combustion Boiler

(Underbed & Overbed feed system design)

Designed and manufactured to the legendary Thermax design & quality, incorporating the latest advances in boiler and control technology, making it the most efficient and reliable boiler for combustion of diverse range of difficult fuels.

**Capacity Range**: Up to 300 TPH

**Pressure**: Up to 135 Kg/cm²g

**Temperature**: Up to 540°C

**Fuel**: Coal / Lignite / Petcoke / Rice Husk / Pith / Oil / Agricultural Waste / Washery Rejects / Char / Biomass / Spent Coffee Waste / Spent Tea Waste, Sawdust, DOB, etc.

**Design Feature**: Top or bottom supported, Single or Bi-drum design boilers suitable for firing low calorific value fuels. Suspension burning of fuel - higher combustion efficiency.

- Coal Size 6 mm
- Bubbling Bed Ash Coolers
- Inbed Superheater
- Stainless Steel Fluidizing Nozzles
- Boiler Bank without Baffles
- High Steam Purity
- Membrane Wall Furnace
- Start-up by Oil / Charcoal
Hopper Bottom (Fluid Bed)

Salient Features

- Combustor does not have any moving parts thus reducing maintenance in the furnace.
- Uniform Temperature distribution in the bed and agitating characterstic of fluid bed ensures optimum combustion.
- Low excess air requirement resulting in higher efficiency.
- Lower NOx and CO emissions.
- Low SOx emission with limestone addition.
- Low temperature operation minimises the biomass fuel ash agglomeration and fouling tendency.
- Continuous slow draining of bed ash which aids:
  - Easy settling and disposal of large sized particles which hamper fluidisation.
  - Maintaining alkali concentration below acceptable levels.
  - Avoiding accumulation of denser particles in bed in maintaining uniform bed density across the entire bed.
- Under bed / over bed fuel feeding for proper distribution of fuel.

AFBC Features

Inbed Evaporator Assembly at Shop

Stainless Steel Dense Studs for Inbed Tubes
Shop Facilities

- Drum Shop
- Coil Shop
- Panel Shop
- Panel Bending Machine
AFBC Installations

Nava Bharat Ferro Alloys Ltd.
Orissa, India
Capacity: 125 TPH
Fuel used: Indian Coal

Nestle Philippines Inc.
Philippines
Capacity: 25 TPH
Fuel used: Spent Coffee Ground, Roasted Chaffs

Central Pulp Mills
Gujarat, India
Capacity: 50 TPH
Fuel used: Coal / lignite

Usha Martin
Jamshedpur, India
Capacity: 110 TPH
Fuel used: Coal
<table>
<thead>
<tr>
<th>CLIENT</th>
<th>STATE</th>
<th>NOS.</th>
<th>TPH</th>
<th>KG/CM² (G)</th>
<th>DEG.C</th>
<th>FUEL</th>
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<td>Bhushan Ltd.</td>
<td>Orissa</td>
<td>1</td>
<td>165</td>
<td>88</td>
<td>520</td>
<td>Washery rejects, char</td>
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<tr>
<td>Orient Paper Mills Ltd.</td>
<td>Madhya Pradesh</td>
<td>1</td>
<td>150</td>
<td>87</td>
<td>510</td>
<td>Indian coal</td>
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<tr>
<td>The Indure Pvt Ltd. A/c Usha Martin Ltd.</td>
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<td>1</td>
<td>140</td>
<td>69</td>
<td>490</td>
<td>Washery rejects, char</td>
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<tr>
<td>Pronico, Guatemala</td>
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<td>Dangote Industries Ltd.</td>
<td>Nigeria</td>
<td>3</td>
<td>130</td>
<td>110</td>
<td>540</td>
<td>Nigerian Coal, South African Coal, LPFO</td>
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<tr>
<td>Dangote Industries Ltd.</td>
<td>Tanzania</td>
<td>3</td>
<td>110</td>
<td>110</td>
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<td>Dangote Industries Ltd.</td>
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<td>65</td>
<td>110</td>
<td>540</td>
<td>South African Coal, Zambian Coal</td>
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<td>89</td>
<td>520</td>
<td>Imported coal, Indian coal</td>
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<tr>
<td>JSW Energy Ltd.</td>
<td>Tarapur</td>
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<td>127</td>
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<td>520</td>
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</tr>
<tr>
<td>Nava Bharat Ferro Alloys Ltd.</td>
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<td>3</td>
<td>125</td>
<td>93</td>
<td>530</td>
<td>Coal</td>
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<tr>
<td>Nava Bharat Ventures Ltd.</td>
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<td>125</td>
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<td>Indian Coal</td>
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<td>West Coast Paper Mills Ltd.</td>
<td>Karnataka</td>
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<td>125</td>
<td>66</td>
<td>480</td>
<td>Coal</td>
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<tr>
<td>DCW</td>
<td>Tamil Nadu</td>
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<td>125</td>
<td>89</td>
<td>515</td>
<td>Imported coal, Indian coal</td>
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<tr>
<td>KJS Steel Ltd.</td>
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<td>120</td>
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<tr>
<td>Ankit Metals Ltd.</td>
<td>Raipur</td>
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<td>92</td>
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<tr>
<td>Madras Cement Ltd.</td>
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<td>110</td>
<td>89</td>
<td>515</td>
<td>Coal, pet coke, lignite</td>
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<td>Madras Cement Ltd.</td>
<td>Tamil Nadu</td>
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<td>80</td>
<td>89</td>
<td>515</td>
<td>Coal, pet coke, lignite</td>
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<td>Suryalakshmi Cotton Mills Ltd.</td>
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<td>112</td>
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<td>JK Cement Ltd.</td>
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<tr>
<td>Oswal Chemical &amp; Fertilizers Ltd.</td>
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<td>110</td>
<td>63</td>
<td>485</td>
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<tr>
<td>L&amp;T A/c Usha Martin</td>
<td>Jamshedpur</td>
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<td>66</td>
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<tr>
<td>Welspun Ltd.</td>
<td>Gujarat</td>
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<td>105</td>
<td>89</td>
<td>520</td>
<td>Lignite, Indian coal, Imported coal / pet coke</td>
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<tr>
<td>Jagdamba Power &amp; Alloys Ltd.</td>
<td>Chhattisgarh</td>
<td>1</td>
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<td>105</td>
<td>525</td>
<td>Indian coal, dolochar</td>
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<tr>
<td>Indure Power A/c Grace Inds. Ltd.</td>
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<td>1</td>
<td>100</td>
<td>67</td>
<td>490</td>
<td>F Grade coal/char/ coal fines</td>
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<tr>
<td>Gallant Metals Ltd. (Sagar Energy)</td>
<td>Gujarat</td>
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<td>100</td>
<td>105</td>
<td>540</td>
<td>Coal char, washery rejects</td>
</tr>
<tr>
<td>Sree Rayalseema Alkalis &amp; Allied Chemicals Ltd.</td>
<td>Andhra Pradesh</td>
<td>1</td>
<td>100</td>
<td>100</td>
<td>525</td>
<td>Coal</td>
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<tr>
<td>Khanna Papers Mills Ltd.</td>
<td>Punjab</td>
<td>1</td>
<td>100</td>
<td>66</td>
<td>500</td>
<td>Pet coke/Rajasthan Lignite/ Paper sludge &amp; plastic waste</td>
</tr>
<tr>
<td>BMM Ispat Ltd.</td>
<td>Karnataka</td>
<td>1</td>
<td>95</td>
<td>108</td>
<td>535</td>
<td>Coal</td>
</tr>
<tr>
<td>L&amp;T</td>
<td>Maharashtra</td>
<td>2</td>
<td>95</td>
<td>66</td>
<td>495</td>
<td>Coal/Washery Middlings</td>
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<tr>
<td>Tamilnadu Newsprint &amp; Papers Ltd.</td>
<td>Tamil Nadu</td>
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<td>90</td>
<td>105</td>
<td>530</td>
<td>Imported Coal + Bagasse Pith + ETP Sludge</td>
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<tr>
<td>ITC Ltd.</td>
<td>Tamil Nadu</td>
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<td>65</td>
<td>480</td>
<td>F Grade coal / biomass</td>
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<tr>
<td>Arasmeta Power Company Ltd.</td>
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<td>Coal</td>
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<tr>
<td>GHCL</td>
<td>Gujarat</td>
<td>1</td>
<td>90</td>
<td>105</td>
<td>505</td>
<td>Lignite/Coal</td>
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<tr>
<td>JK Cement Ltd.</td>
<td>Rajasthan</td>
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<tr>
<td>Crescent Power</td>
<td>West Bengal</td>
<td>2</td>
<td>88</td>
<td>89</td>
<td>515</td>
<td>Washery rejects</td>
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<tr>
<td>Predominant A/c Trimula Inds Ltd.</td>
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<td>66</td>
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<td>Indian coal / Char</td>
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<tr>
<td>Crest Steel &amp; Power Pvt. Ltd.</td>
<td>Chhattisgarh</td>
<td>2</td>
<td>80</td>
<td>67</td>
<td>495</td>
<td>Washery Rejects + Char + Indian Coal</td>
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<tr>
<td>Topworth Urja &amp; Metals Ltd.</td>
<td>Maharashtra</td>
<td>2</td>
<td>80</td>
<td>67</td>
<td>495</td>
<td>Washery Rejects + Char + Indian Coal</td>
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<tr>
<td>Chettinad Cement Corporation Ltd.</td>
<td>Tamil Nadu</td>
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<td>68</td>
<td>89</td>
<td>515</td>
<td>Coal</td>
</tr>
<tr>
<td>Nestle Russia Ltd.</td>
<td>Russia</td>
<td>1</td>
<td>18</td>
<td>22</td>
<td>D&amp;S</td>
<td>Spent Coffee Ground/ Natural Gas &amp; Diesel</td>
</tr>
<tr>
<td>Nestle Philippines Inc.</td>
<td>Philippines</td>
<td>1</td>
<td>25</td>
<td>18</td>
<td>Sat.</td>
<td>Spent Coffee Ground, Green Coffee Residue, Roasted Chaffs &amp; HFO</td>
</tr>
</tbody>
</table>

*Thermax supplied boiler in a wide range of capacity from 6 TPH to 175 TPH, pressure from 9 to 112 Kg/cm²(g) & temperature from 209 to 540 Deg C. Thermax has capability to burn any type of unconventional fuels like coffee husk, deoiled powder of activated earth, effluent slurry, jullia flora, wood chips, mustard, stalk, gram stalk, saw dust, coconut shell, ground nut shell etc.*
Other products offered by B & H Solid Fuel

**Solid Fuels, Agro-wastes, Biomass**

<table>
<thead>
<tr>
<th>Circulating Fluidized Bed Combustion Boiler (CFBC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- <strong>Capacity:</strong> Up to 1000 TPH</td>
</tr>
<tr>
<td>- <strong>Pressure:</strong> Up to 200 bar (g)</td>
</tr>
<tr>
<td>- <strong>Temperature:</strong> Up to 560°C</td>
</tr>
<tr>
<td>- <strong>Fuels:</strong> High-ash/low ash coal, high-sulphur coal, mill rejects, washery rejects, lignite, pet-coke, sludge, oil pitches, agro-wastes, biomass etc.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Biomass Boiler (Travelling grate, Dumping grate, Pinhole grate, Pusher grate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- <strong>Capacity:</strong> Up to 300 TPH</td>
</tr>
<tr>
<td>- <strong>Pressure:</strong> Up to 160 bar (g)</td>
</tr>
<tr>
<td>- <strong>Temperature:</strong> Up to 560°C</td>
</tr>
<tr>
<td>- <strong>Fuels:</strong> Bagasse, rice husk, straw, coffee grounds, coconut shells, lignite, coal, pith, jula flora oil, mustard husk, wood chips, paper sludge, biogas etc.</td>
</tr>
</tbody>
</table>

**Waste to Energy**

<table>
<thead>
<tr>
<th>Spent Wash (Vinasse) Fired Boiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>- <strong>Capacity:</strong> Up to 75 TPH, <strong>Pressure:</strong> Up to 66 bar (g), <strong>Temp:</strong> Up to 480°C</td>
</tr>
<tr>
<td>- <strong>Support Fuels:</strong> High ash, coal, imported coal, bagasse</td>
</tr>
<tr>
<td>- <strong>Washery rejects fired</strong> in AFBC &amp; CFBC boilers</td>
</tr>
<tr>
<td>- <strong>Petcoke fired</strong> in AFBC &amp; CFBC boilers</td>
</tr>
</tbody>
</table>

**Municipal Solid Waste / Refused Derived Fuels**

The MSW/RDF fired boiler technology draws from Thermax’s innovative tradition and experience with firing various non-conventional fuels including agro-wastes, spent-wash, sludge and other industrial wastes, and a variety of biomass.

**Product Features**

- Specially designed furnace to ensure complete combustion and automated soot removal system
- Positive movement of fuel over the grate minimises clinkering and blockages
- Hydraulic ram feeder provided considering fuel size variation
- Ram feeding system ensures uniform distribution of fuel onto the grate
- Specially designed pusher grate to handle wide variation in fuel type, moisture and particle size; special grate and air plenum sections provided to ensure better distribution/control
- No rotating parts, hence enhanced life and robust construction
Other Products offered by B & H

**Oil & Gas**
- Ranging in capacities upto 500 TPH, 160 kg/cm²(g), 560°C
- Bi-Drum Packaged/Site Erected Boiler (FM/HCFM/PFM)
- Singe-Drum High-Capacity Boiler ("Radiant" Boiler)
- Heat Recovery Steam Generator (HRSG)
- Waste Heat Recovery Unit (WHRU)

**Lean Gas Fired Boiler**
- Ranging in capacities upto 500 TPH, 160 kg/cm²(g), 560°C
- Blast Furnace Gas, Coke Oven Gas, Corex Gas Fired Boiler
- CO/H₂ Gas Fired Boiler

**Fired Heater**
- Vertical, Cylindrical or box type heaters upto 140 MM Kcal/hr capacity
- Chemical & Petrochemical
- Upstream Oil & Gas
- Refinery

**Waste Heat Recovery Boiler (WHRB)**
- Ranging in capacities upto 500 TPH, 160 kg/cm²(g), 560°C
- Sponge Iron
- Coke Oven
- Non Ferrous (Copper Smelter/Zinc Smelter etc)
- Refinery and Petrochemical
- Cement
- Chemical
- Sulphur Recovery
- Exhaust Gas Boiler
- Hydrogen Plant
- Glass Furnace
- Coal Gasification
- Coke Calcination

**Services**
- Condition Assessment and Remaining Life Analysis and Engineering Studies
- Fuel Conversion and Firing System Upgrade
- Performance Enhancement Solutions
- Pressure Part Replacements and Upgrades
- Utility Boiler Revamps
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