Boiler Construction, Pressure Parts & Drum Internals
Objectives and other details of modules

Duration – 75 minutes

Training aids
Power point Presentations
Reading Material

Objective

At the end of the session participants will be able to:

- Describe essential parts of boiler and their functions
- List out design criteria of various pressure parts and furnace, material of construction
- Detail out of steam separation principles, drum and its function
- Distinguish between boilers for subcritical and supercritical units
Pressure Parts arrangement
This closeness in size reflects the fact that a coal-fired unit has to be designed to prevent excessive slagging, whereas an oil-fired unit has to take into account, as a primary sizing factor, its furnace tube-wall integrity.
Important design considerations for the proper sizing of the furnace include **Net-heat-input-to-plan-area (NHI/PA) release rate.** As the rank of coal decreases, furnaces increase in plan area and vertical height from the top fuel nozzle to the furnace arch. The NHI/PAs range from \((1.6 \times 10^9 \text{ J/hr-929 cm}^2)\) for severe slagging coals, through \((2.2 \times 10^9 \text{ J/hr-929 cm}^2)\) for low slagging coals.

**Distance from the upper fuel nozzle level to the furnace exit.** Sufficient furnace dimensions, including adequate height between the top row of burners and the furnace exit, must be used to obtain the proper retention time for the combustion.

**Furnace exit gas temperature (FEGT).** Sufficient waterwall heat transfer surface is necessary to allow sufficient cooling of the combustion gas so that the fly ash is solidified before it enters the first pendant tube bank. This will minimize deposition and fouling of the pendant tube banks.

The **velocity of the flue gas** must not exceed specified limits in order to control erosion from the ash in the coal. Depending on the ash analysis and quantity, the velocity is generally limited to \((18.3 \text{ to } 21.3 \text{ m/s})\).
500MW construction details

SH PLATEN
assy = 25
ELE = 400
St = 752
Sl = 60.3
OD = 51.0

RH PLATEN
assy = 74
ELE = 888
St = 254
Sl = 63.5
OD = 54.0

RH FINAL
assy = 74
ELE = 888
St = 254
Sl = 90.0
OD = 54.0

LTSH Terminal
assy = 124
ELE = 744
St = 304.8
Sl = 95
OD = 44.5

SH PANELETTE
assy = 48
ELE = 432
St = 3048
Sl = 54
OD = 44.5

LTSH
assy = 124
ELE = 744
St = 152.4
Sl = 95
OD = 44.5

ECOMISER
assy = 184
ELE = 552
St = 103
Sl = 76.2
OD = 38.1

F.D = 15797
F.W = 19177

13259
Boiler materials Consideration

The primary consideration in material choice is a function of expected tube temperature of operation.

Economizers and water wall sections are usually constructed with a mild or medium carbon steel, whereas

low alloy ferritic steels are used for most super heater and re heater sections, with austenitic stainless steels specified for the highest-temperature circuits or corrosion performance.

Alloys for use as boiler tube materials in the United States are identified by an ASME designation (SA-xxx) or an essentially equivalent
<table>
<thead>
<tr>
<th>Class of Material</th>
<th>Typical Alloy Designations</th>
<th>General Properties</th>
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<tbody>
<tr>
<td></td>
<td>SA-192: Seamless carbon-silicon steel</td>
<td>Mild corrosion resistance.</td>
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<tr>
<td></td>
<td>SA-210: Seamless carbon-silicon steel</td>
<td>Moderate strength up to 1000°F (538°C).</td>
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<tr>
<td>Carbon-molybdenum steel</td>
<td>SA-209-T1, T1a, and T1b: Seamless carbon-1/2 molybdenum steel</td>
<td>Greater creep strength than carbon steels.</td>
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<td></td>
<td>SA-250-T1: Welded carbon - 1/2 molybdenum steel</td>
<td>Susceptible to graphitization with prolonged exposure above 875°F (468°C).</td>
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<tr>
<td>Chromium-molybdenum steel</td>
<td>SA-213-T2: Seamless 1/2 chromium - 1/2 molybdenum steel</td>
<td>Most common boiler tube materials (particularly T22 and T11).</td>
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<tr>
<td></td>
<td>SA-213-T12: Seamless 1 Cr - 1/2 Mo steel</td>
<td>Each increase in Cr content yields improved properties, particularly higher strength</td>
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<tr>
<td></td>
<td>SA-213-T11: Seamless 1-1/4 Cr - 1 Mo steel</td>
<td>creep properties, and improved corrosion resistance.</td>
</tr>
<tr>
<td></td>
<td>SA-213-T22: Seamless 2-1/4 Cr - 1 Mo steel</td>
<td>Resistant to graphitization.</td>
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<td></td>
<td>SA-213-T21: Seamless 3 Cr - 1/2 Mo steel</td>
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<td>SA-213-T5: Seamless 5 Cr - 1/2 Mo steel</td>
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<td>SA-213-T5b: Seamless 5 Cr - 1/2 Mo steel</td>
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<td>SA-213-T5c: Seamless 5 Cr - 1/2 Mo steel</td>
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<td>SA-213-T7: Seamless 7 Cr - 1/2 Mo steel</td>
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<td></td>
<td>SA-213-T9: Seamless 9 Cr - 1 Mo steel</td>
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</tr>
<tr>
<td></td>
<td>SA-213-T91: Seamless 9 Cr - 1 Mo steel</td>
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<tr>
<td></td>
<td>1/2 V-X(Cb/N/Ni/Al) steel</td>
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Boiler drum and steam separation
Steam Separation

(a) Simple Natural or Thermal Circulation Loop

(b) Simple Forced or Pumped Circulation Loop
Boiler steam water schemes
Heat Transfer in a pipe

![Diagram of heat transfer in a pipe showing fluid at different temperatures and boundary layers with thermal resistances R1 to R4 leading to ambient temperature T5.](image-url)
Common Circulation systems

(a) Natural Recirculation
(b) Forced Recirculation
(c) Once-Through
(d) Once-Through with Part-Load Recirculation
Boiler Drum and internals
Drum design criteria

\[ t = \frac{PR}{SE - 0.6P} \]

- \( t \) = minimum required wall thickness, in.
- \( P \) = internal design pressure, psi
- \( R \) = inside radius, in.
- \( S \) = allowable stress at design temperature, psi (Section II, Part D) = 20,000 psi
- \( E \) = lower of weld joint efficiency or ligament efficiency (fully radiographed with manual penetrations) = 1.0
Steam Drum and separators

- Scrubber Elements (Secondary)
- Cyclone Separators (Primary)
- Steam Outlet Connection
- Manifold Baffle Plates
- Downcomer Inlet
- Feed Pipes