

Engineering Thermodynamics – ME 302

Steam Power Plant

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Arrangement

- mechanical power is produced by a heat engine that transforms thermal energy (from combustion of a fuel) into rotational energy
- heat (generated in the furnace) is transmitted to the boiler where water forced into the boiler by the feed pump is converted into steam

Arrangement

- steam drives turbine blades —————> shaft

Efficiency

- the efficiency of a steam turbine is limited by the maximum temperature of the steam produced and is not directly a function of the fuel used (for the same steam conditions, coal, nuclear and gas power plants all have the same theoretical efficiency)

Keywords

- Operating pressure
- Boiler efficiency
- Steaming hours
- Heating surface
- Generating surface
- Superheated steam

Basic Glossary

- **Operating pressure** – the pressure at which the boiler is operated in service
- **Boiler efficiency** -the ratio between the thermal energy actually absorbed by water and the thermal energy available in fuel (80 – 90 %)

Basic Glossary

- **Steaming hours** -the time during which the boiler generates steam
- **Heating surface** -the total surface of all parts exposed to combustion gases (tubes, superheater, economiser)

Basic Glossary

- **Generating surface** - a part of the surface in which water is heated and steam is generated (tubes, drum)
- **Superheated steam** = saturated steam + more heat at constant pressure → dry steam (to avoid damage to turbine blades)

Main Elements of SPP

- FURNACE
- BOILER
- SUPERHEATER
- TURBINE
- CONDENSER

Furnace

- a chamber in which heat is produced – combustion of fuel & generation of hot gases
- burners – break oil into fine particles to ensure efficient combustion

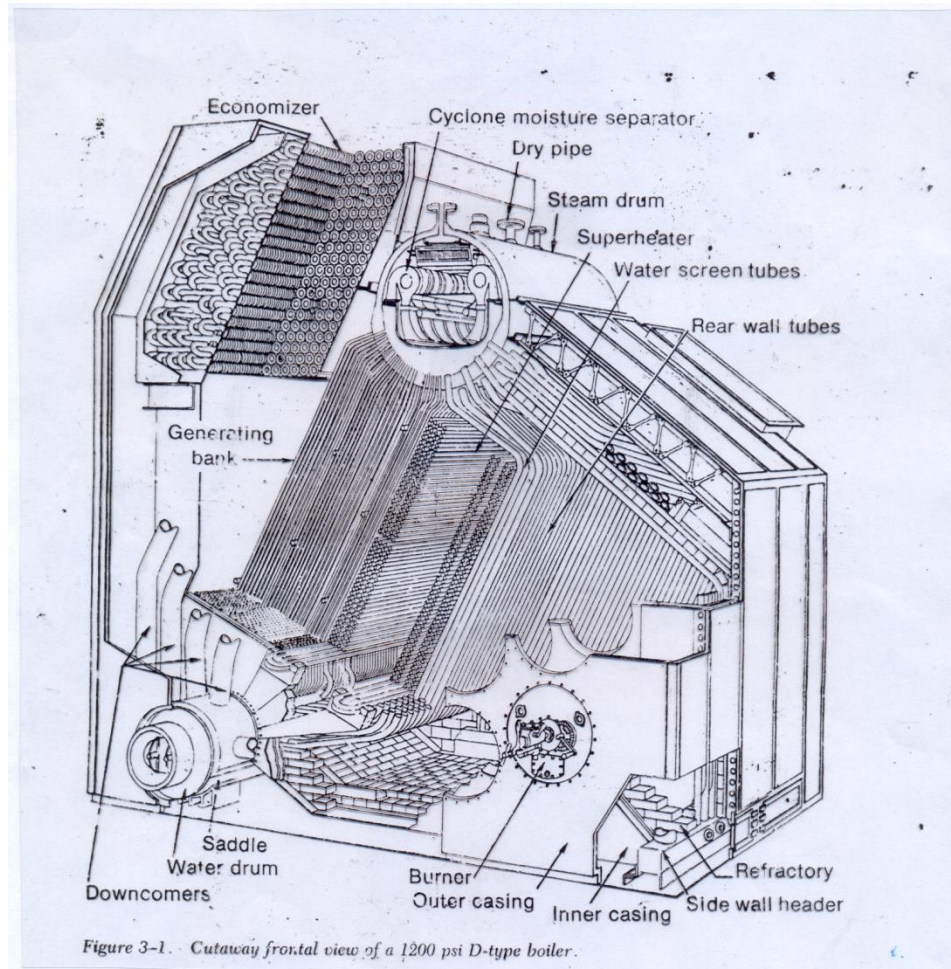
Boiler

- steam generator – saturated & superheated steam
- steam drum - a reservoir of water/steam at the top end of the water tubes, it stores the steam generated in the water tubes and acts as a separator for the steam/water mixture (difference in densities)
- water circulation – natural or forced

Boiler

- watertube boiler
- firetube boiler

Boiler



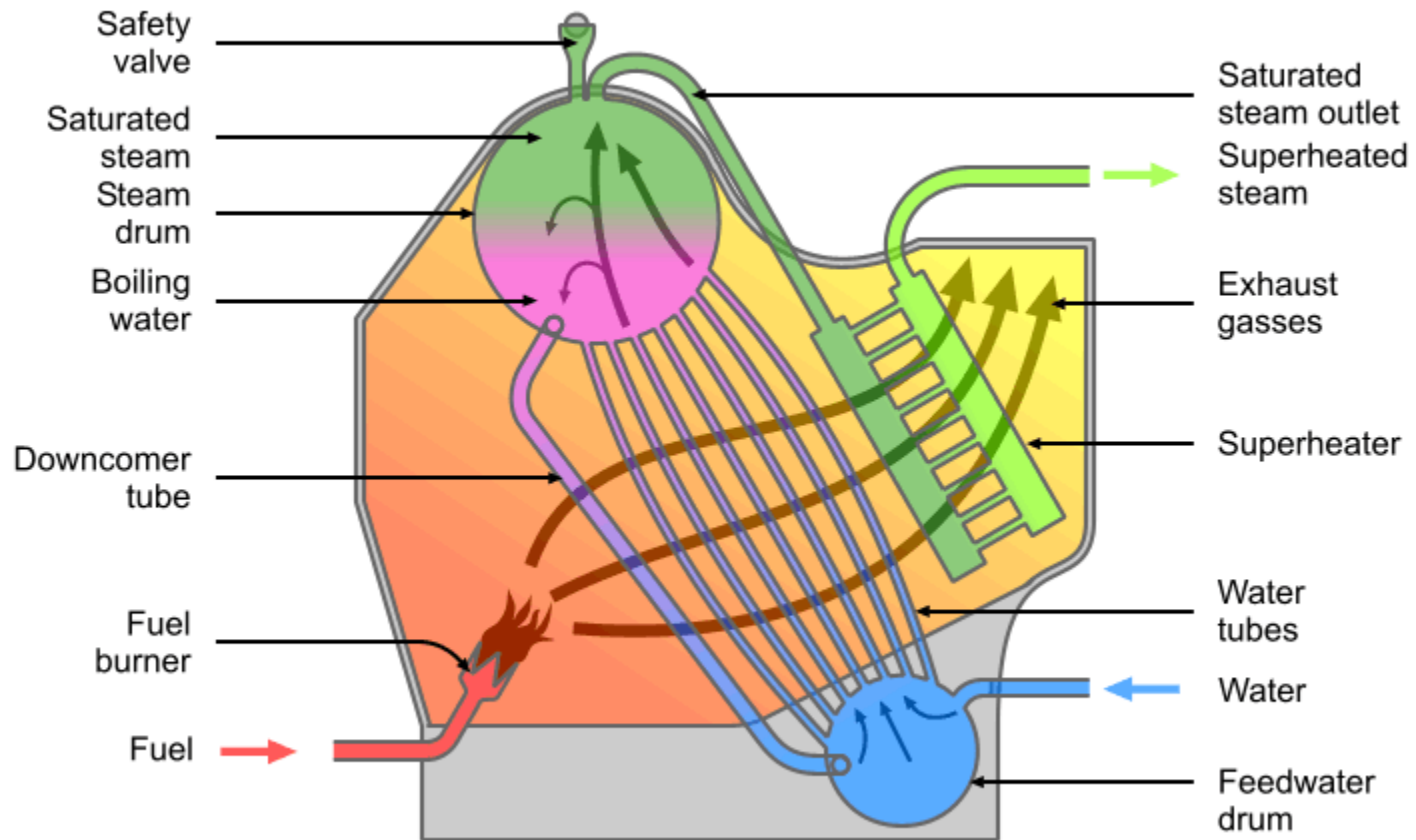
Fire Tube Boiler

- hot gases pass through the tubes, feed water surrounds them

Water Tube Boiler

- steam and water circulate through drums and small diameter tubes, gases of combustion pass around them
- more commonly used, lighter, occupies less space and has increased efficiency (higher pressure and temperature)

Water tube Boiler



Water Tube Boiler

- main boiler
- donkey (auxiliary) boiler
- low, intermediate, high pressure b.
- single-drum b., two-drum b., three-drum b.
- vertical b., horizontal b.
- single-flow b., double-flow b.

Superheater

- consists of headers and superheater tubes
- converts saturated steam into dry steam

Turbine

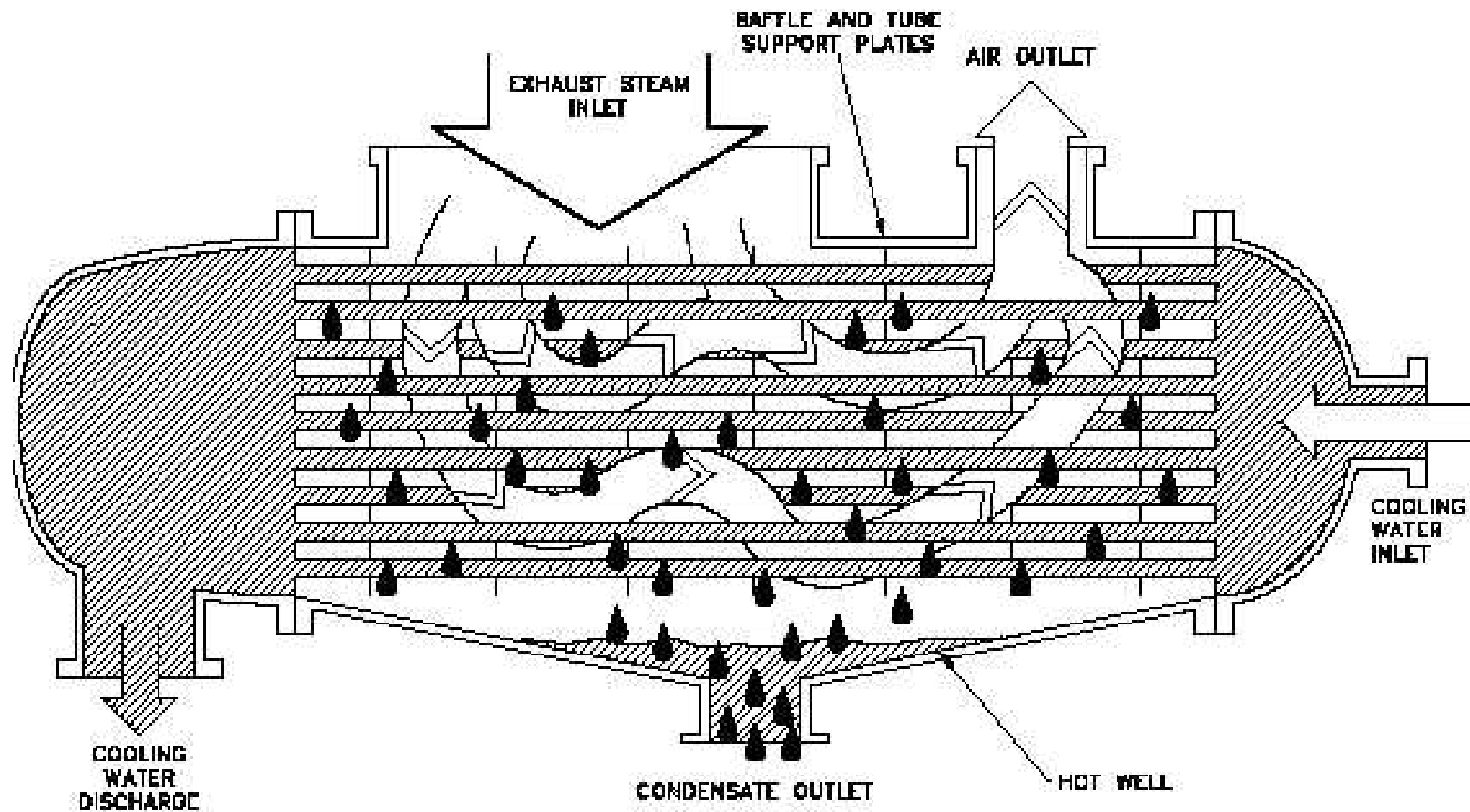
- steam is admitted to the turbine
- heat energy is converted into mechanical energy – useful work
- high pressure turbine
- low pressure turbine

Condenser

heat exchanger

- tubes → sea water
- steam → water (condensate)
- vacuum is created due to steam / condensate volume difference
- vacuum is maintained by constant cool water circulation through the tubes

Condenser



Auxiliaries

- CONDENSATE – COLLECTING TANK (HOTWELL)
- MAIN CONDENSATE PUMP
- AIR EJECTOR
- DEAERATING FEED TANK
- MAKE UP TANK (EMERGENCY FEED TANK)
- FEED PUMP
- FEED HEATER
- ECONOMISER

Main Condensate Pump

- condensate – collecting tank (hotwell)
- Main Condensate Pump
- to pump water from the hotwell through the main air ejector to the deaerating feed tank

Air Ejector

- no moving parts
- jet pump
- Bernoulli's principle
- to remove air and gases from the condensate

Economiser

- to improve the efficiency of the steam plant by using thermal energy, i.e. preheating the feedwater before it passes into the boiler
- water is heated under pressure to remove dissolved air and vapour to minimize internal boiler corrosion

THANK YOU!