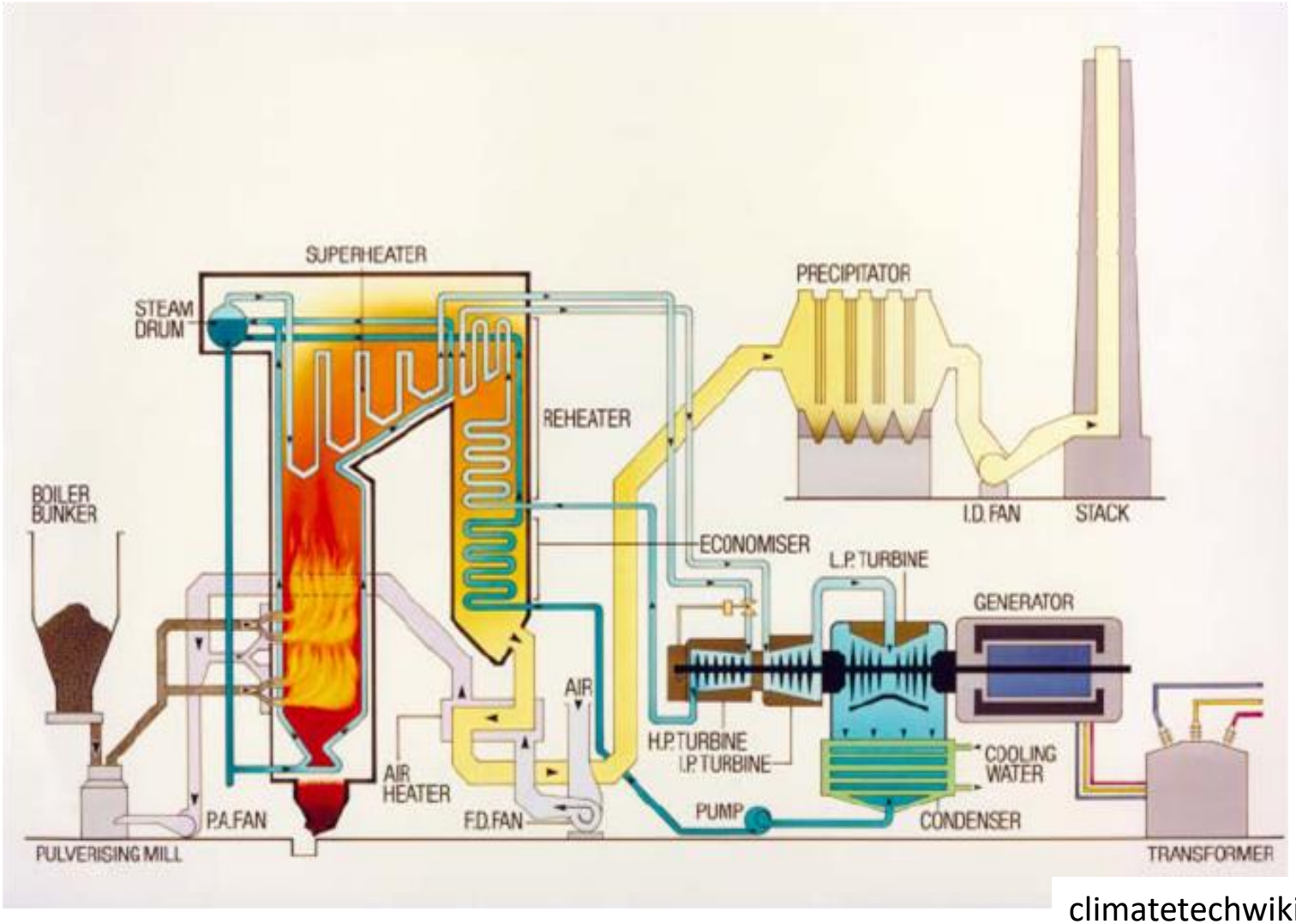
Technological circuits of thermal power plants

Lay out scheme of coal power plant



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- Coal and ash circuit
- Air and gas circuit
- Feed water and steam circuit
- Cooling water circuit

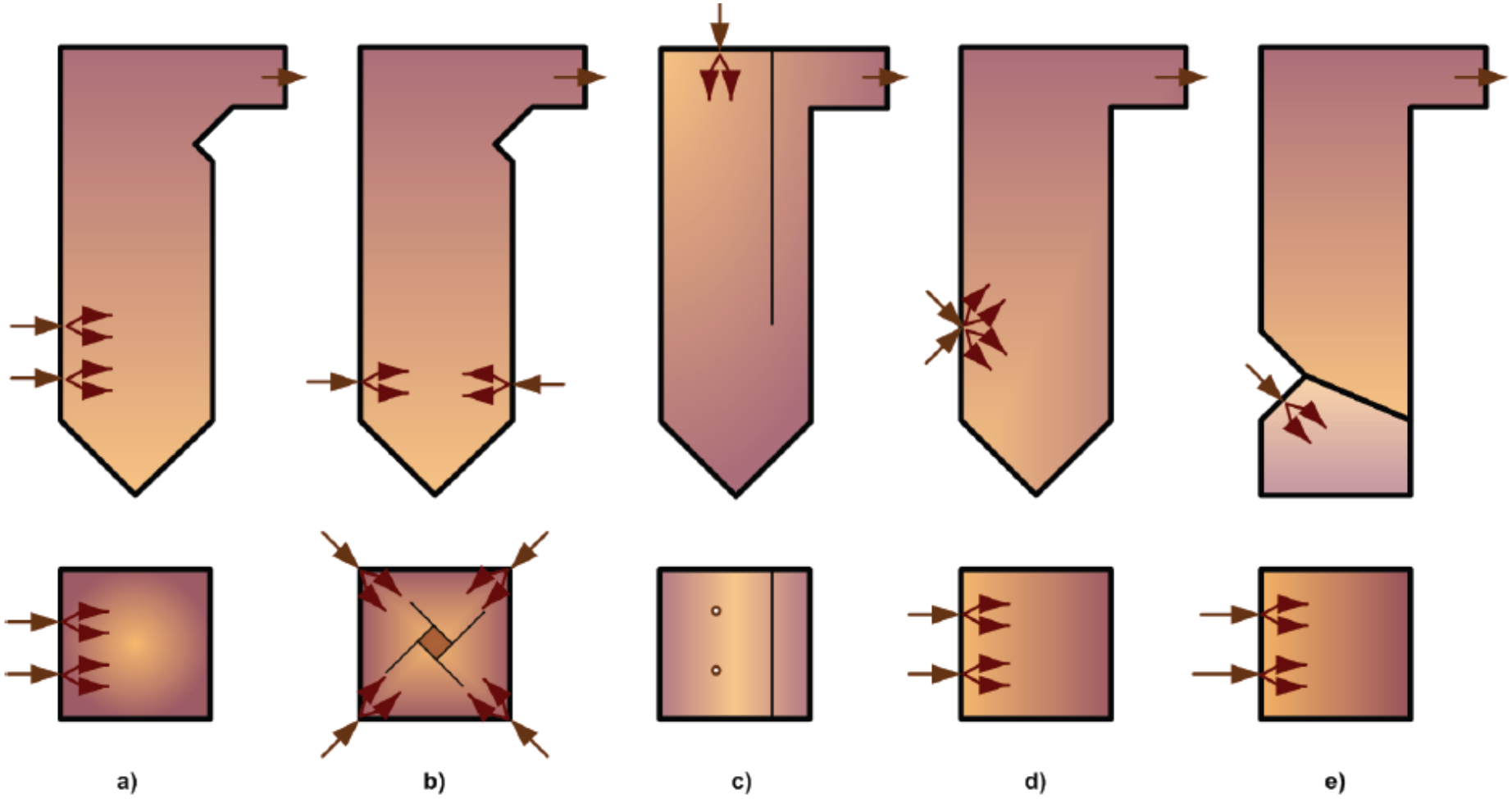
Coal circuit

- Coal
  - Lignite – youngest brown coal, energy value circa 10-20 MJ/kg
  - Brown coal – energy value 15-20 MJ/kg (sulfur content 0,5-4,5%, ash content 30-45%)
  - Black coal – energy value 18-30 MJ/kg
  - Anthracite – best quality coal, energy value 26-30MJ/kg

Coal circuit - boilers

- Boilers with grate furnace
  - Moving grate
  - Worst coal burning on grate
  - Rocking grate bars
- Pulverized boilers
  - Combustion of coal dust fueled by compressed air into the furnace, coal dust and compressed air are mixtured in burners
  - Better coal burning, wide control range (min power 30% of rated power)
  - Necessary coal milling
  - Higher requirements to fly ash separation

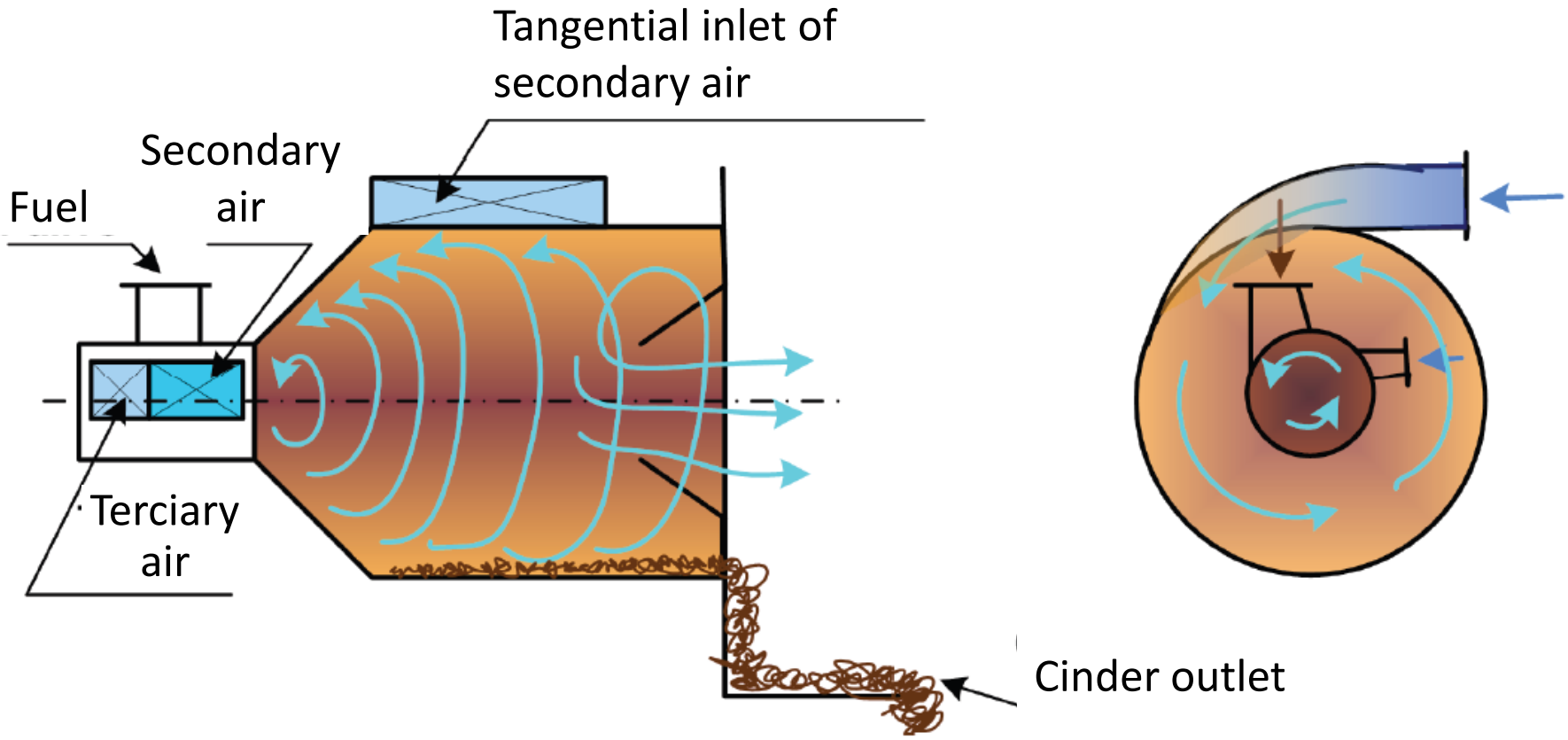
Coal circuit – burners configurations



Coal circuit - boilers

- Cyclone furnace
  - Vortex field -> high speed between air and burned grain
  - Combustion of a low quality fuel
  - Combustion of coarse-grained fuel -> saving of milling work
  - Vertical or horizontal arrangement

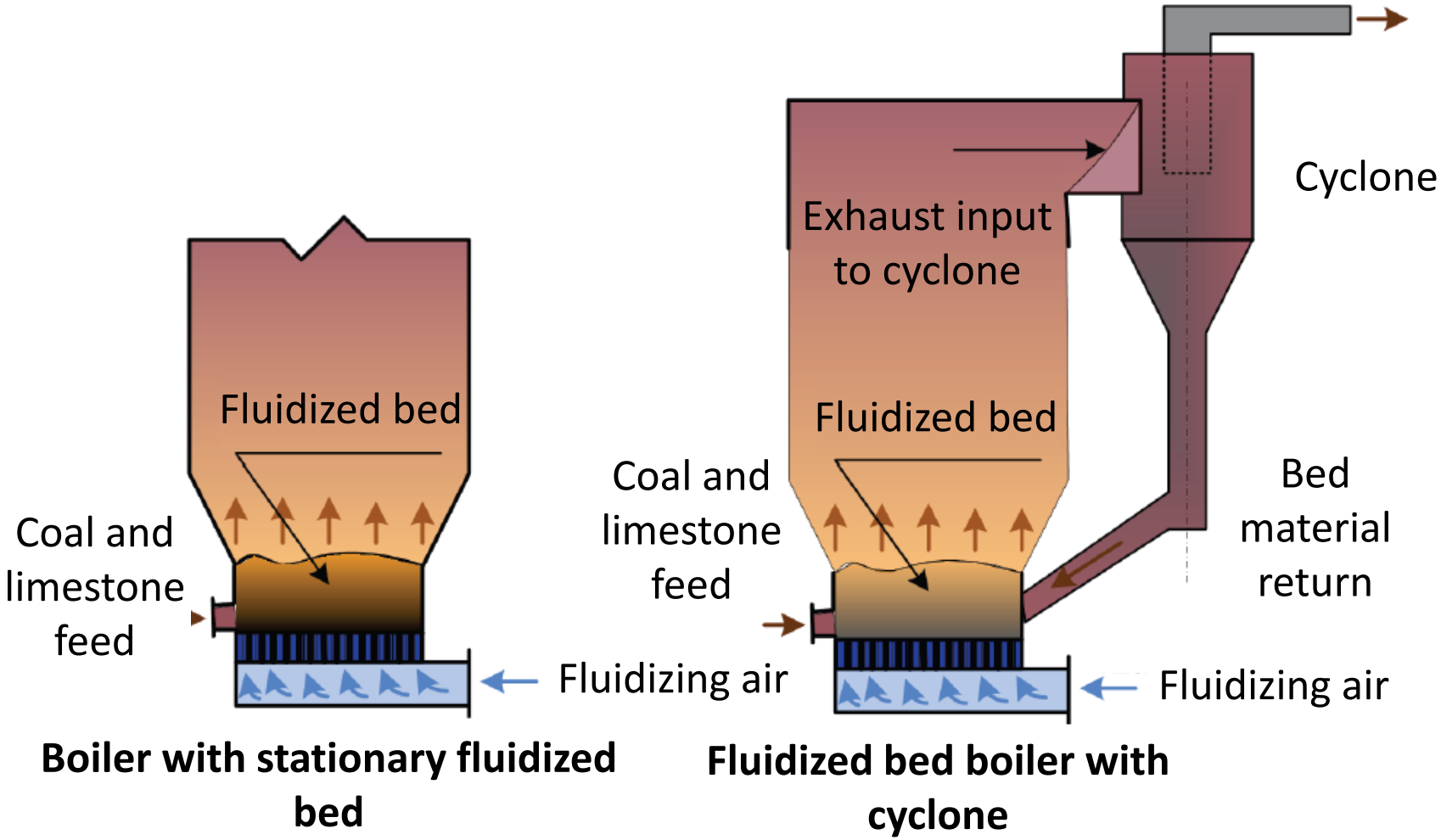
Coal circuit - boilers



Coal circuit - boilers

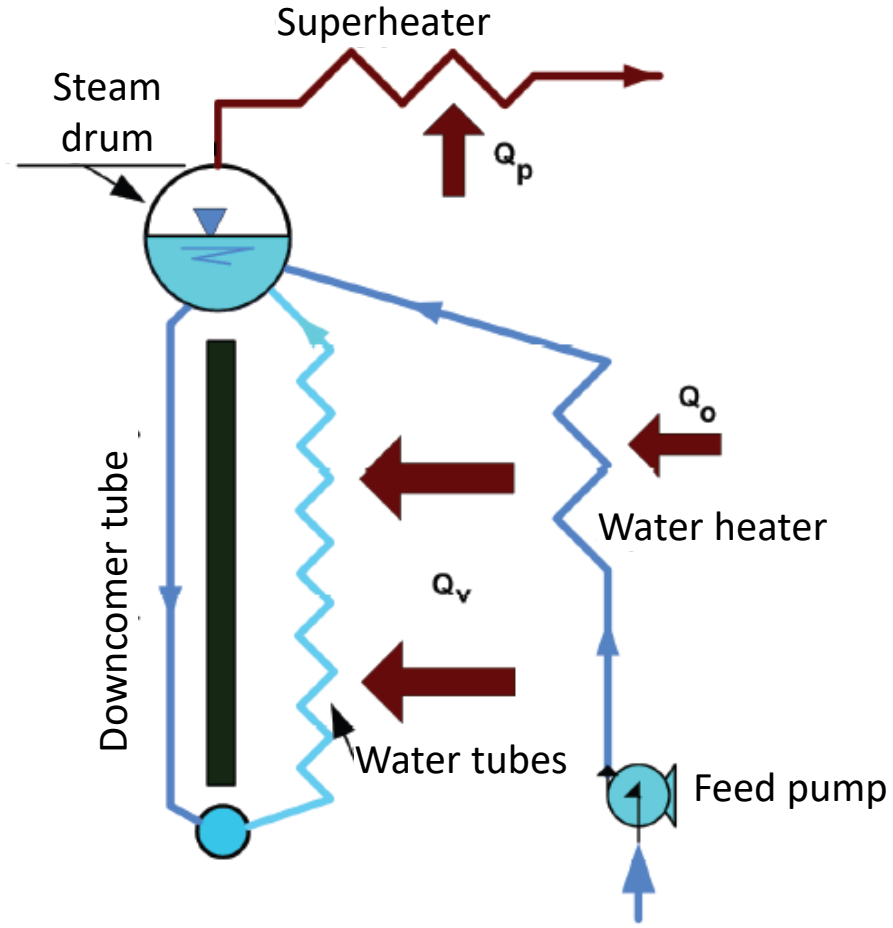
- Fluidized bed combustion
  - Combustion of grained fuel in fluidized bed which is created by vertically jets of air
  - Gradually burning grains of fuel get into higher layers, in the final phase they are carried out by a flow of exhaust out from a furnance
  - Combustion of fuel with low energy value, SO_x caption by adding of crushed limestone, lower NOx production due to lower temperature

Coal circuit - boilers



Feed water and steam circuit

- Steam drum boiler

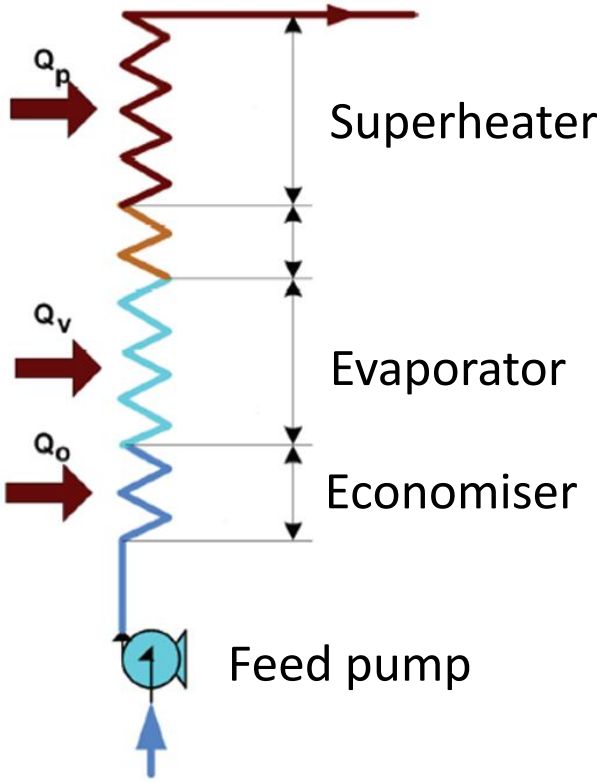


Feed water and steam circuit

- Steam drum is a gravitational water and saturated steam separator
- Natural water circulation is caused by density difference of heated water in water tubes and nonheated water in downcomer tubes
- High hot water accumulation inside a steam drum improve control possibilities of boiler, the higher mass flow can be delivered for a short while than it would correspond to the instantaneous boiler output

Feed water and steam circuit

- High pressure boiler (Benson)

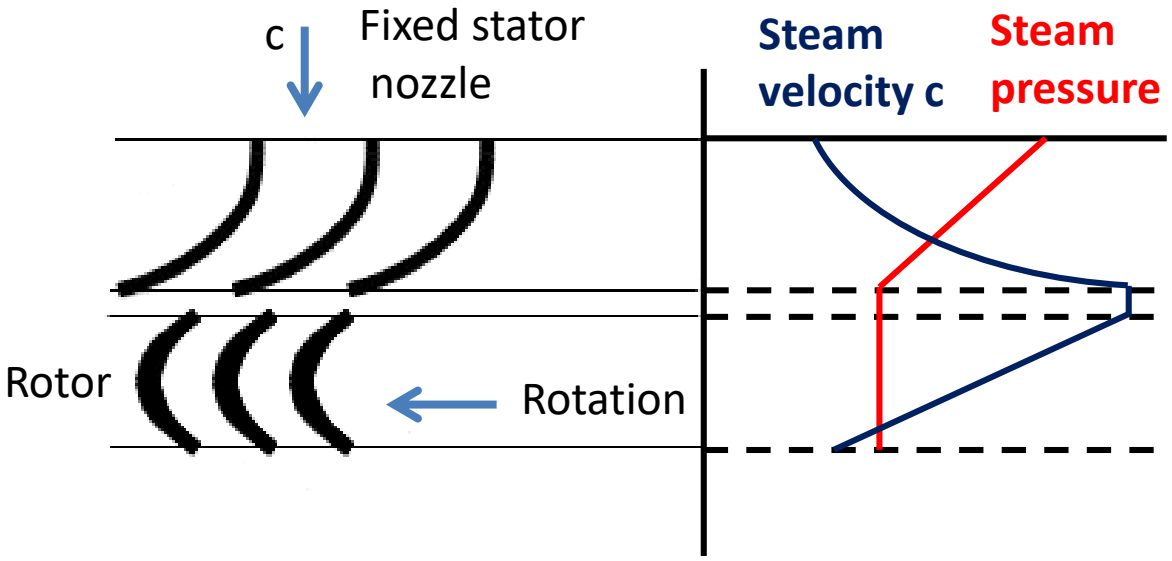


Feed water and steam circuit

- Water flow is given by output pressure of feed pump
- There are no fixed borders between heating, evaporating and superheating parts of boiler
- Control of high pressure boiler is more difficult due to the low accumulation ability (faster starting and shutting down the boiler)

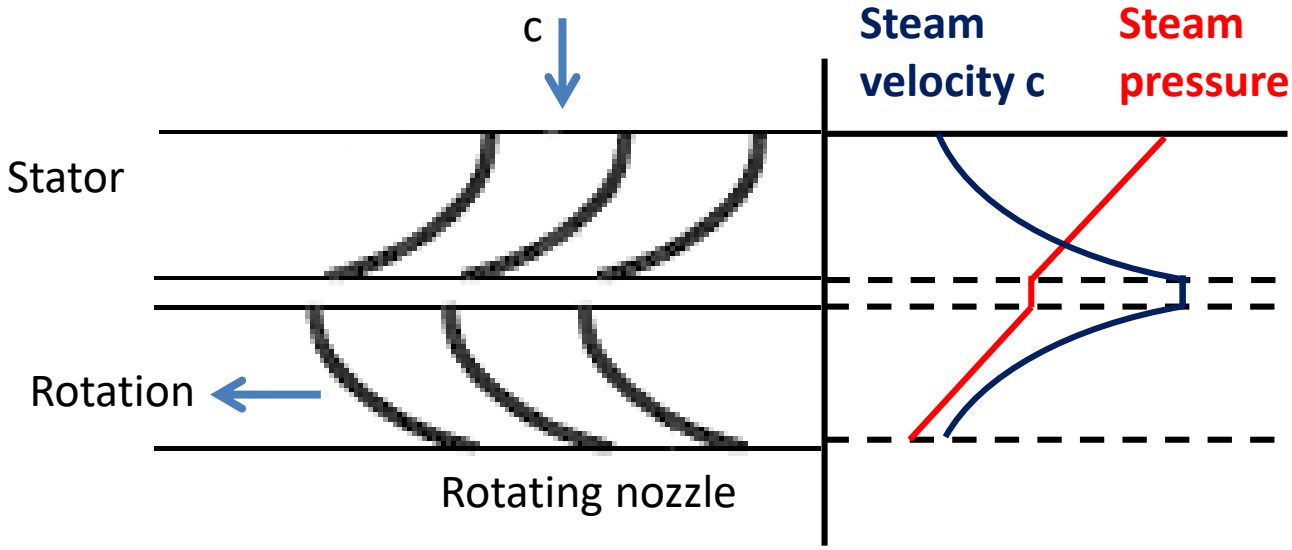
Steam turbines

- Impulse turbines
  - Steam expansion occurs in stator nozzles and all hydraulic energy is converted into kinetic energy



Steam turbines

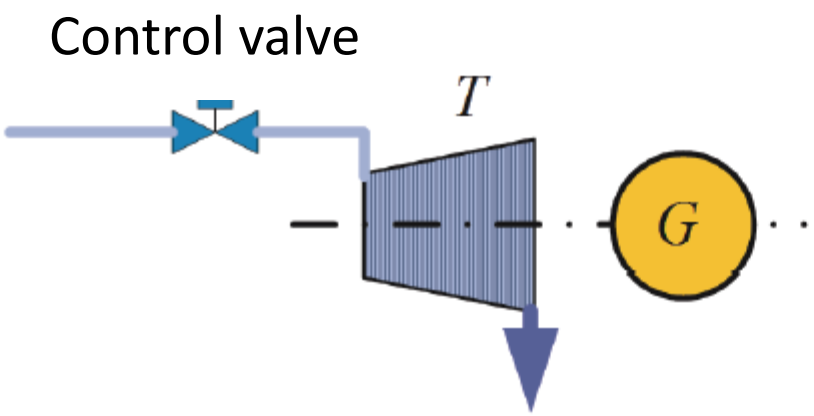
- Reaction turbine
  - Steam expansion occurs in both stator and rotor nozzles

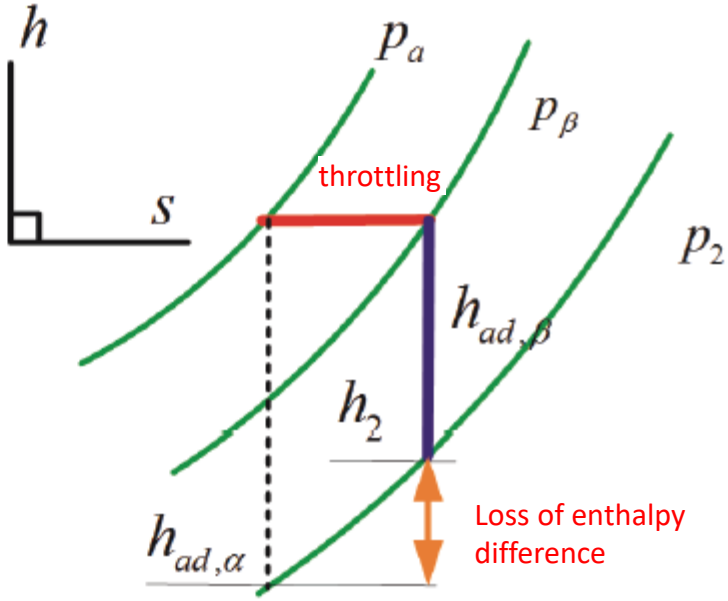


Steam turbines

Steam turbine governing

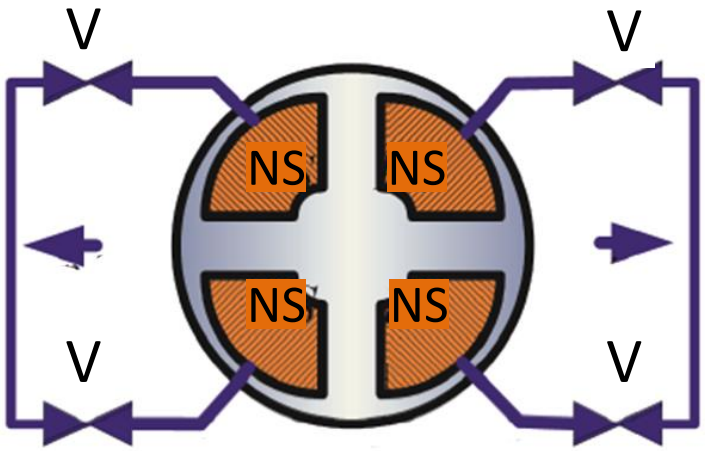
- Throttle governing
  - The pressure is reduced at the turbine input – loss of energy

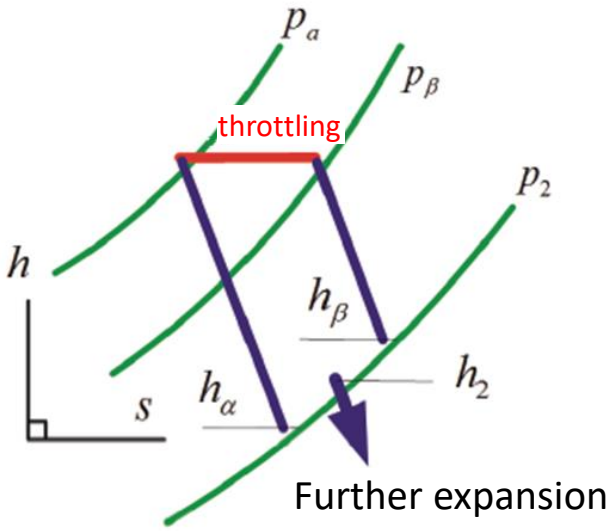




Steam turbine governing

- Nozzle governing
  - The steam is regulated by opening or closing of sets of nozzles

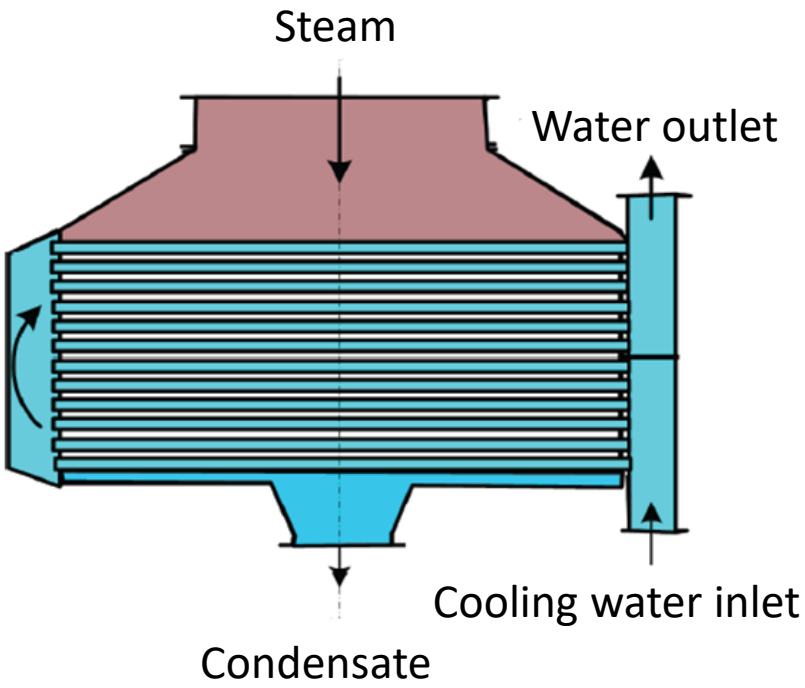


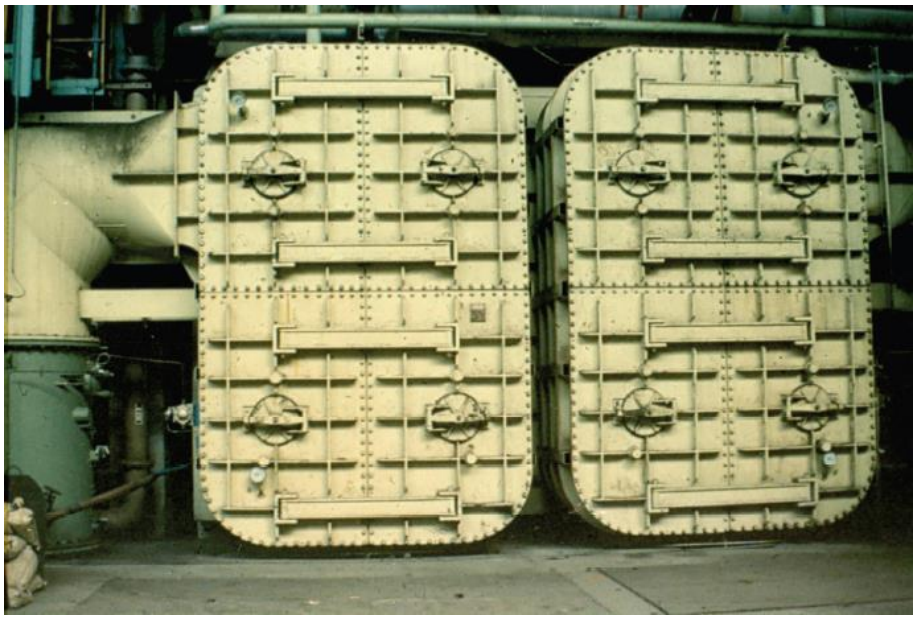


V …. Valves
NS … Nozzle sets

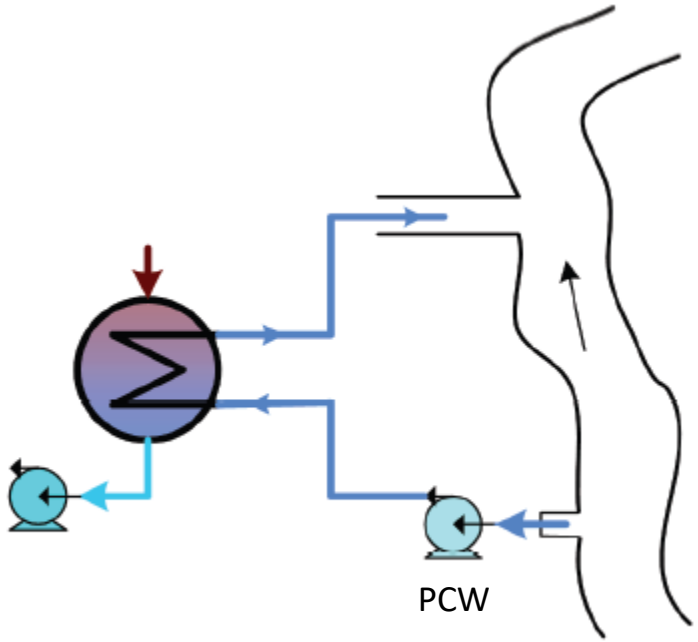
Cooling water circuit

- Condenser

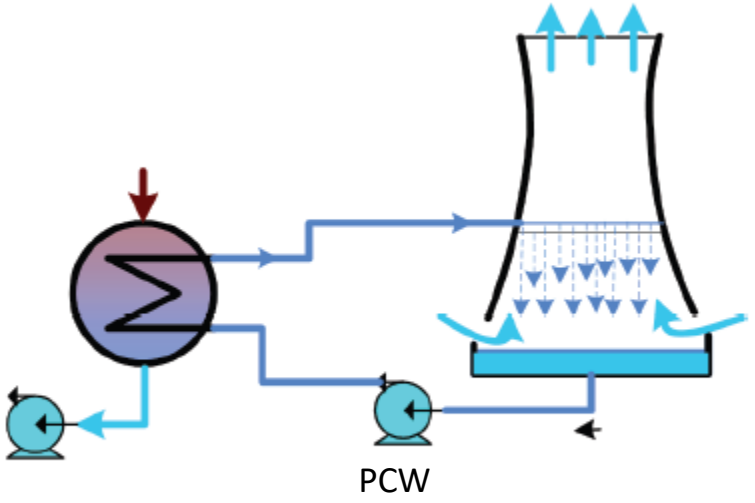




Cooling water circuit



Once-through cooling system



Recirculating cooling system

PCW – Pump of cooling water