Combustion Methods and Systems

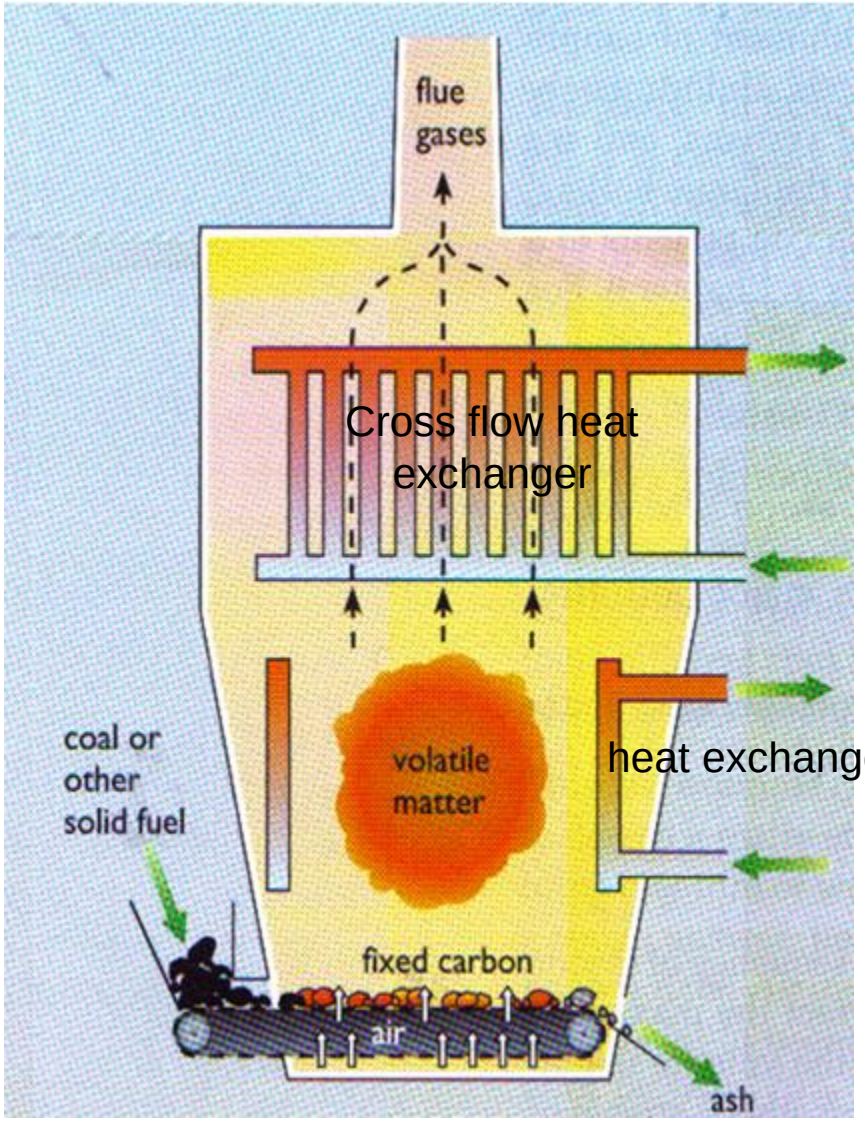
Solid-Fired System

Liquid-Fired System

Gas-Fired System

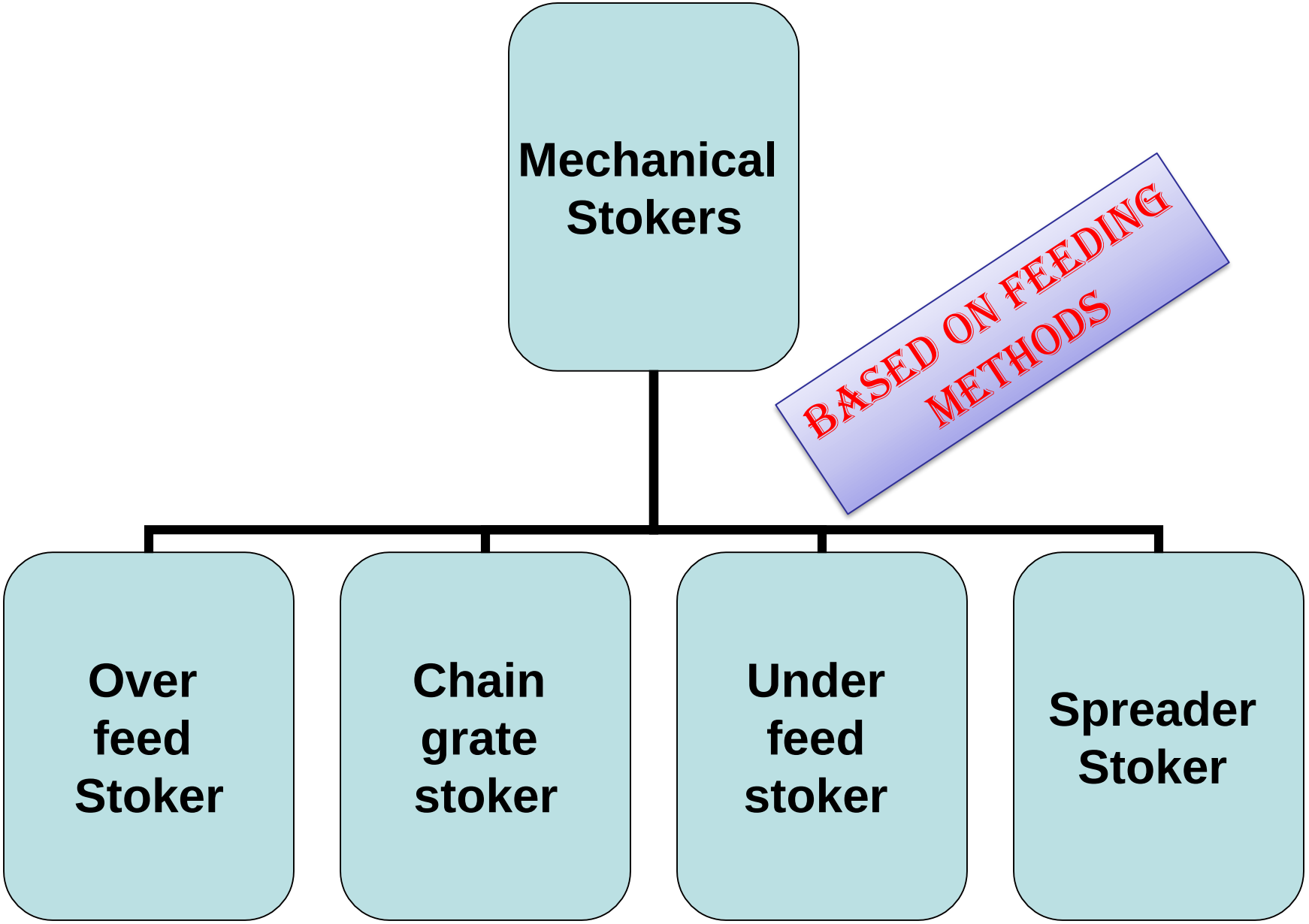
Power Station Boilers
Solid Fuel

Mechanical Stoker; Grate Boiler



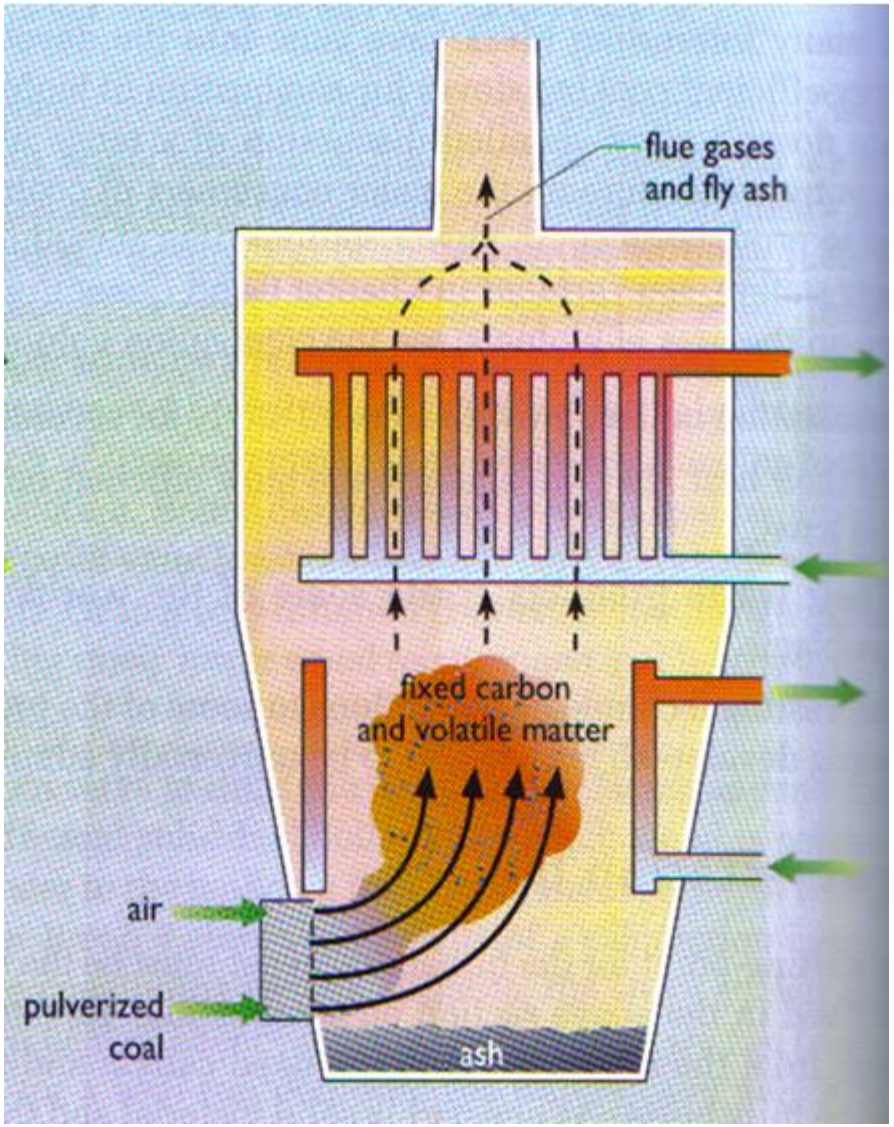
Air-feed: either cross flow or counter current

Vibration is used to remove ash


Mechanical Stokers
BASED ON FEEDING METHODS
Over feed Stoker
Chain grate stoker
Under feed stoker
Spreader Stoker

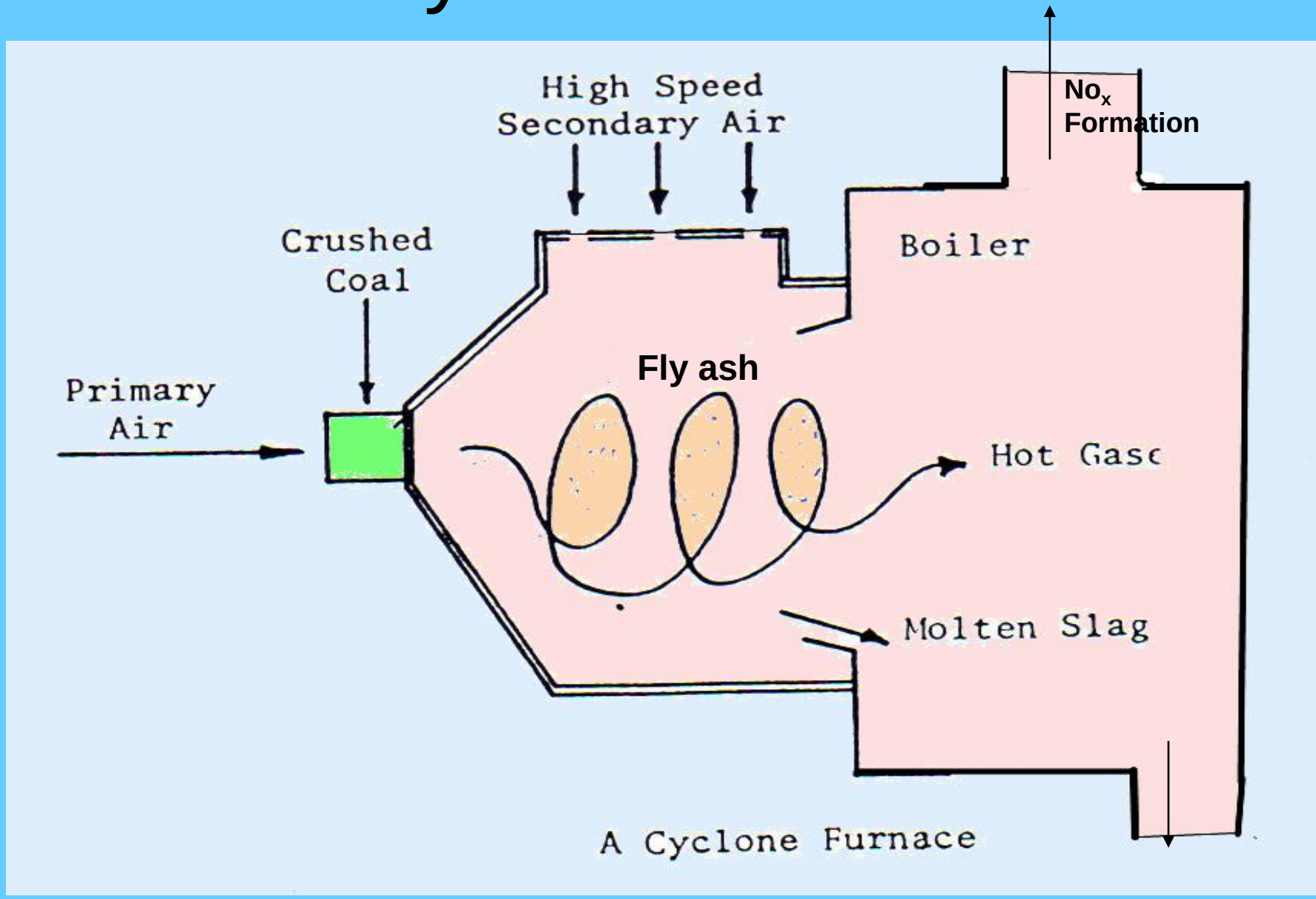
Pulverized-fuel Boiler

Pulverized means powder



Large Capacity ; high efficiency; low excess air; low labors; high cost due crushing

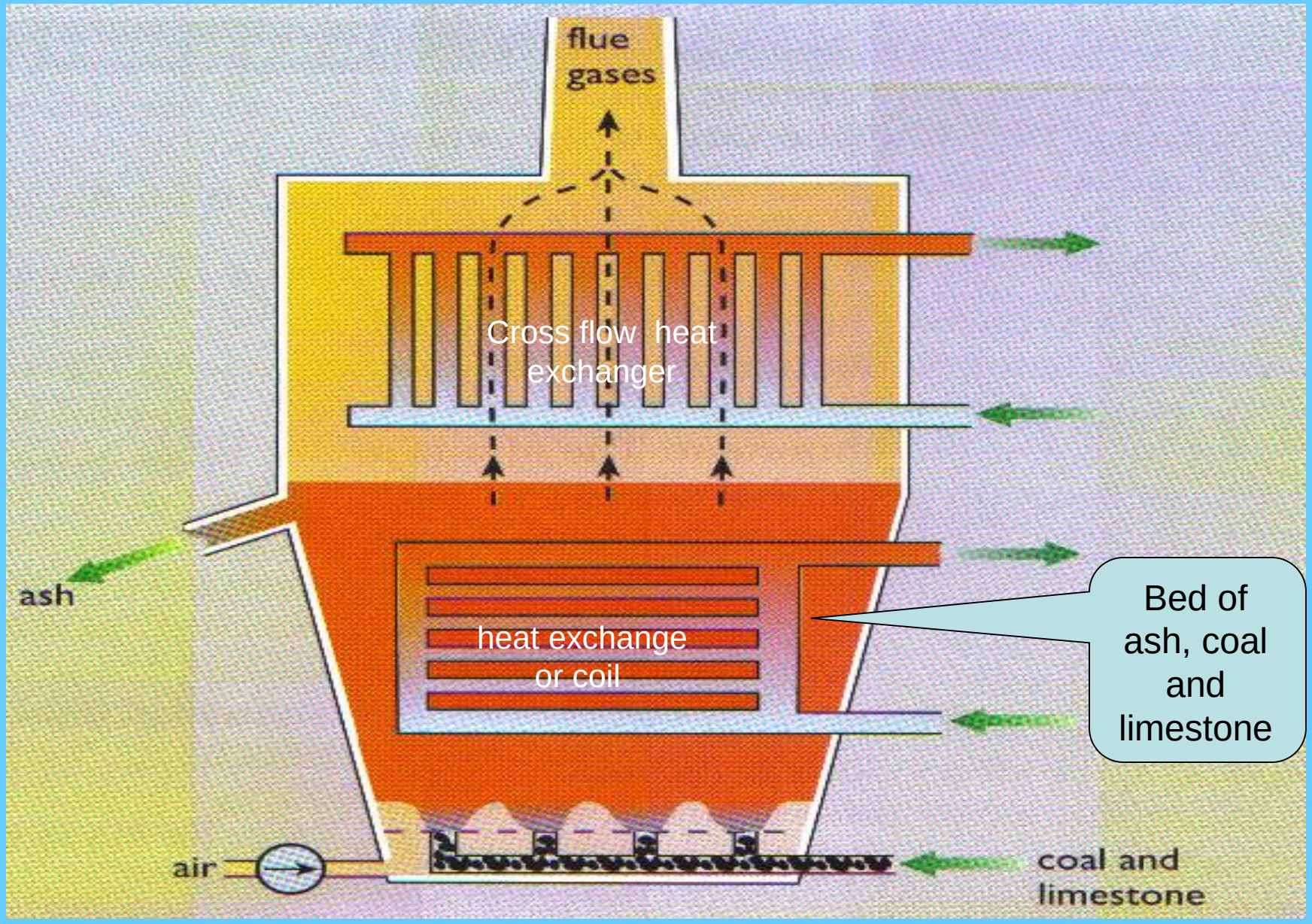
A cyclone Furnace



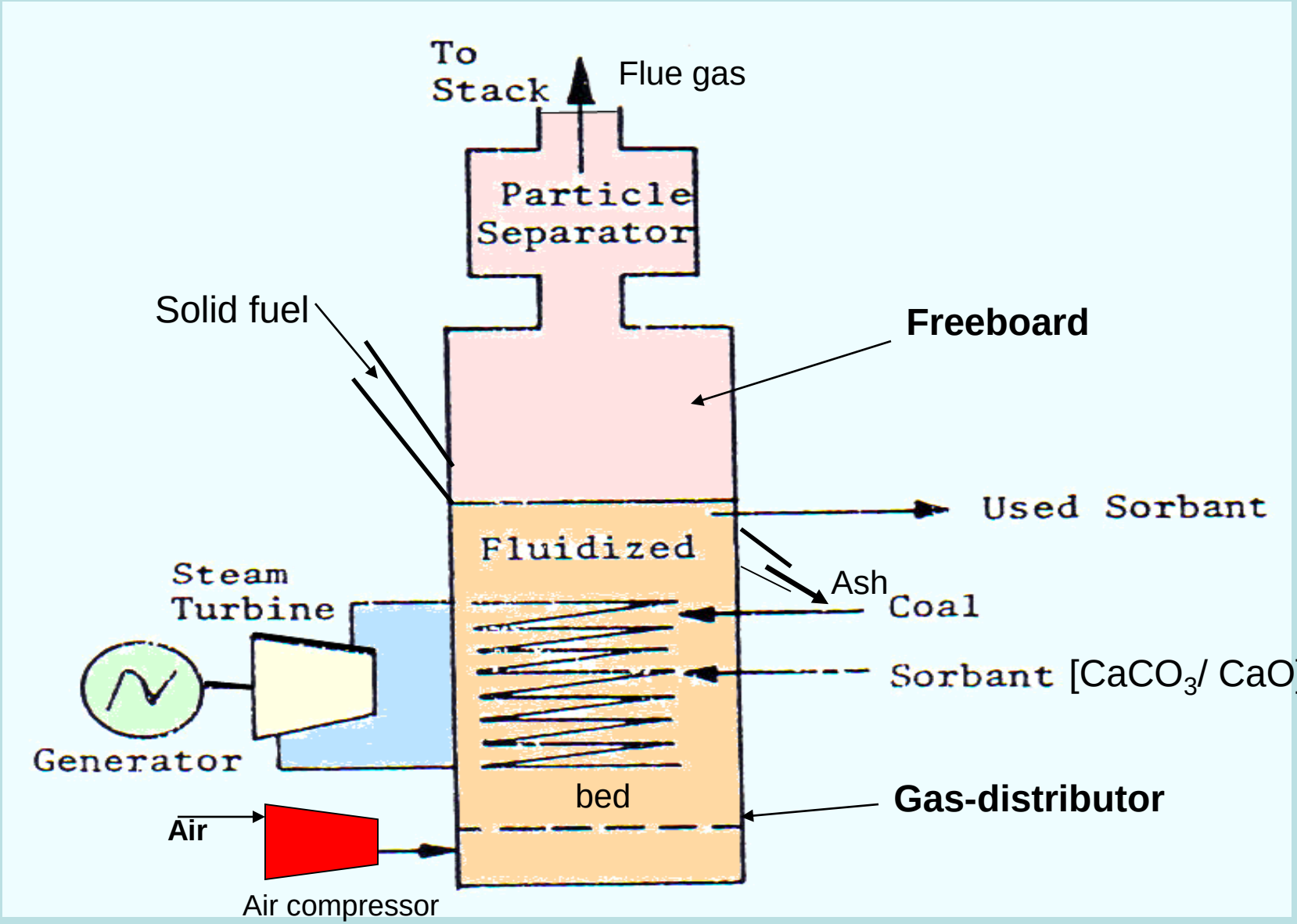
Some points for cyclone furnace

1. **Horizontal inclined, water cooled, tubular unit.**
2. **Max temp: 2000K**
3. **Crushed Coal enters tangentially. Coal fines burn in suspension**
4. **Low dust emission**
5. **Heat rate > pulverized sy. 50 times**
6. **High slag formation (molten ash)**
7. **Required high energy to create a high velocity tangent to the walls.**

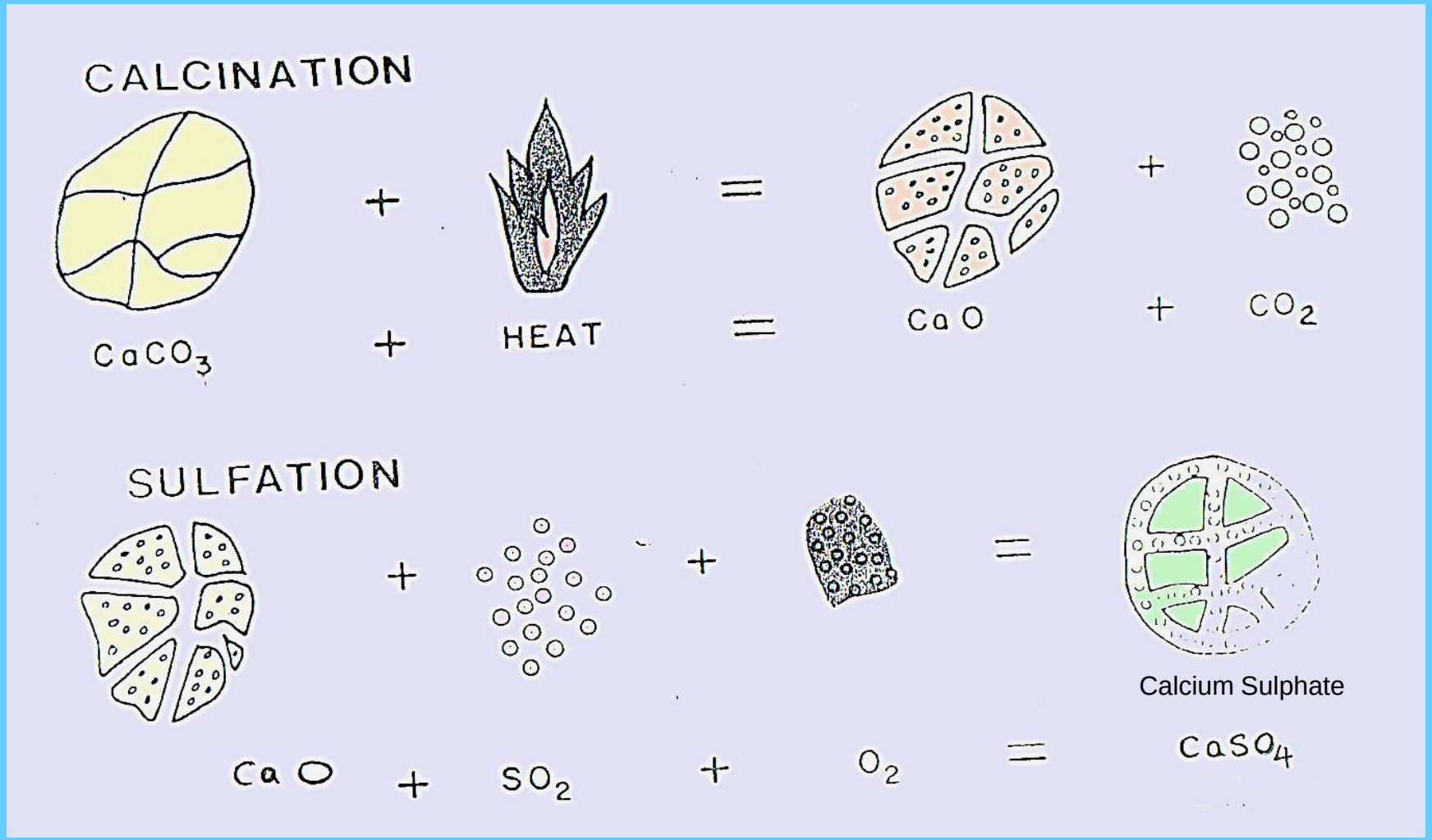
Fluidized-bed Boiler



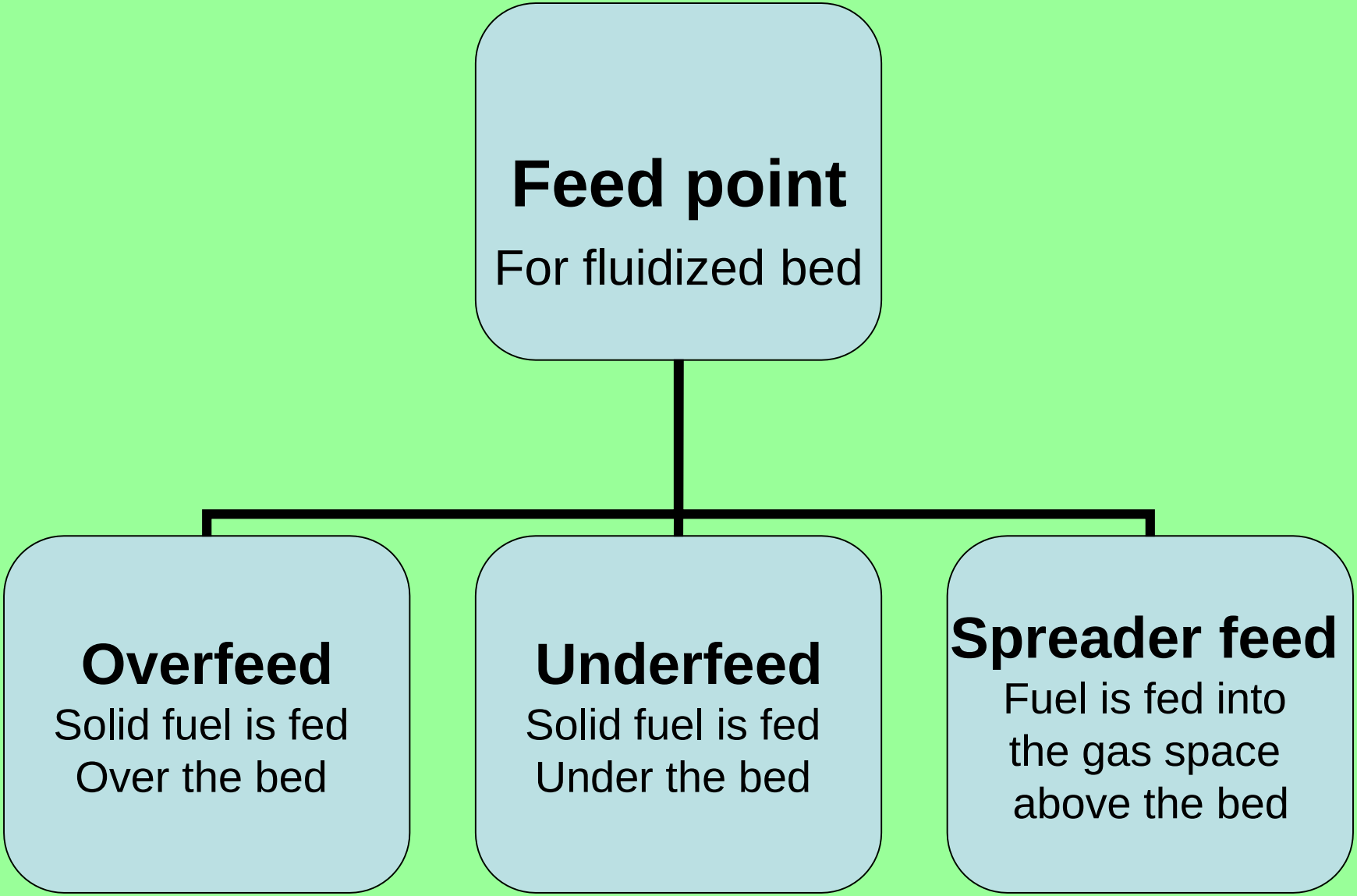
Fluidized Bed Combustor main components

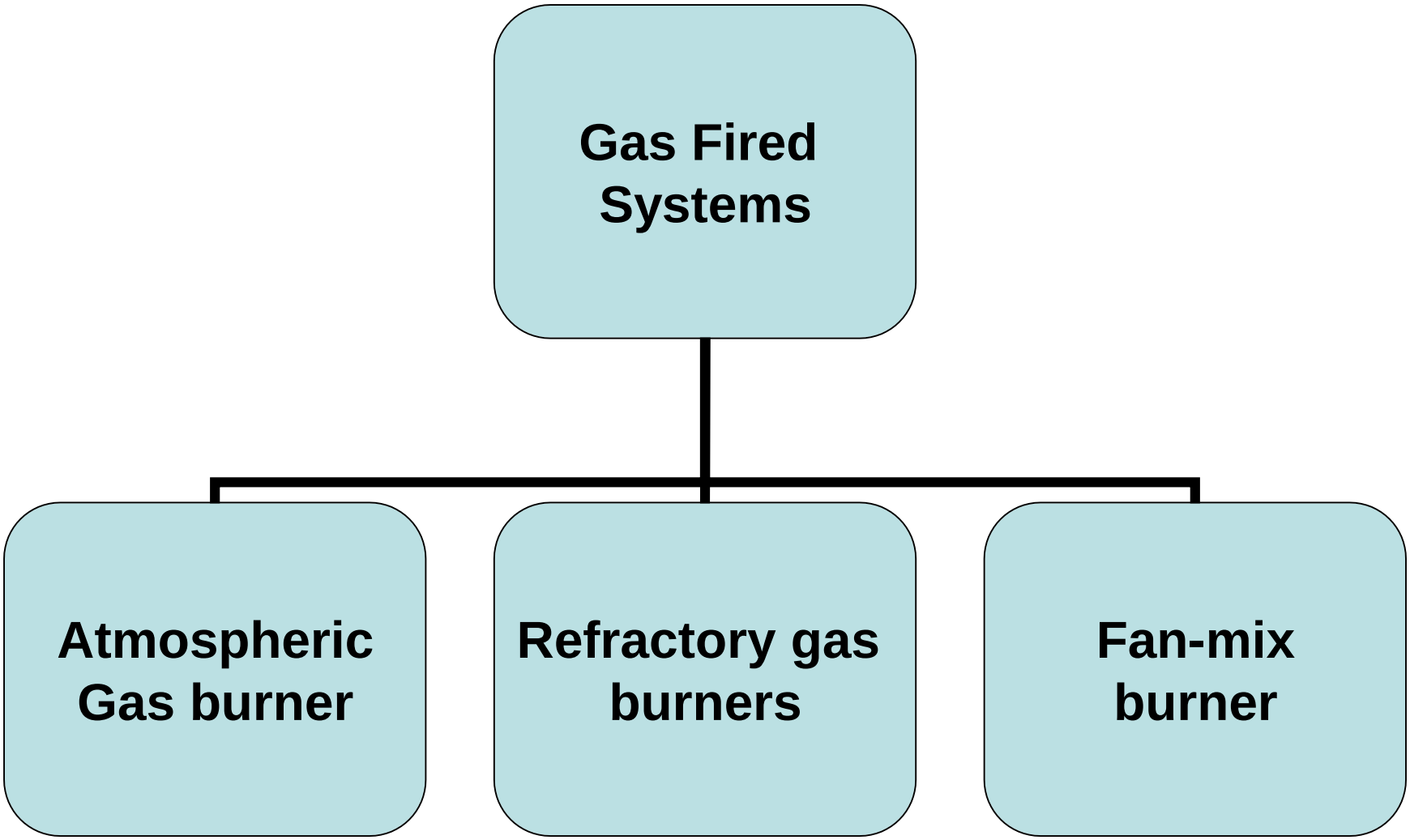


Mechanism of sorbent in a fluid bed

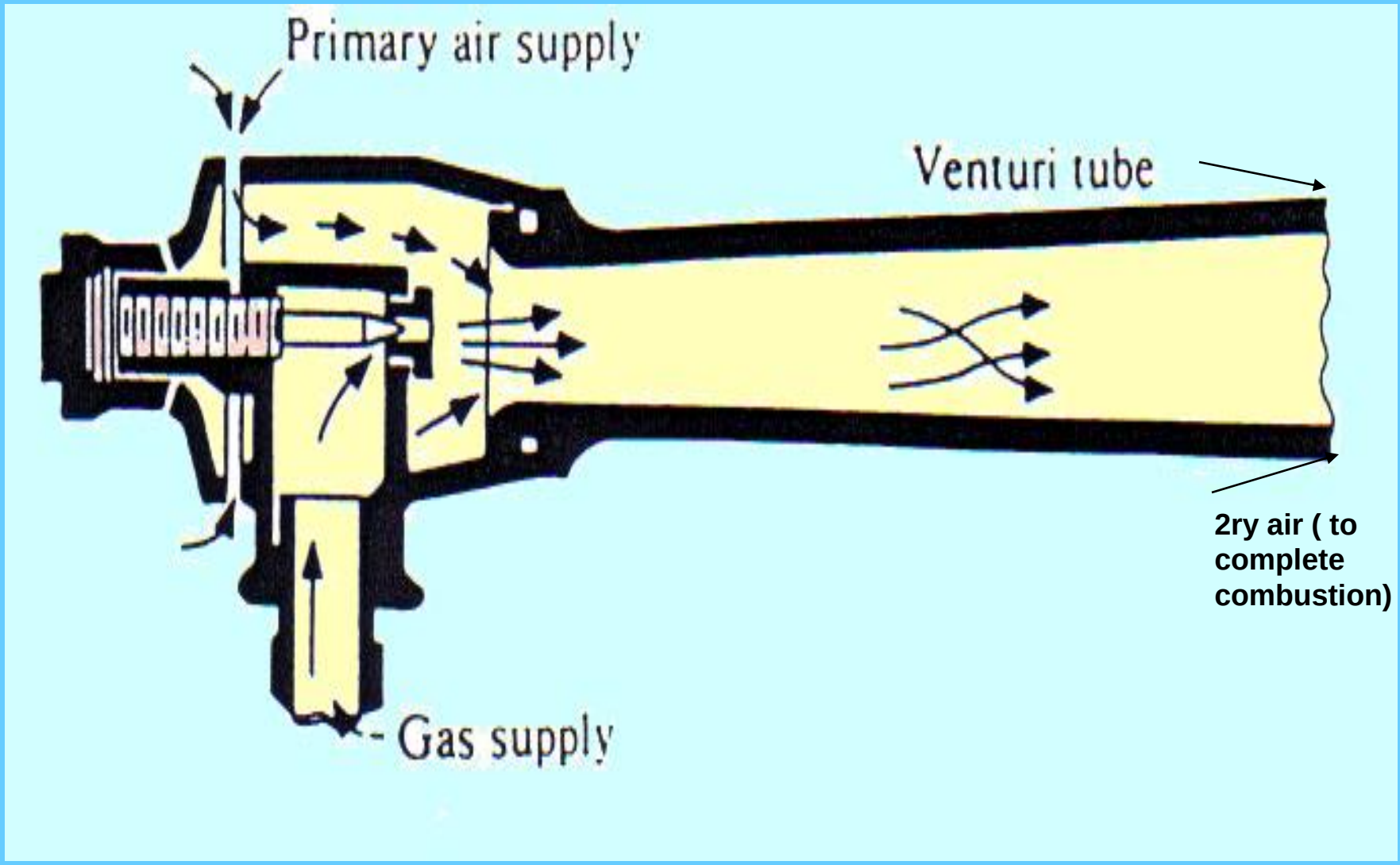


∴ Limestone is commonly used to capture the sulfur.

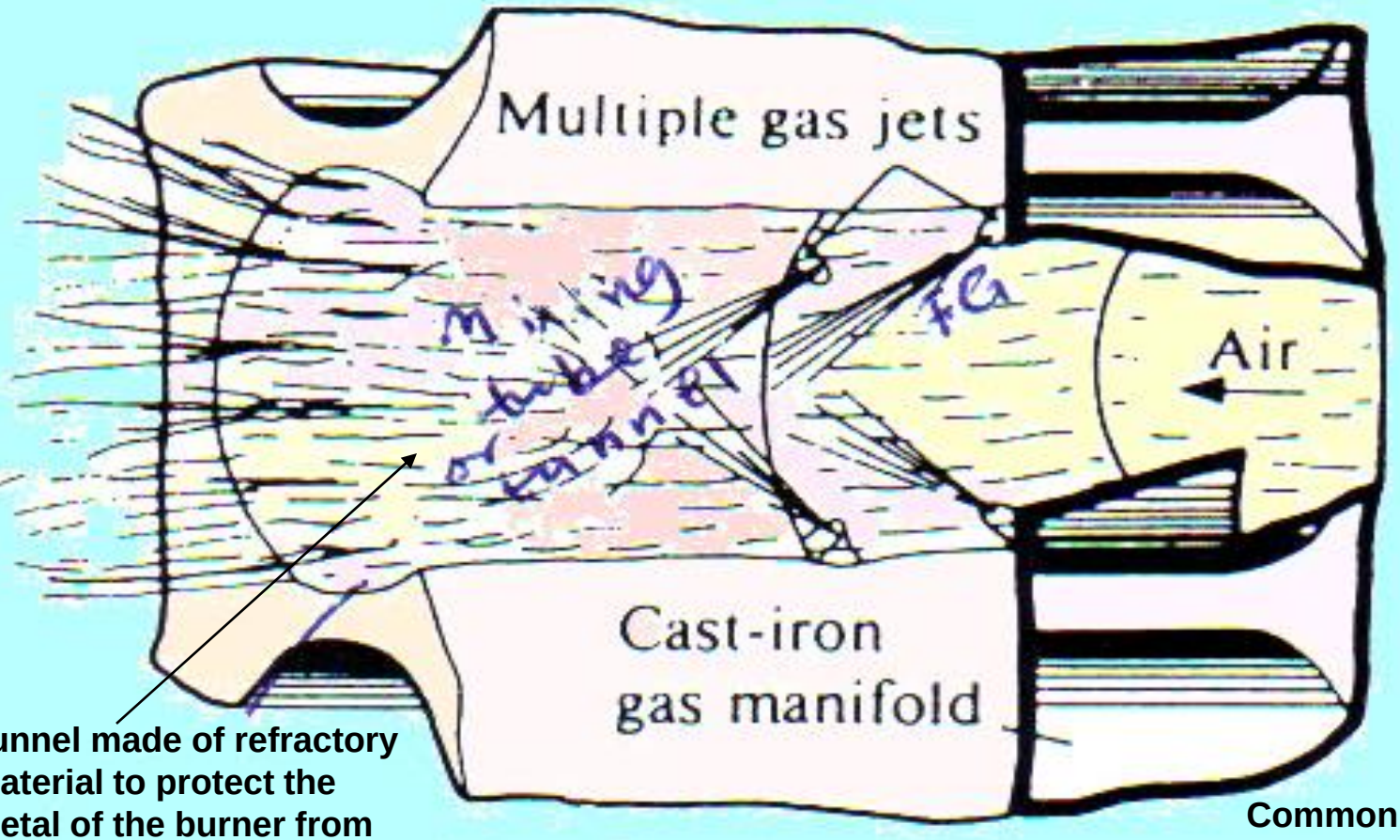

Feed point
For fluidized bed
Overfeed
Solid fuel is fed
Over the bed
Underfeed
Solid fuel is fed
Under the bed
Spreader feed
Fuel is fed into
the gas space
above the bed


Gas Fired Systems
Atmospheric Gas burner
Refractory gas burners
Fan-mix burner

Atmospheric gas burner



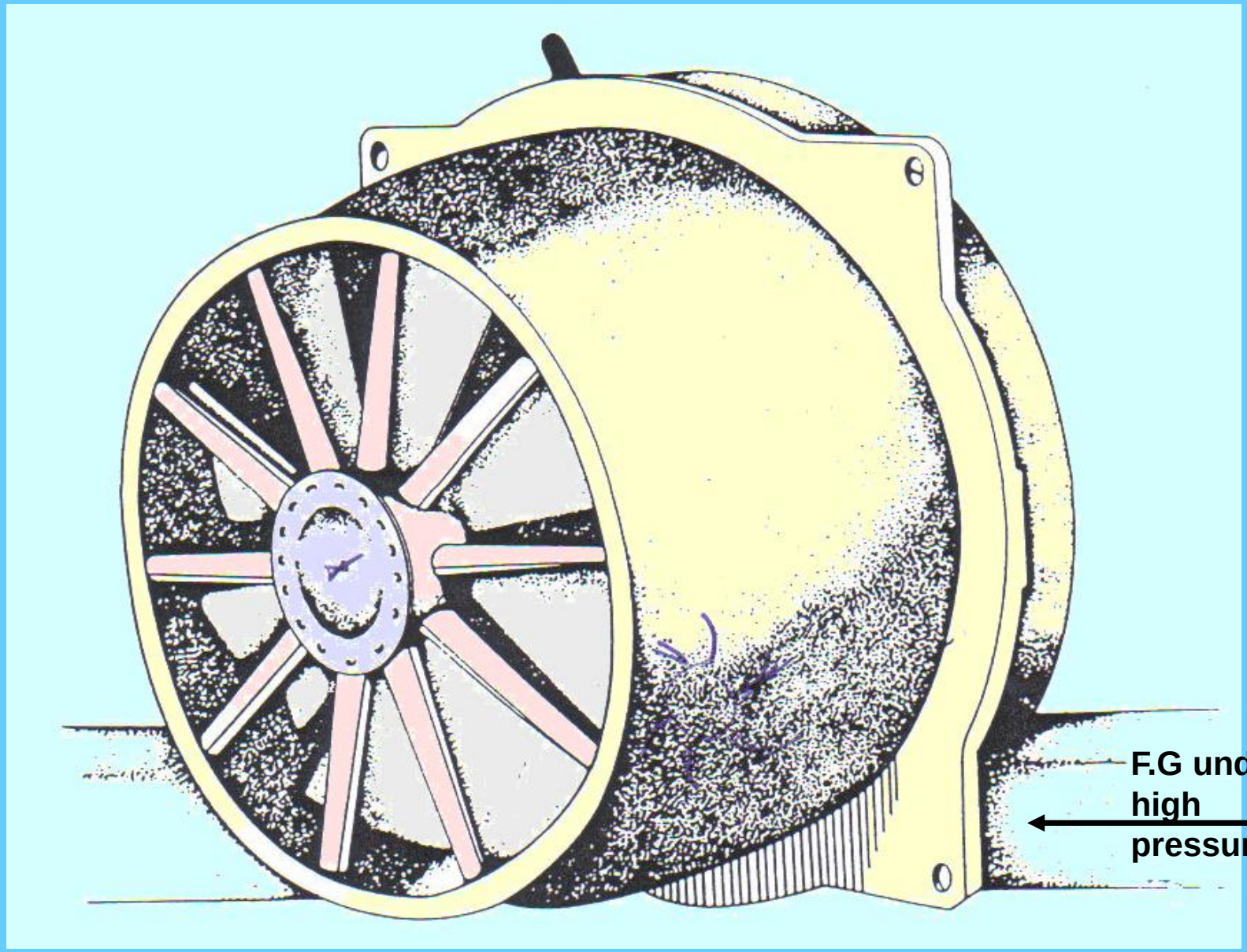
Refractory gas burner

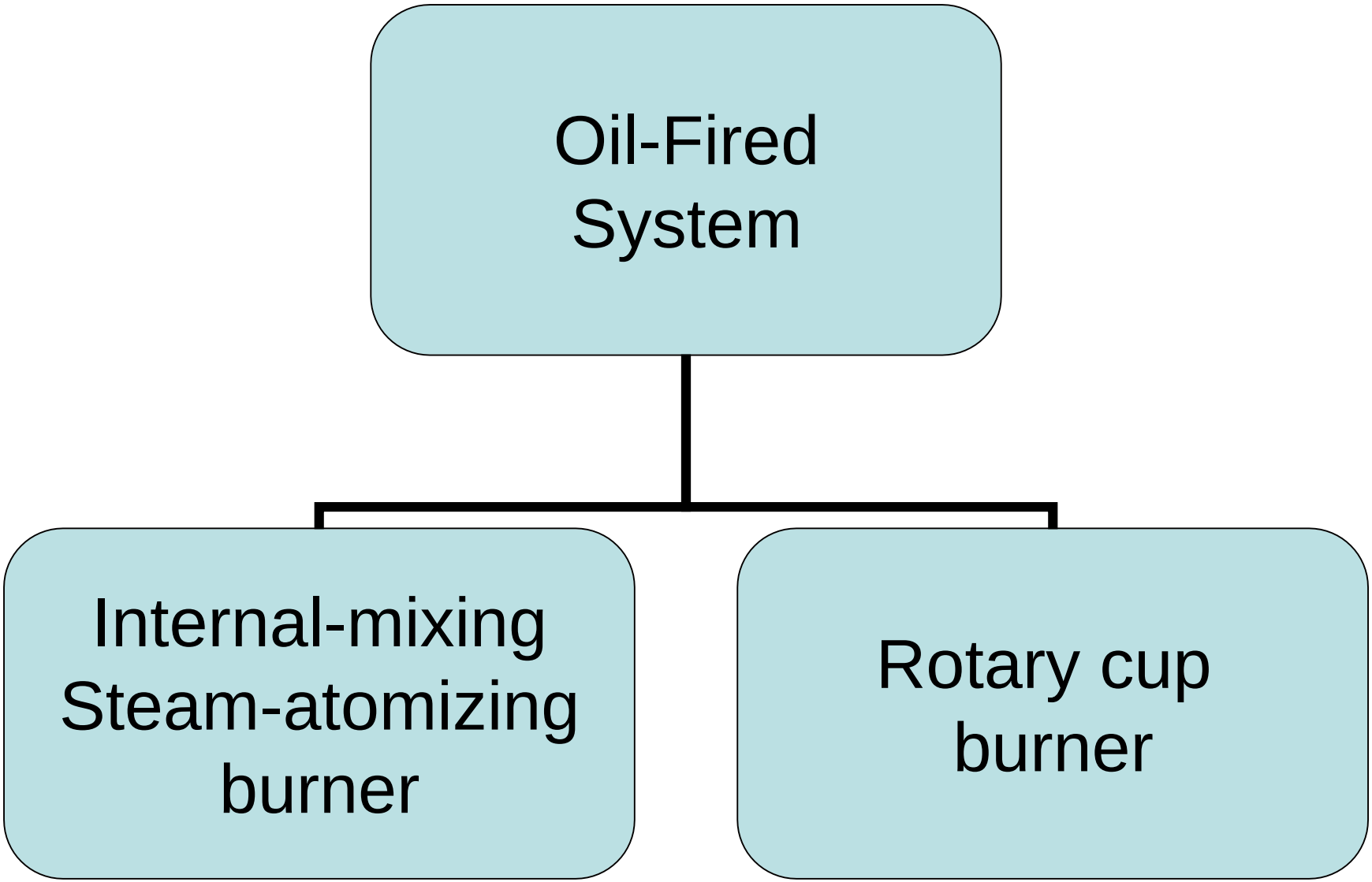


Tunnel made of refractory material to protect the metal of the burner from high temperature

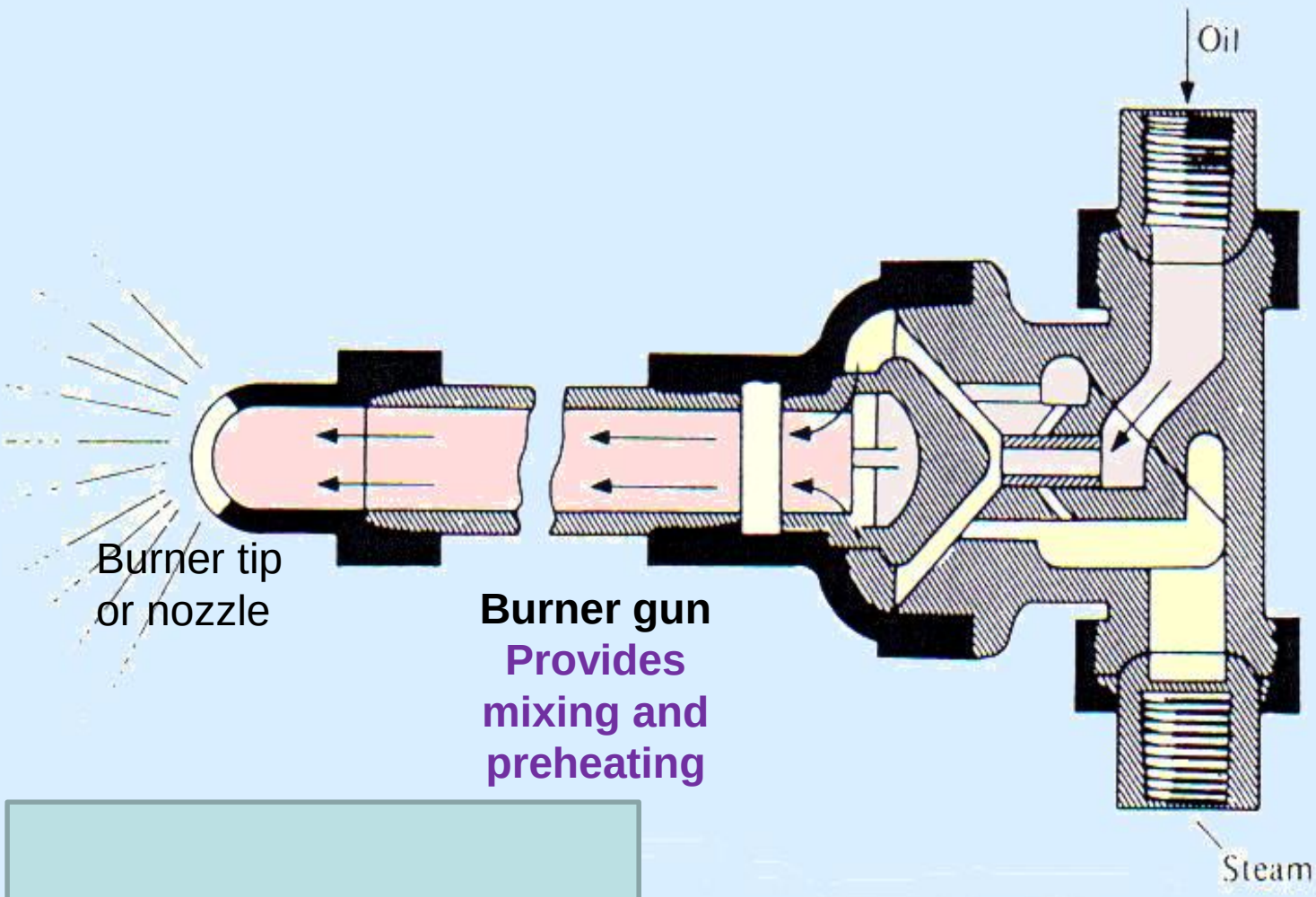
Commonly used in steam generators

Fan-mix burner

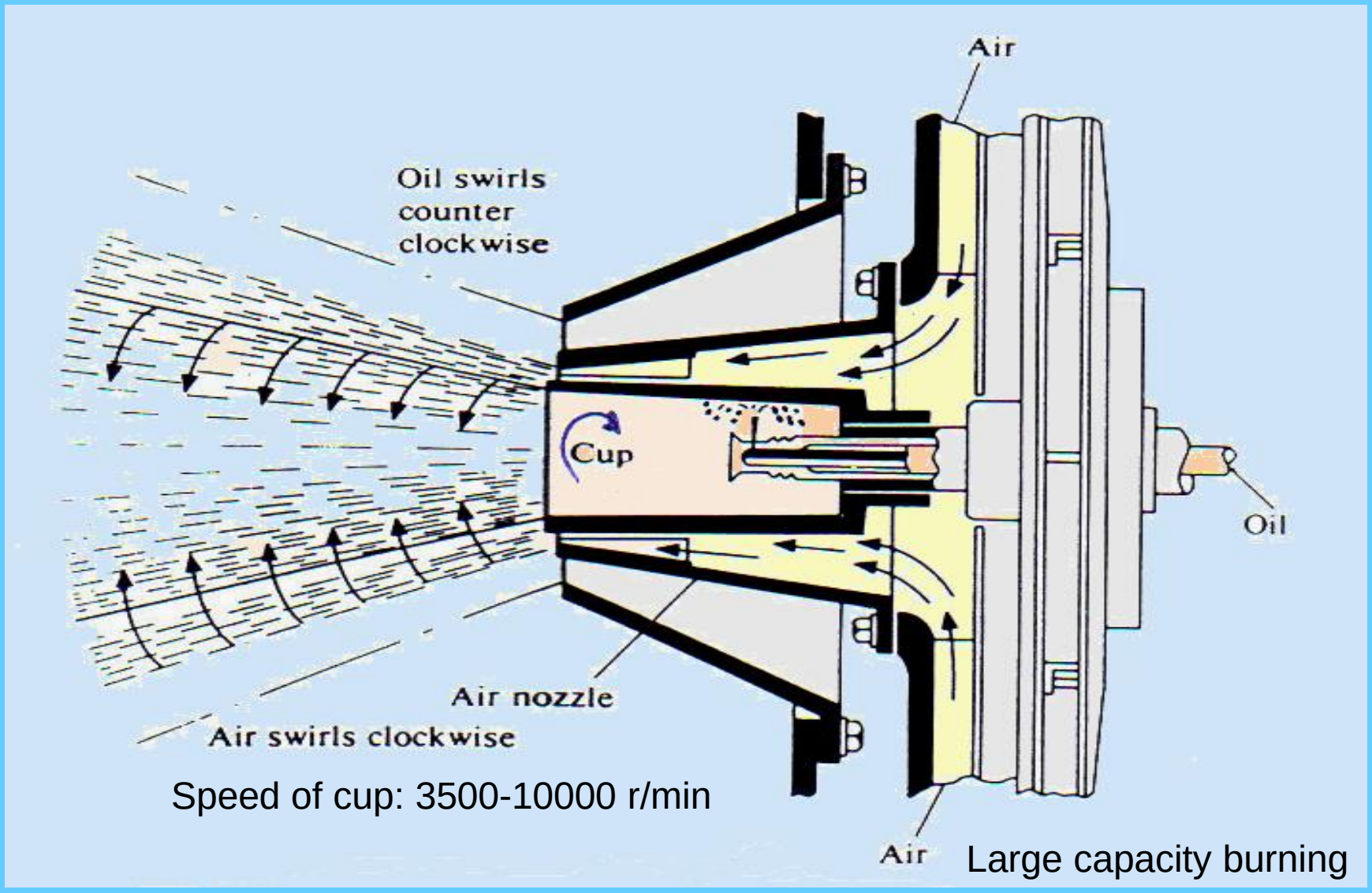



Oil-Fired System
Internal-mixing Steam-atomizing burner
Rotary cup burner

Steam-atomizing burner



Rotary cup burner

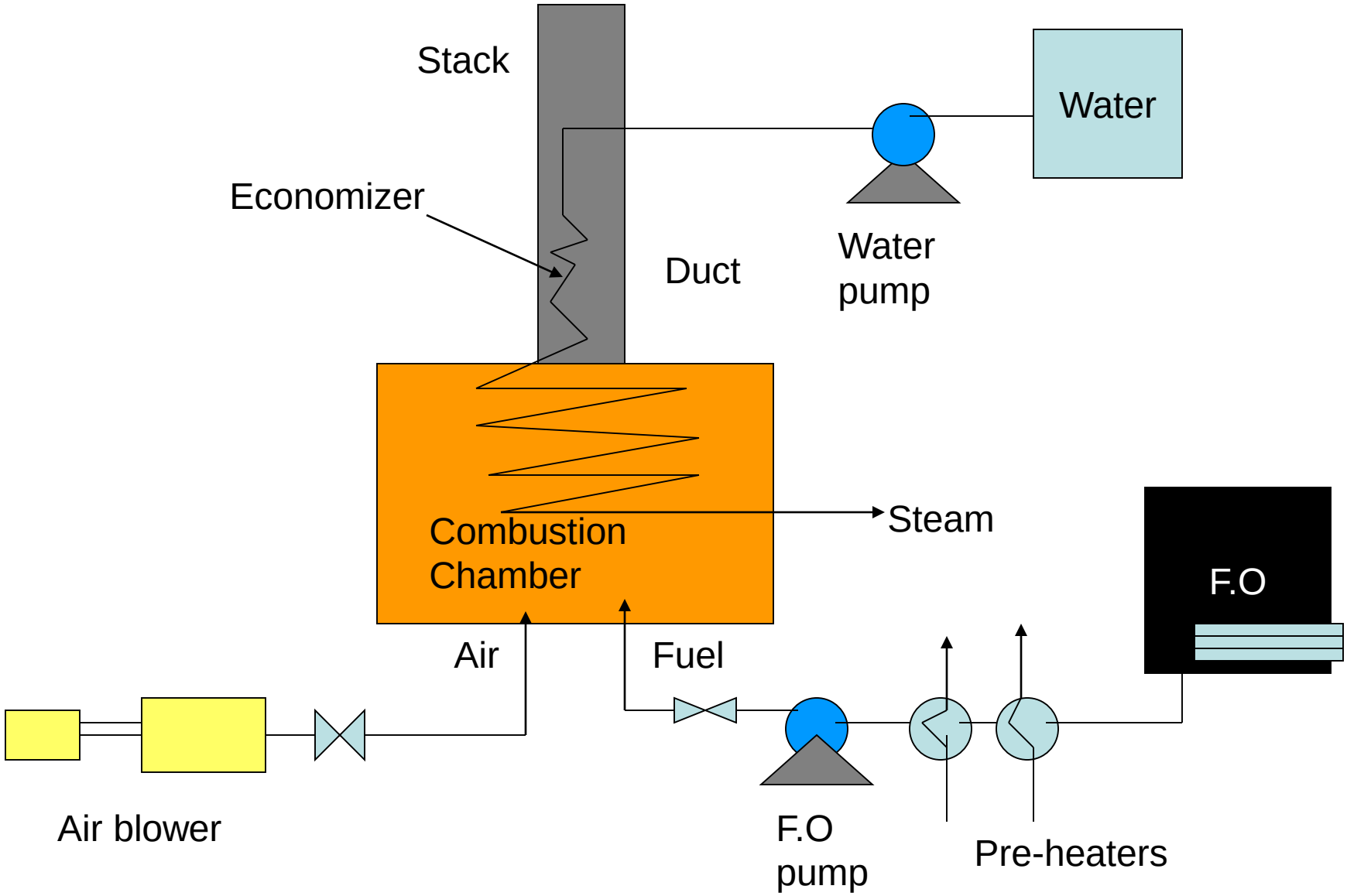


Speed of cup: 3500-10000 r/min

Large capacity burning

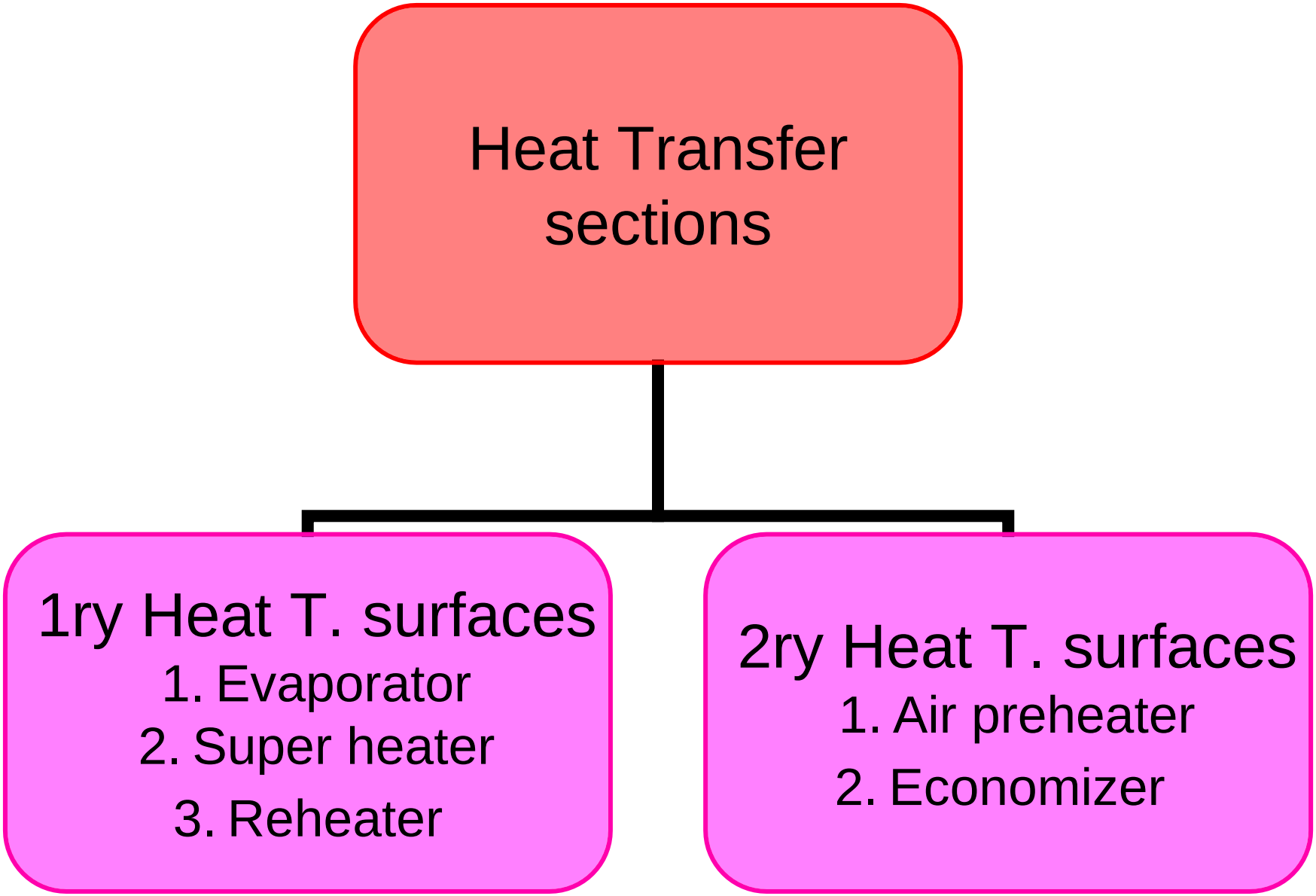
Boilers

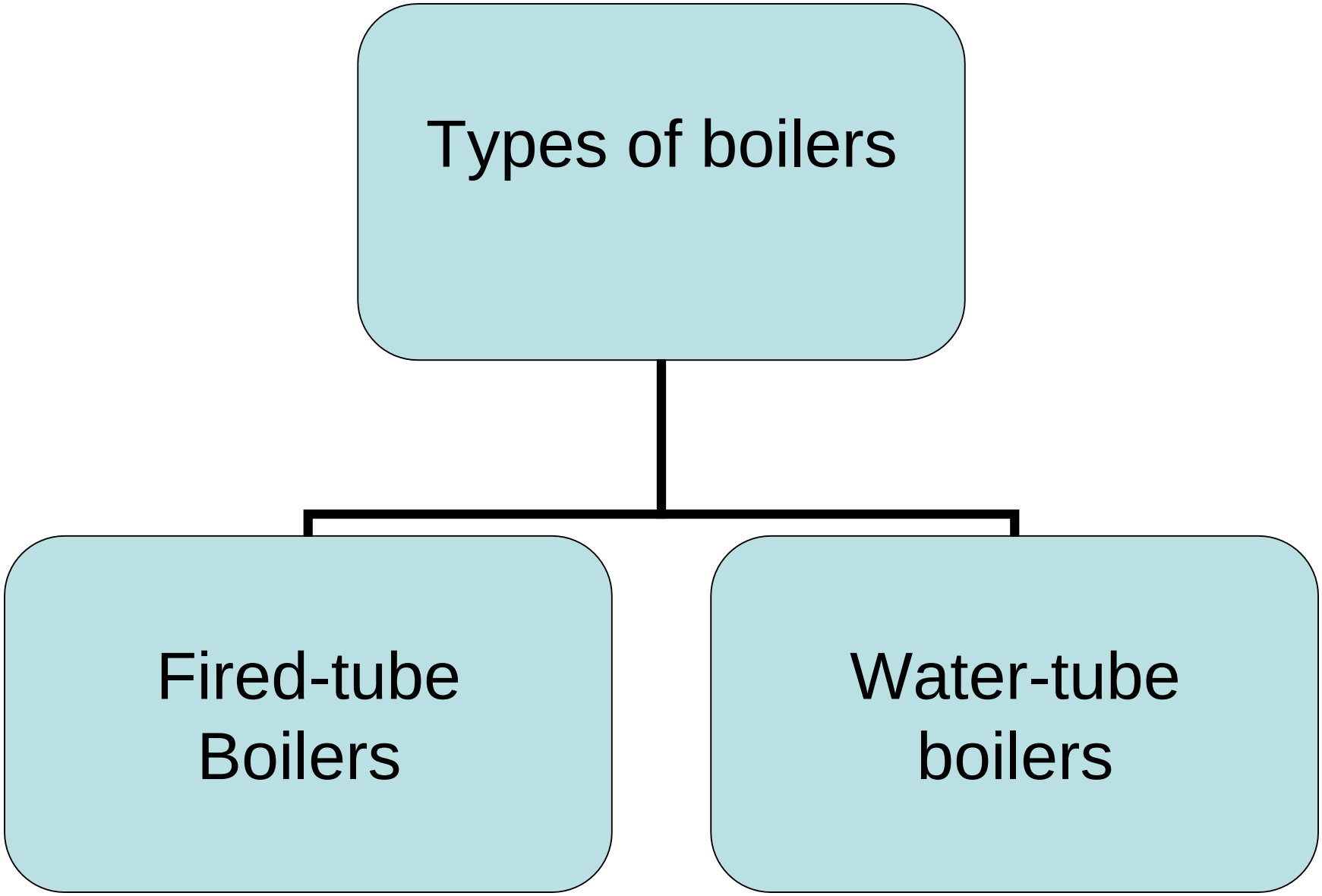
Design & operation


Stack
Water
Economizer
Duct
Water
pump
Combustion
Chamber
Steam
F.O
Air
Fuel
Air blower
F.O
pump
Pre-heaters

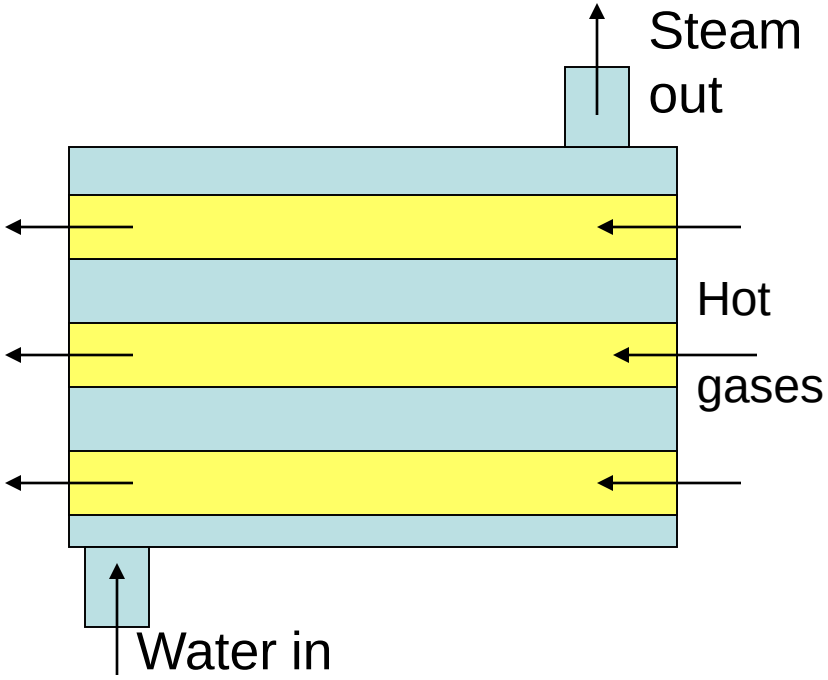
Boiler components

1. Air handling equipment
2. Fuel handling equipment.
3. Duct and Combustion Chamber
4. Water supply system.
5. Steam drums and piping
6. Exhaust-gas system and pollution-control system


Heat Transfer sections
1ry Heat T. surfaces
1. Evaporator
2. Super heater
3. Reheater
2ry Heat T. surfaces
1. Air preheater
2. Economizer

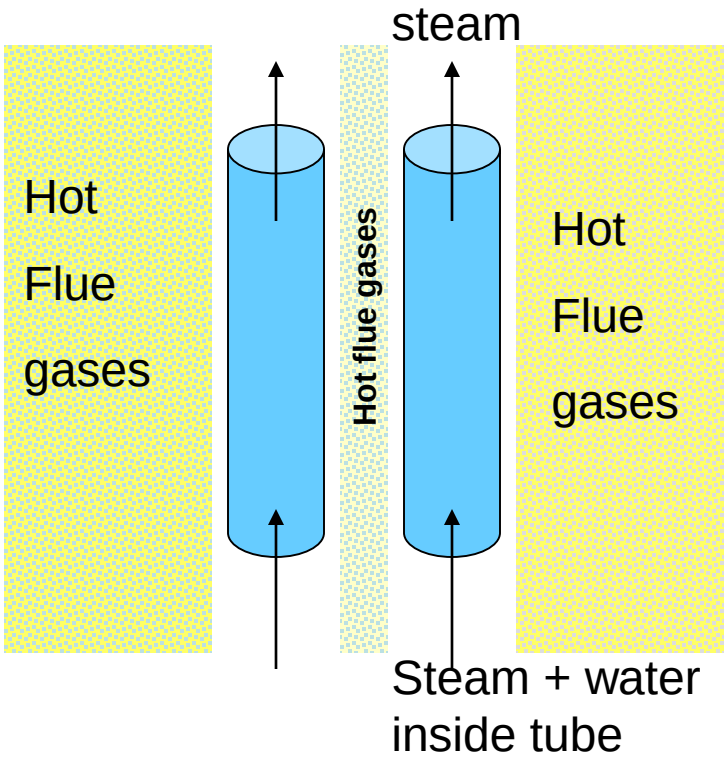

Types of boilers
Fired-tube Boilers
Water-tube boilers

Fired-tube boilers



Serious explosion may take place in case of tube rapture or failure.

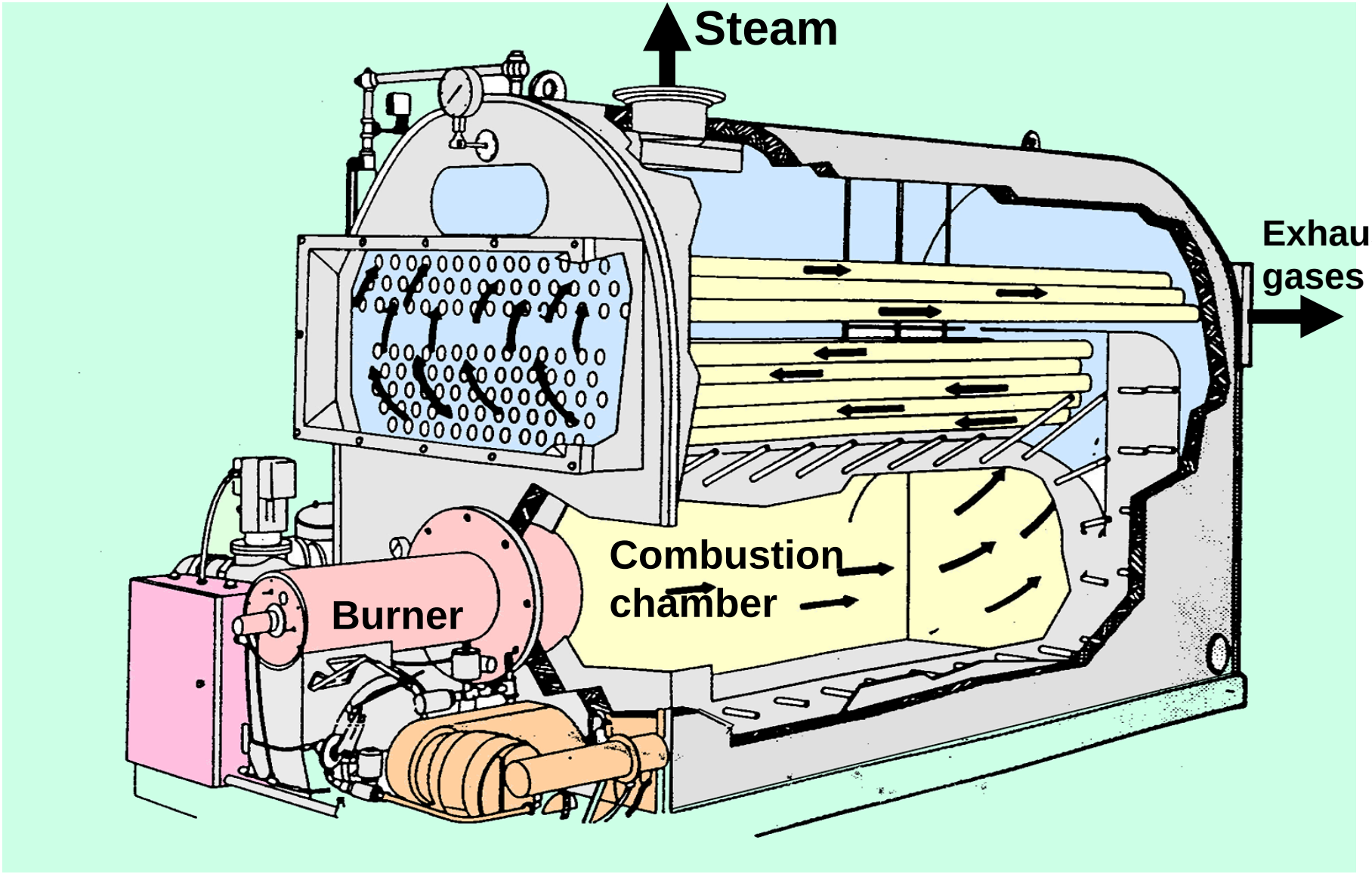
Water-tube boilers



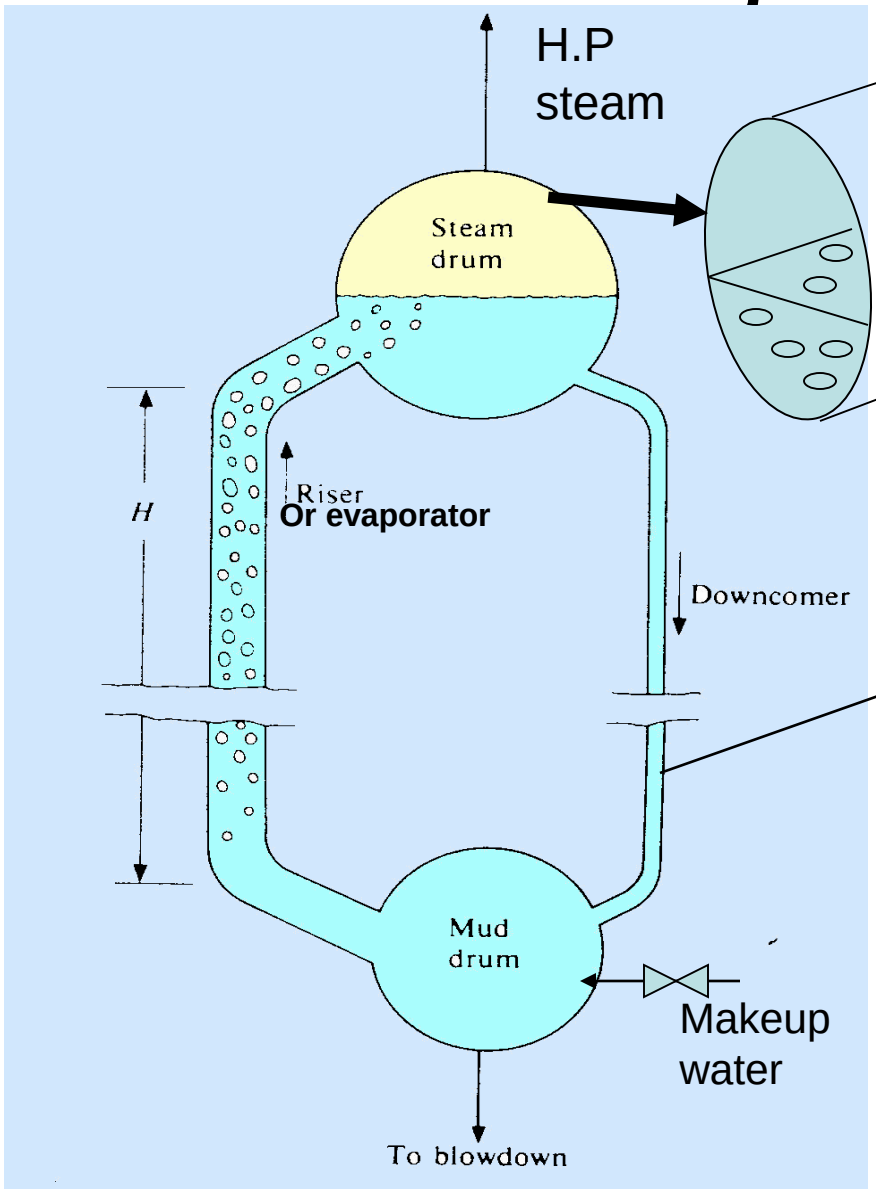
In general;

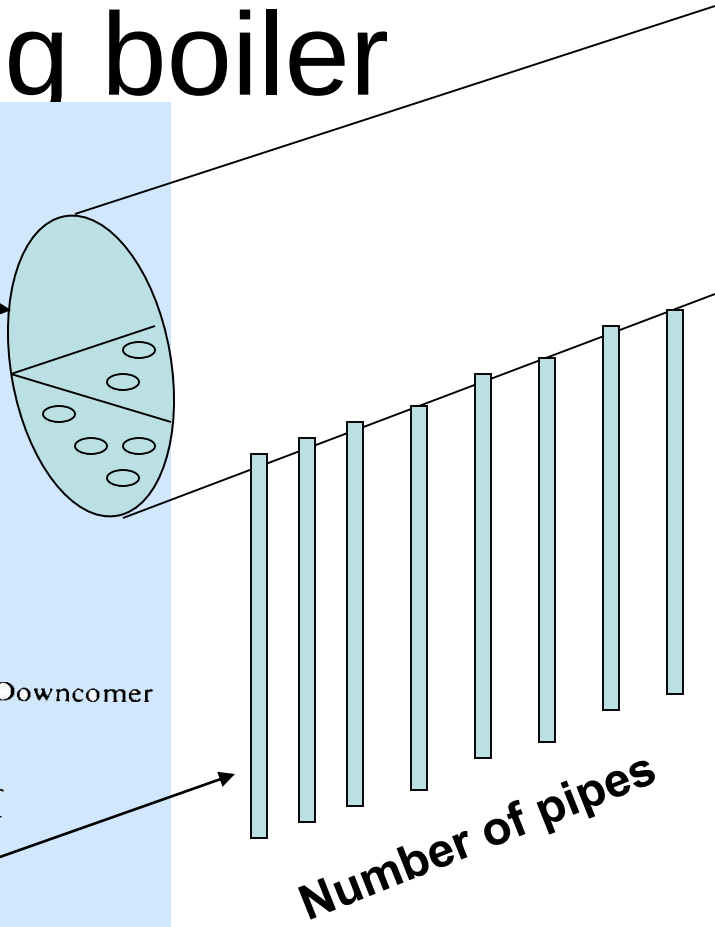
- Natural circulation boilers
- Forced-circulation boilers

Fired-tube steam boiler 2-passes

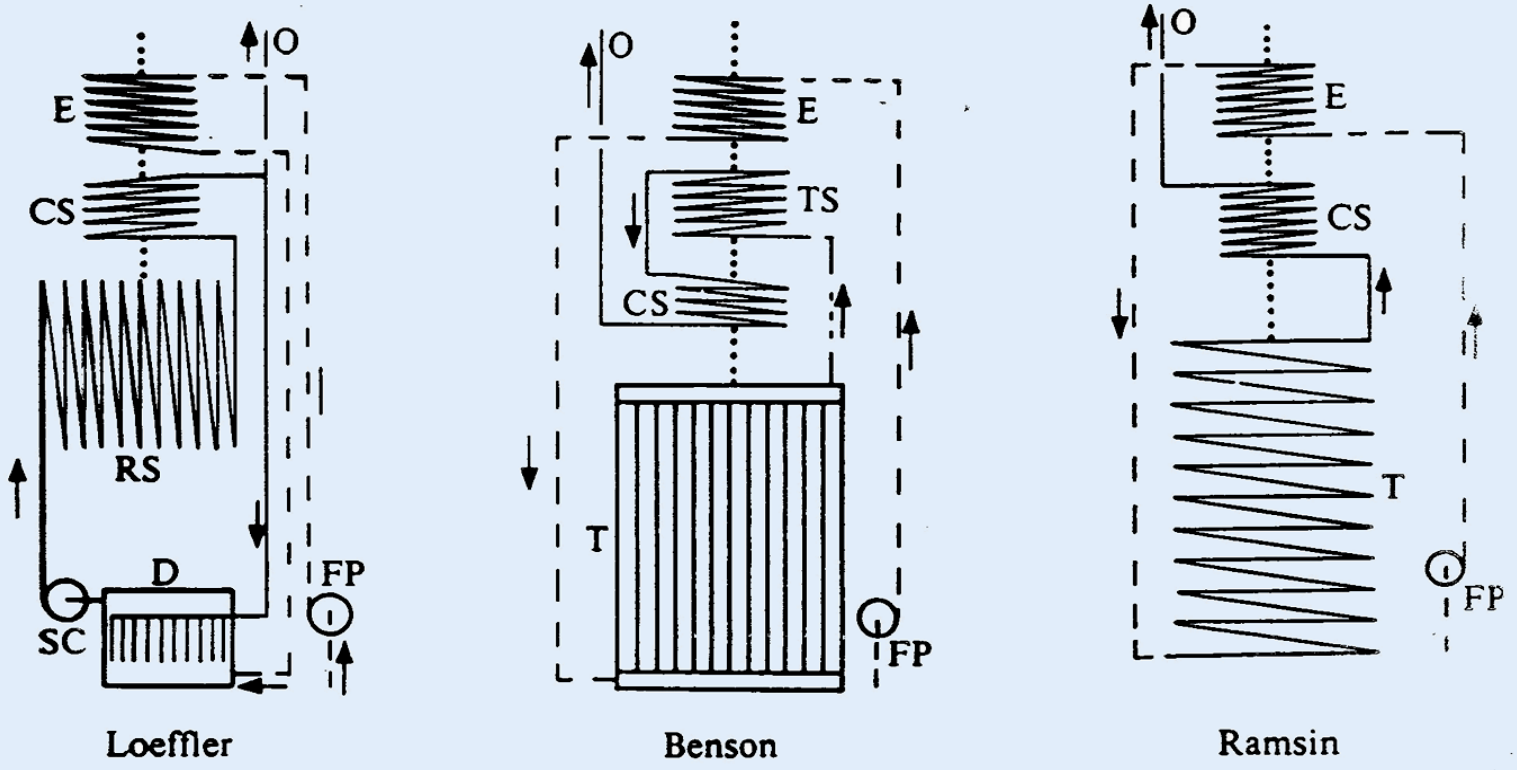


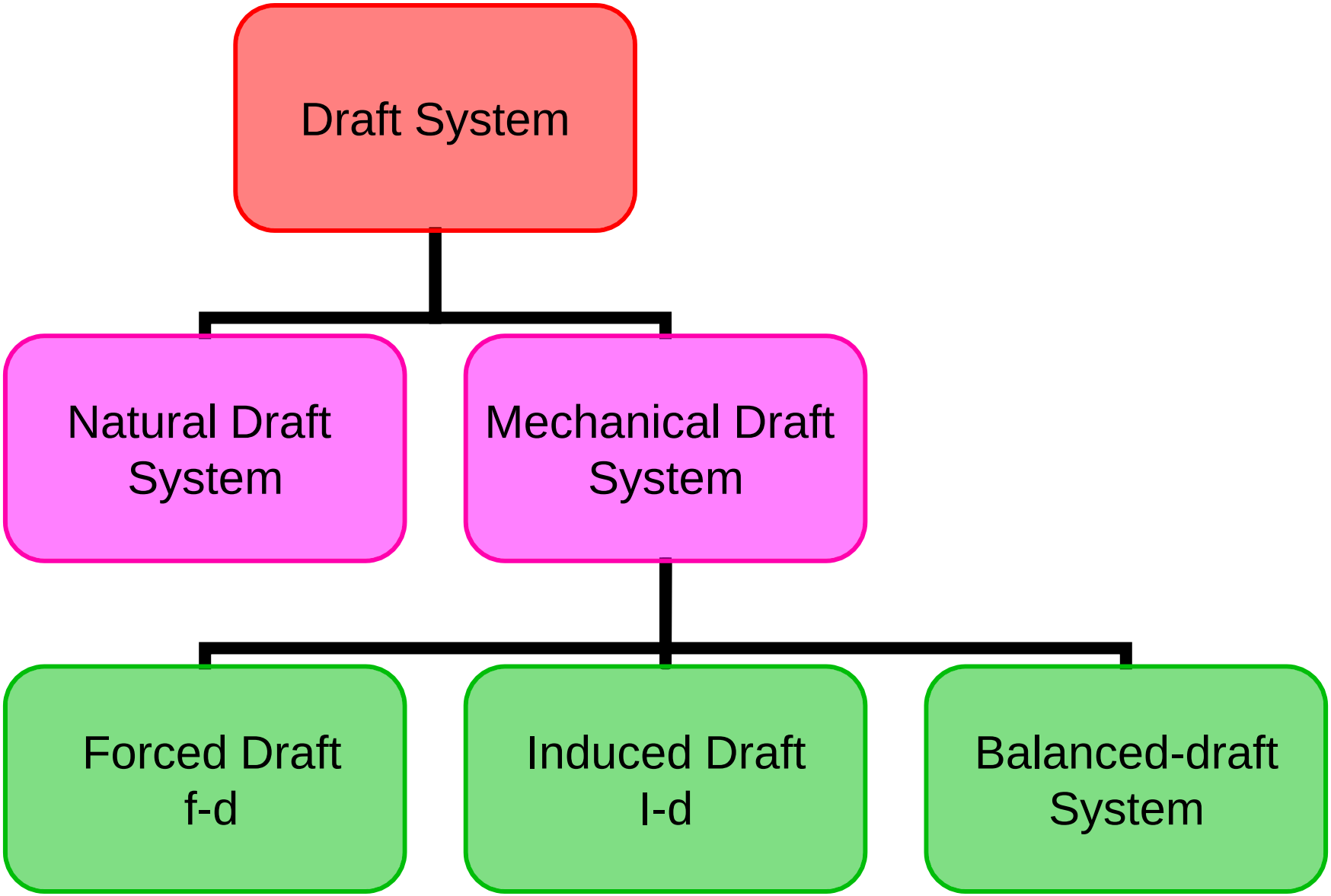
Natural-circulating boiler



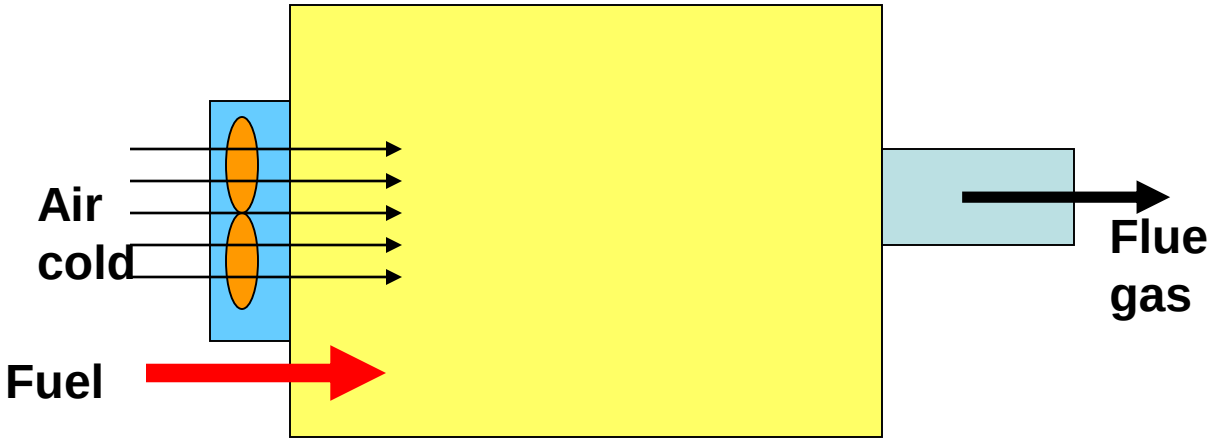


Forced-circulating Boiler




Draft System
Natural Draft System
Mechanical Draft System
Forced Draft f-d
Induced Draft I-d
Balanced-draft System

Forced Draft System

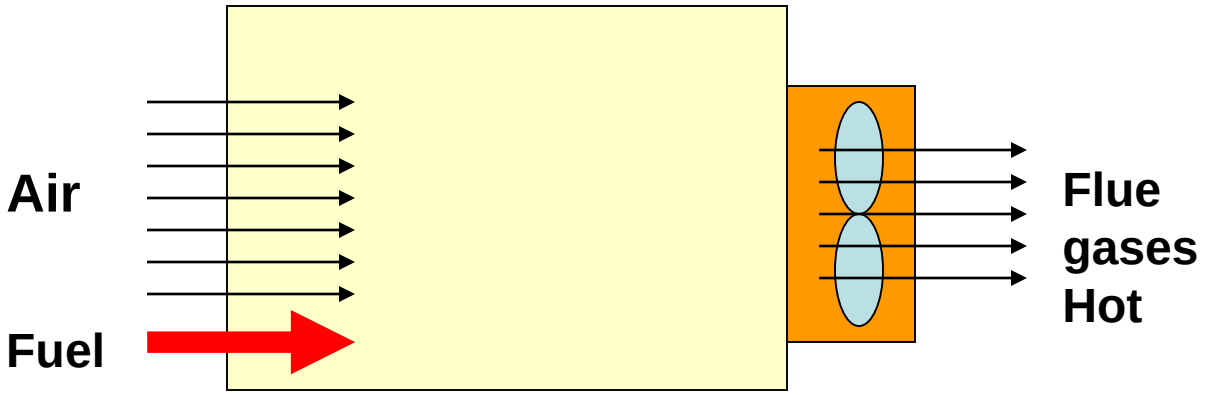


Min mass flow rate = fuel rate (A/F)$_{act,\ mass,\ w}$.

To account leakage the flow must be increased by 20 – 40 %.

Most f-d fans are high-speed centrifugal fans.

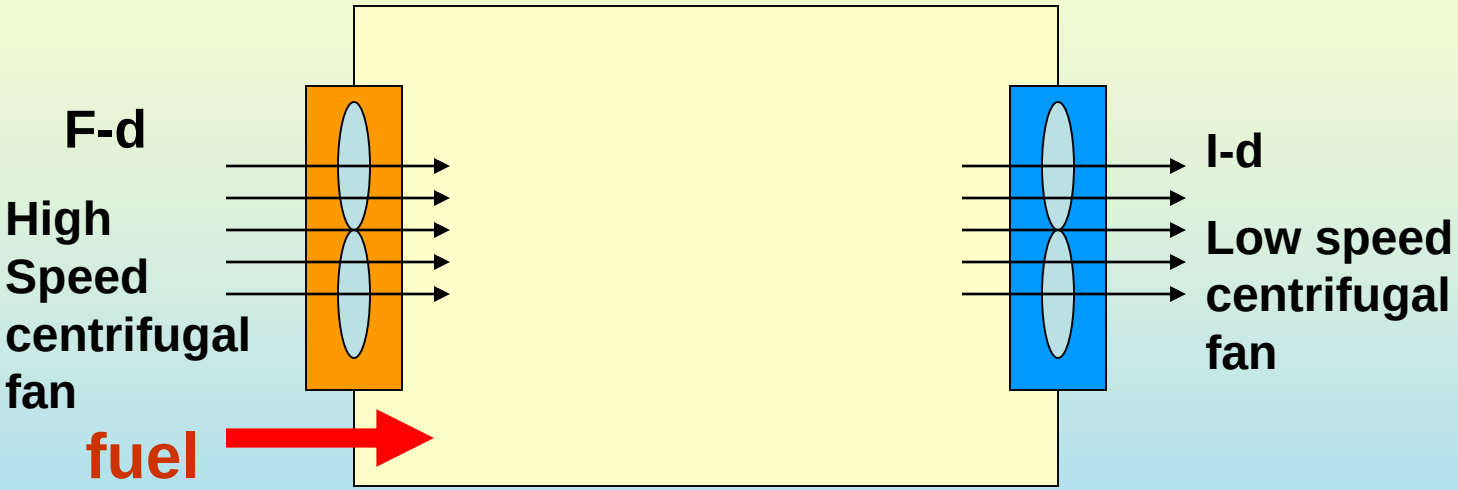
Induced draft Fan



$$\text{min mass flow rate}, \dot{m}_{\text{I-d}} = \dot{m}_{\text{fuel}}\left[\left(\frac{A}{F}\right)_{\text{act}} + 1.0 - R\right) \quad //$$

The flow rate which is given by this equation must be increased by 20 % to account for losses or leakage into the furnace and duct work.

Balanced-draft System



The system operates at or slightly below atmospheric pressure