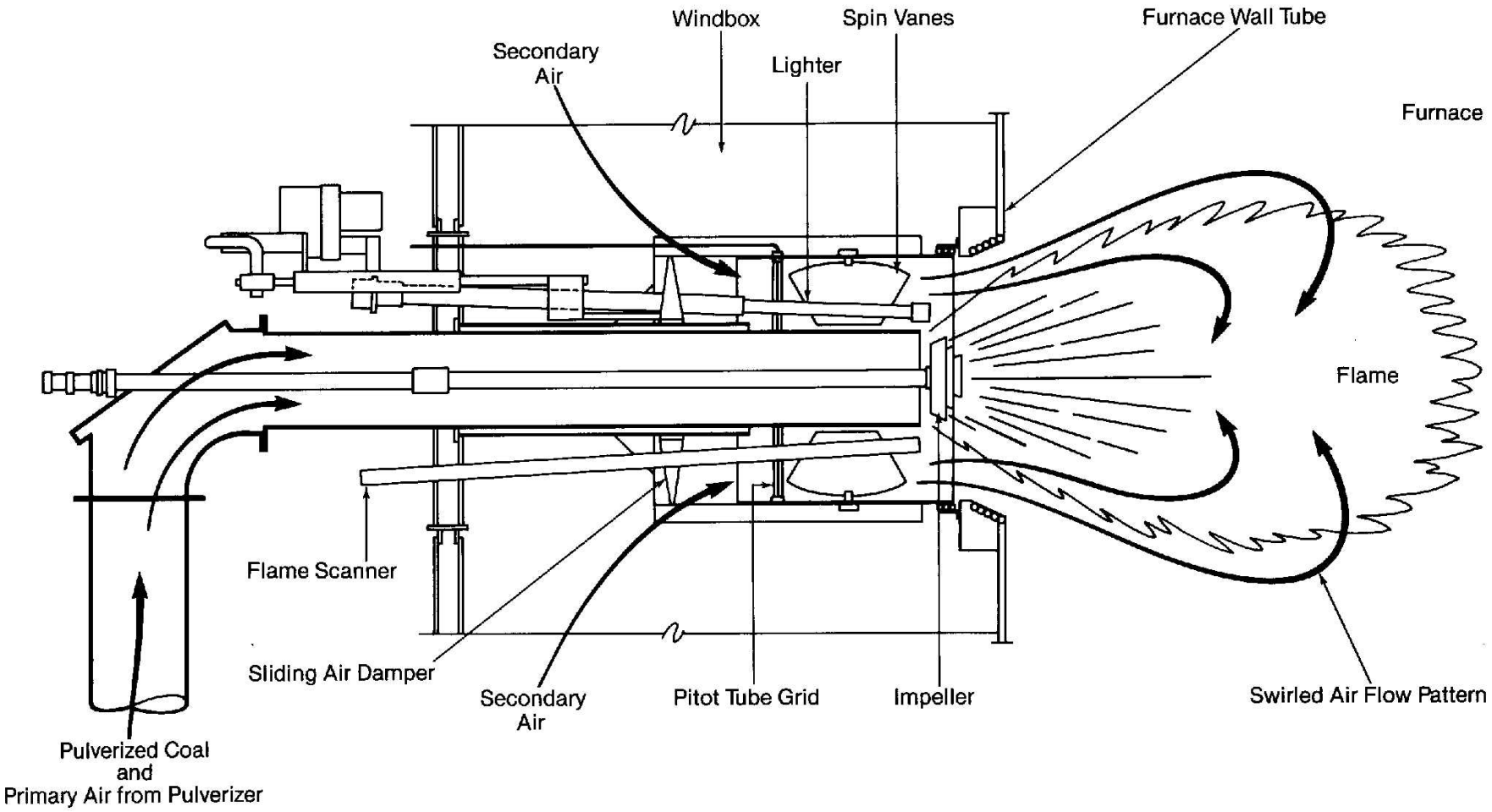
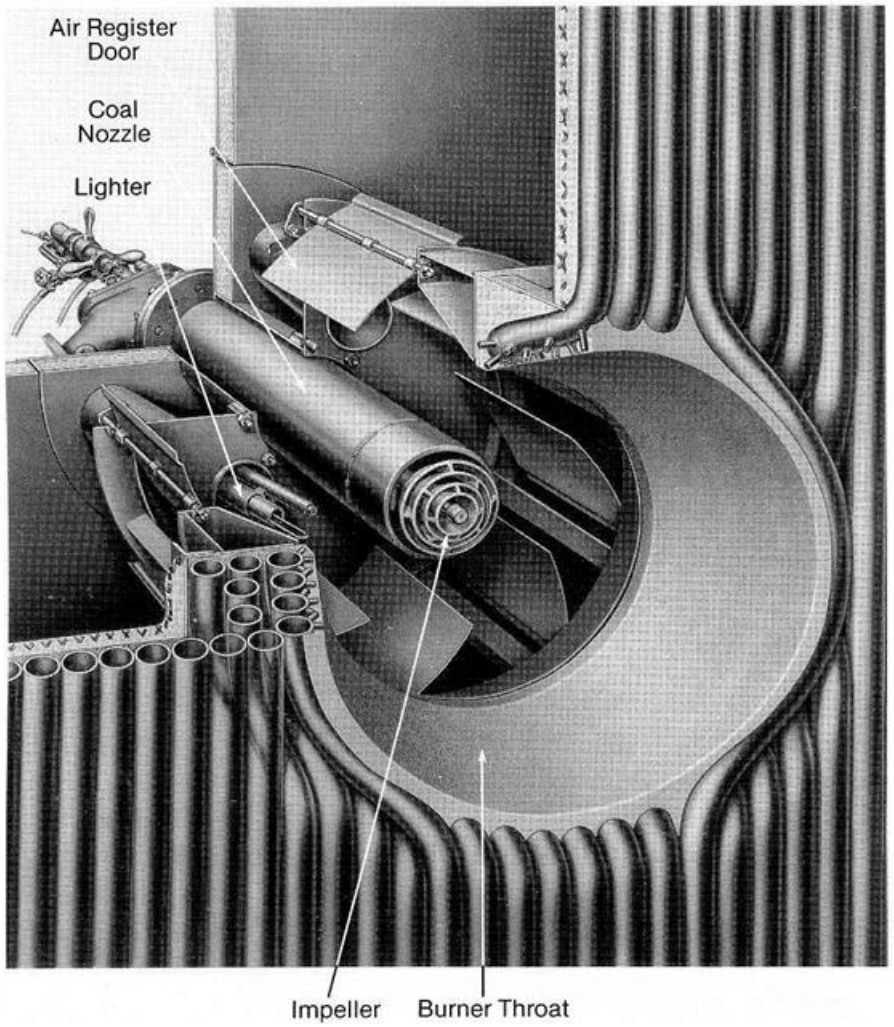
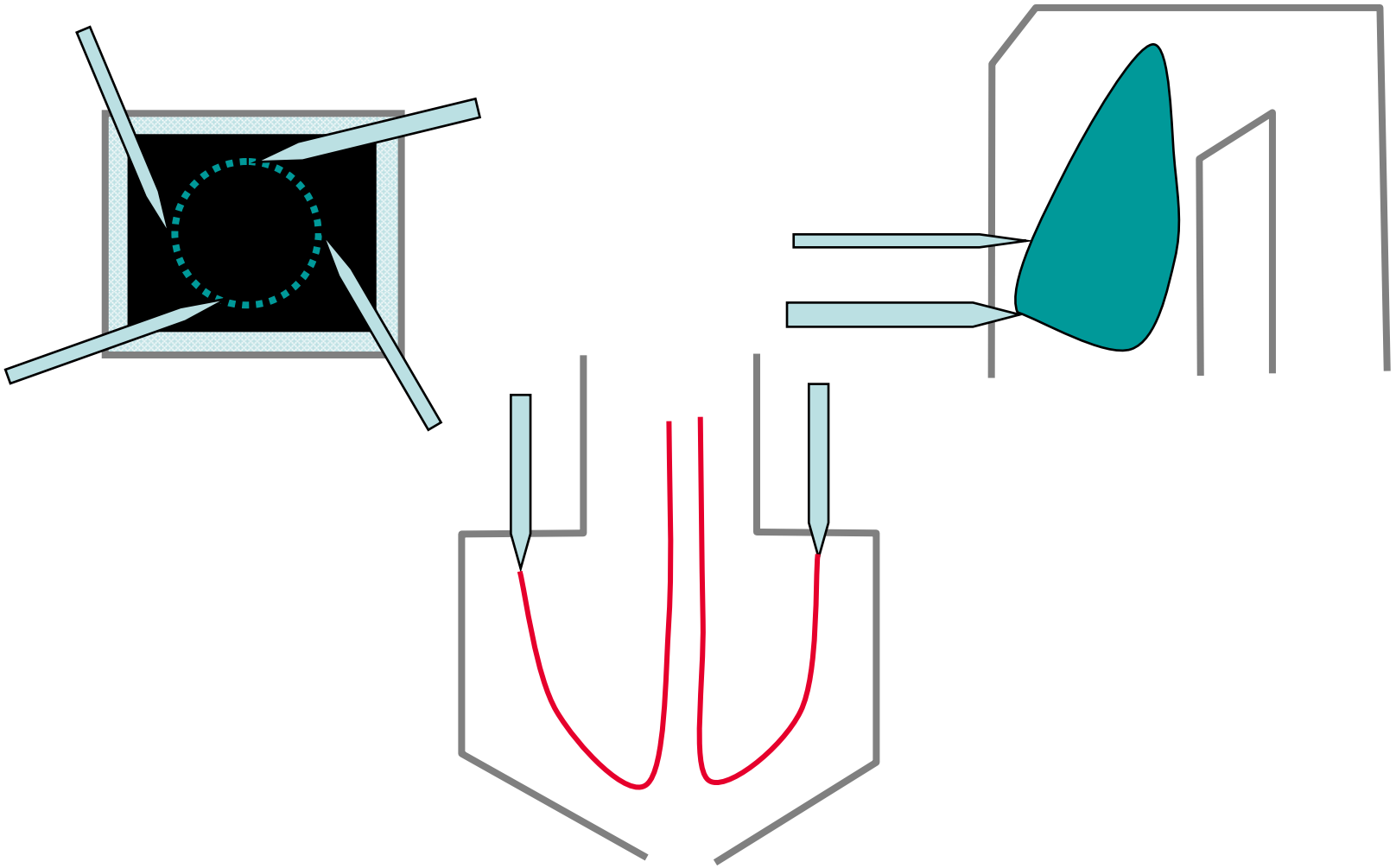
S-shaped coal ejector



Assembly of ejector into furnace



Arrangement of ejector

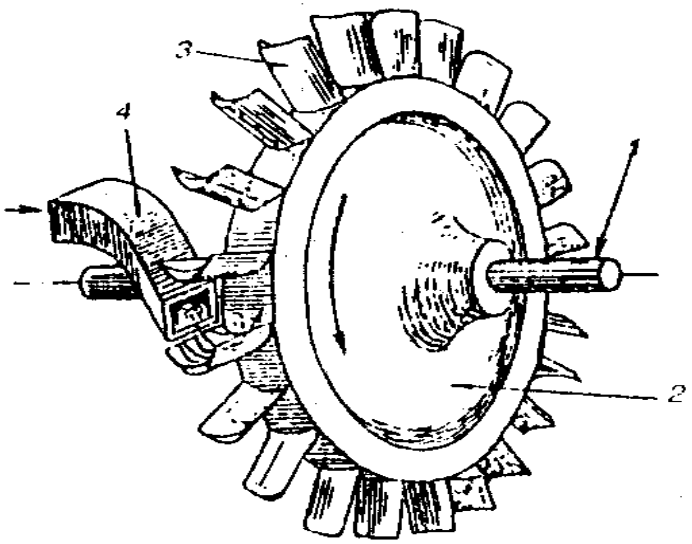


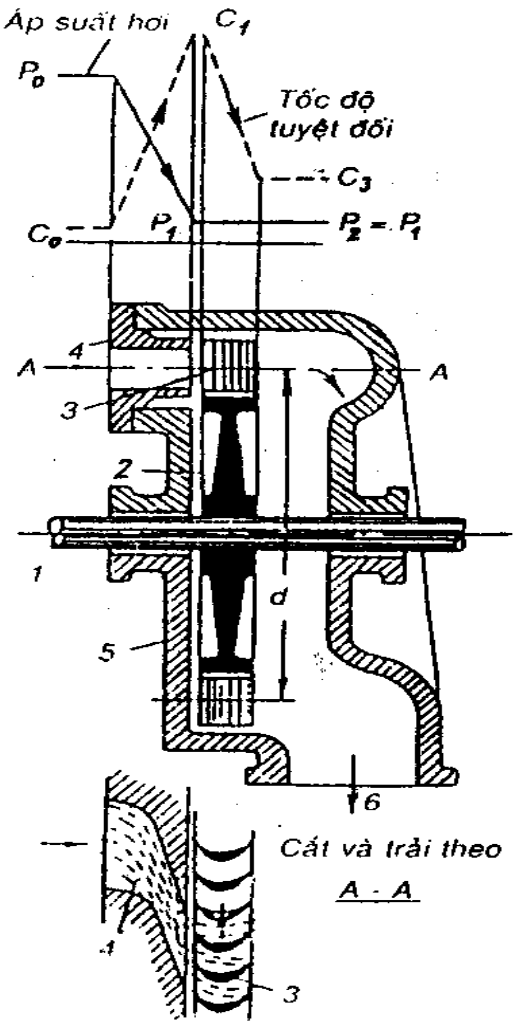
Steam turbine: components and operation principle

- A steam turbine is a device that extracts thermal energy from pressurized steam and uses it to do mechanical work on a rotating output shaft
- Turbine components: the combination of main devices and auxiliaries (turbine, condenser, superheater, pipe system, etc)
- Condenser is to condense the exhaust steam from the turbine for reuse in the cycle and to maximize turbine efficiency by maintaining proper vacuum.
- ……..

Scheme of Impulse Turbine

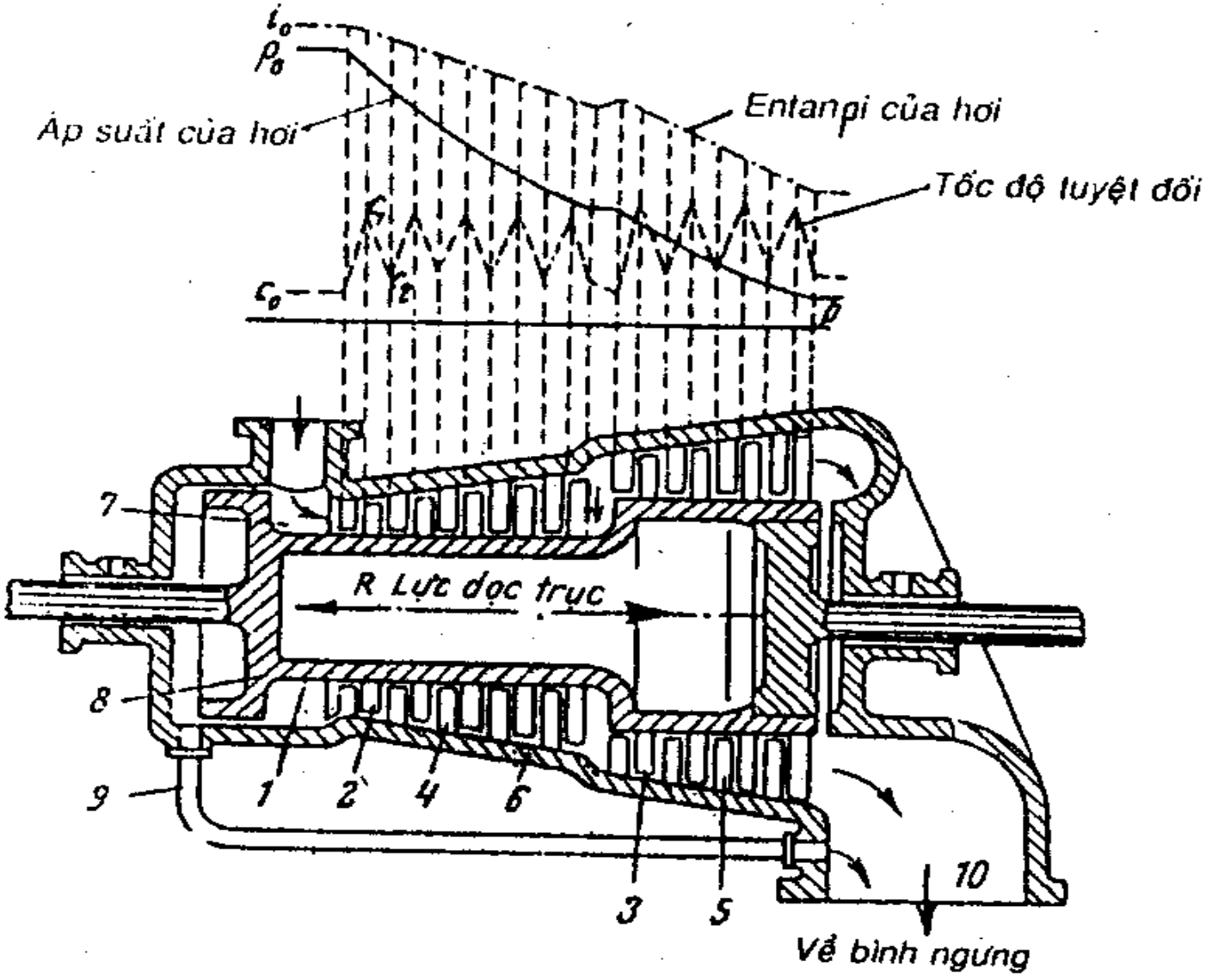
- *1-trục;*
- *2-đĩa;*
- *3-các cánh động;*
- *4-ống phun;*
- *5-thân máy;*
- *6-ống thoát.*



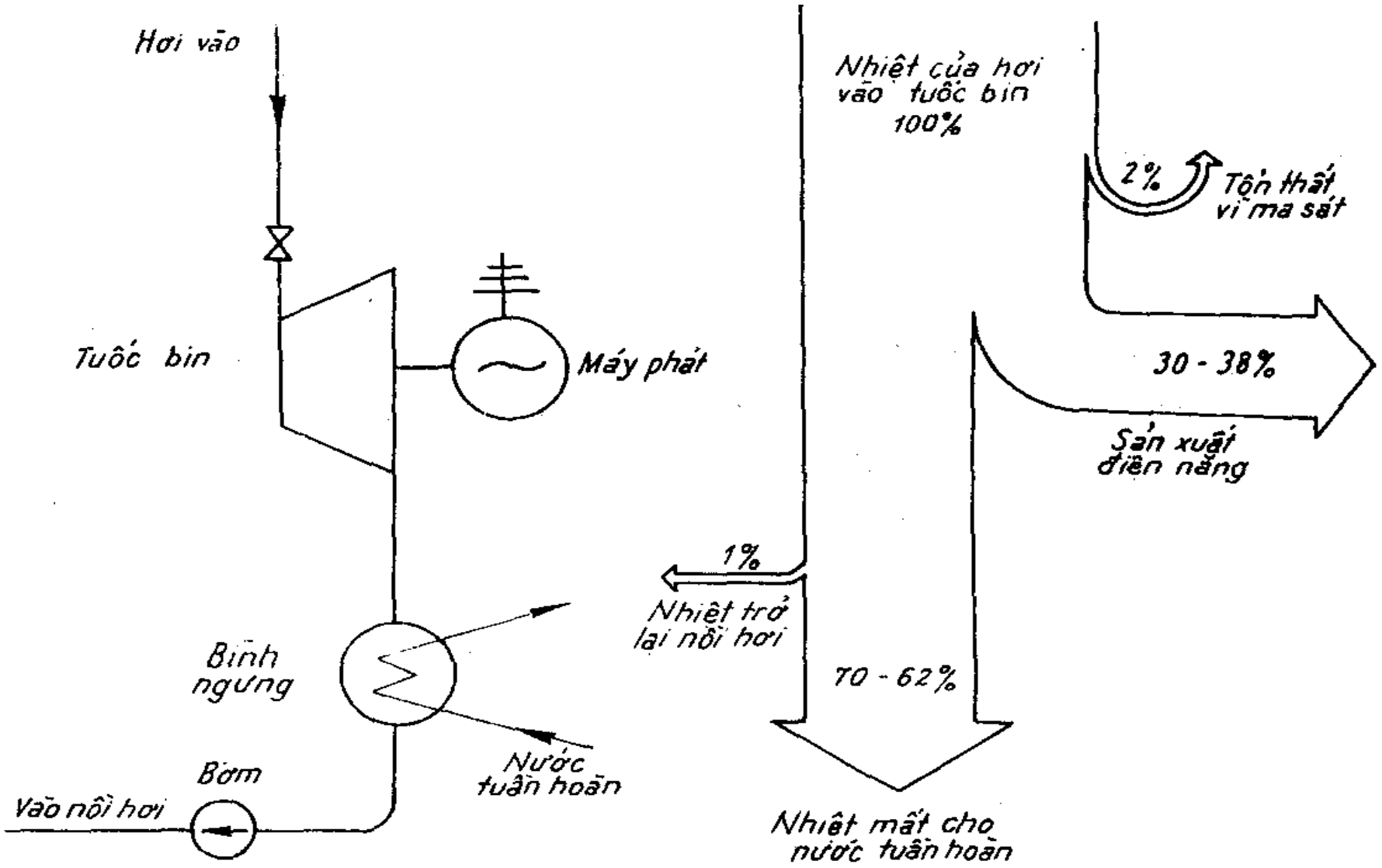


Prototype steam turbine

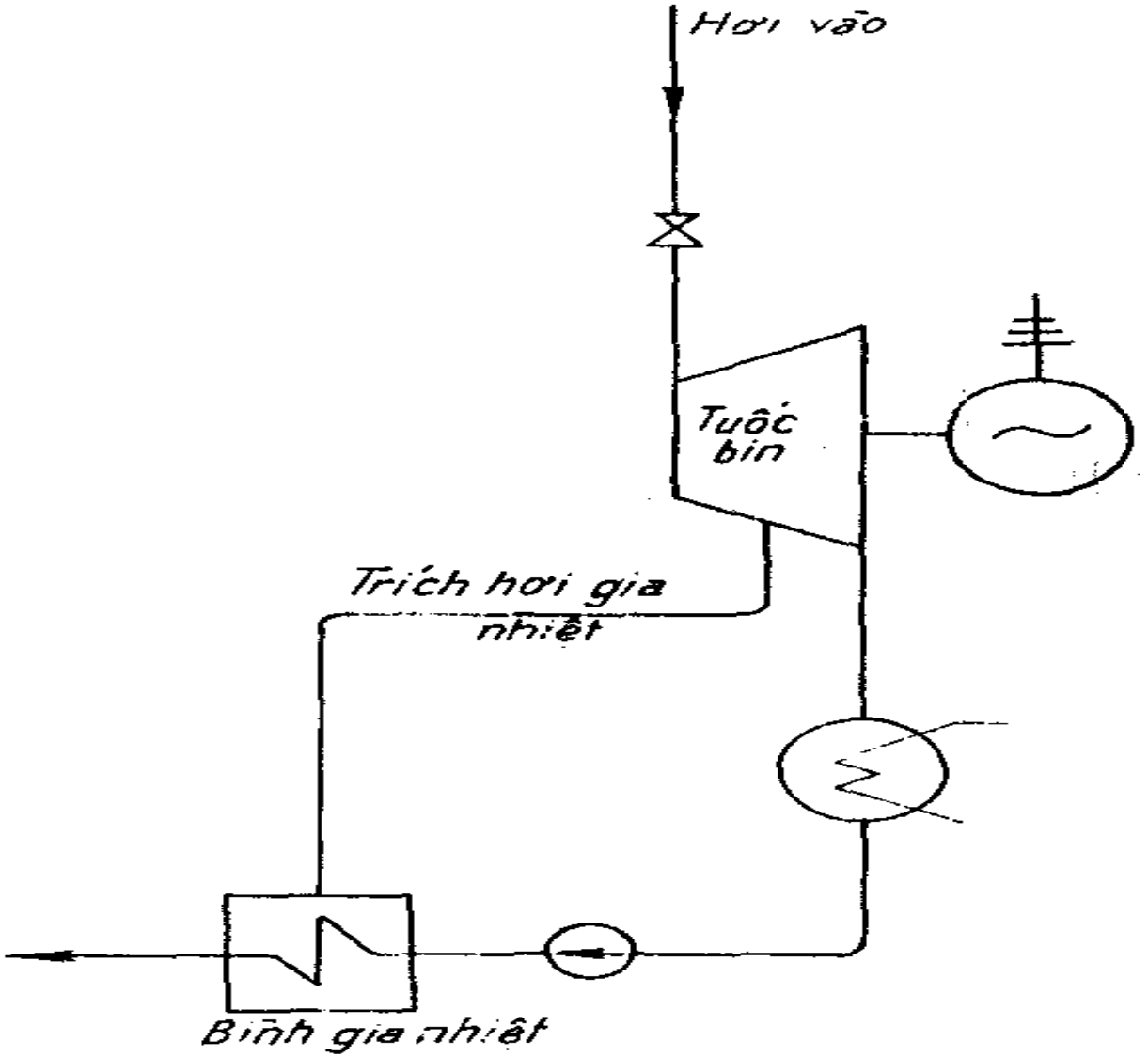
1-tang rụto;
2 và 3-cánh động;
4 và 5-cánh hướng;
6-thân máy;
7-buồng hơi mới;
8- Pittụng giảm tải
để giảm bớt áp lực dọc trục;
9-ống dẫn hơi;
10-ống thoát.



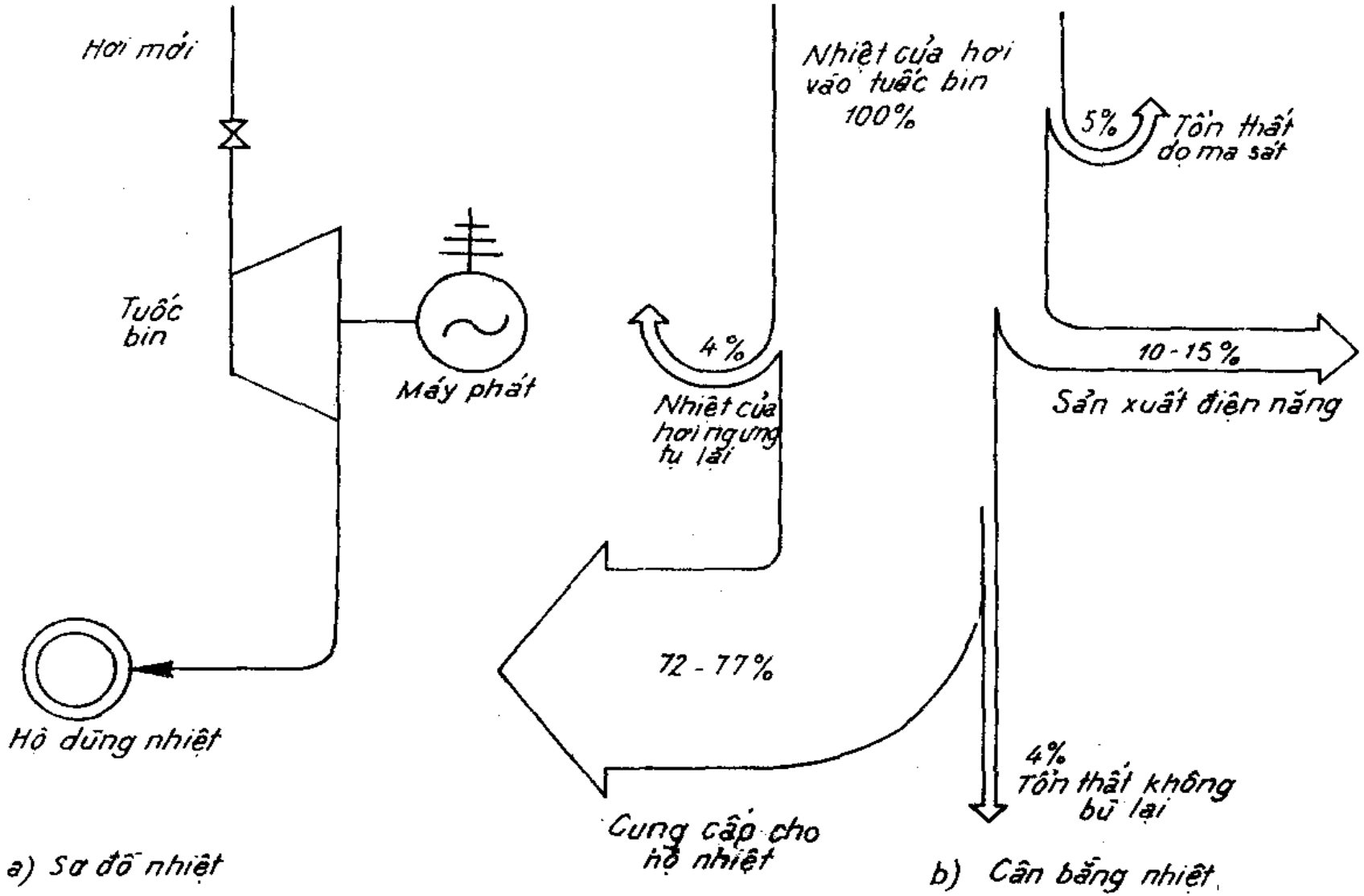
Heat diagram of steam turbine (1)



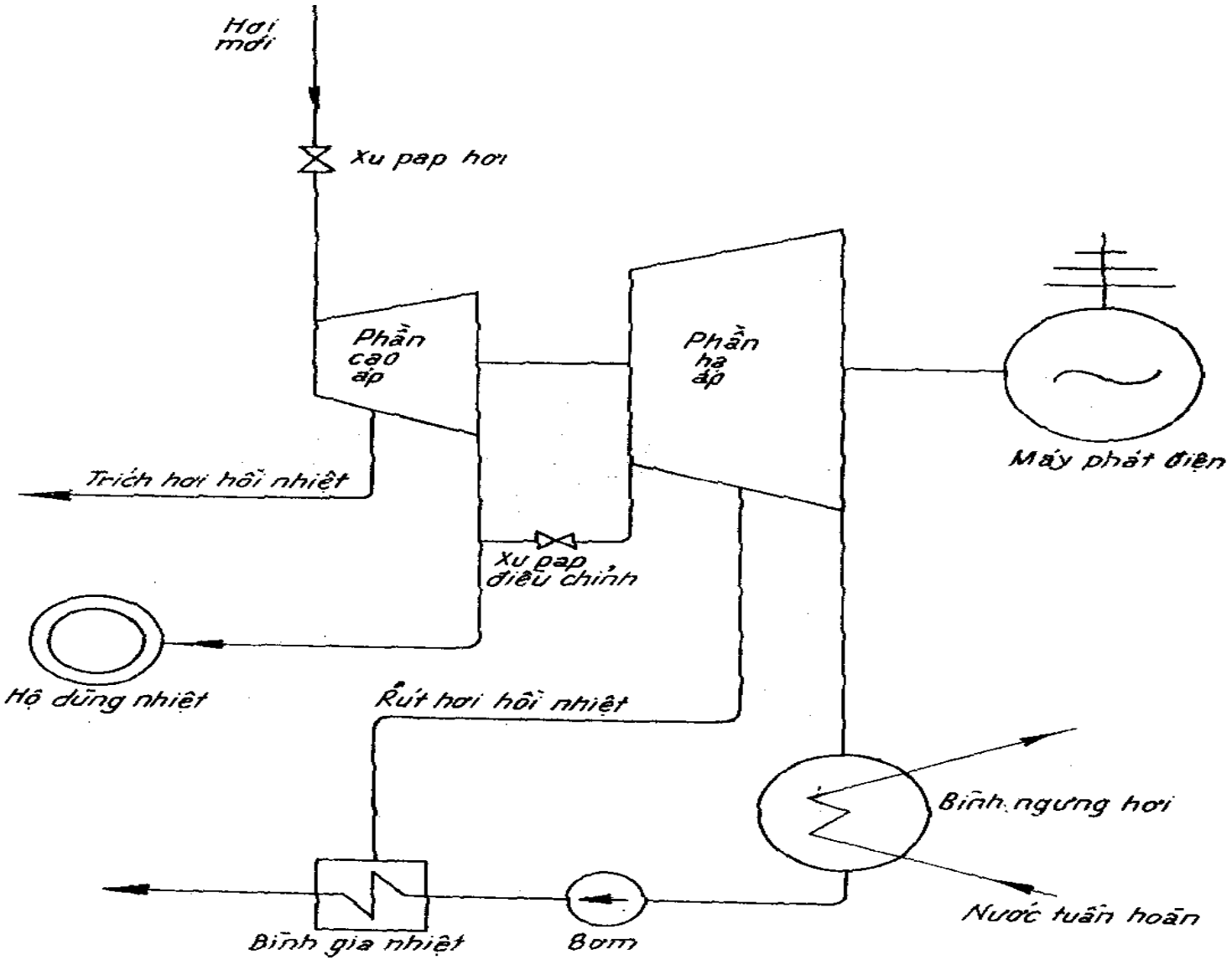
Heat diagram of steam turbine (2)



Heat diagram of steam turbine (3)



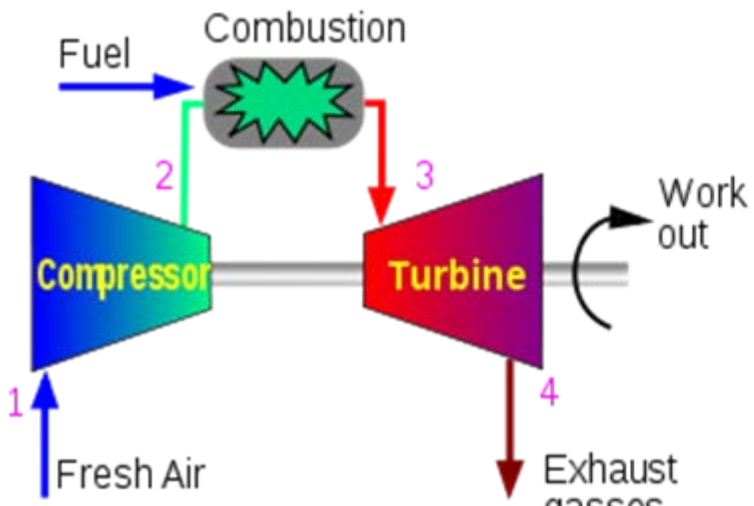
Heat diagram of steam turbine (4)

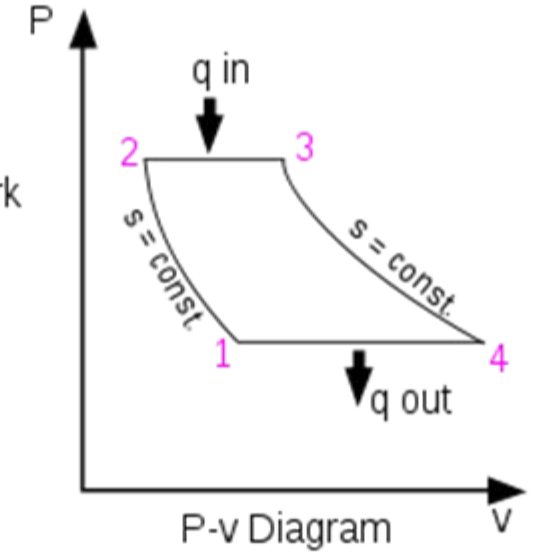


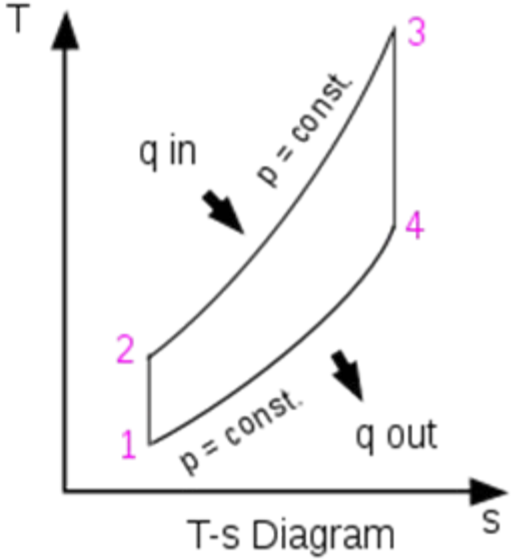
Wing shape of steam turbine

Brayton cycle

Brayton cycle is used in gas turbine (thermal power plants)







Brayton cycle:

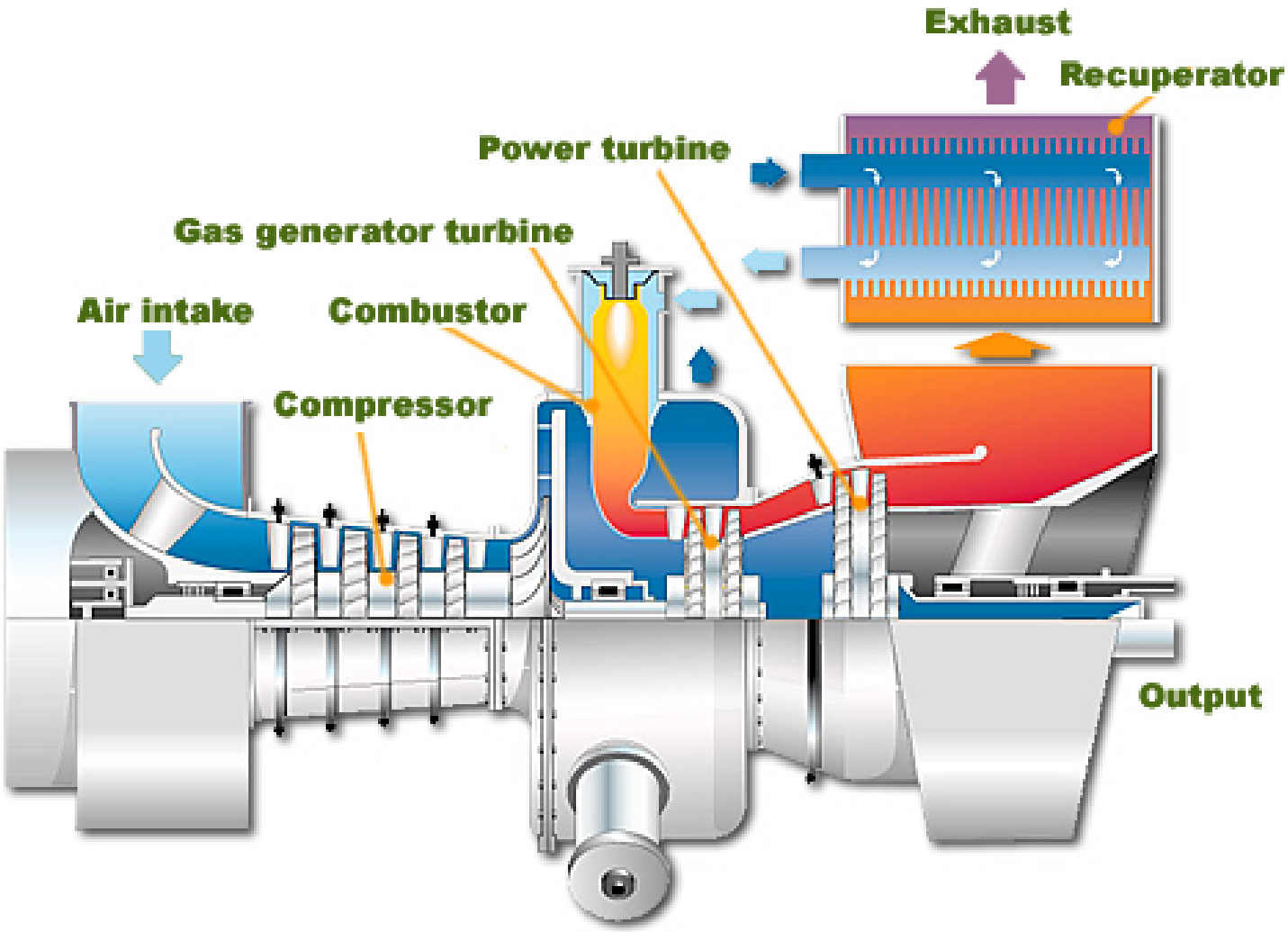
The required work Win to drive the compressor is comparable to the gross turbine work so that the rest useful work Wout to drive the generator becomes relatively small

The efficiency of gas turbine is lower than that of steam turbine. The exhausted gas is not returned to the compressor, but rejected to the environment, although its high temperature (450oC-600oC). Brayton is often combined with Rankine cycle

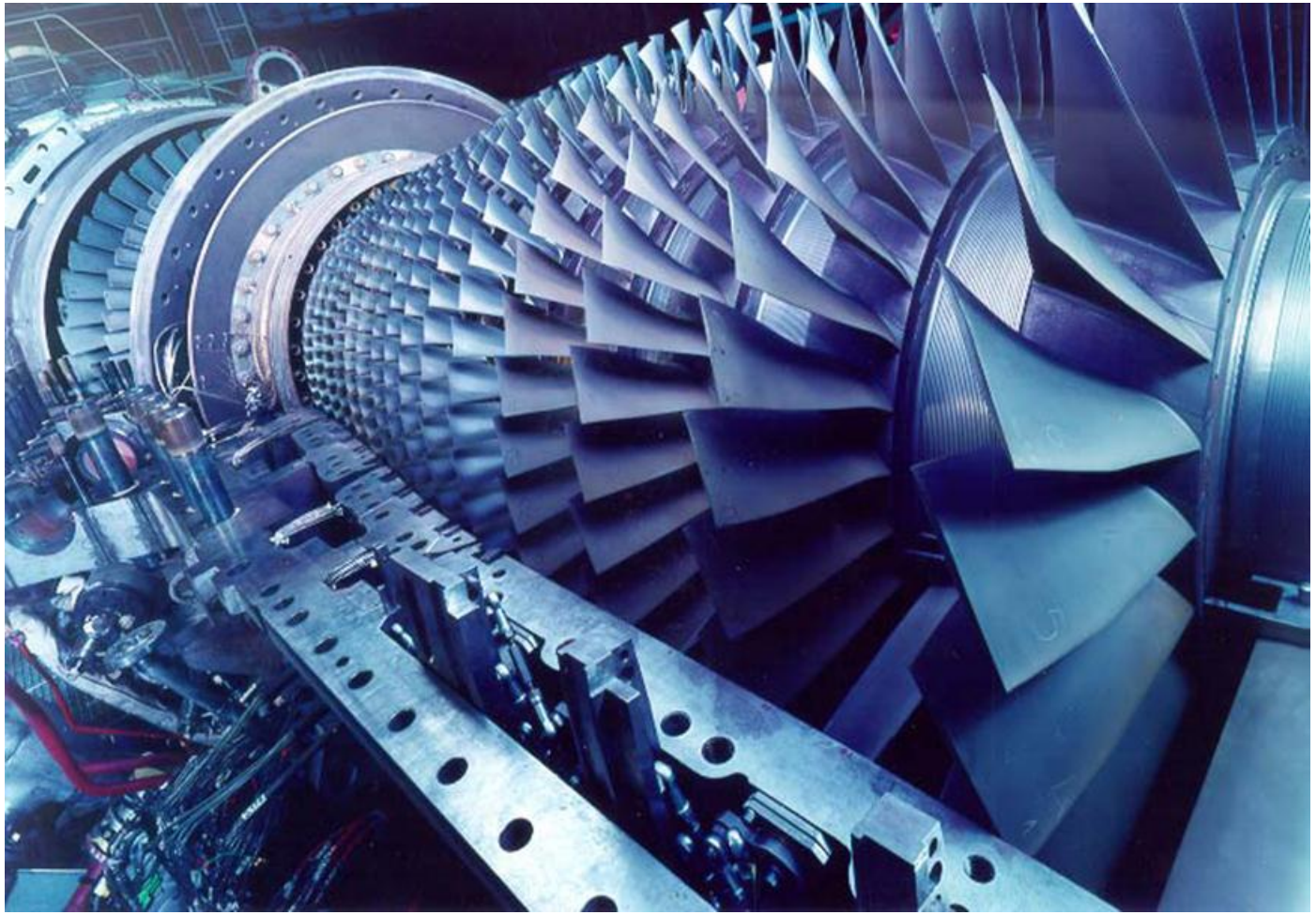
Gas turbine can not use solid fuels

The electricity generation cost by gas turbine is quite high → for peak time

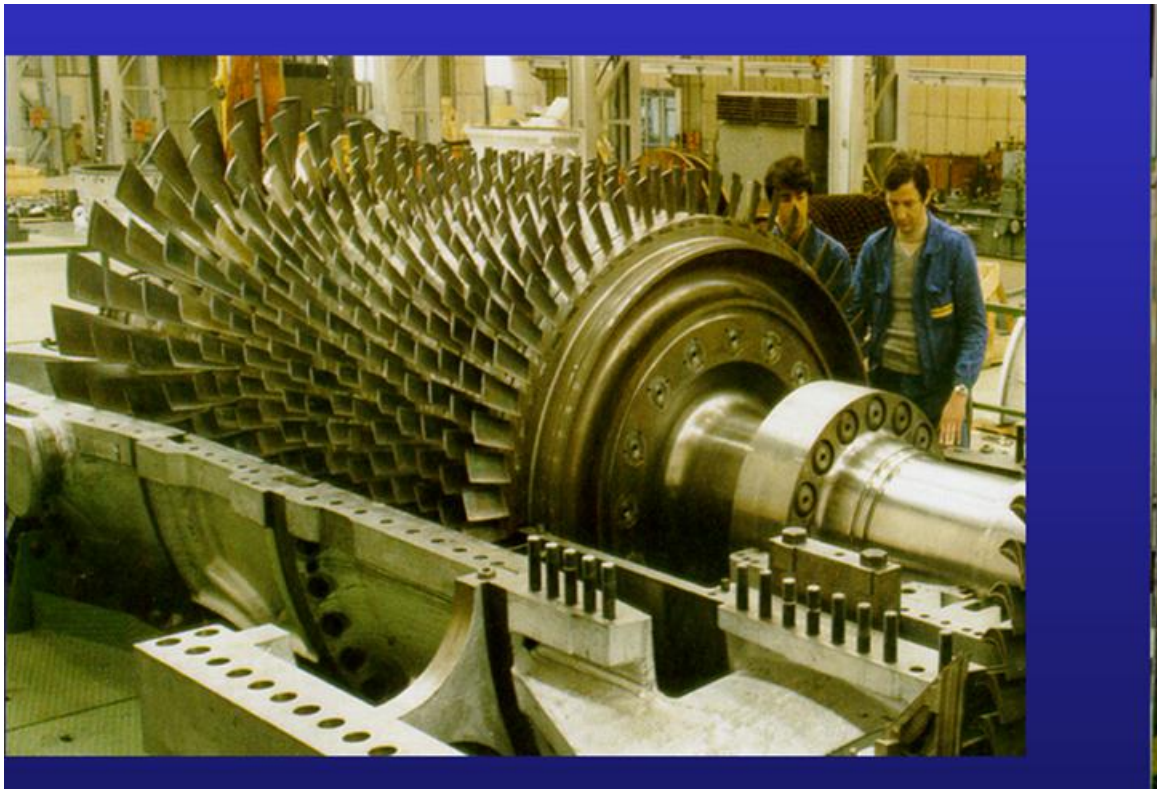
Components and working principle of gas turbine



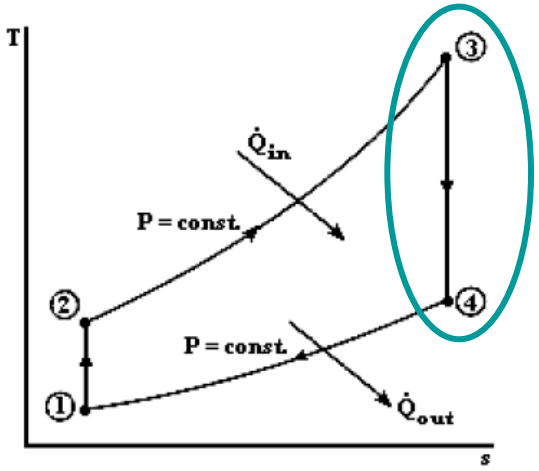
Structure of compressor

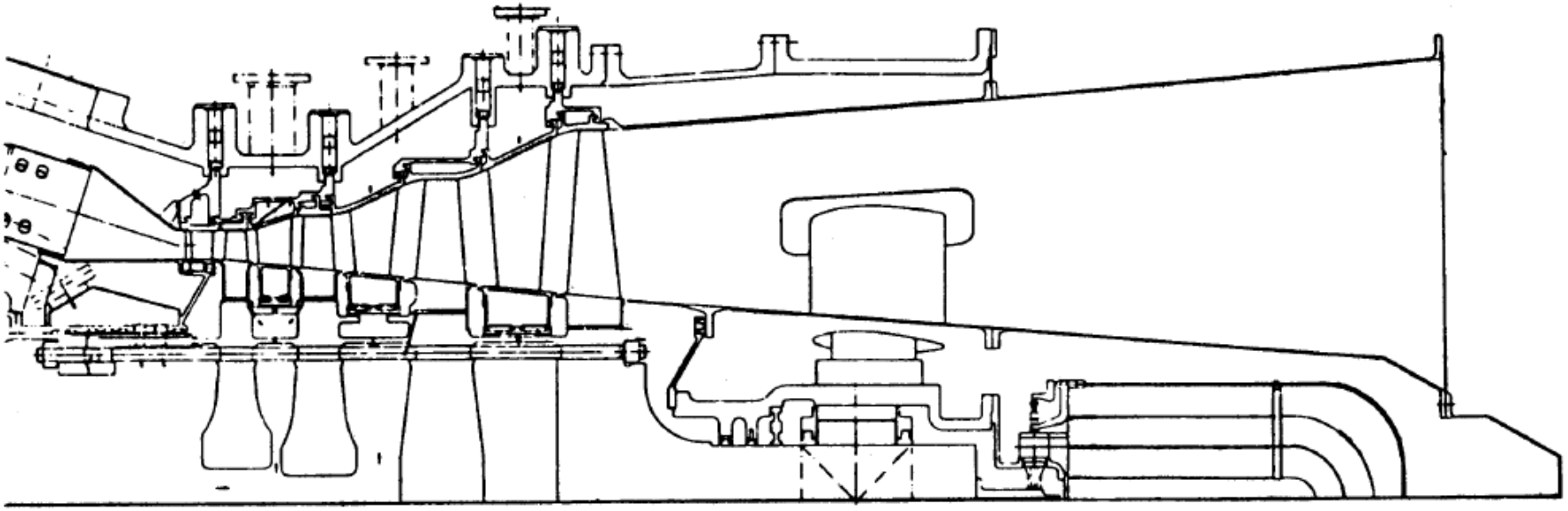


Structure of compressor

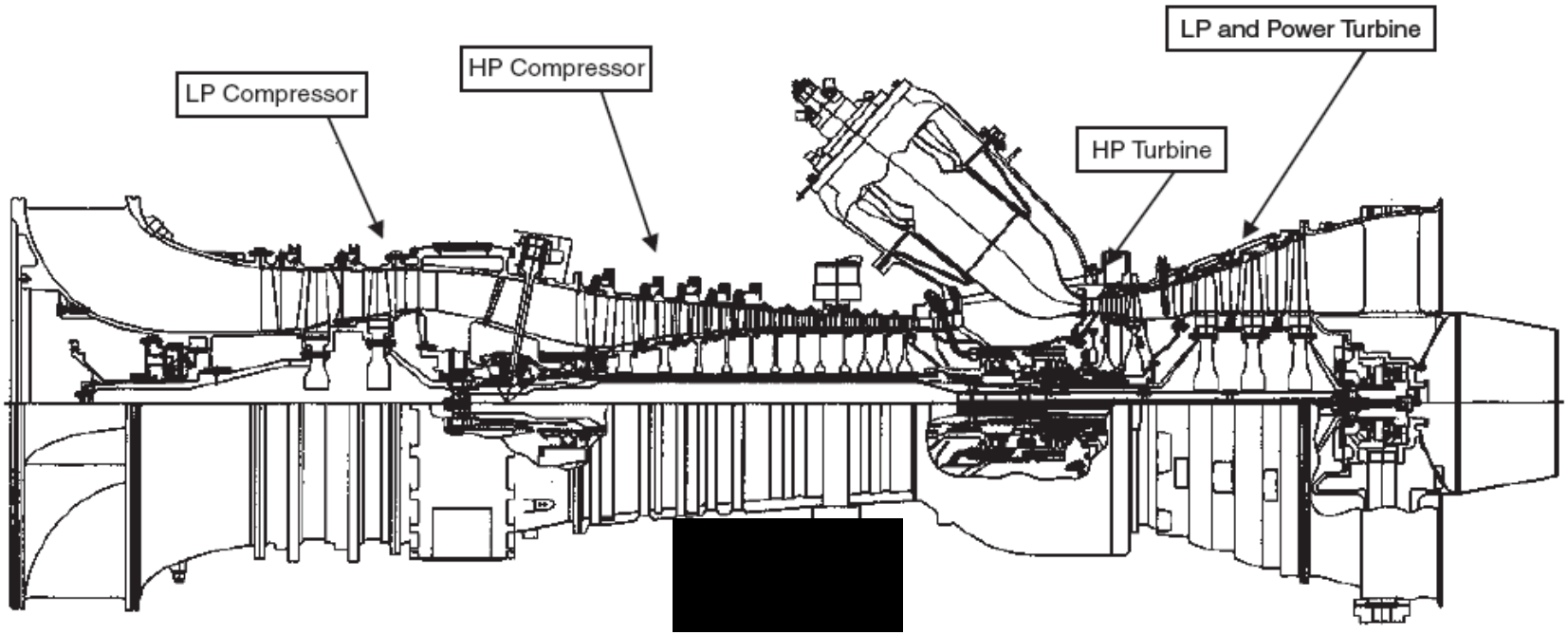


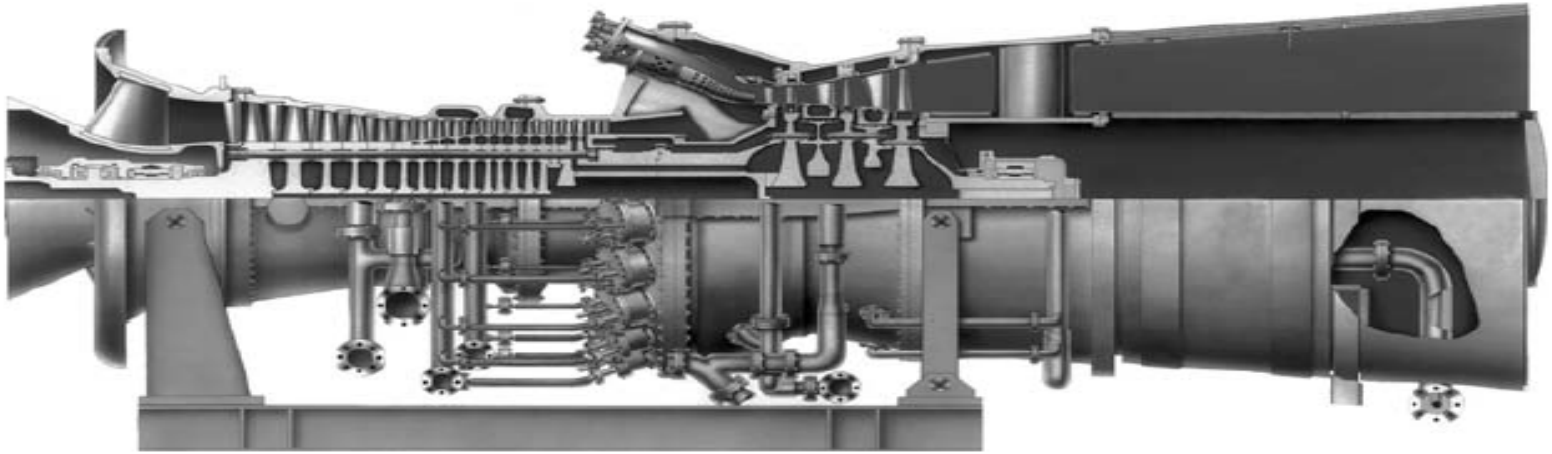
Longitudinal section of four-layer wing gas turbine



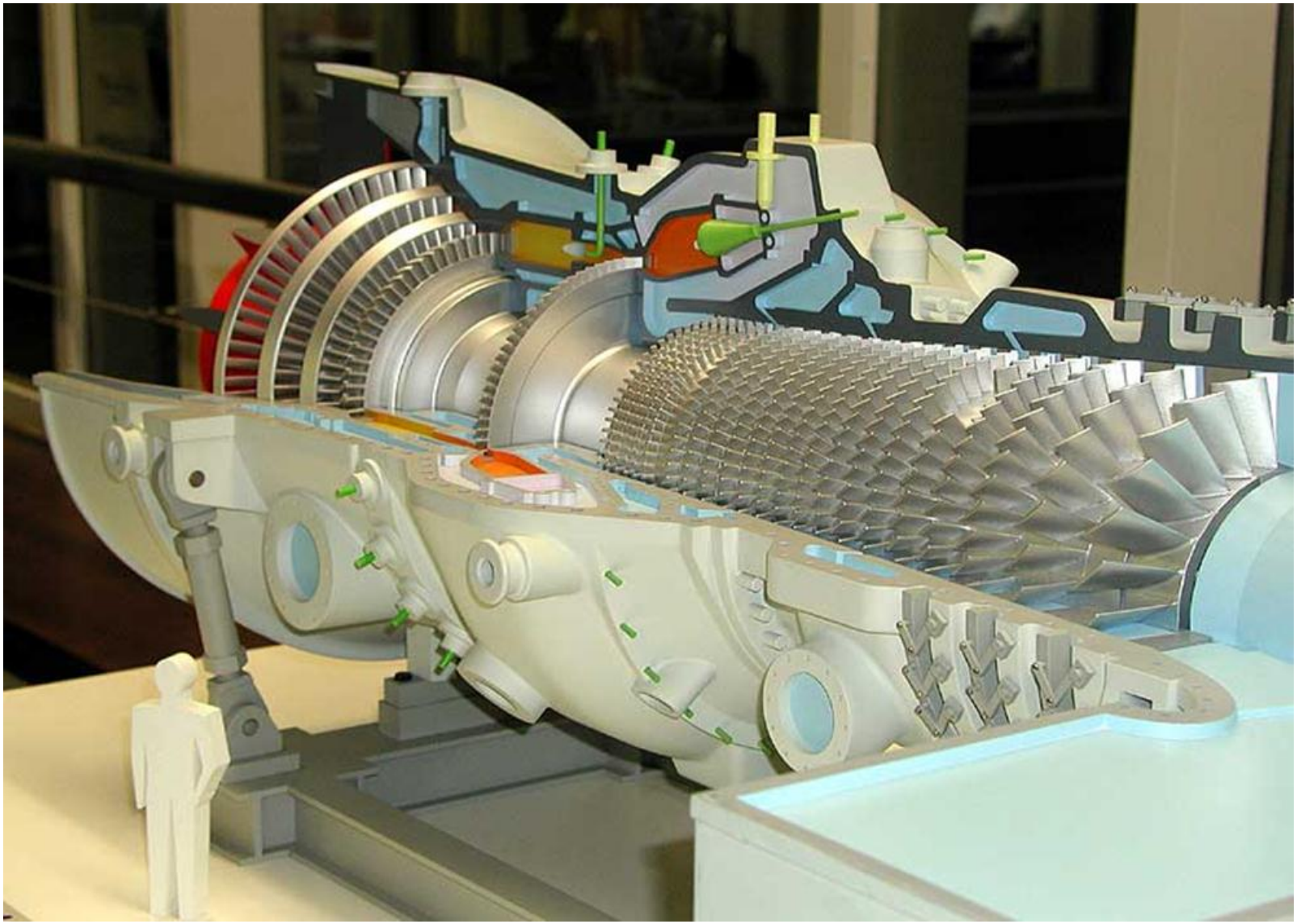


Longitudinal section of gas turbine

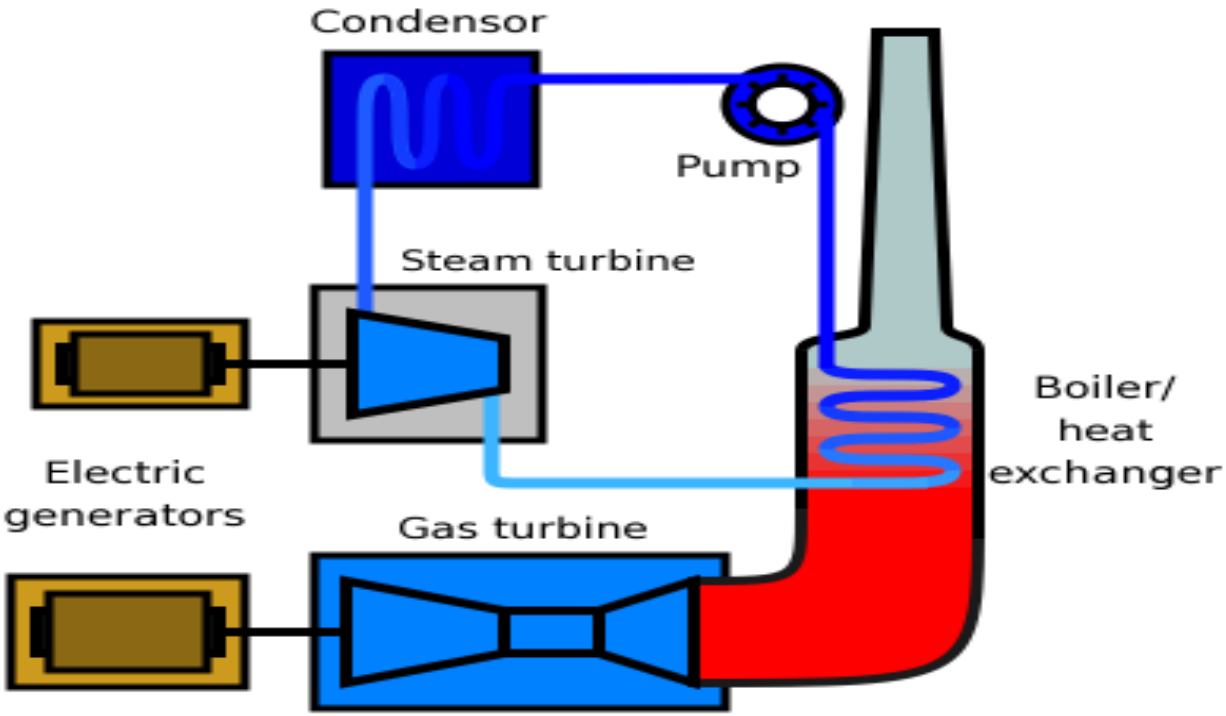




Overall structure of gas turbine



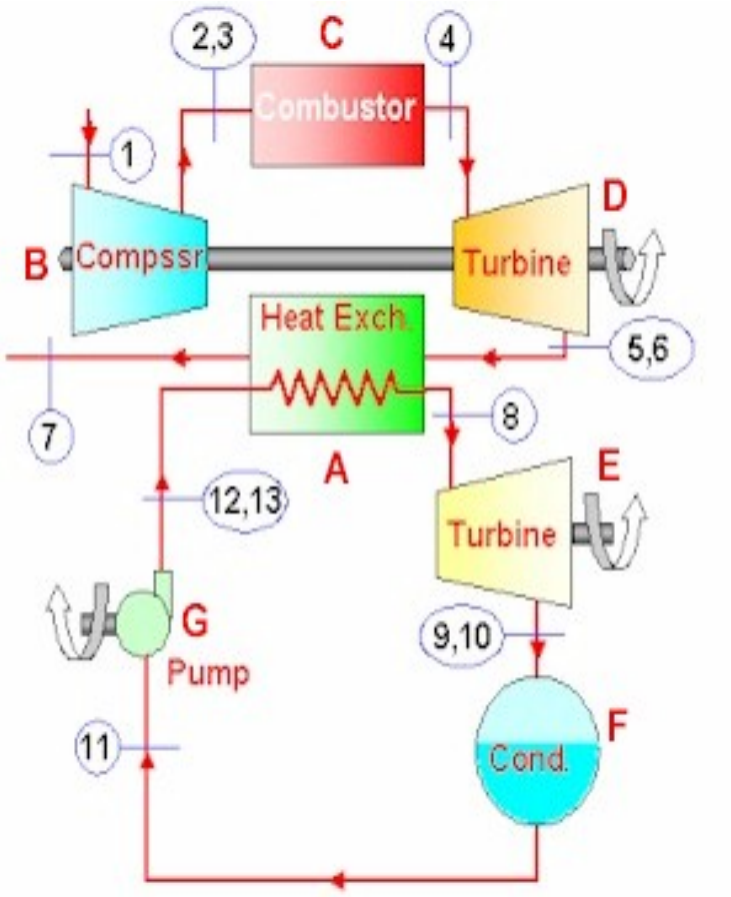
Combined Cycle

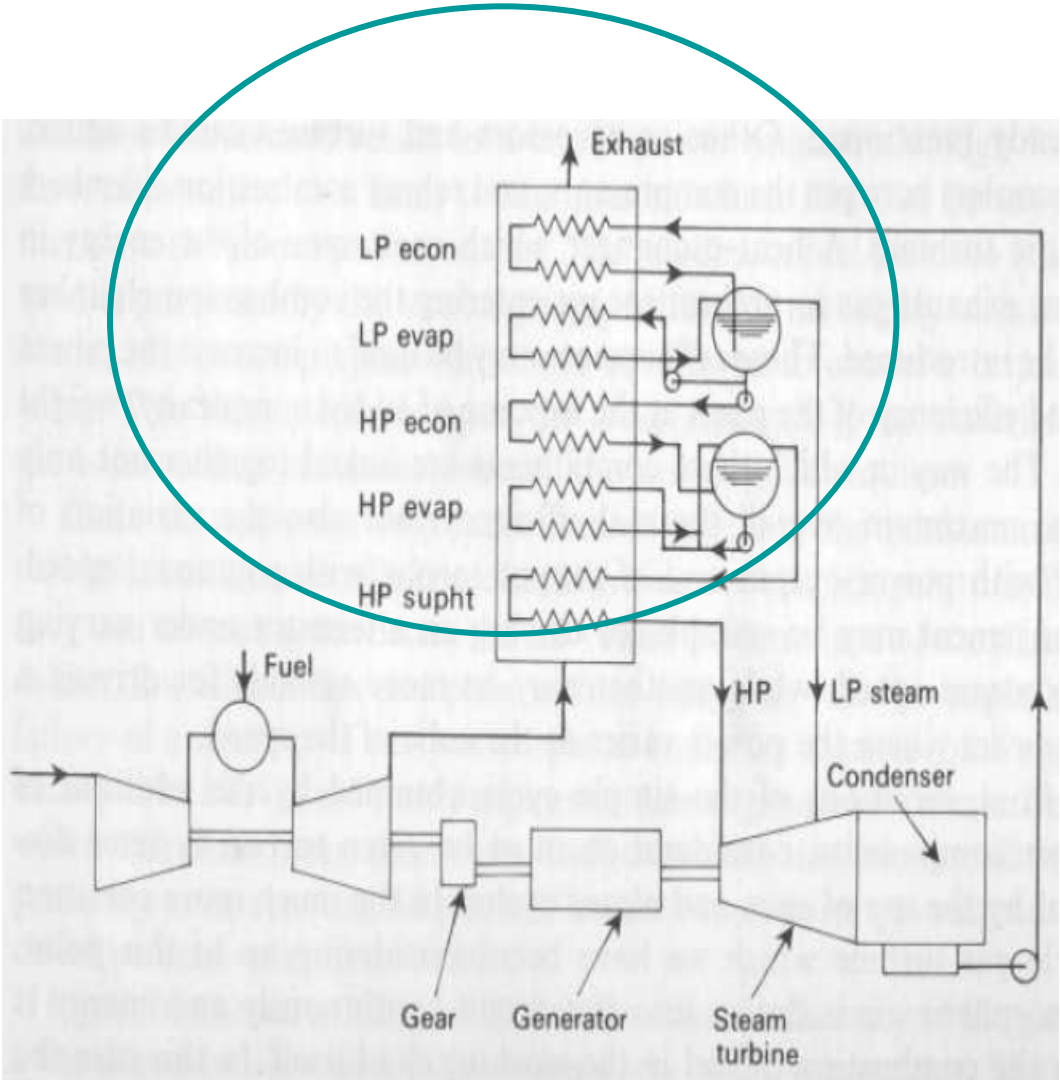


Combined cycle is used in steam-gas turbine power plants, where Rankine cycles is used simultaneously with Brayton cycle.

The overall thermal efficiency is better than that of the single Rankine cycle

Scheme of combined cycle





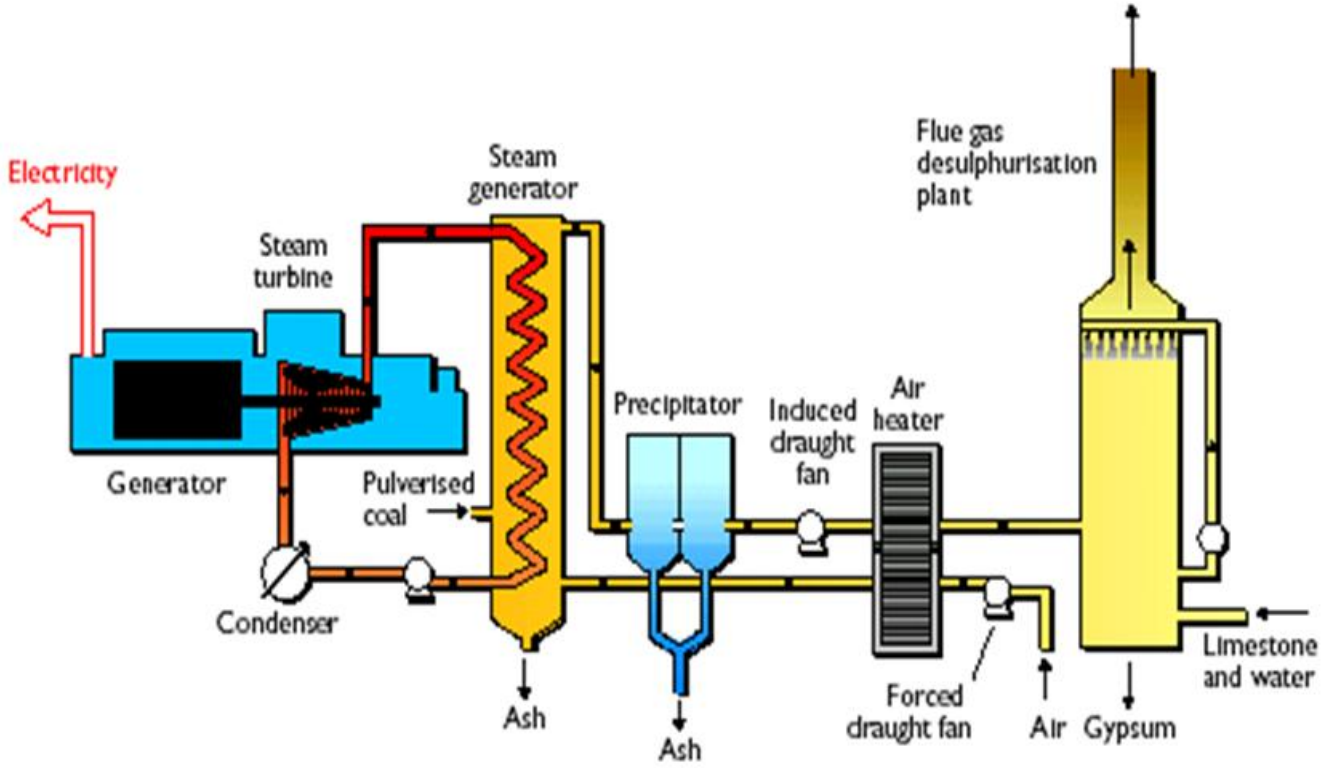
Advantages of conventional power plants

- Conventional power plants are able to produce large scale electricity
- Electricity generation in larger scale can lead to higher plant efficiency and more economical production.
- Technologies of conventional power plants are well proven and mature.
- Researches and developments are out continuously to guarantee carried higher efficiency, less fuel consumption, less pollutants and lower production cost.

Problems and challenges

- Fossil fuel resources are depleting rapidly
- Fossil fuel combustion emits more CO2, SO2, NOx , PM than renewable sources
- Gaseous fuels are the best one, very suitable to be utilized for multi-purposes
- Solid fuels are the worst one because they burn hardly and slowly
- Liquid fuels are appropriately used as transportation fuels.
- Do not use high sulfur and low heat capacity coal

Techniques reducing exhaust fumes when using solid fuel

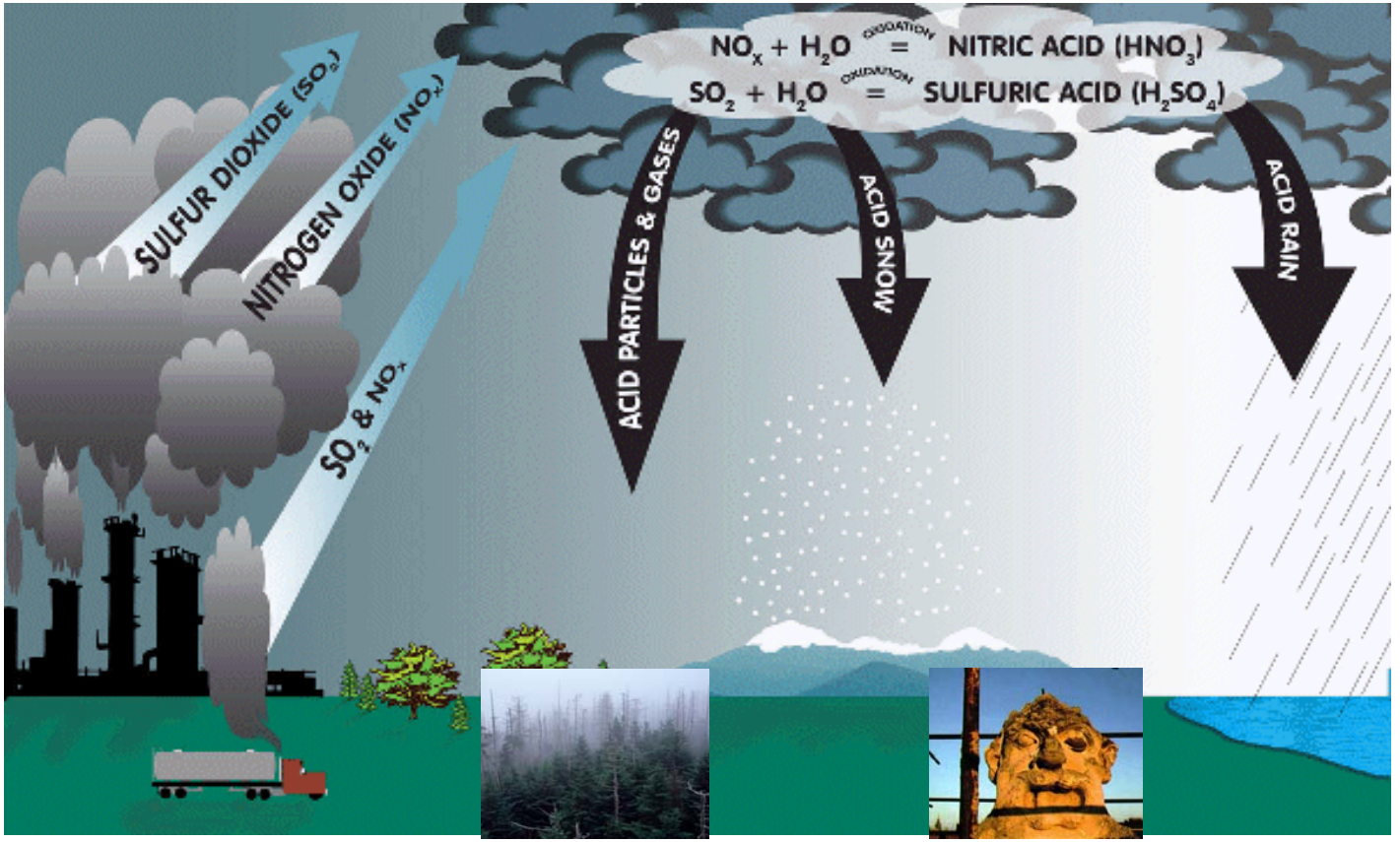


Outline

- **NOx generation mechanism and treated techniques in exhaust fumes**
- **Mechanism generating SO_2 and diminishing technology**

- NO, NO_2 (NO_x), SO_2,

- Have bad effects to Human
- Have bad effects to living environment
- Have bad effects to technical devices



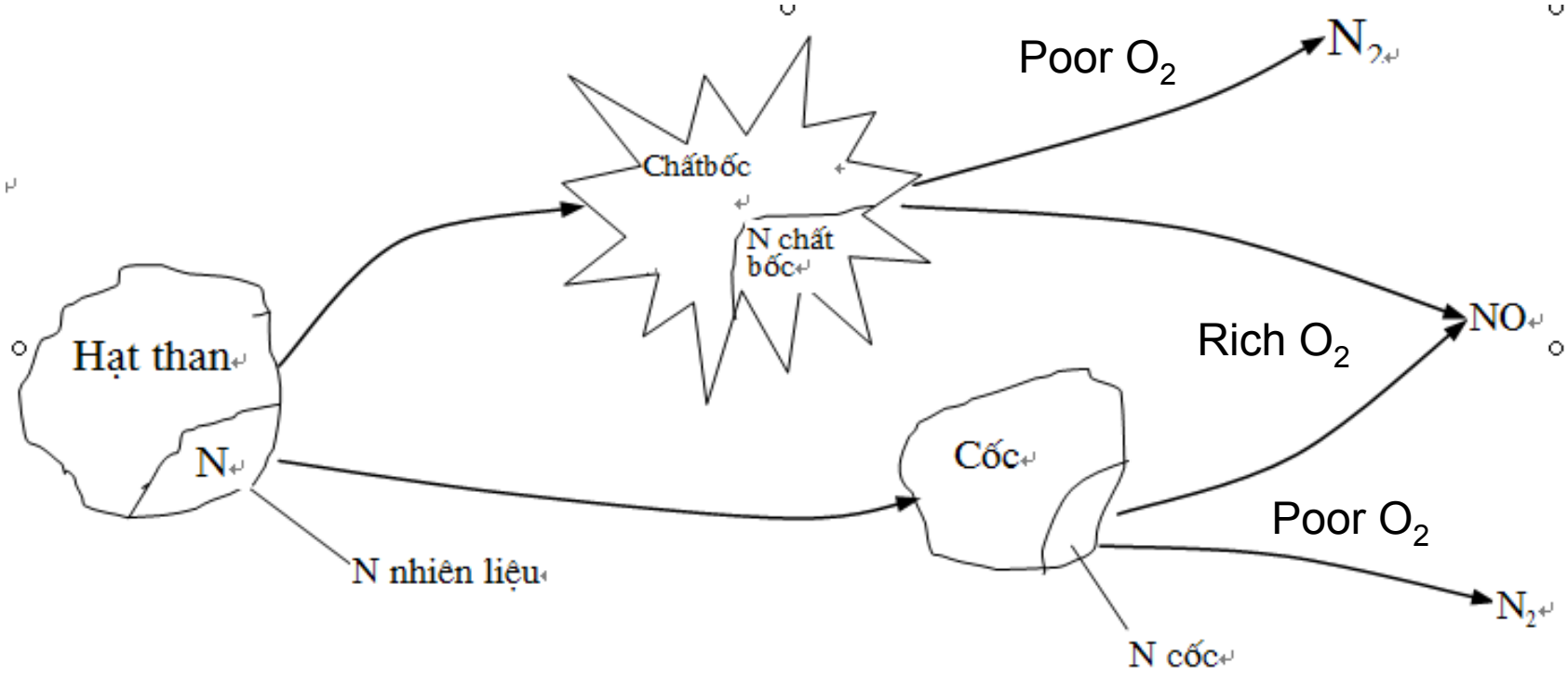
NO_x generation mechanism and treated techniques in exhaust fumes

NOx generation mechanism

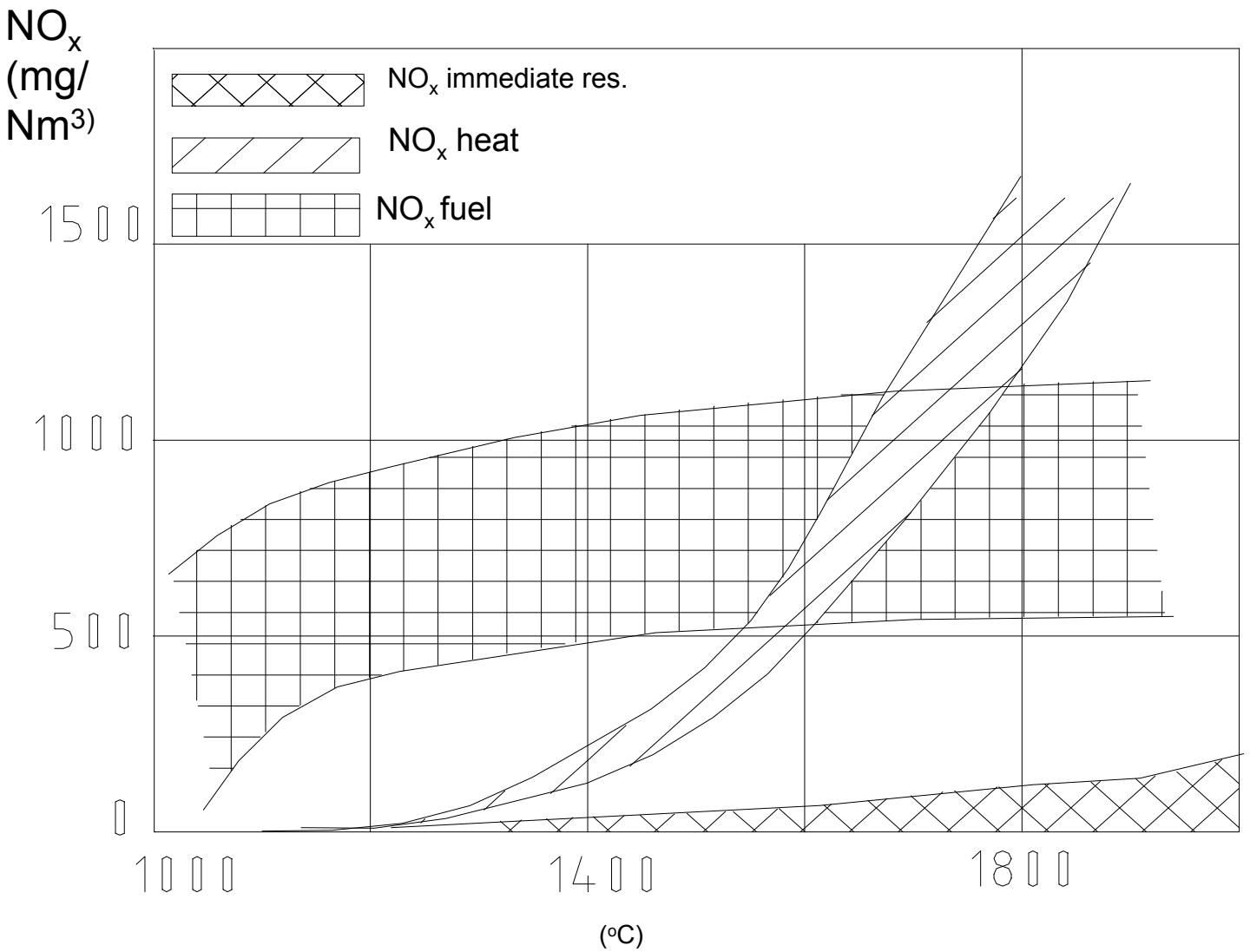
When coal burnt above 1000 ^oC, NO_x is generated, in which NO is more than 90%, while NO_2 is 5 ÷10%.

1. Heat disintegrate mechanism
2. Mechanism generating NO_x fuel
3. Immediate response mechanism

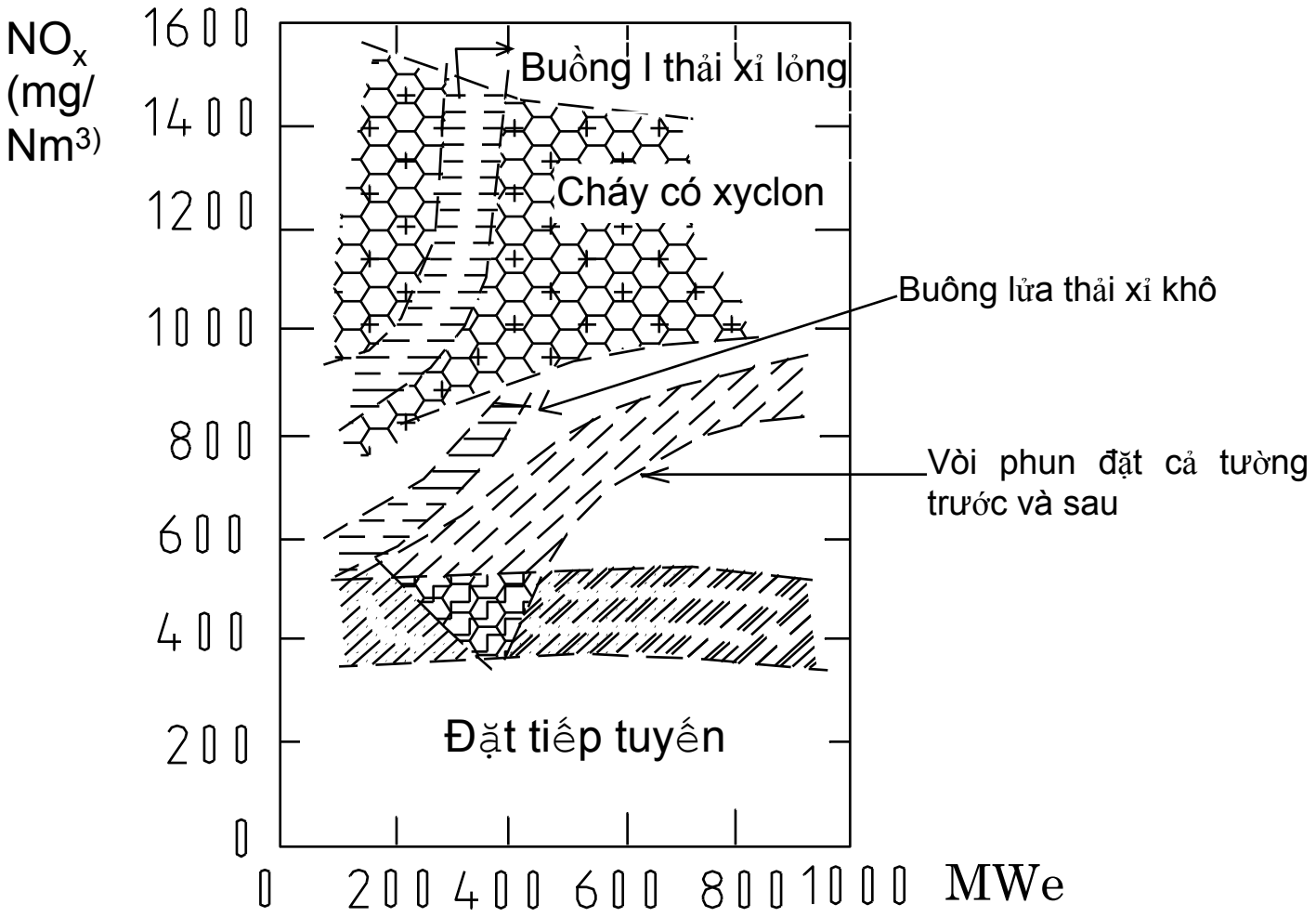
NO_x generation Mechanism



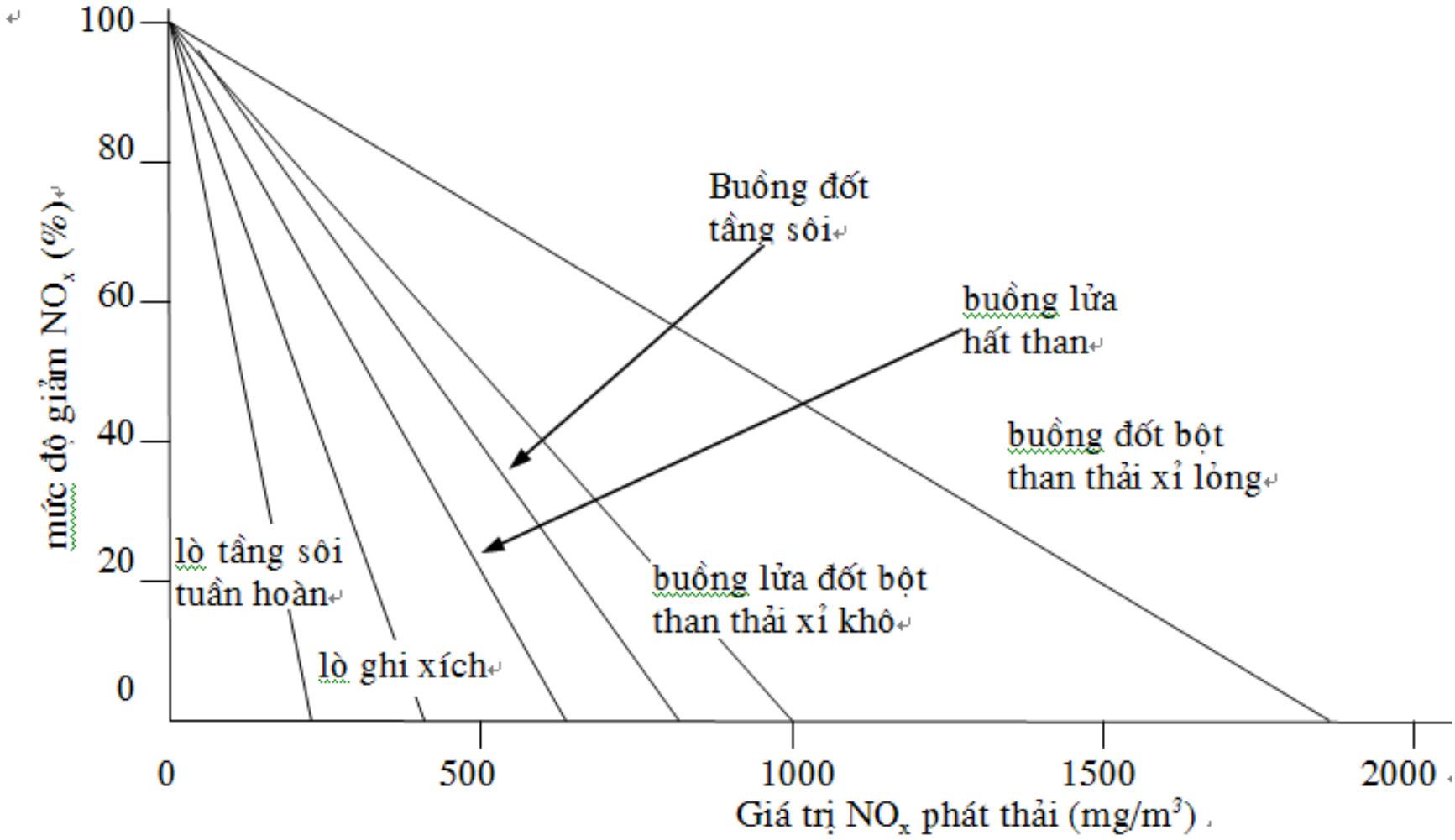
Comparison in 3 mechanisms



NO_x in coal burning method in traditional technologies



NOx reduction efficiency



NOx generated much depends on burning conditions

Low-concentration NOx burning technique

Requirements:

- Reduce NOx in environment standards

- Not affect to the stability of the burning process

- Guarantee a high burning efficiency

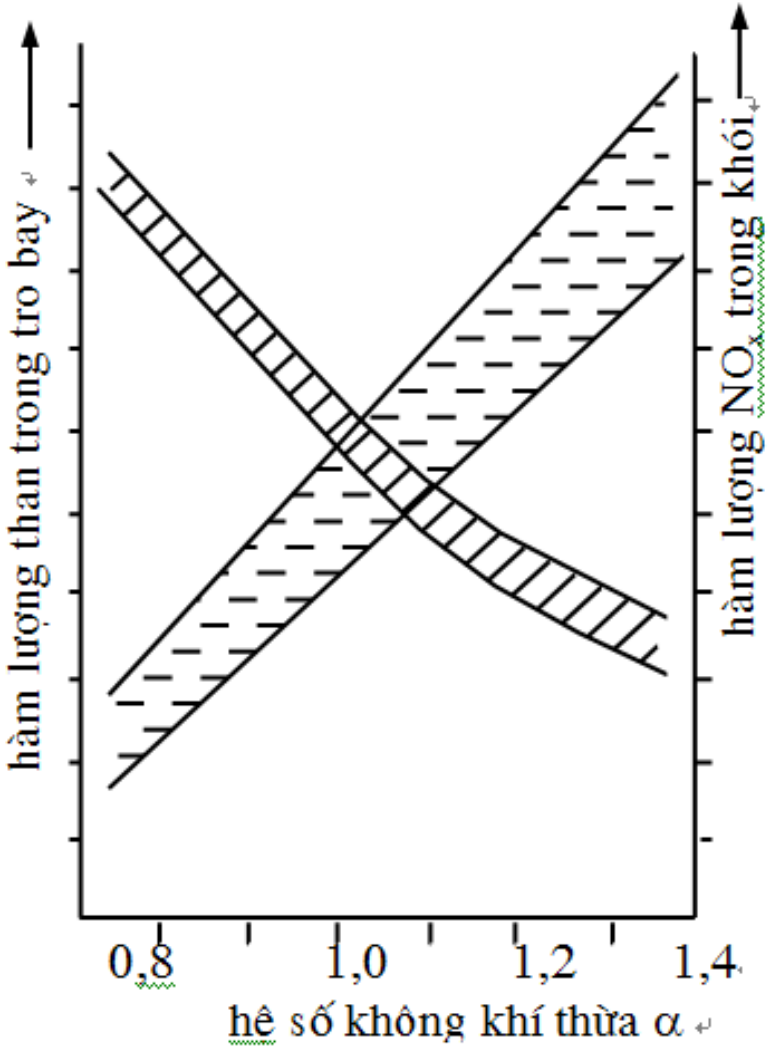
- Not to revert to the original state of CO_2

1) Burning with low redundant air coefficient

The simplest method

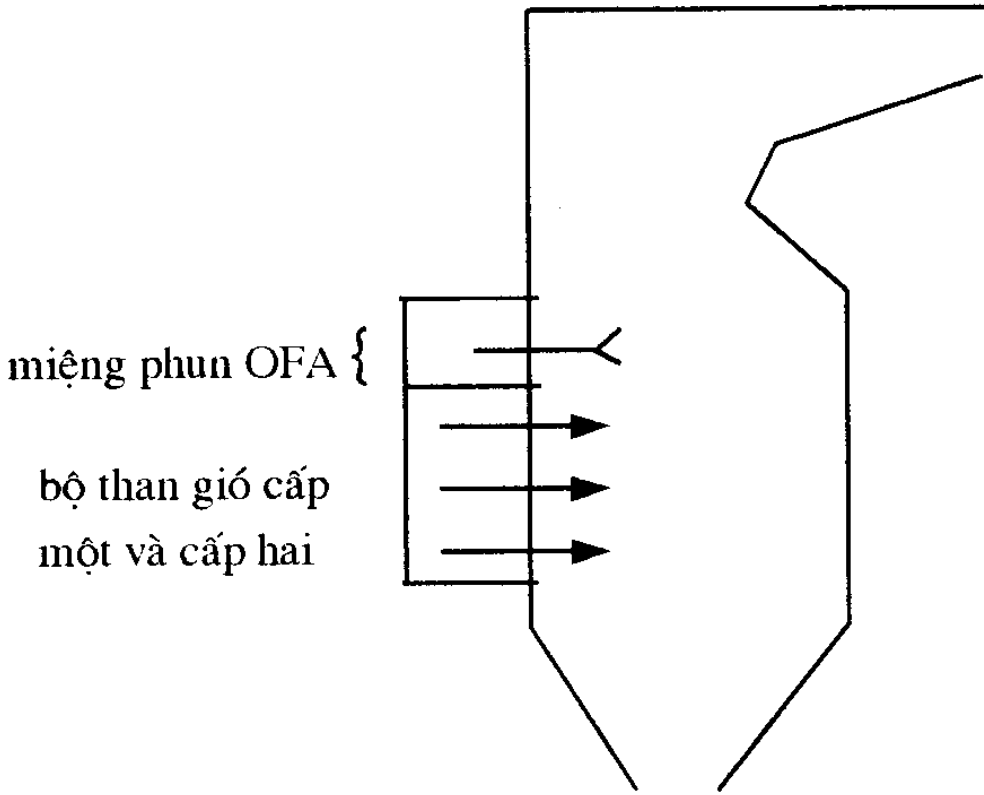
Can reduce 15% NOx quantity

should select a reasonable value for the coefficient

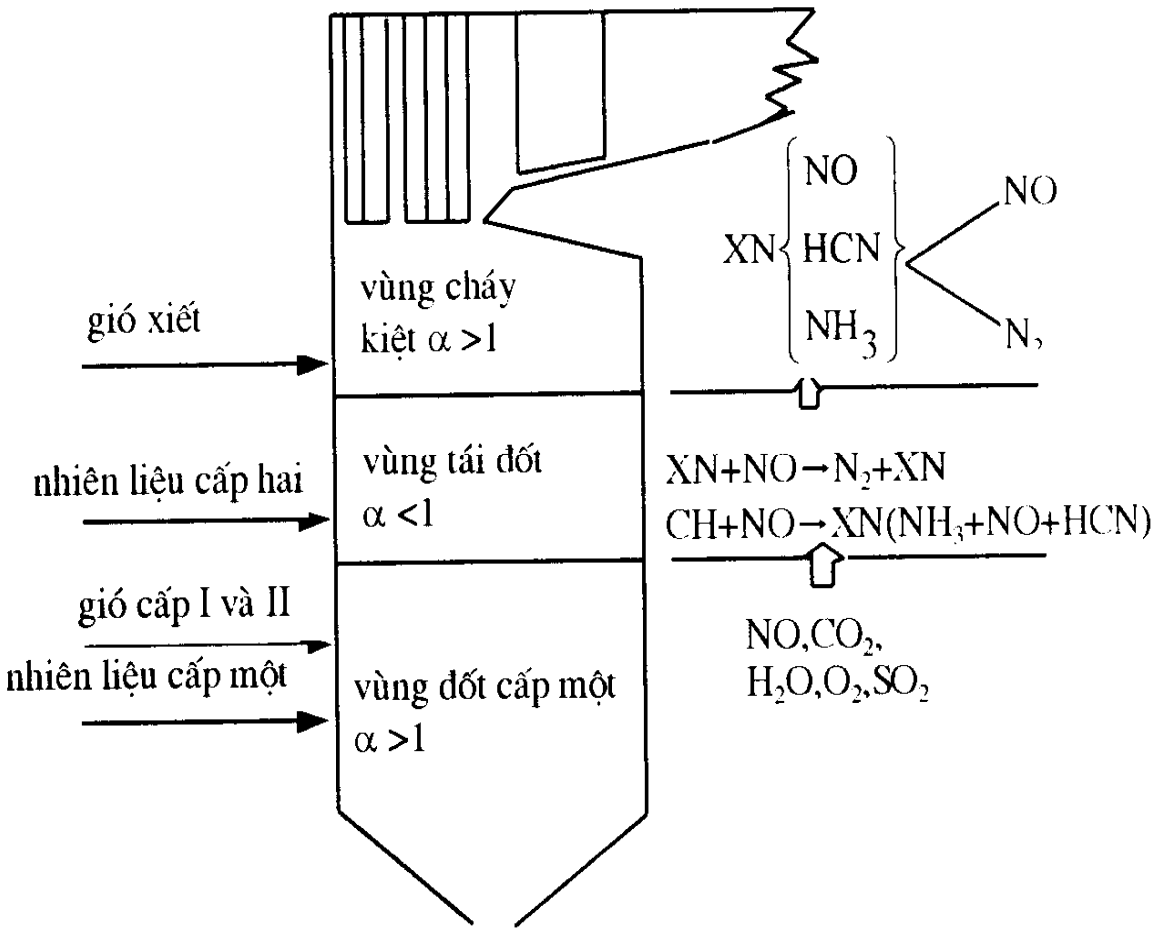


2) Burning with various air levels

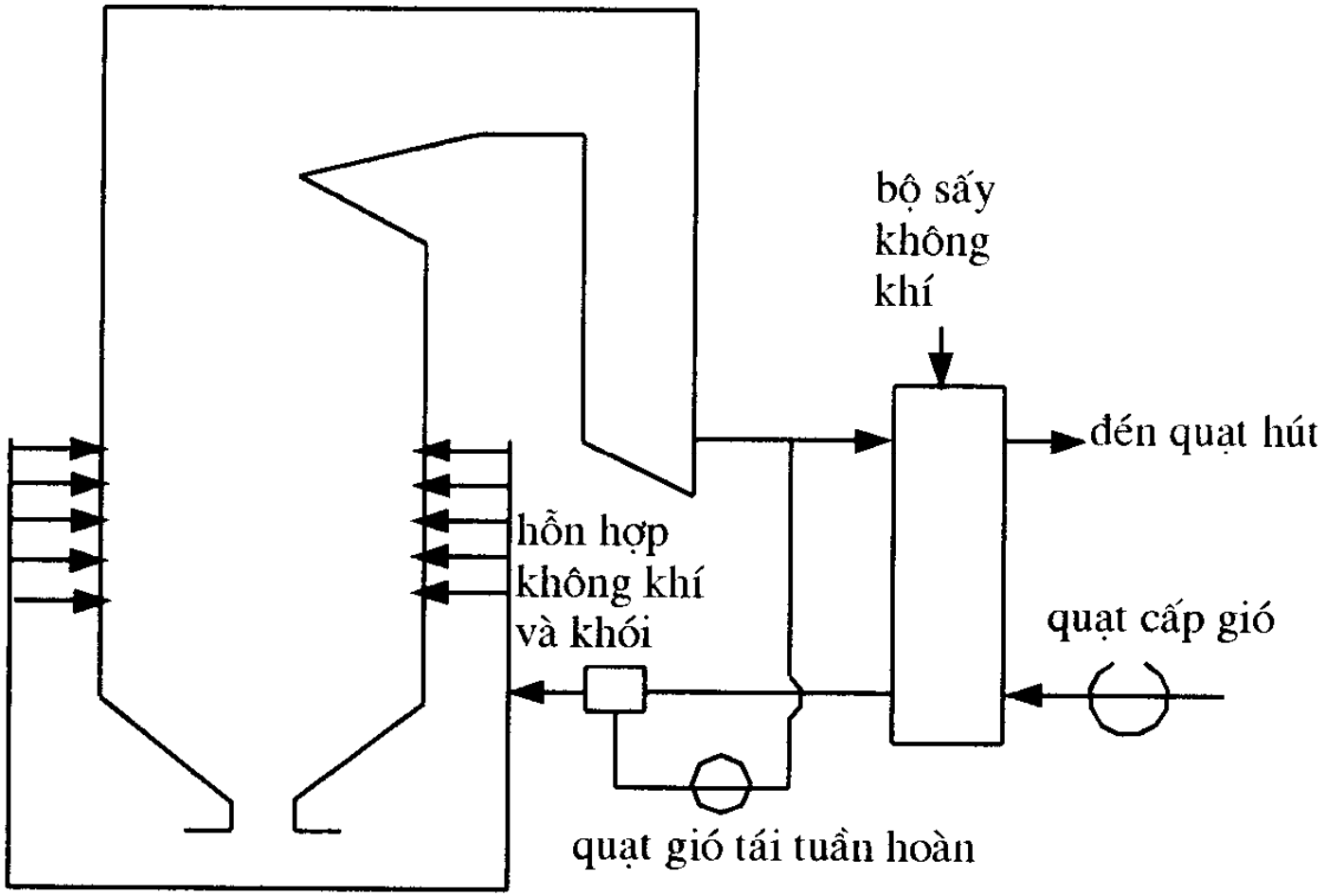
- Quite popular
- Burning is performed in some stages
- Primary burning: $0,7 < \alpha < 1$
- Secondary burning $\alpha > 1$
- Note to keep burning products in high temperature stage



3) Burning with various fuel levels



4) Recirculation of smoke

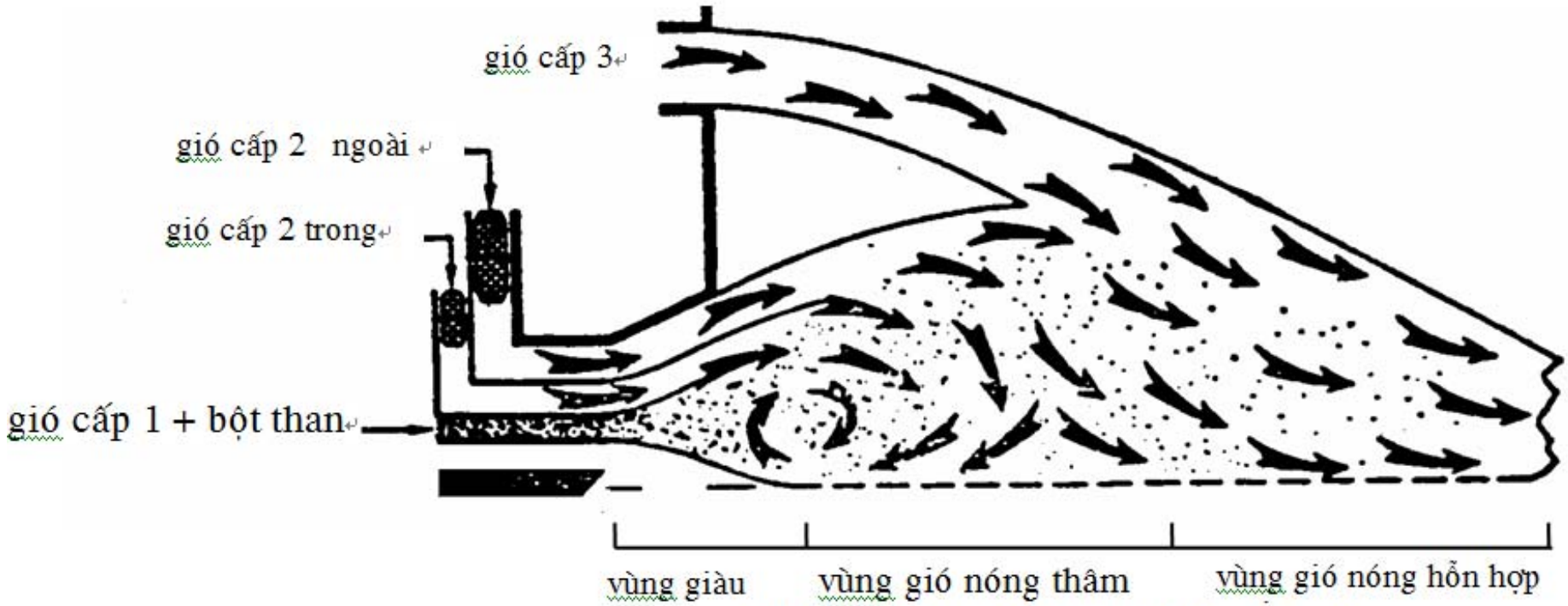


5) ejector with NOx low-concentration coal

Rules:

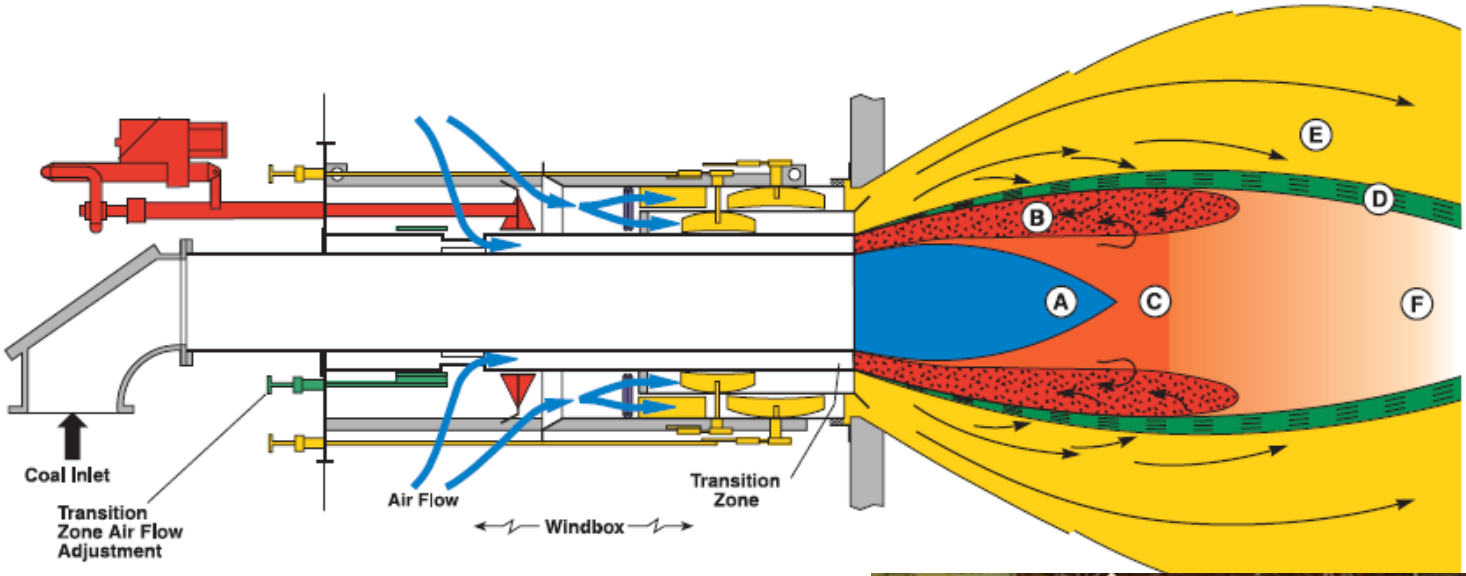
- Generate a rich burning fuel area with α<1, which is close to the nozzle of ejector
- Generate secondary area with α>1
- Burning efficiency is high
- Stable burning
- Easy to burn

1) Principle of wind-level ejector



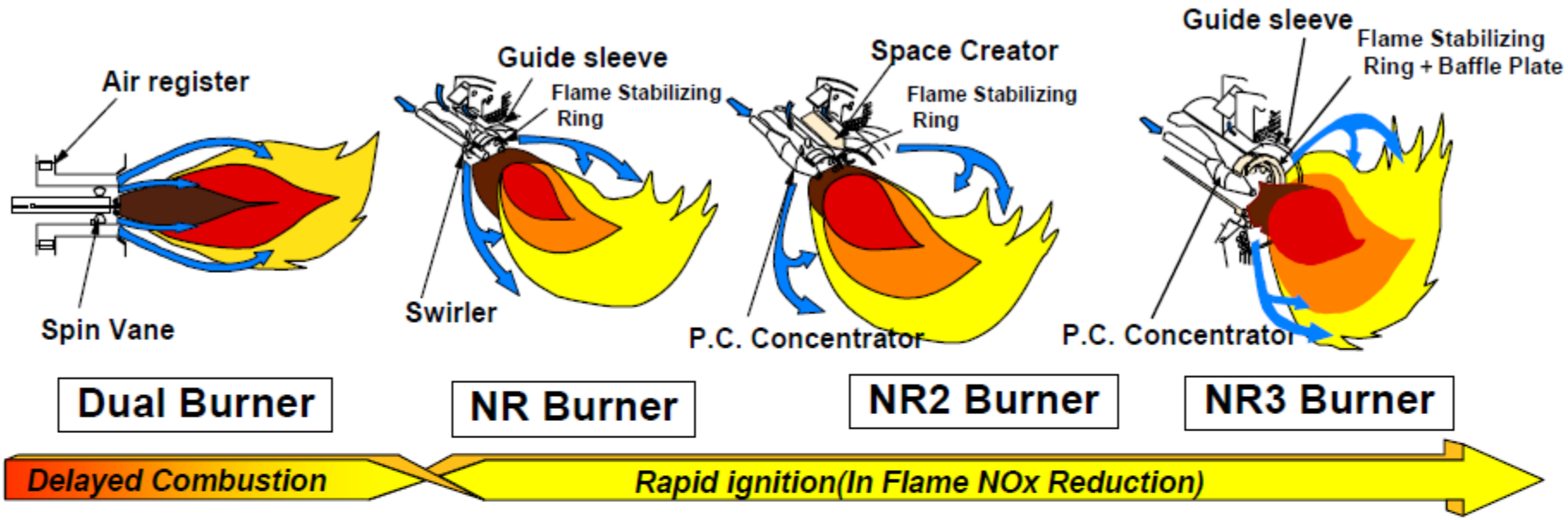
Nguyên lý vòi phun phân cấp gió

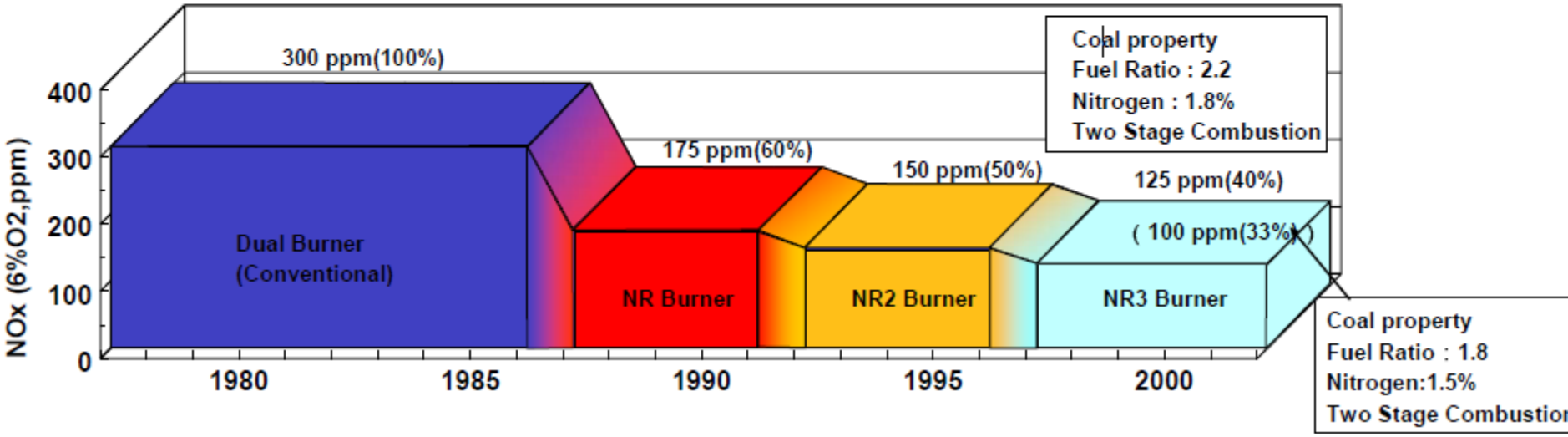
2) DRB Ejector(US)



A. Oxygen lean devolitilization
B. Recirculation of products
C. NOx reduction zone
D. High temperature flame sheet
E. Controlled mixing of secondary combustion air
F. Burnout zone

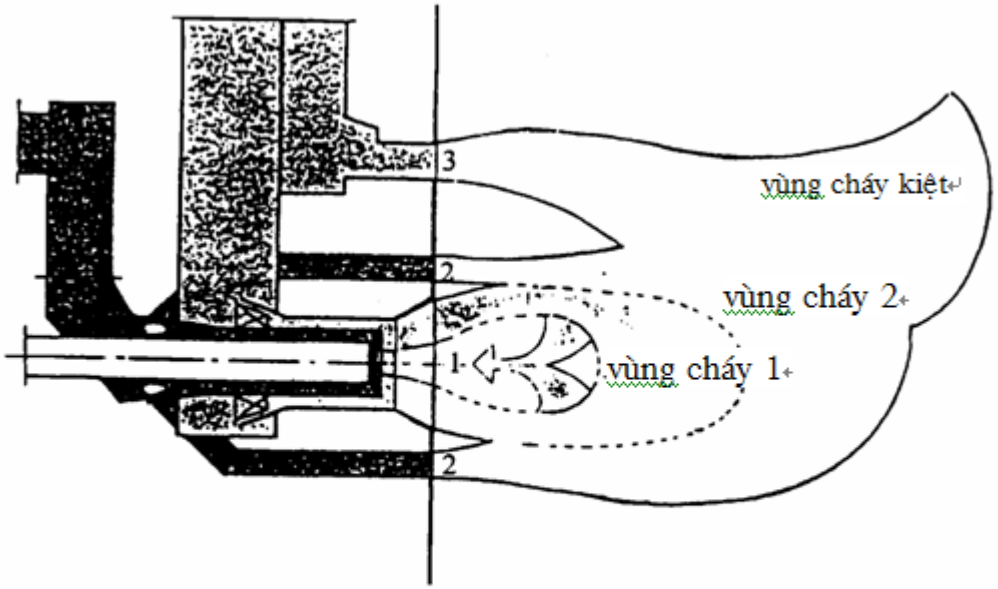
3) HT-NR Ejector (Babcock - Hitachi)





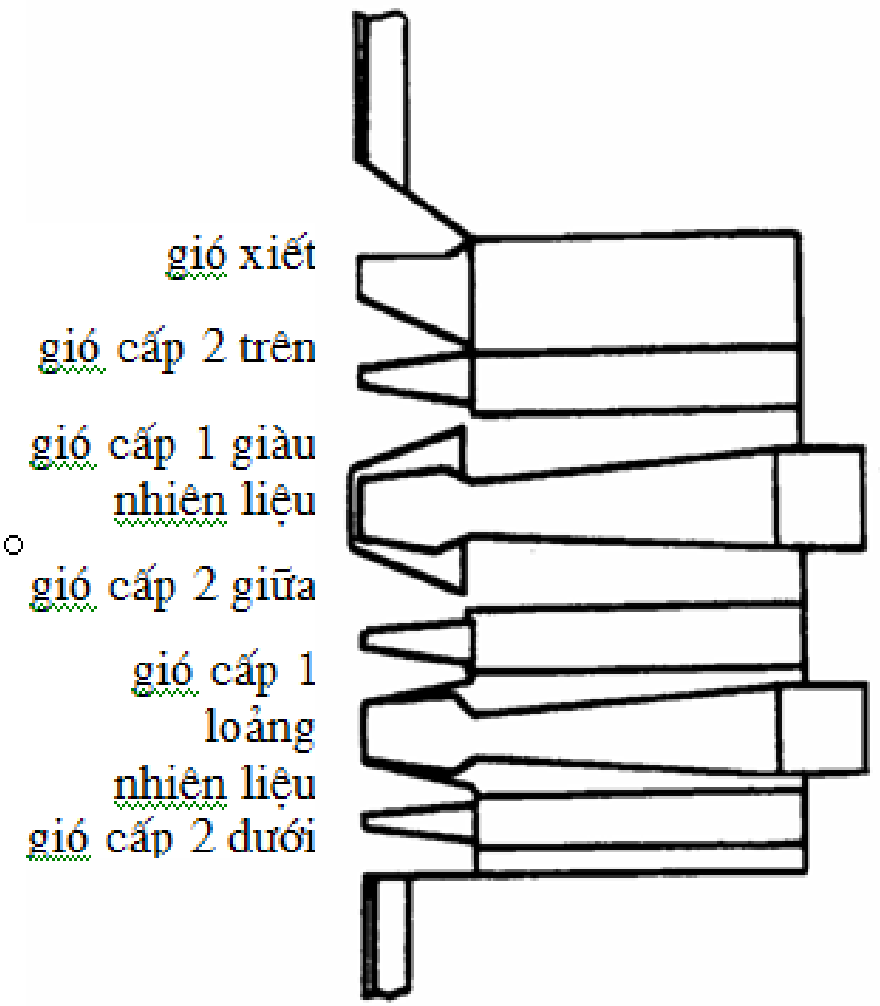
3) MSM Ejector (Steinmuller)

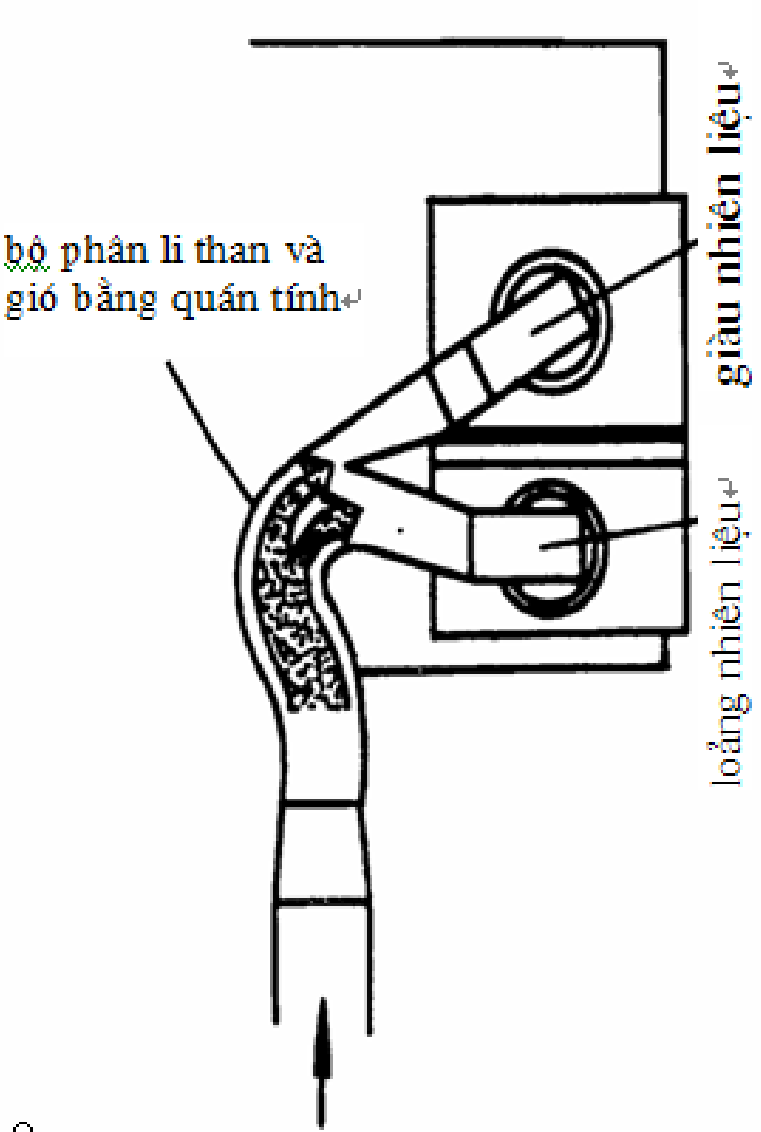
Property: is separated by 1-level inside branch and 1-level outside branch



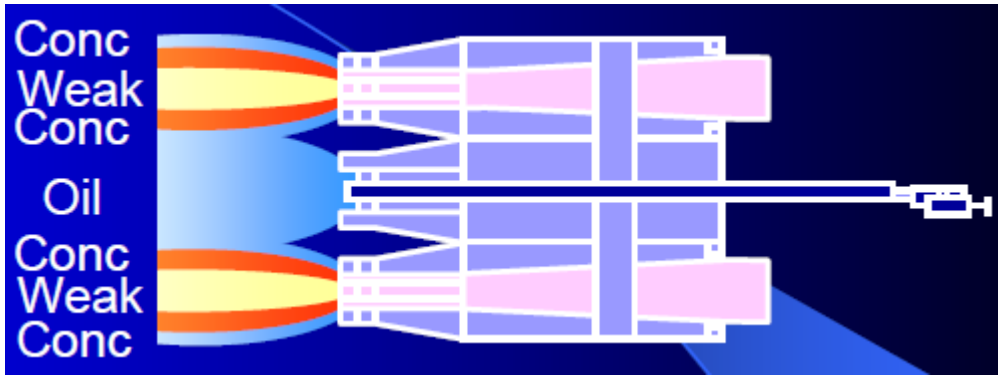
1- miệng gió phun cấp 1 + bột than (giàu nhiên liệu)
2- miệng gió phun cấp 2 + bột than (loảng nhiên liệu)
3- miệng phu gió xiết (OFA)

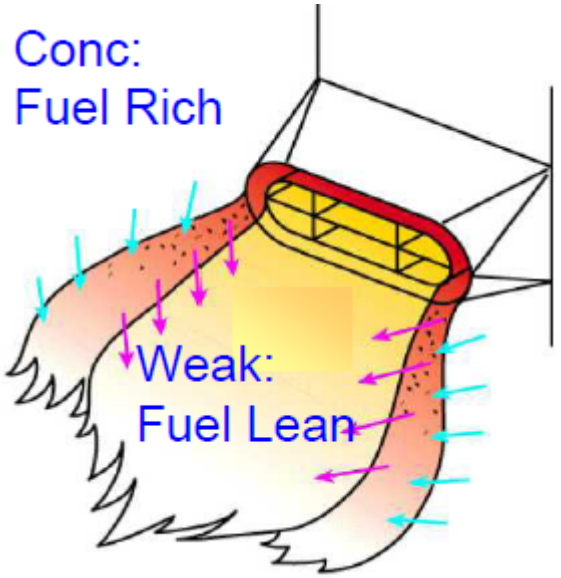
4) PM Ejector


gió xiết
gió cấp 2 trên
gió cấp 1 giàu nhiên liệu
gió cấp 2 giữa
gió cấp 1 loảng nhiên liệu
gió cấp 2 dưới


bộ phân li than và gió bằng quán tính
giàu nhiên liệu
loảng nhiên liệu

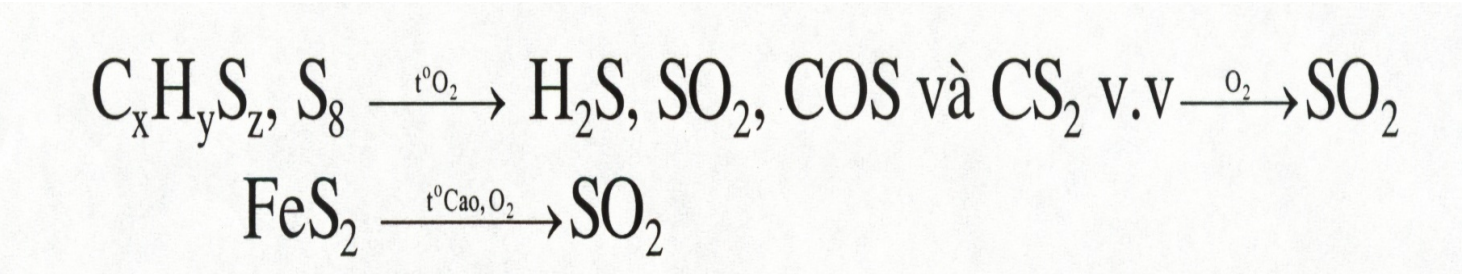
Low NOx A- PM Burner for PM Burner



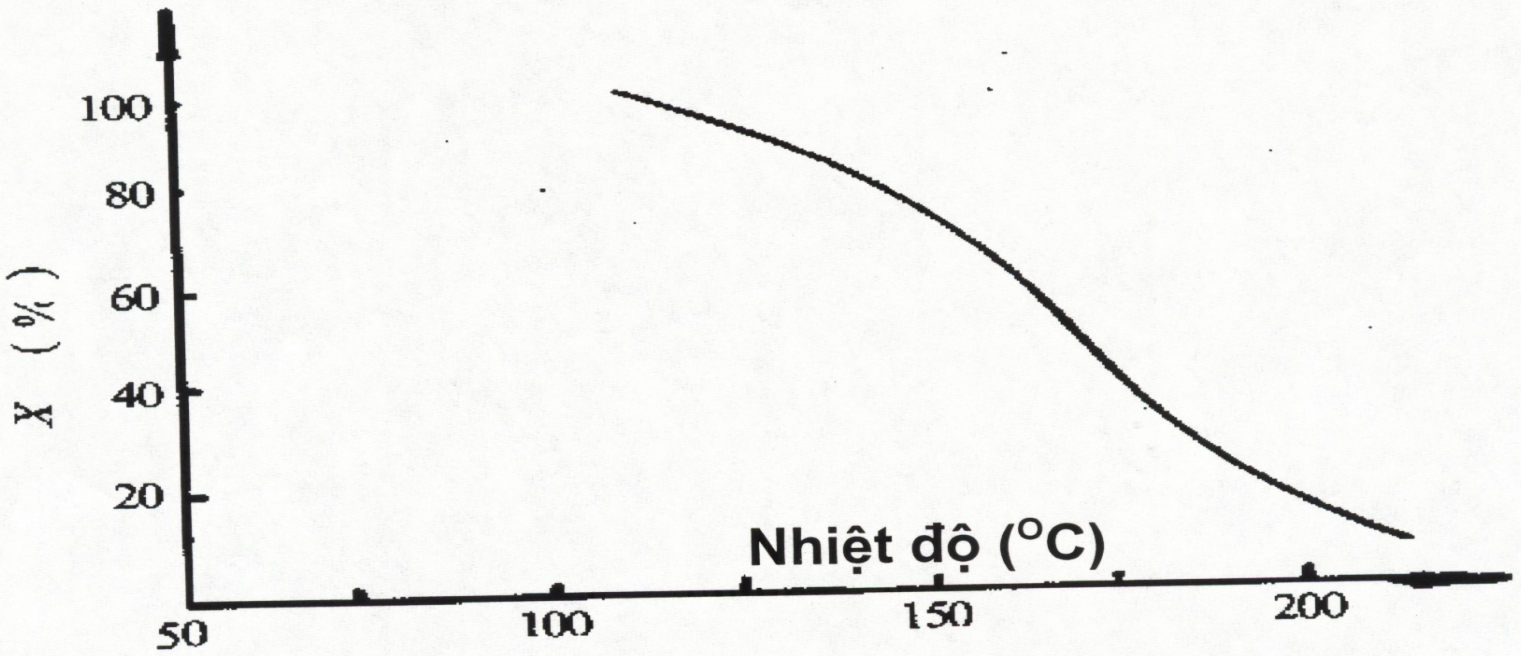


SO_2 generation mechanism

1) Oxygenate FeS_2
2) Oxygenate organic sulfur
3) Oxygenate SO
4) Oxygenate sulfur
5) Oxygenate H_2S
6) Oxygenate CS_2 and COS

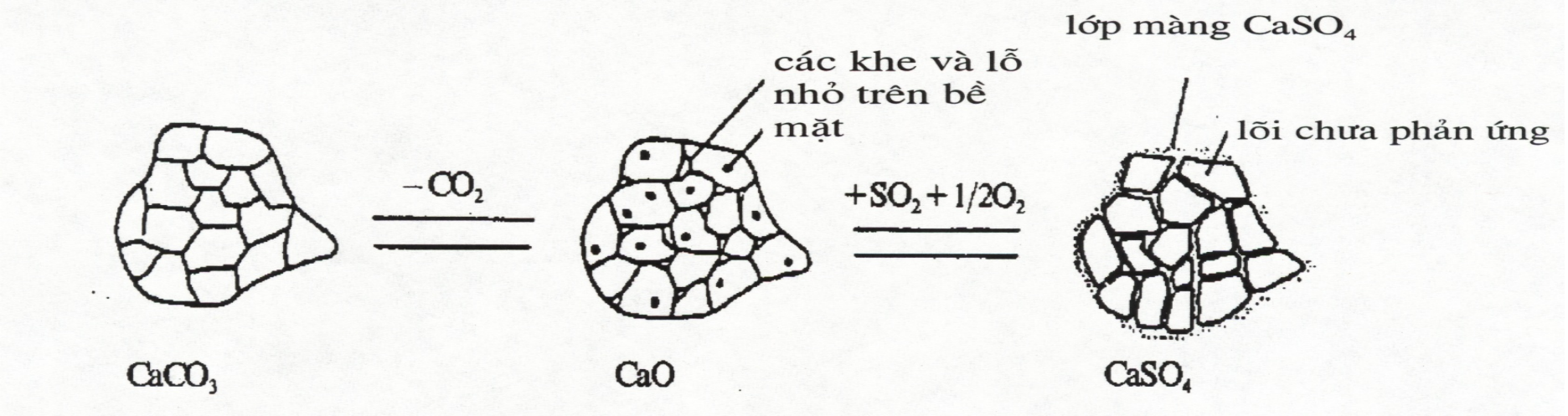


$$X = \frac{p_{H_2SO_4}}{p_{SO_3} + p_{H_2SO_4}} \times 100\% \qquad (3\text{-}52)$$

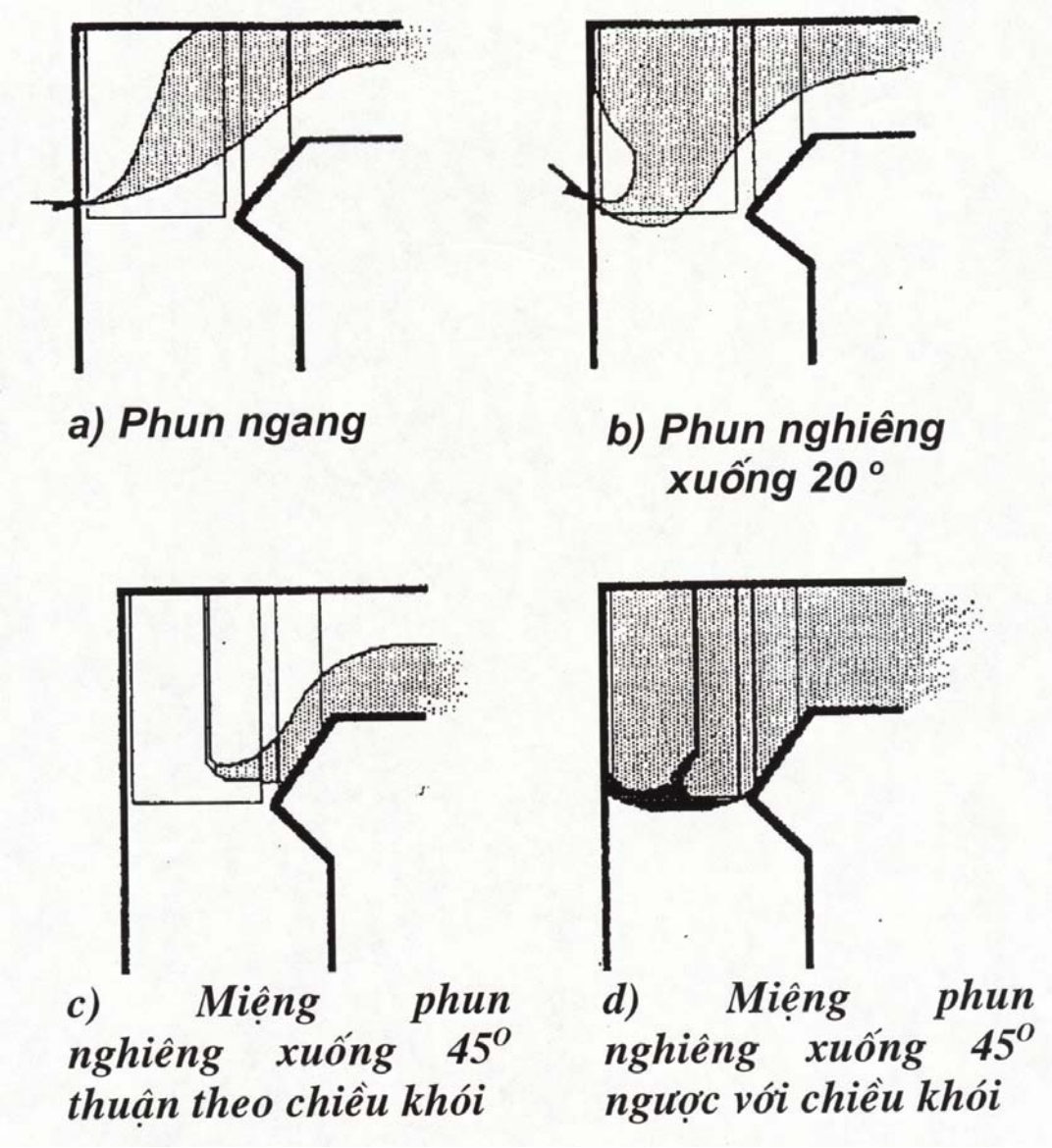


H.3.3. Quan hệ giữa suất chuyển hoá SO_3 thành H_2SO_4 với nhiệt độ [1a]

Desulfurize with limestone



Eject limestone powder into upper side of combustion chamber



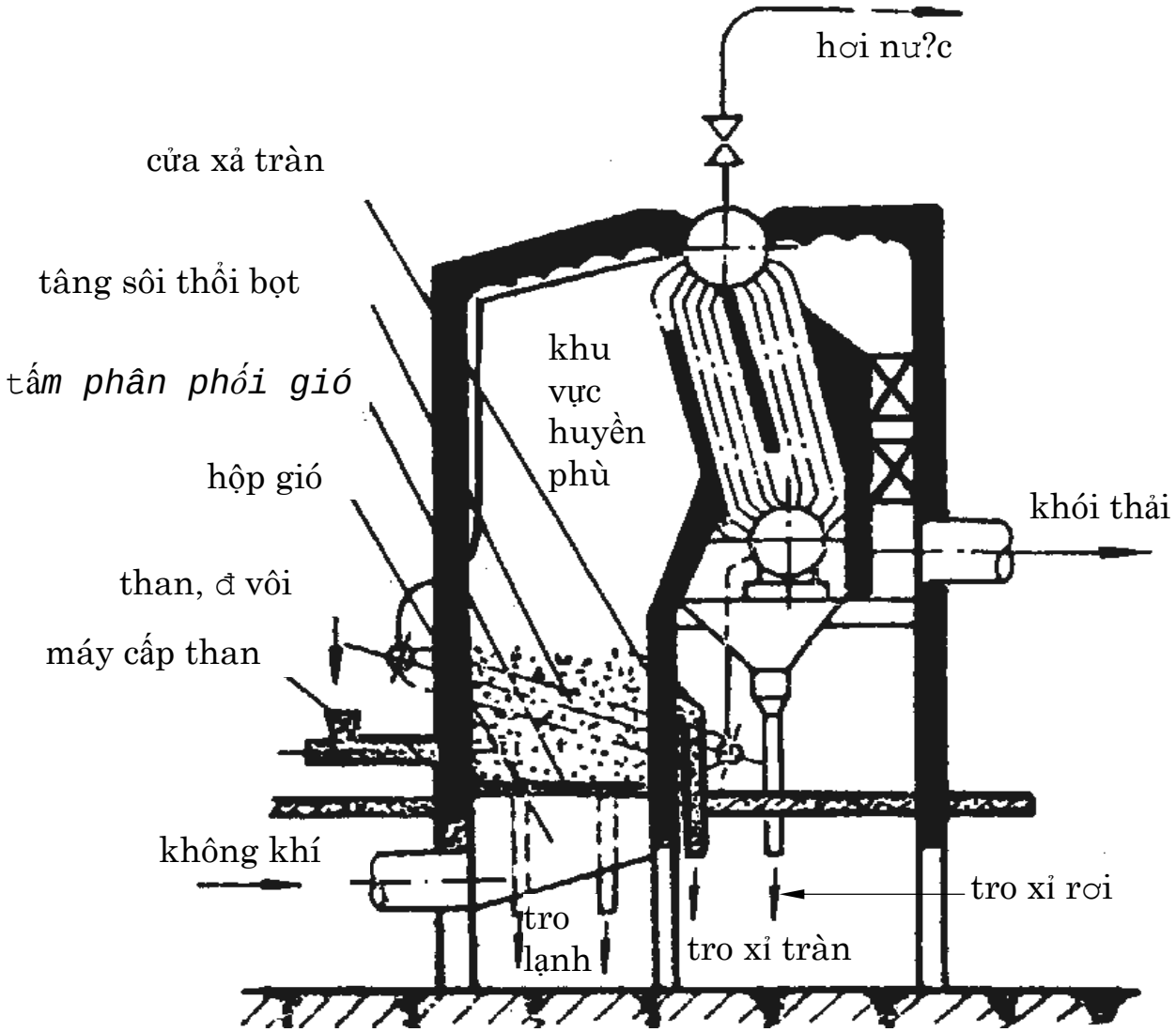
a) Phun ngang

b) Phun nghiêng xuống 20 °

c) Miệng phun nghiêng xuống 45° thuận theo chiều khói

d) Miệng phun nghiêng xuống 45° ngược với chiều khói

Desulfurize in Fluidized bed combustion boiler



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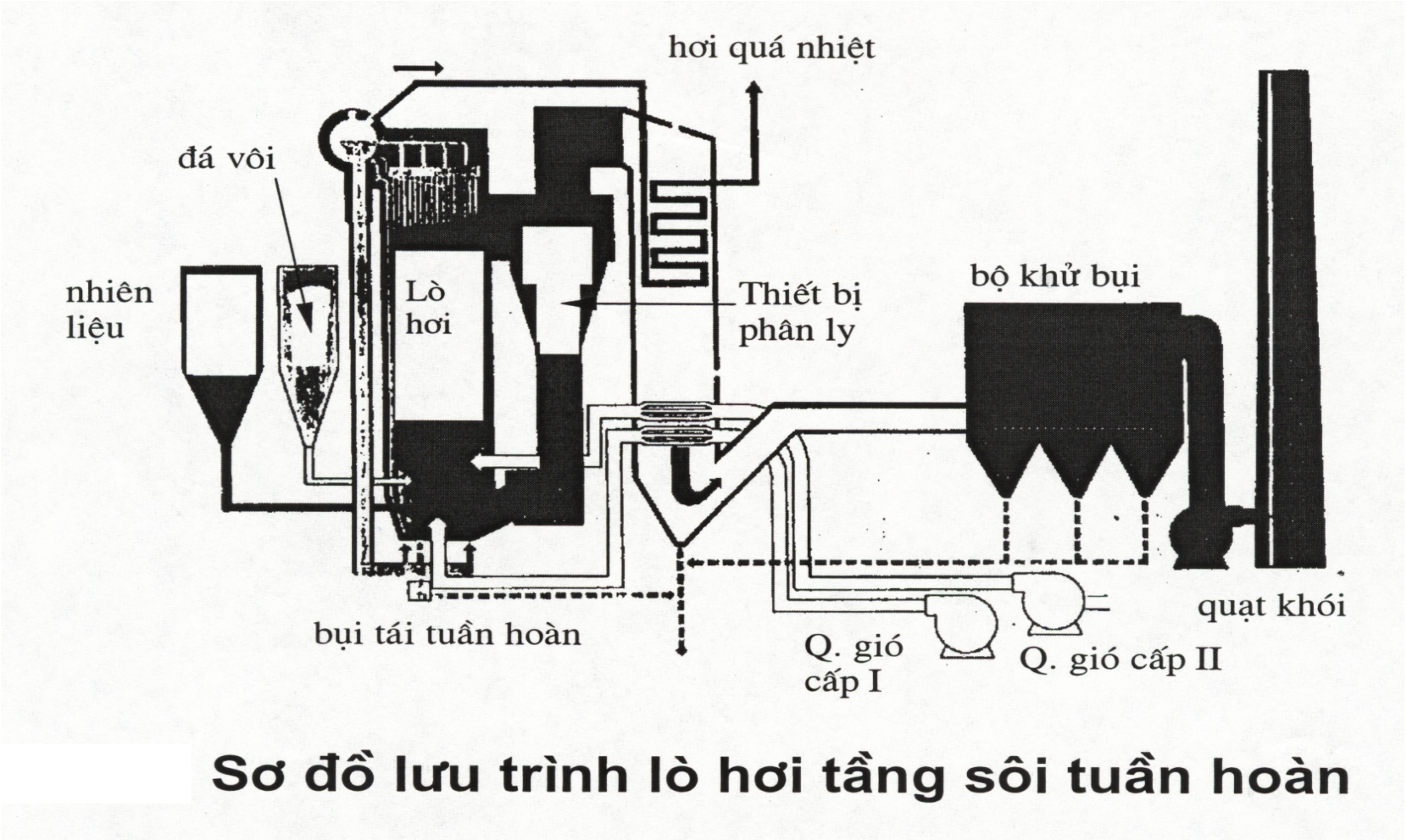
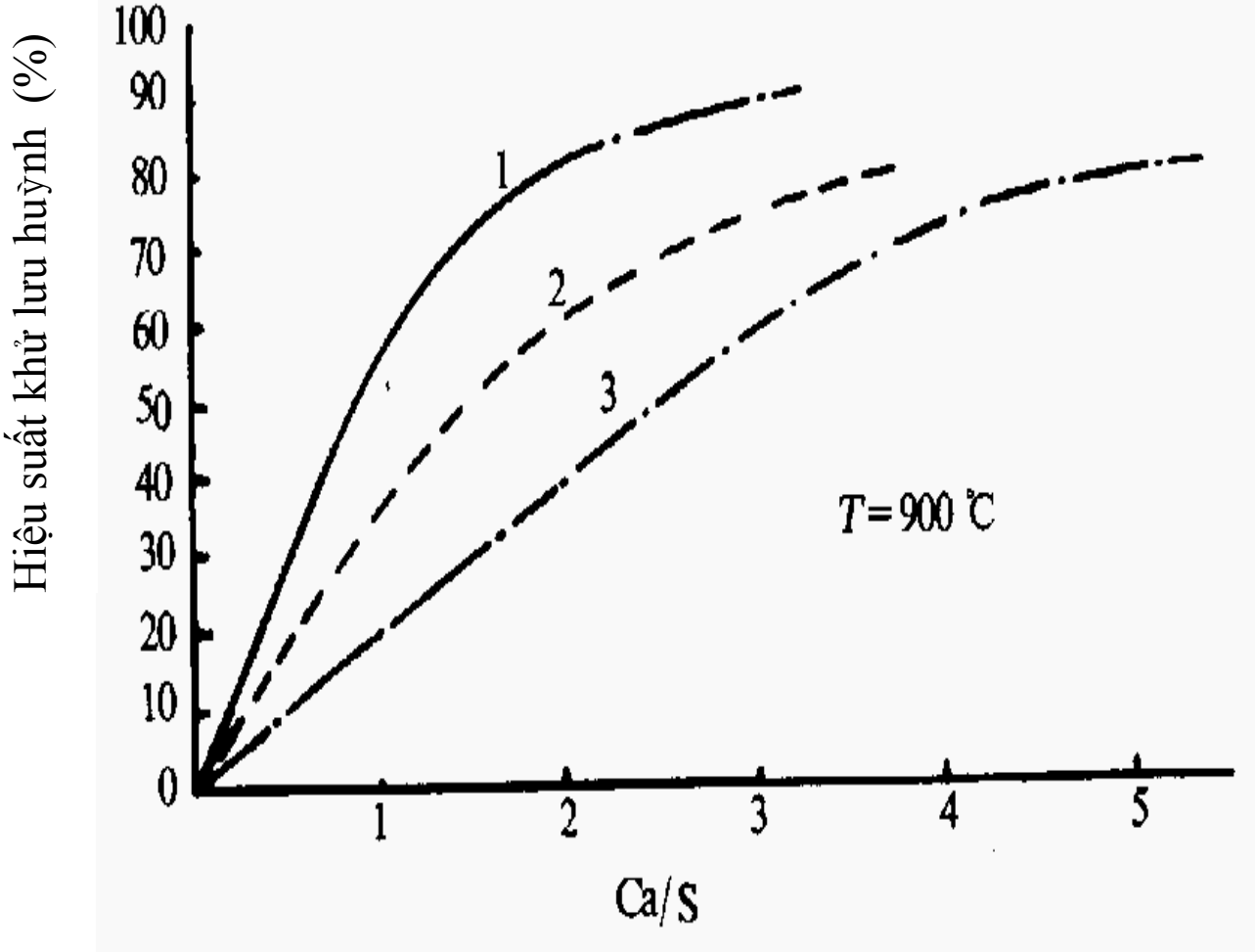
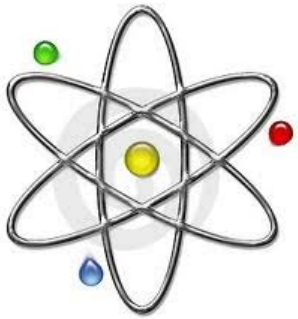


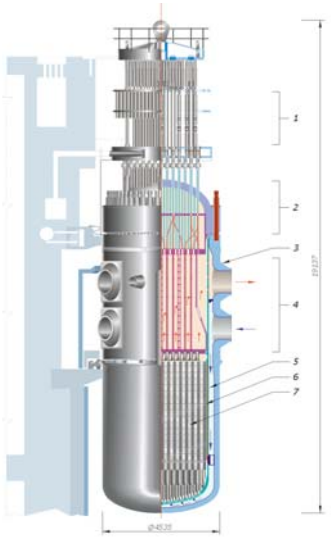
Sơ đồ lưu trình lò hơi tầng sôi tuần hoàn



Desulfurized efficiency, sulfur content and diameter of limestone

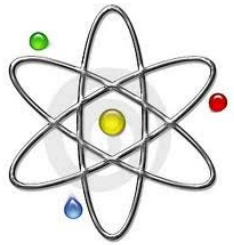
1. Coal sample C: S= 2,03%, diameter 0~ 5 mm
2. Coal sample B: S= 1,55 %, diameter 0~5 mm
3. Coal sample A: S= 0,78 %, diameter 0 ~ 13 mm





3. Nuclear Energy

Content

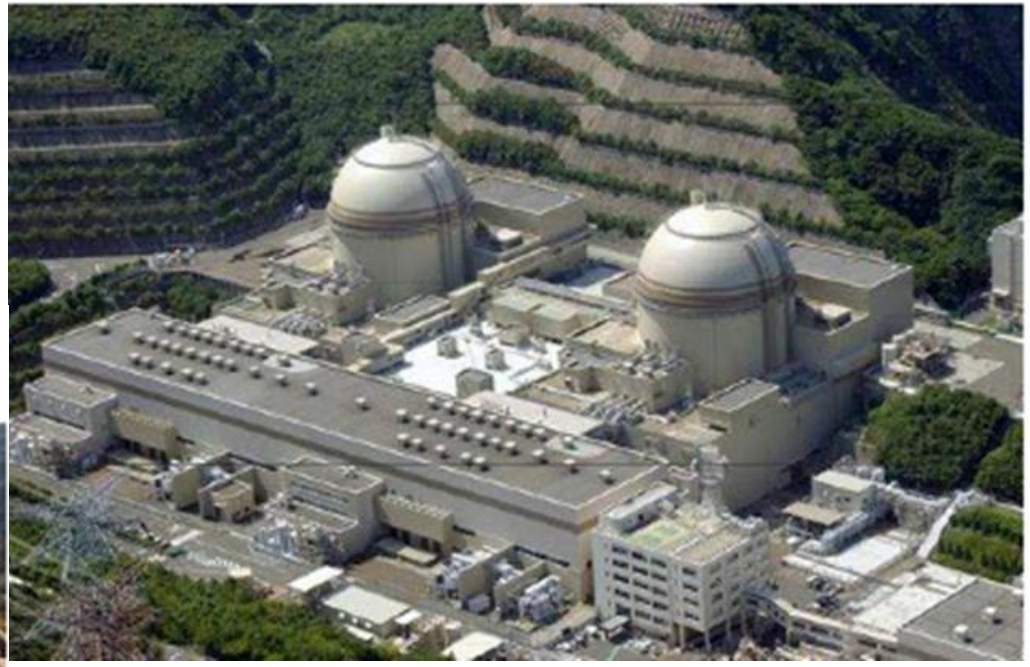


- Present basis knowledge about nuclear energy for undergraduate level students including social sciences fields

- Part 1: current situation of nuclear energy
- Part 2: Developing history nuclear power plant

Part 1: current situation of nuclear energy

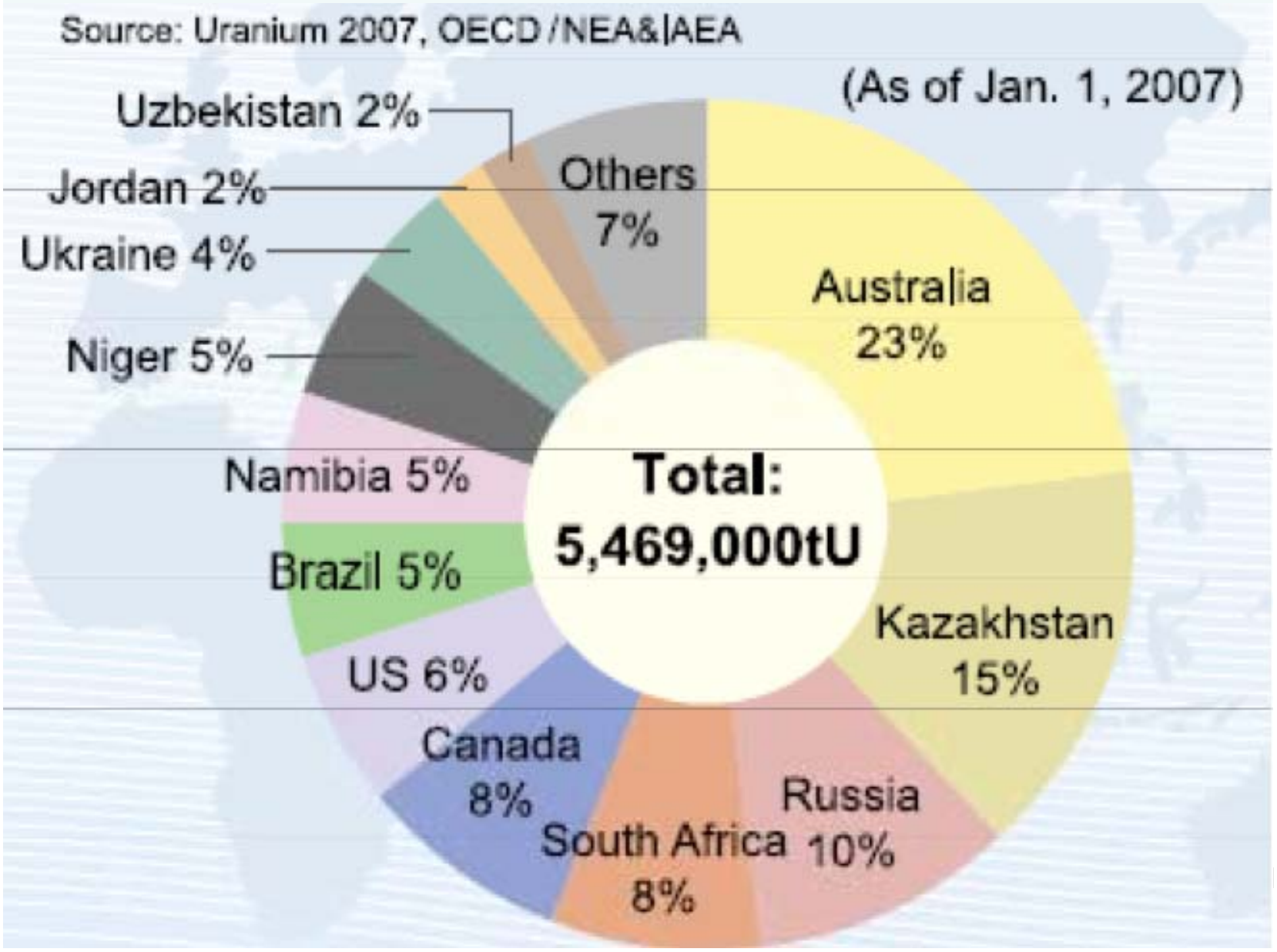
- Nuclear Energy has a capacity to provide large-scale electricity production with very low CO2 emissions over the plant lifecycle.
- The technology has already proven, although new designs hold out the prospect of better levels of performance and reliability, as well as enhanced safety systems.
- Nuclear power is already in use in 30 countries and provides around 14% of global electricity supply.
- The share of nuclear energy in countries with operating reactors ranges from less than 2% to more than 75%.



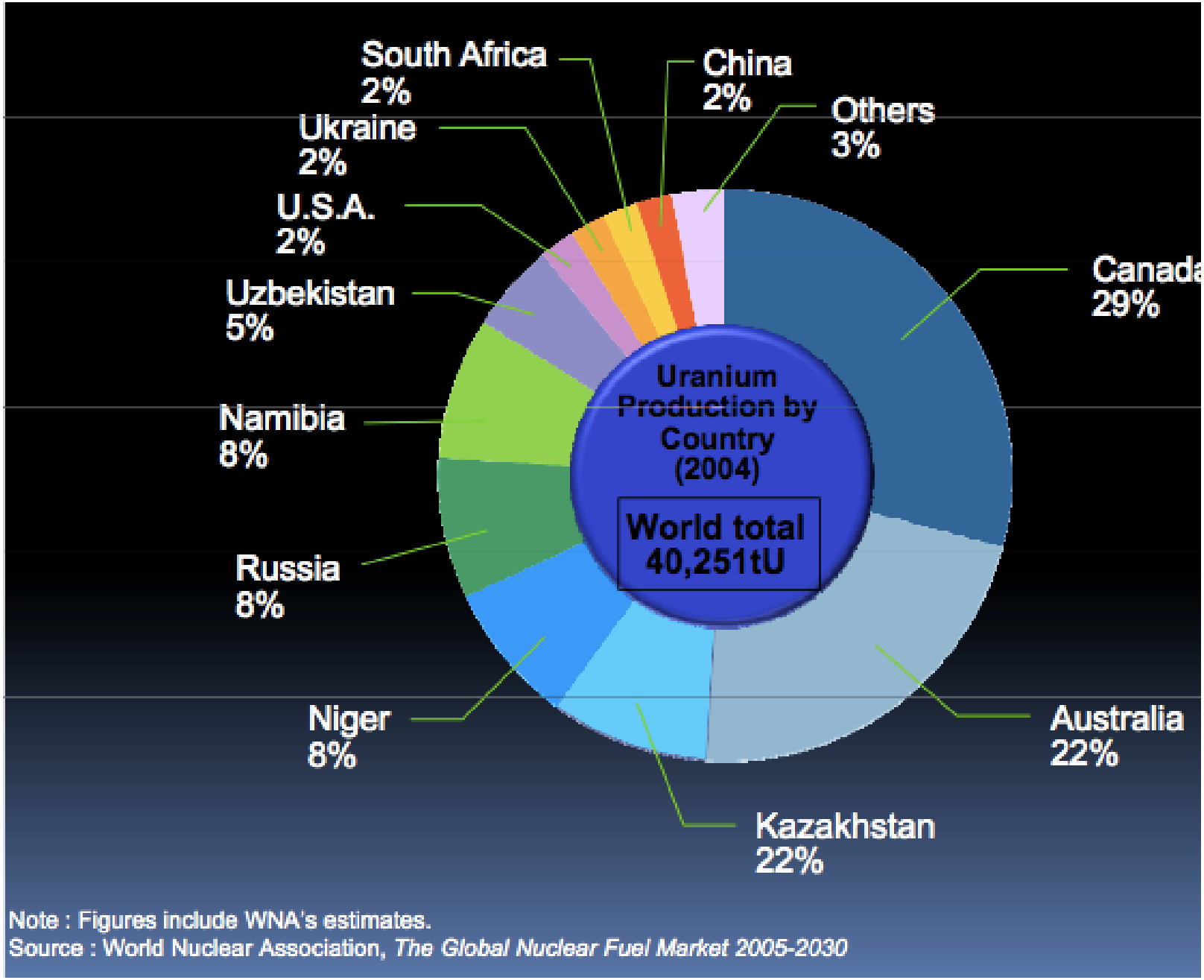
Japan (4 reactors, 1,100 MW)

Brazil (2 reactors, 1,350 MW)

World's reserve of Uranium resources



URANIUM Production by country



CO_2 emission

CO2 Emission

Life Cycle CO2 Emission (g/kwh)

Technology	Facilities & Operation	Power Generation
Coal-fired	88	887
Oil-fired	38	704
LNG-fired	130	478
LNG-Combined	111	408
Solar	53	-
Wind	29	-
Nuclear**	22-25	-
Geothermal	15	-
Hydro	11	-

* From mining to maintenance
**No Recycling process

Central Research Institite of the Electric Power Industry (2000,2001)

Global trend of nuclear power generation