Contract project-2004
With Ministry of the Environment, Japan

環境省

Ministry of the Environment

Air Pollution Control Technology In Glass Manufacturing Industry

March 2005

Overseas Environmental Cooperation Center, Japan

Air Pollution Control Technology in Glass Manufacturing Industry

Committee Members

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Prepared by

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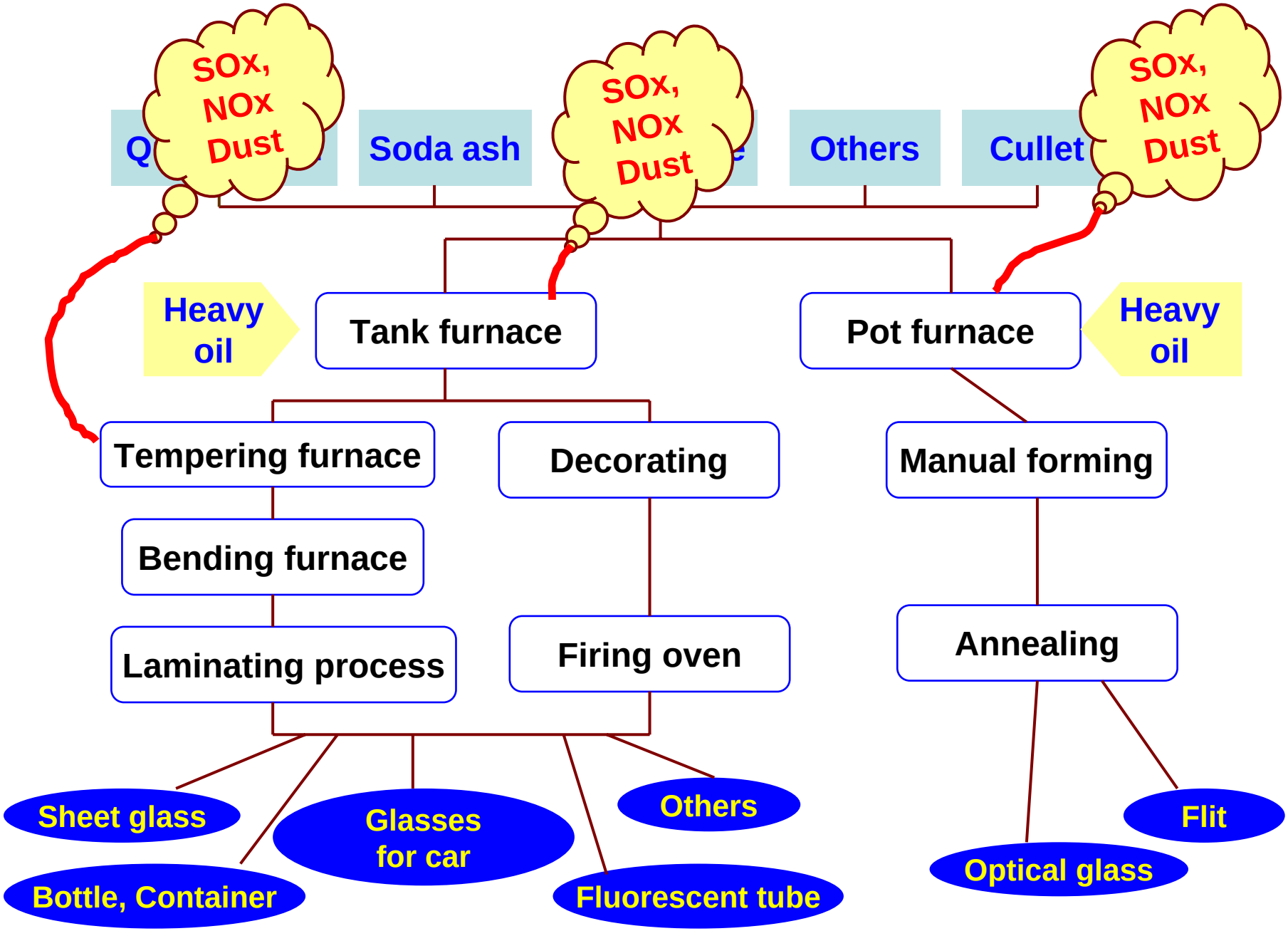
Asahi Glass Co., Ltd. Kashima Plant
Product: Flat glass, Automotive glass, others

1. Glass Manufacturing Process and Air Pollutants



2. Soot & Dust Reduction

2-1 Reduction by means of Fuel and Furnace Operation

Causes of Dust

- Fuel → Dust (soot, ash, heavy metal)
- Raw Material → Scattered substances (ash, heavy metal)
- Non-uniform mixing fuel and air

Dust Reduction Method in Soda-Lime Glass Melting

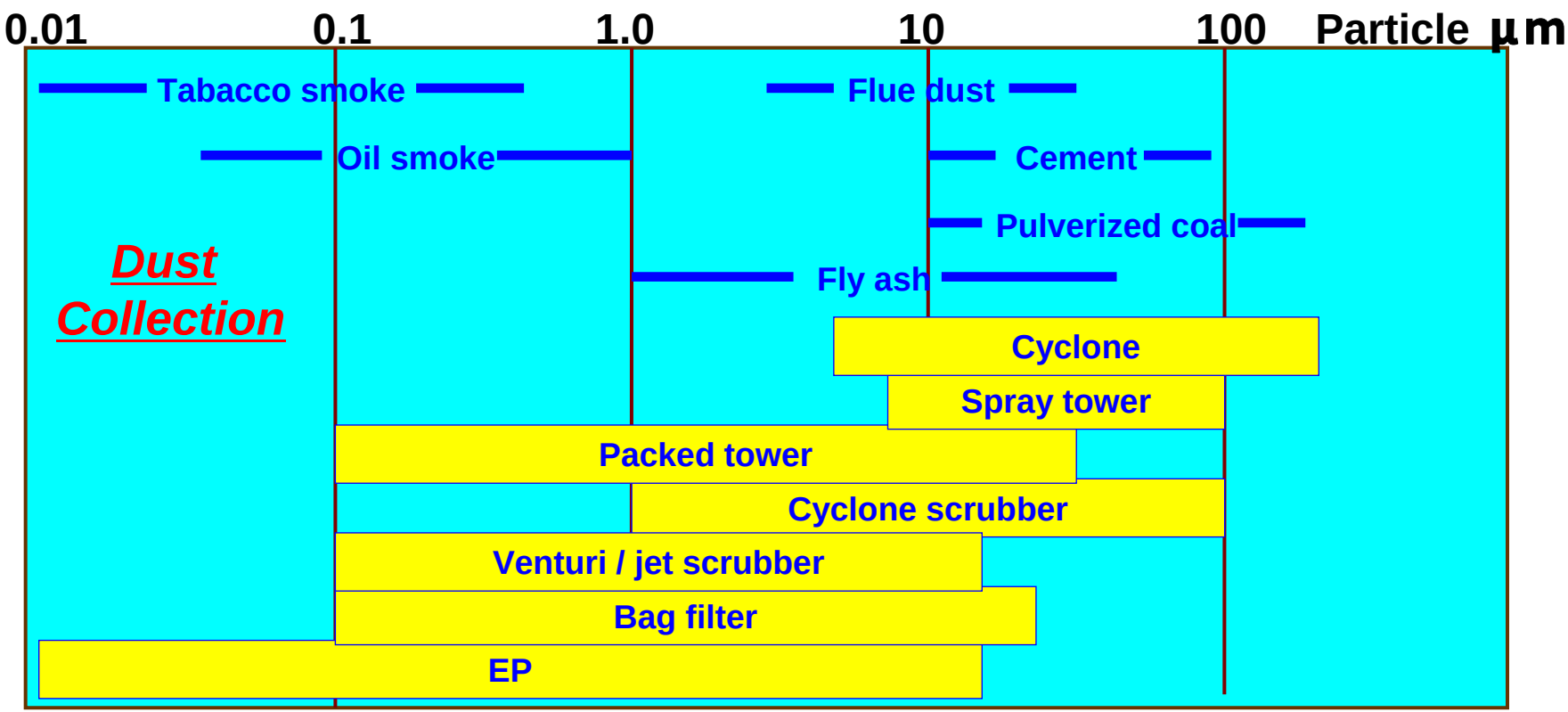
- Switching fuel; Solid → Liquid → Gas
  Heavy oil → Kerosene
- Effective atomization of fuel
- Careful manipulation of air supplying
- Adequate proportion of furnace configuration to flame shape
- Reviewing particle size of batch (glass raw material)
- Adjustment of batch moisture content in batch wise charge
- No direct striking surface of batch with flame

2. Soot & Dust Reduction

2-2 Properties of Dust and Applicable Scope of Dust Collection

Soda-Lime Glass Melting Furnace Flue Gas

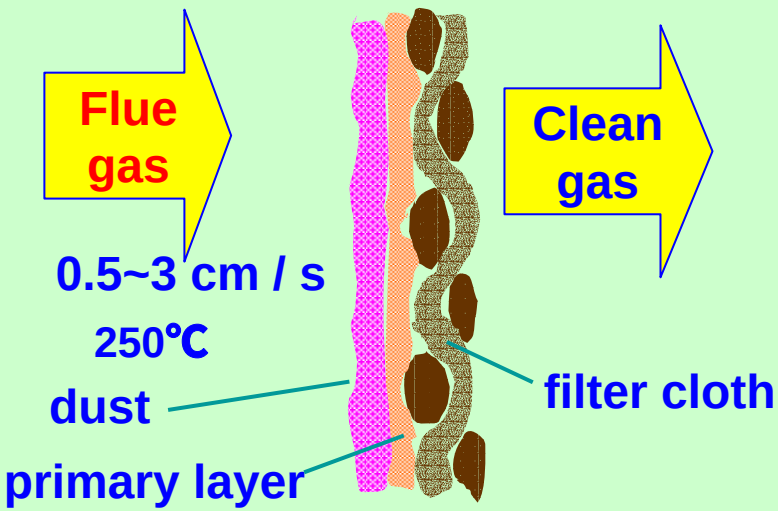
Flue gas (400~600℃)		Dust		
O_2	8~9%	Dust conc.	0.2~0.4 g/Nm^3	
CO_2	10%	Particle size	~ 0.5 μm	25%
H_2O	10%		0.5~ 0.3 μm	50%
SOx	500~1,500ppm		0.3~0.1 μm	20%
NOx	400~600ppm		0.1 μm ~	5%



2. Soot & Dust Reduction

2-3 Filter Dust Collector

Filtration Action in Filter Cloth



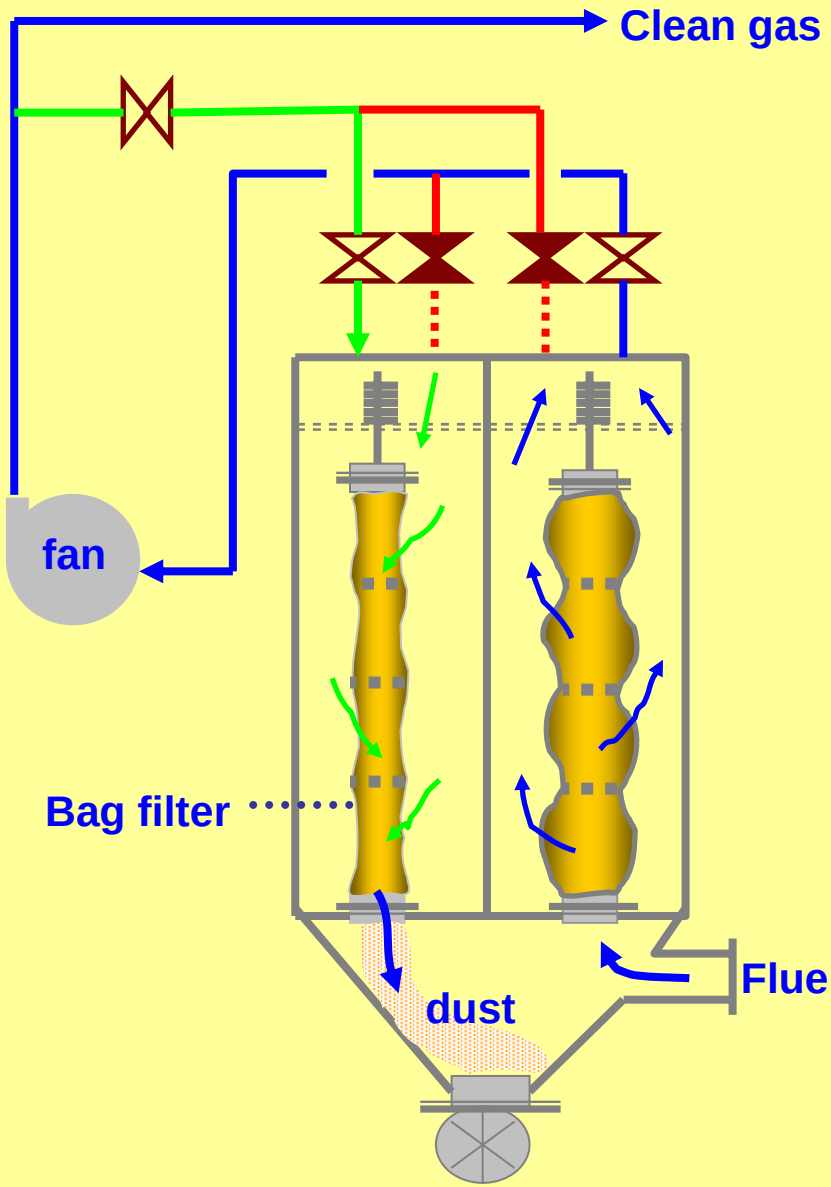
△P 150 mg Hg → dusting

Dusting frequency

- intermittent
- continuous

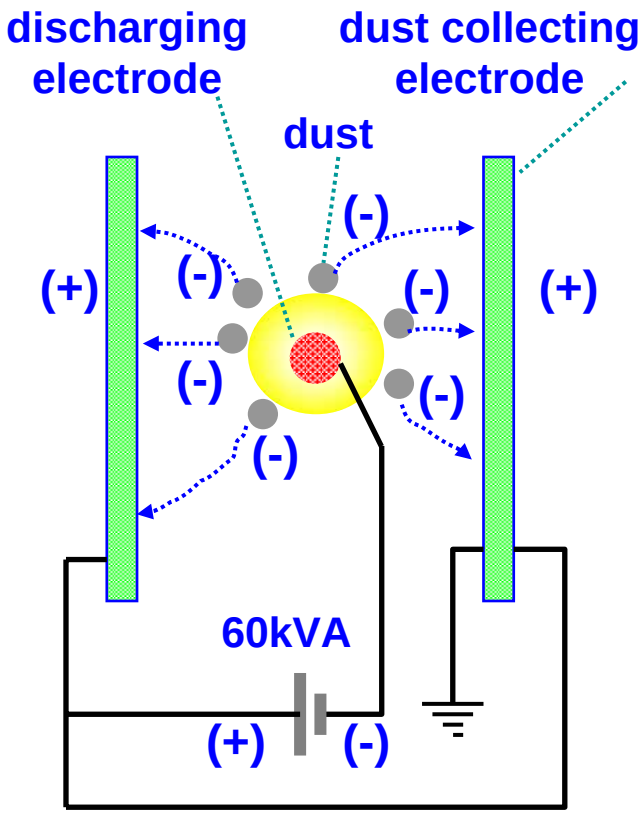
Dusting drive

- vibration
- reverse air



2. Soot & Dust Reduction

2-4 Electrostatic Precipitator



Feature

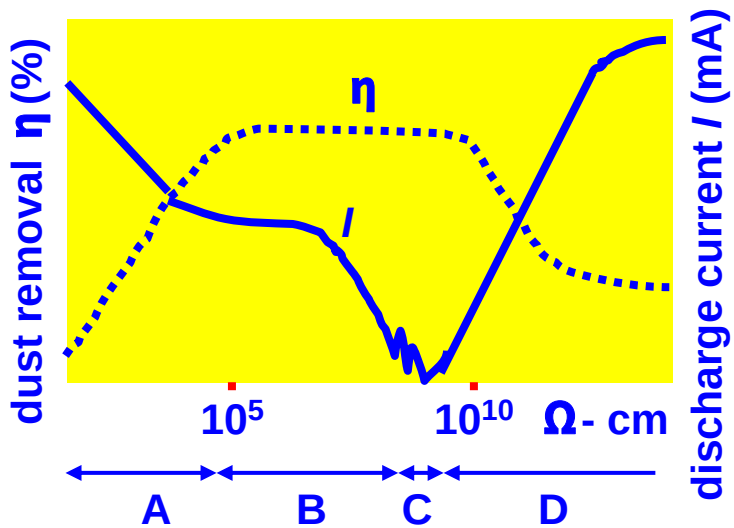
- Less influence of flue gas & dust
- Low pressure loss

Peeling dust from electrode

- Dry EP : hammering impact
- Wet EP: flow down with water film

Factors affecting dust collection

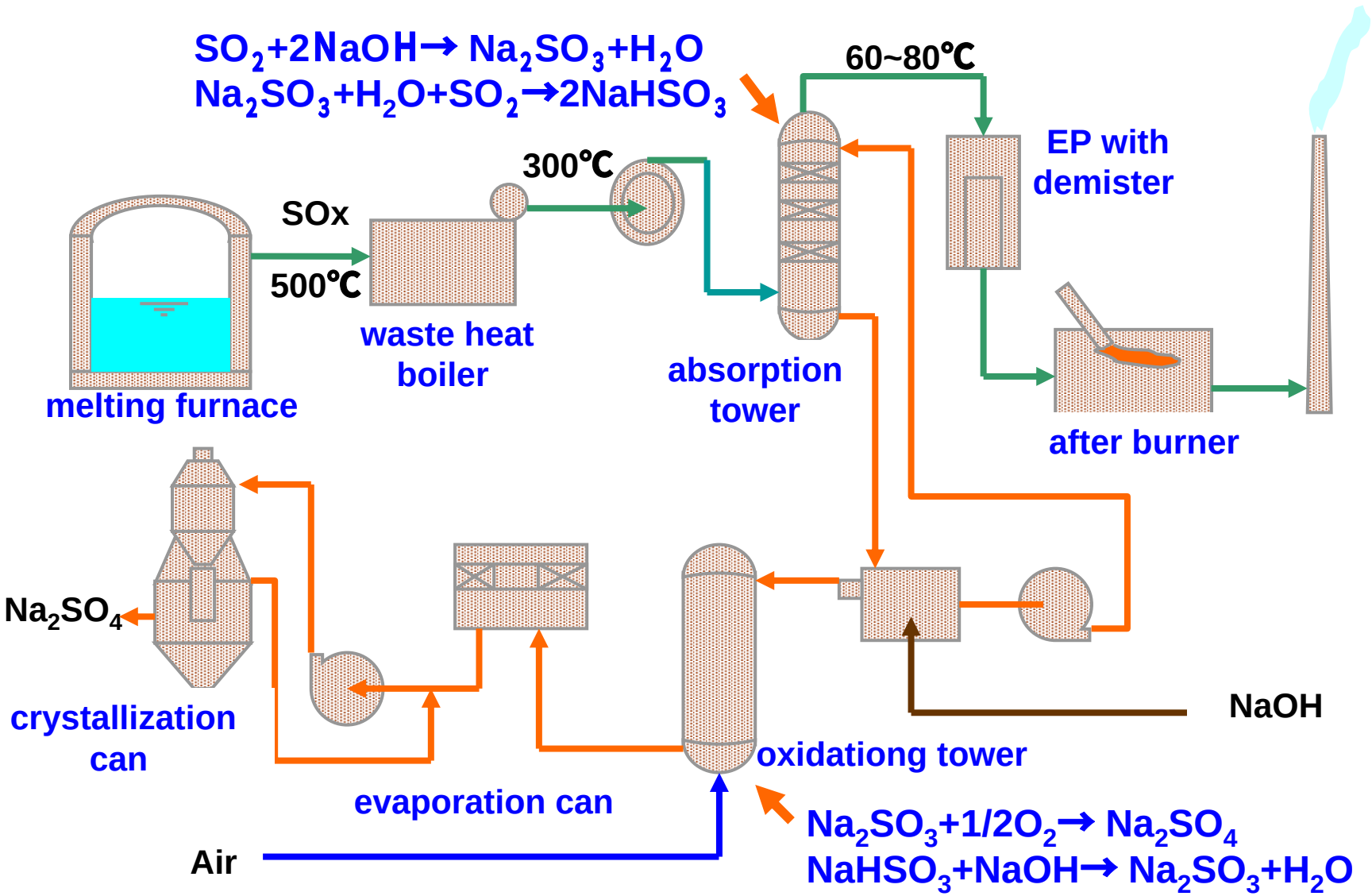
- particle size
- temperature, moisture, SO_3 → Ω- cm



A: re-scattering
B: normal
C: frequent occurring of sparks
D: counter electric dissociation

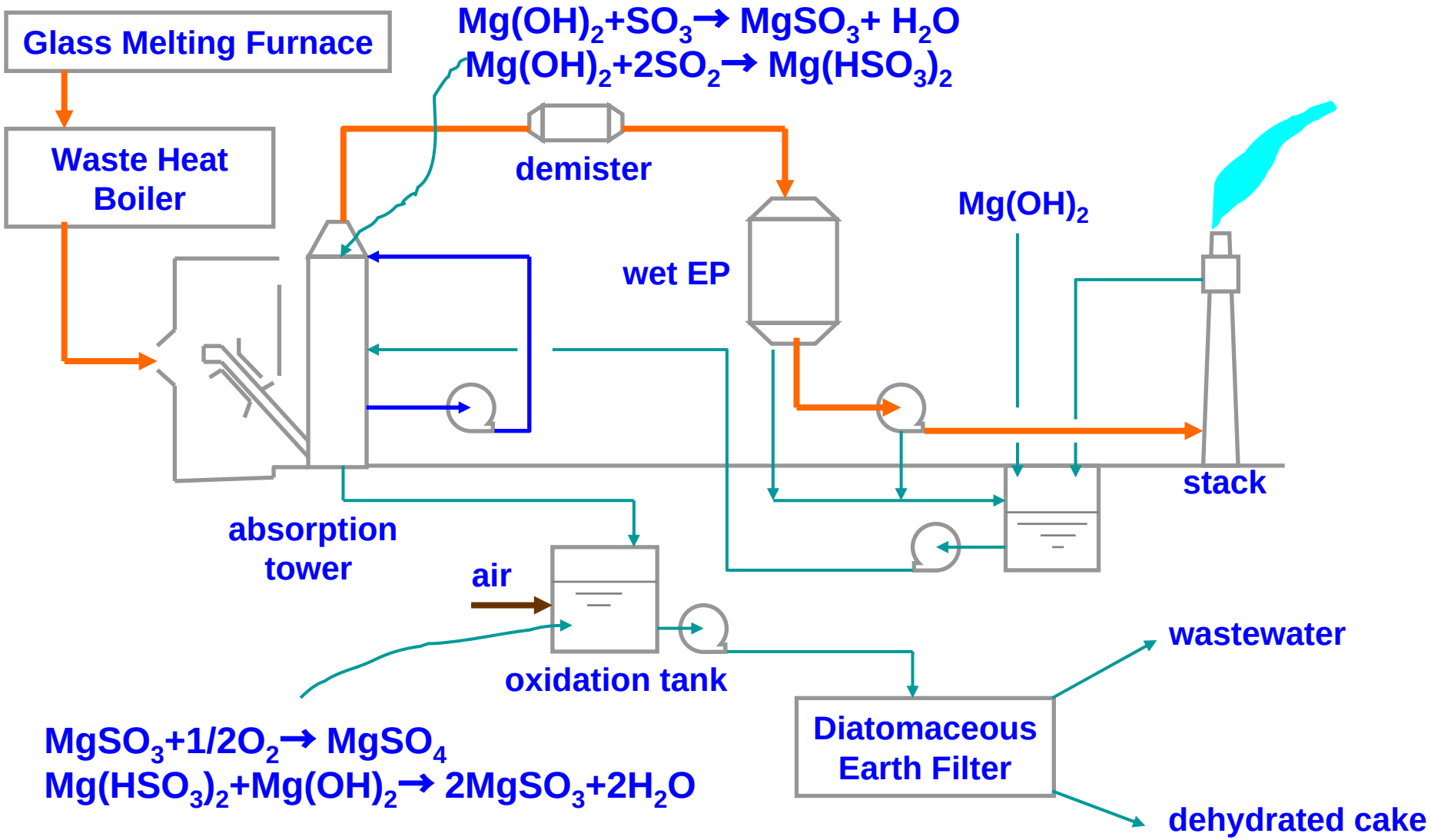
3. SOx Reduction Method

3-1 Desulphurization using Caustic Soda



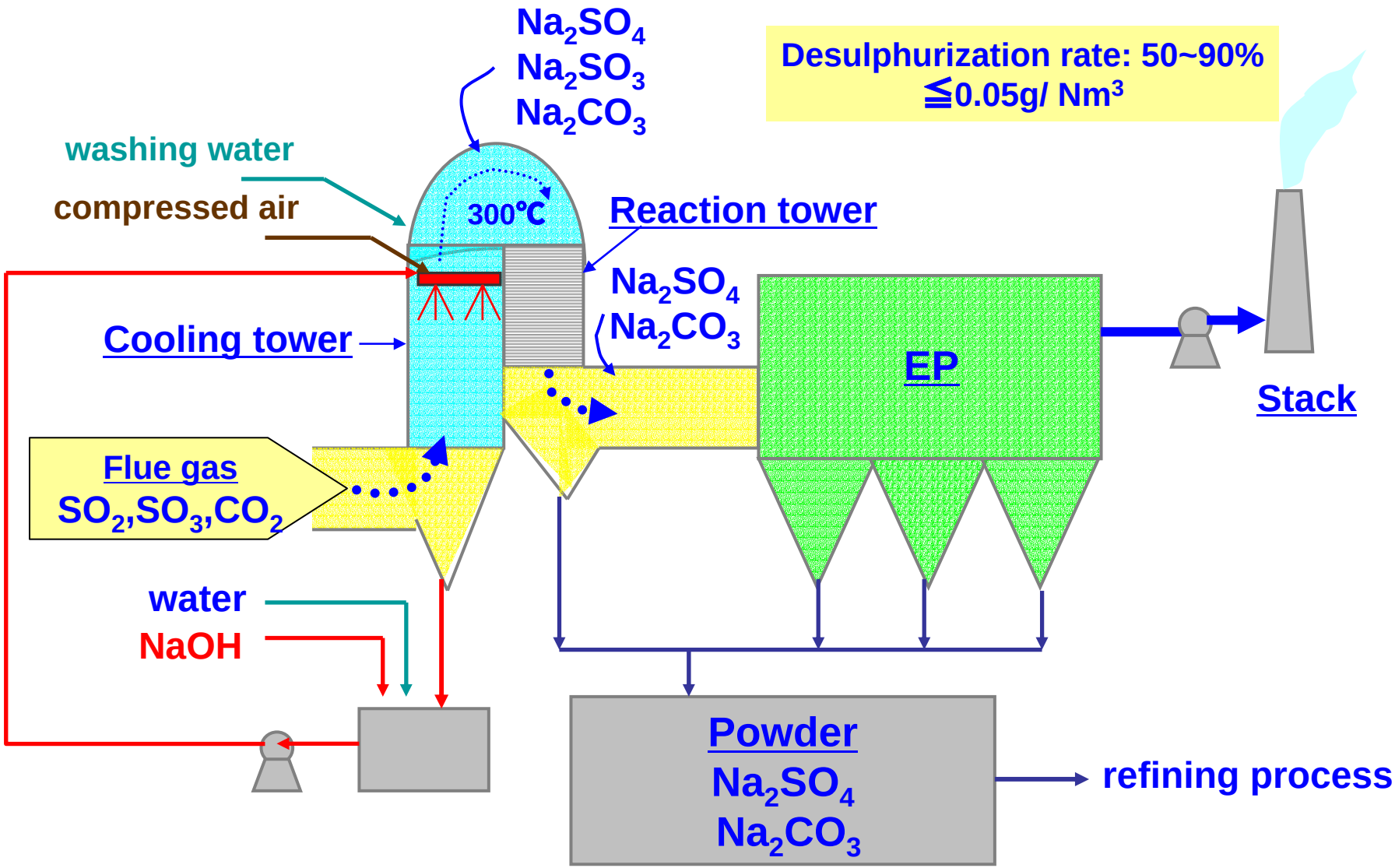
3. SOx Reduction Method

3-2 Desulphurization using Magnesium Hydroxide



3. SOx Reduction Method

3-3 Dry- type Flue Gas Desulphurization



4. NOx Reduction Method

4-1 Reduction of Nitrate in Raw Material

NOx generation : $NaNO_3$ (oxidation, refining agent)

Reduction Method :

1. Reducing $NaNO_3$ additives
   Quantity of pull : 100 t / day
   Flue gas volume : 17,000 m^3 / h
   Trial calculation : $NaNO_3$: silica sand = 0.5 : 100 NOx 169 ppm
   〃 : 〃 = 0.3 : 100 〃 102 〃
   reduction ▲ 67 ppm

2. Changing refining agent ($Sb_2O_3 \Rightarrow Na_2O \cdot Sb_2O_5 \cdot 6H_2O$)

$$Sb_2O_3 + O_2 \xrightarrow[\text{vitrification}]{\text{Low temp.}} Sb_2O_5 \xrightarrow[\text{refining}]{\text{high temp.}} Sb_2O_3 + O_2 \uparrow + \text{thermal NOx} \uparrow$$

$$Na_2O \cdot Sb_2O_5 \cdot 6H2O \xrightarrow{\text{low temp.}} Na_2O \cdot Sb_2O_5 + 6H_2O \uparrow$$

$$\xrightarrow[\text{refining}]{\text{high temp.}} Na_2O \cdot Sb_2O_3 + O_2 \uparrow$$

4. NOx Reduction Method

4-2 NOx Reduction Related to Fuel

Furnace temp. 1,500 ~ 1,600 ℃ ⇒ Thermal NOx ≫ Fuel NOx

N in Fuels

Fuel	Nitrogen (wt %)
Coal	0.7 ~ 2.2
C- heavy oil※	0.2 ~ 0.4
A- heavy oil※	0.005 ~ 0.08
Light oil	0.004 ~ 0.006
Kerosene	0.0005 ~ 0.01
LNG	Tr.
LPG	Tr.

※ JIS K2205 kinematic viscosity (cSt, mm2/s)
C-heavy oil: 50≦~1,000, A-heavy oil: ≦20

Heating value
Blight flame

Heavy oil < **Light gravity oil**
Gaseous fuel

↓

Fuel increasing

↓

NOx increasing

∴ **Electric energy**
resistance heating

4. NOx Reduction Method

4-3 NOx Reduction by Furnace Operation Method

1. Declining Glass Melting Temp.
- chemical composition ----- melting at lower temp.
- using the largest possible quantity of cullet

2. Lowering Primary Air Pressure
- lowering air pressure for fuel injection

  ex. 4 kg /cm^2 → 3 kg /cm^2 ⇒ NOx ▲24%

3. Lowering Secondary Air Volume
- decreasing air ratio ex. 1.2 → 1.1 ⇒ NOx ▲25%

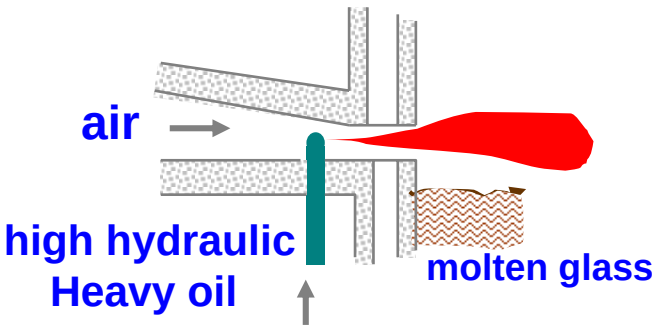
4. Lowering Furnace Temp. (Max. Temp.)
- allotting fuel distribution to maintain uniform temp. in furnace
- electric boosting

5. Combustion Control Work Standards

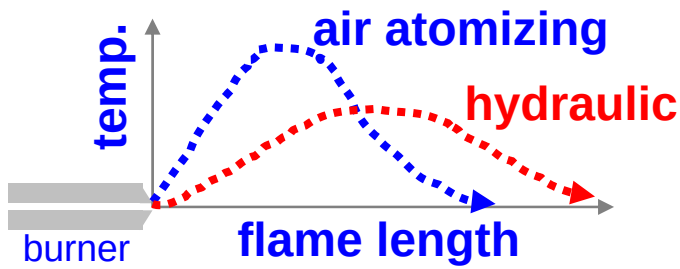
4. NOx Reduction Method

4-4 Using Low NOx Burner

1. Hydraulic burner



Burner	Heavy oil use ratio	NOx conc. ratio
Air atomizing	1.00	1.00
Hydraulic	0.88	0.62



2. Supersonic burner

- Low O_2 combustion ex. Air 170 → 120 m3/h ⇒ NOx ▲25~30%

3. Laidlaw burner

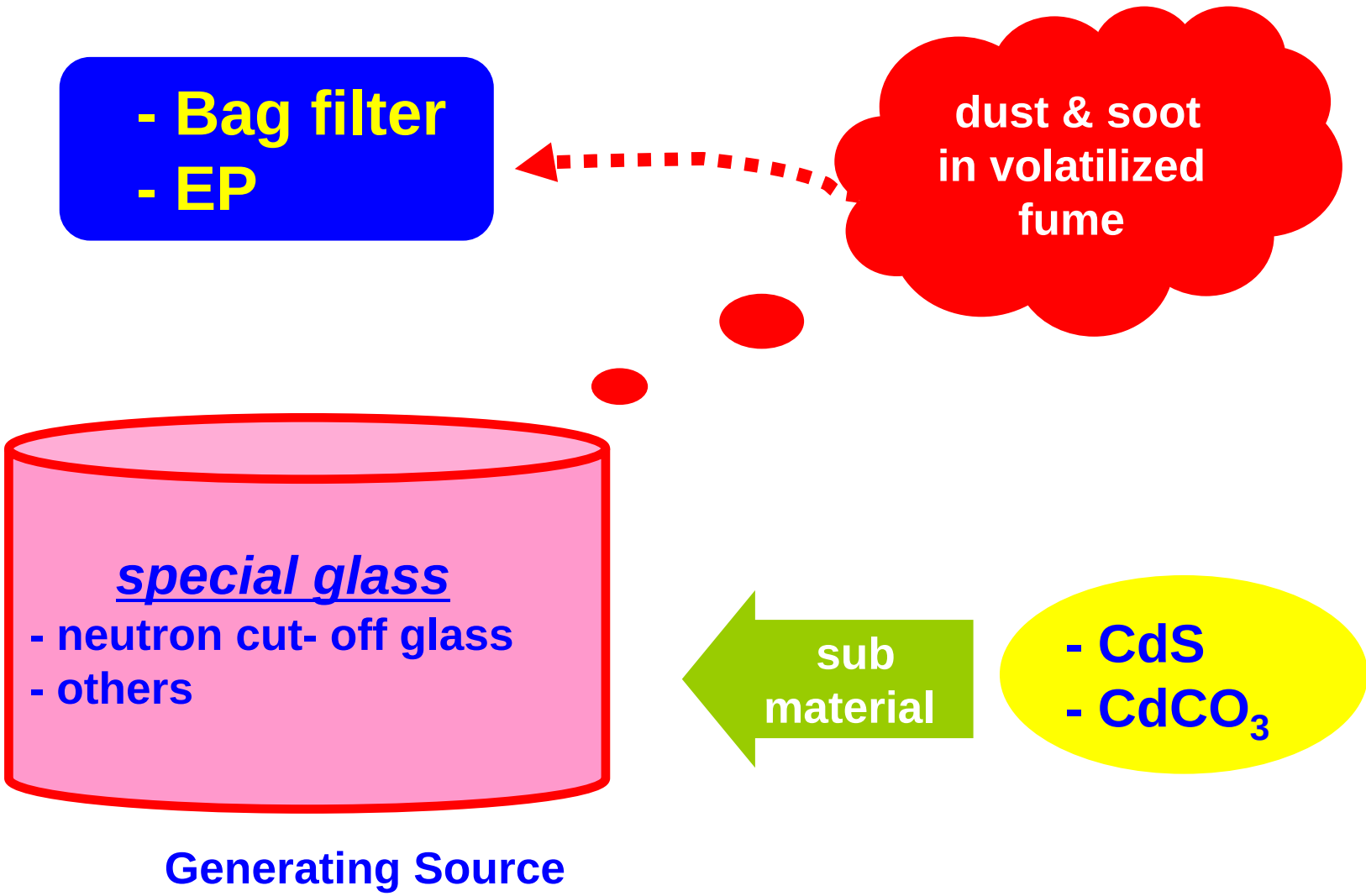
- Primary air: 30~40% less than conventional burner ⇒ lower NOx

4. Gas atomizing heavy oil burner

- Town gas is used instead of primary air ⇒ NOx ▲ 20~25%

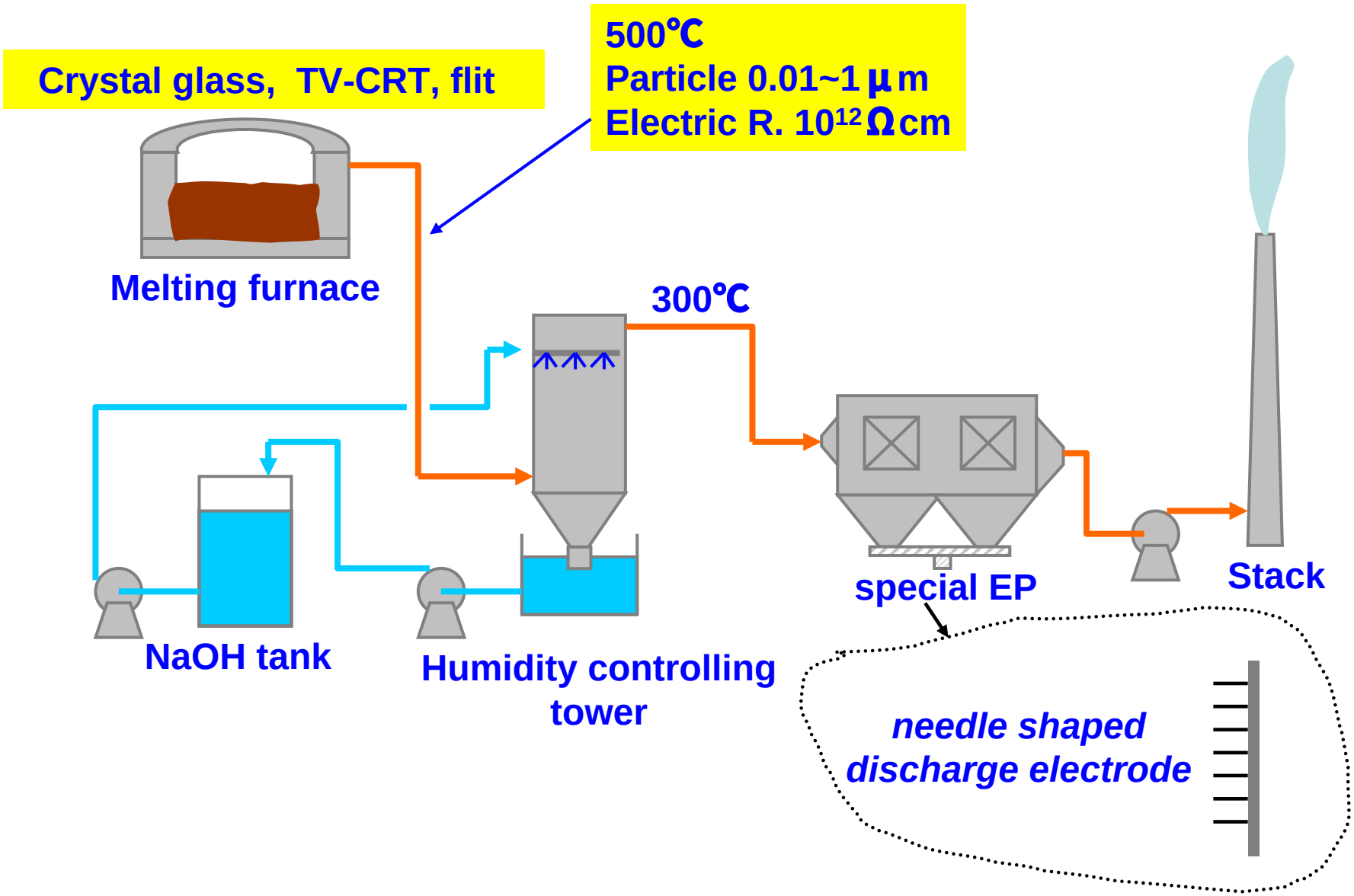
5. Removing Toxic Substances

5-1 Cd & its Compounds



5. Removing Toxic Substances

5-2 Pb & its Compounds

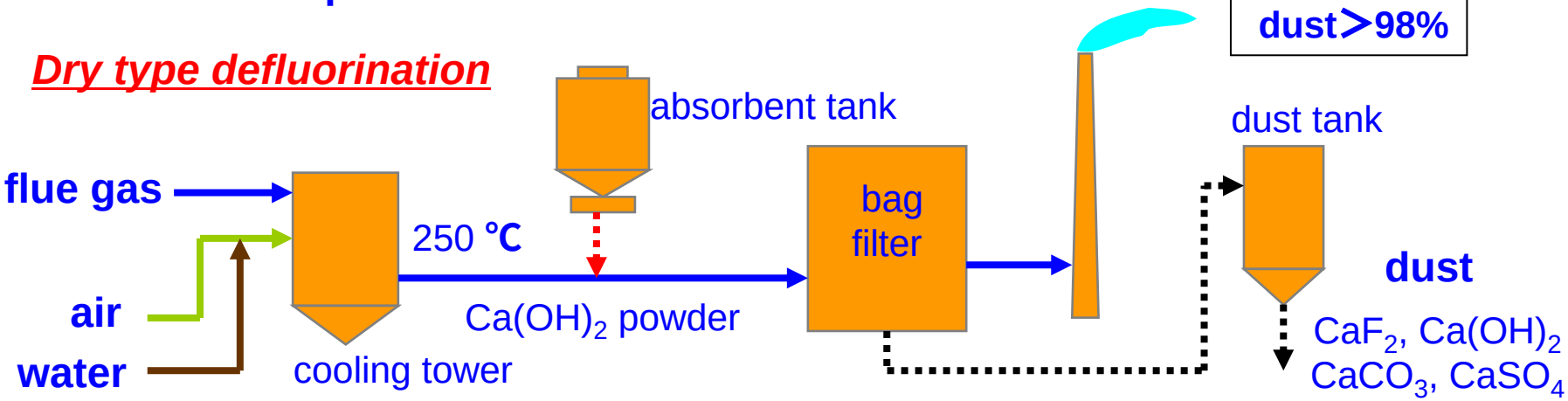


5. Removing Toxic Substances

5-3 F & its Compounds

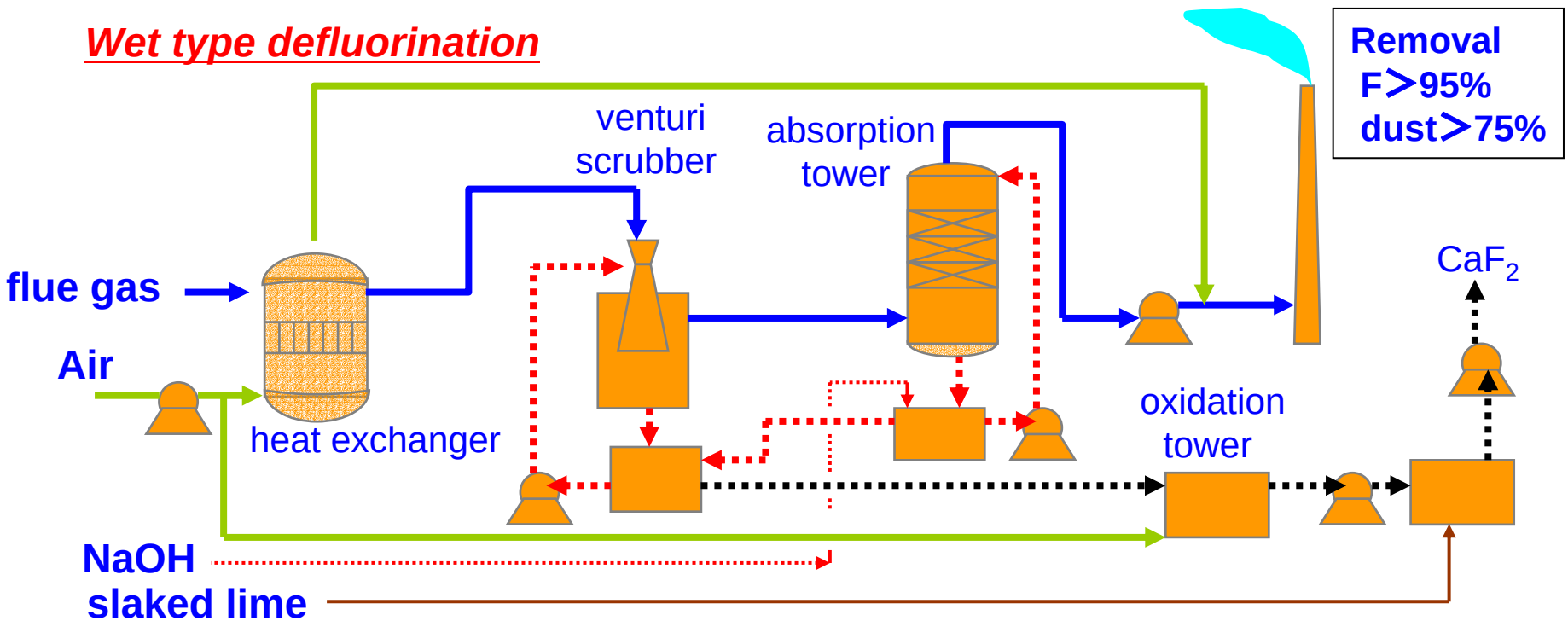
Removal
F > 95%
dust > 98%

Dry type defluorination

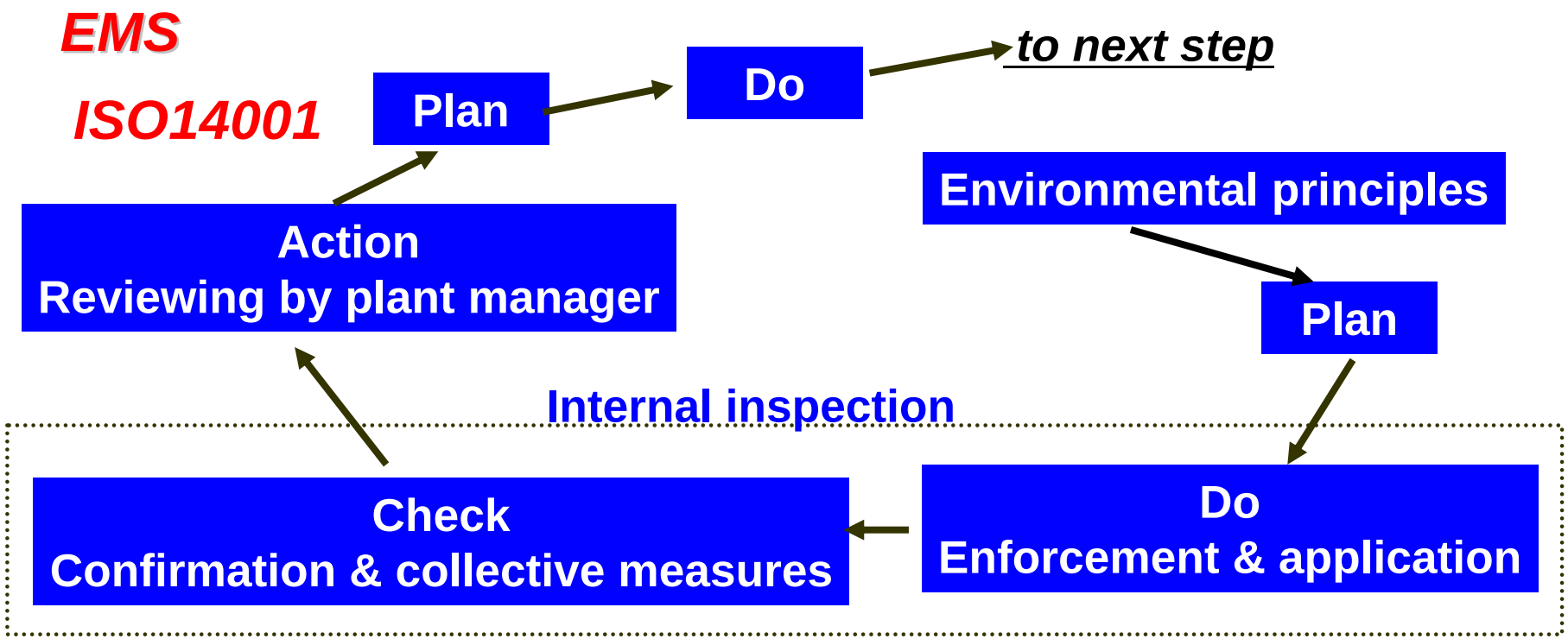


Removal
F > 95%
dust > 75%

Wet type defluorination



6. Environmental Management System



Items to be considered at factory construction & operation

1. ***Environmental impact assessment***
2. ***Environmental standards & emission standards***
3. ***Planning of plant & air pollution control equipment***
4. ***Operation control & worker training***
5. ***Environmental monitoring***
6. ***Environmental management system***

7. Energy Saving Technology

1. How to promote energy saving

Basic policy → Understanding current state → Goal → Measures

2. Energy saving methods

- *Acceleration of glass melting*
  - *increasing cullet use ratio*
  - *refining of grain of raw material*
  - *moisture control of batch*
  - *improvement of fusibility by glass composition*
- *Combustion*
  - *combustion control*
  - *work standards*
  - *preventing of air intrusion*
  - *improvement & change of burner*
- *Heat insulation & reduction of cooling air*
- *Waste heat recovery*
- *Others*
  - *introduction of cogeneration system & inverter control*
  - *development thinner & lighter glass bottle*
  - *stabilization of production process*