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With Ministry of the Environment, Japan

環境省

Ministry of the Environment

Air Pollution Control Technology In Fertilizer Manufacturing Industry

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Overseas Environmental Cooperation Center, Japan

Air Pollution Control Technology in Fertilizer Manufacturing Industry

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Urea Plant in Bangladesh

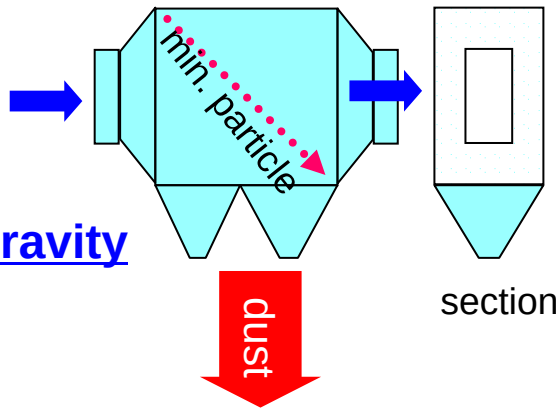
1. Air Pollution in Fertilizer Plant

Fertilizer	*Raw materials*
Nitrogenous F.	: ammonia, Chilean saltpeter, limestone + N_2, ‘‘‘‘
Phosphate F.	: phosphate rock
Potassium F.	: ore (ingredient ; KCl + NaCl), KCl, ‘‘‘‘
Coated F.	: N, P, K + **thermo plasticity resin**

Pollutants	*Origins of Pollutants*
Soot, SOx, NOx	Boiler, Dryer, Calcining furnace, etc.
Dust	Raw material stock yard, Raw material feed equipment, Belt conveyer, Bucket conveyer, Crusher, Mill, Sieve
HF	Phosphate fertilizer plant------ Reactor, Calcining furnace, Melting furnace, Phosphoric acid concentration plant
NH_3	Pelletizer, Dryer
Solvent	Coated fertilizer manufacturing process

2. Soot & Dust Collection

2-1 Gravitational, Inertial & Centrifugal Dust Collector



Gravity

Stokes' Law

$V=(g/18\mu)(\rho_1-\rho)D^2$ (cm/s)

V: settling velocity (cm/sec)

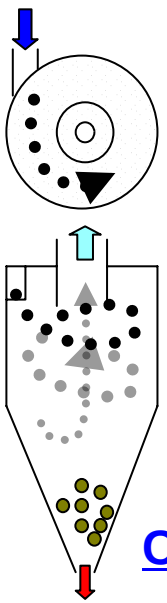
μ : gas viscosity (kg/ms)

g: gravitational acceleration (cm/s^2)

ρ_1: particle density (g/cm^3)

ρ : gas density (g/cm^3)

D: particle diameter (cm)



Centrifugal

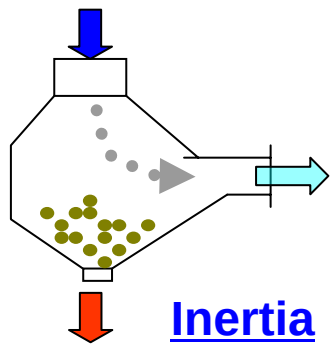
Principle of dust collection ;

Centrifugal force (F) = mv^2/R ,(N)

m: particle mass (kg)

V: particle velocity (m/ s)

R: cyclone radius (m)



Inertia

2. Soot & Dust Collection

2-2 Scrubbing Dust Collector

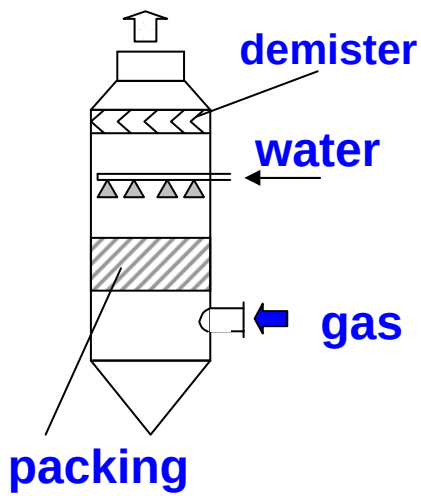
Mechanisms of Separation

- Adhesion of dust to water drops & water film by inertia force
- Adhesion by diffusion force among dusts
- Increase of coagulation force of particles by increasing moisture
- Moisture condensation triggered by dust as a nucleus
- Particle adhesion by bubbles

Typical Types of Scrubbers

Type	Velocity m / s	L/G l / m³	△P kPa	Th. Φ μm
Spray	1~2	2~3	0.1~0.5	≧3
Packed	0.5~1	2~3	1~2.5	≧1
Jet	10~20	10~50	0~ -1.5	≧0.2
Venturi	60~90	0.3~1.5	3~8	≧0.1

Th. Φ: Particle size of threshold to allowing 50 % removal

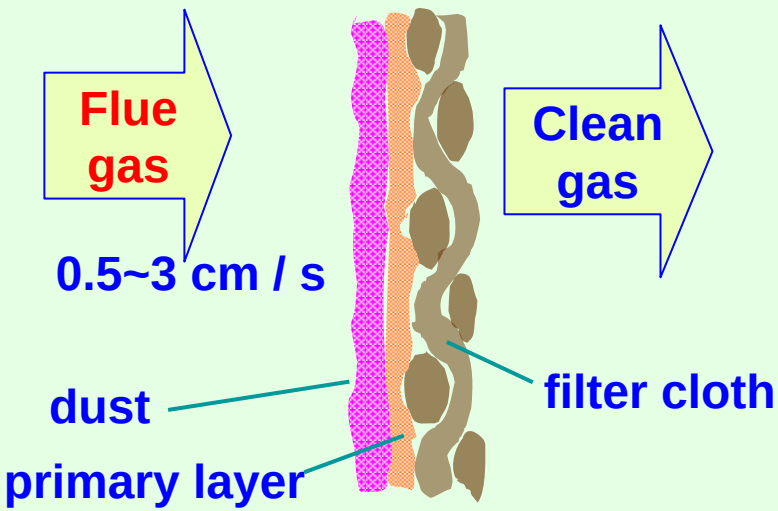


Packed tower

2. Soot & Dust Collection

2-3 Filter Type Dust Collector

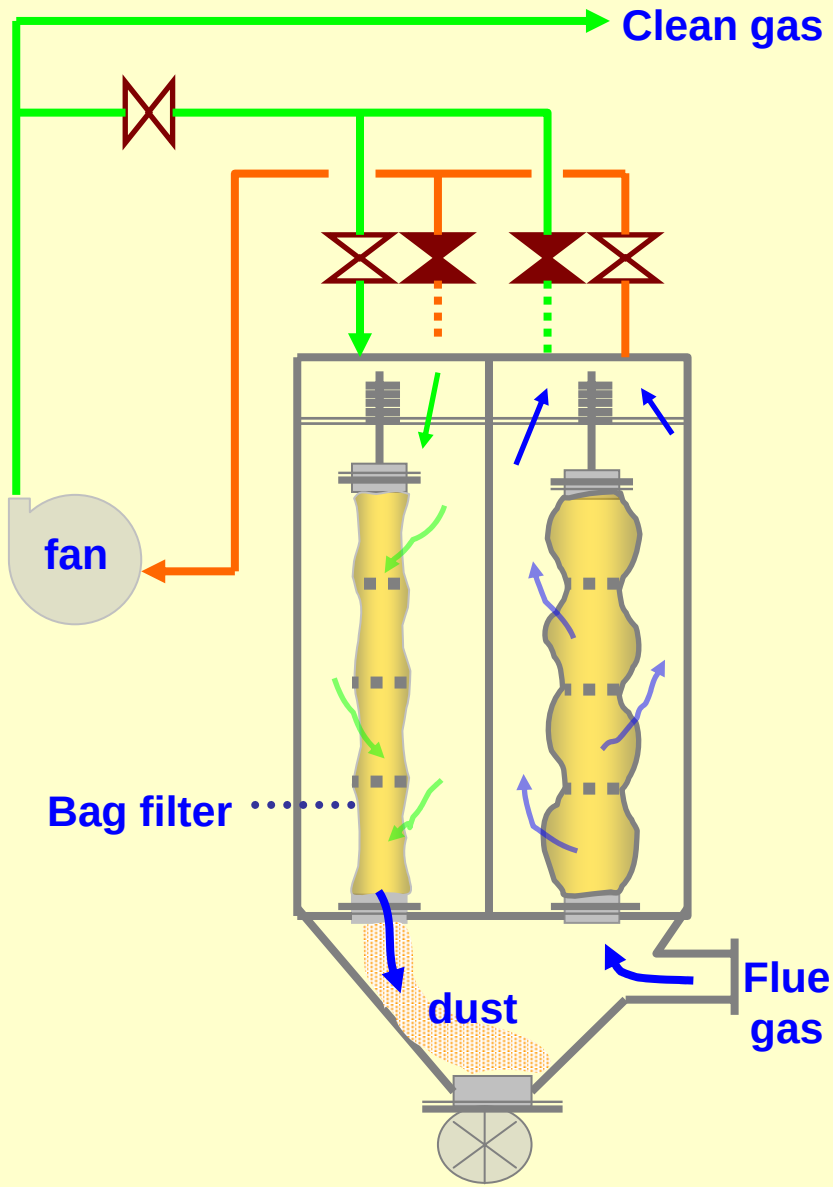
Filtration Action in Filter Cloth



△P 150 mg Hg → dusting

Dusting frequency
- intermittent
- continuous

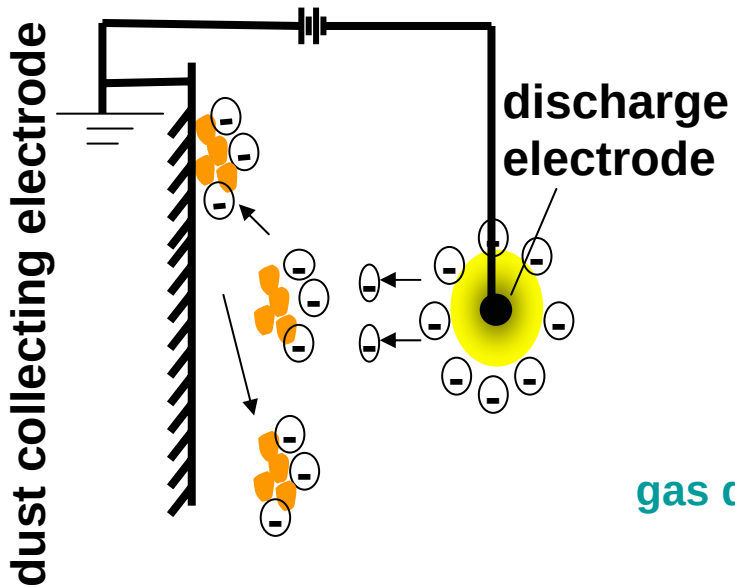
Dusting drive
- vibration
- reverse air



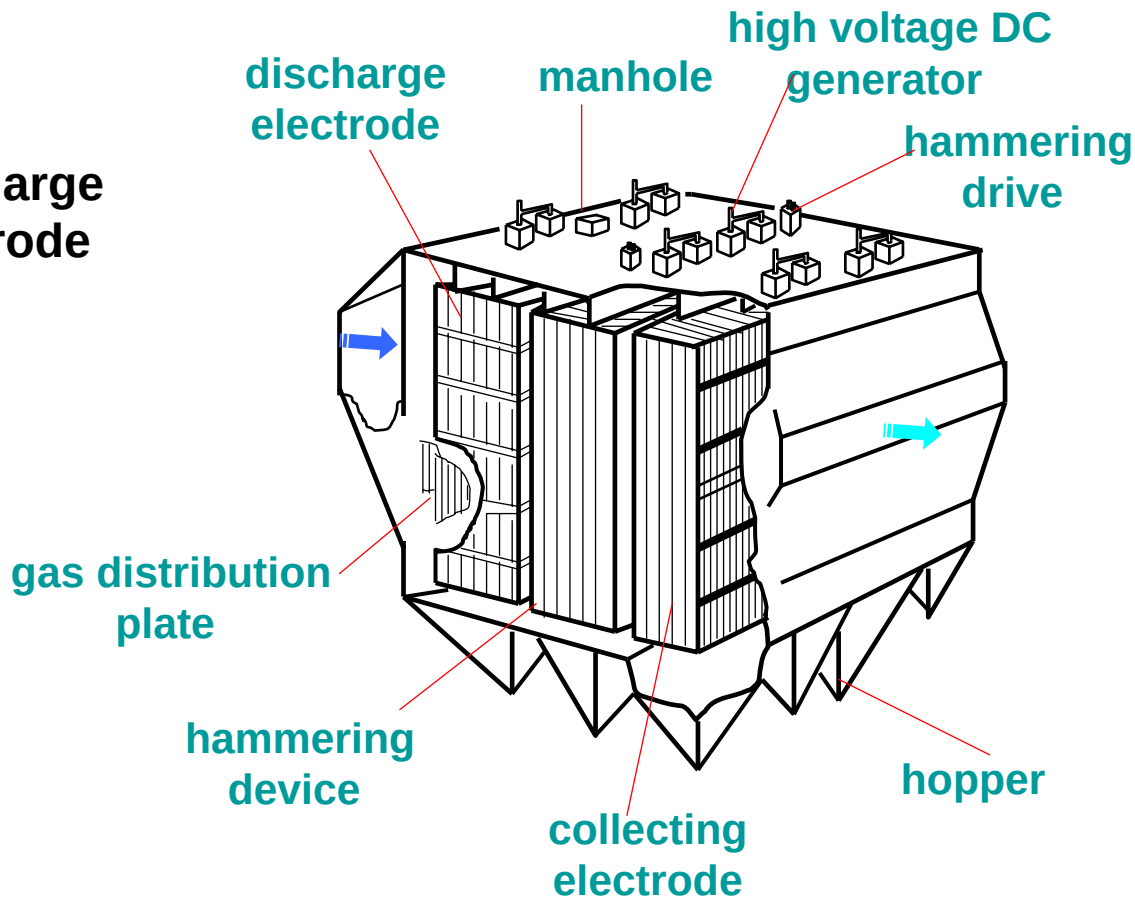
2. Soot & Dust Collection

2-4 Electrostatic Precipitator

Principle of dust collection ;



Structure of EP



2. Soot & Dust Collection

2-5 Selection of Dust Collector

***Factors affecting Dust Collection*:**

dust concentration, particle size distribution, temperature of dust, apparent electric resistance rate, due point, gas temperature, composition of flue gas, gas volume, etc.

Applicable Range of Dust Collector

Type	Particle (μm)	Working (℃)	Cutback Level (%)	Pressure Drop (mm H_2O)	Equipment Cost	Running Cost
Gravity	1000~50	d.p. ~ 400	40~60	10~15	S	S
Inertia	100~10	d.p.~ 400	50~70	30~70	S	S
Centrifuge	100~3	d.p. ~ 400	85~95	50~150	M	M
Scrubbing	100~0.1	no- limit	80~95	300~800	M	L
Filtration	20~0.1	no- limit	90~99	100~200	≧M	≧M
EP	20~0.05	d.p. ~ 400	90~99.9	10~20	L	S~M

L: expensive M: average S: cheap

3. SOx Reduction Technology

Sources of SOx: Fuel SOx

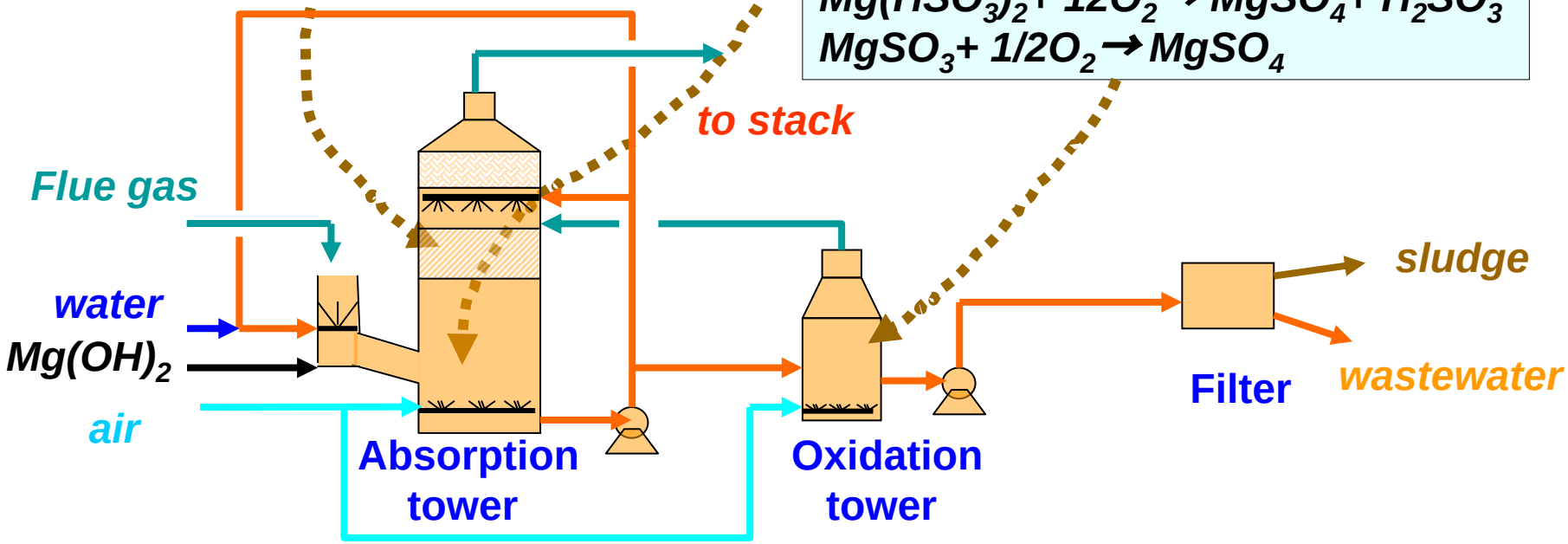
- Boiler - Dryer - Calcining furnace - Melting furnace

Wet Type Absorption

$SO_2 + H_2O \rightarrow H_2SO_3$
$H_2SO_3 + Mg(OH)_2 \rightarrow MgSO_3 + 2H_2O$
$MgSO_3 + H_2SO_3 \rightarrow Mg(HSO_3)_2$

$Mg(HSO_3)_2 + Mg(OH)_2 \rightarrow 2MgSO_3 + 2H_2O$
$H_2SO_3 + Mg(OH)_2 \rightarrow MgSO_3 + 2H_2O$
$MgSO_3 + 1/2O_2 \rightarrow MgSO_4$

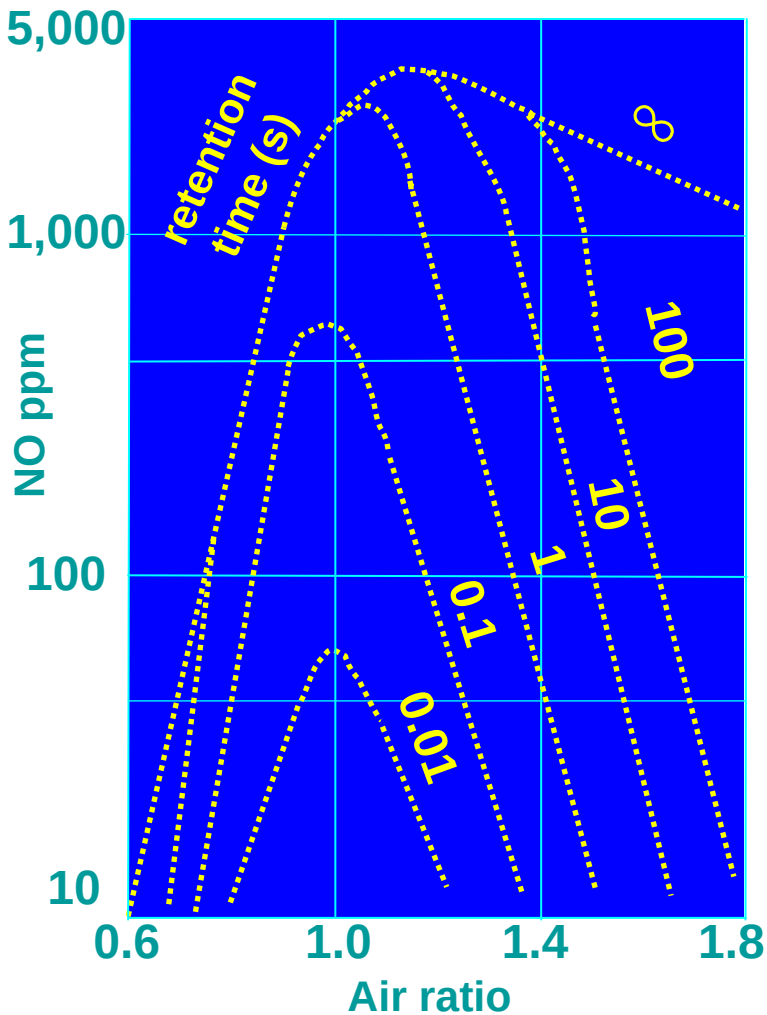
$Mg(HSO_3)_2 + 12O_2 \rightarrow MgSO_4 + H_2SO_3$
$MgSO_3 + 1/2O_2 \rightarrow MgSO_4$



4. NOx Reduction Technology

4-1 NOx Generation in Fertilizer Plant

Air ratio ~ Retention time ~Thermal NOx



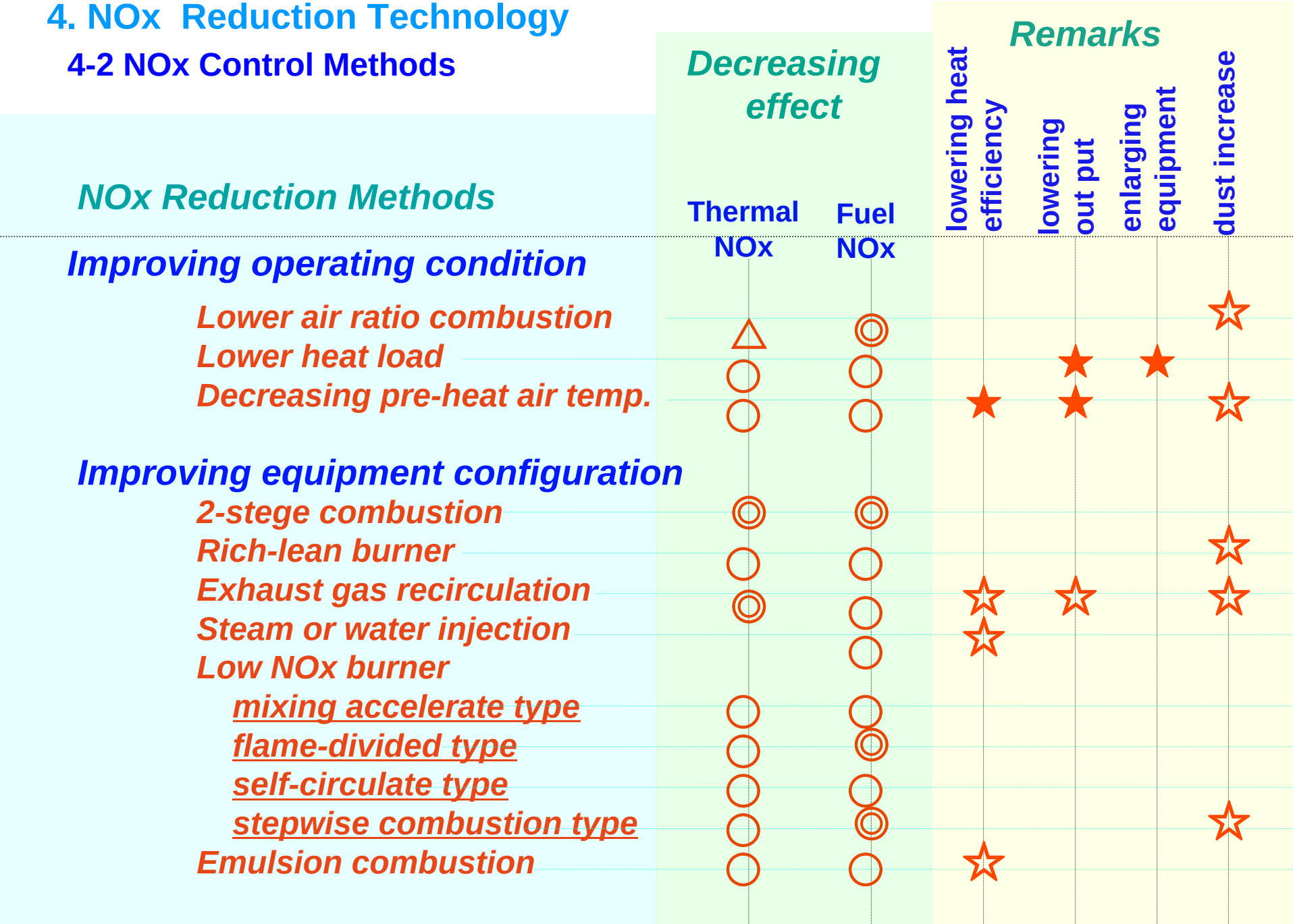
Thermal NOx ≫ Fuel NOx

NOx concentration increases at:

- **higher temp. in combustion**
- **higher O_2 conc.**
- **longer retention in high temp. zone**

4. NOx Reduction Technology

4-2 NOx Control Methods



5. Dust Scattering Prevention

Dust generating equipment & location designated by air pollution control law

- belt conveyer
- bucket conveyer
- crusher, mill
- sieve
- ore stock yard

Equipment protected work shop environment from dust scattering

- silo, hopper for raw material & product
- transporting equipment except belt & bucket conveyer
- packing machine, etc.

Measures

- outdoor stock with sheet cover (phosphate rock)

- indoor allocation
- closed cover, negative pressure
- Sealed dust collecting cover
- dust collecting hood

- cyclone
- bag filter

6. NH_3 Removal Technology

1. Permissible NH_3 emission:

1~ 5 ppm at boundary of premise (set forth by prefecture governors)

$Q = 0.108 \times He^2 \times Cm$

Q : gas volume (Nm^3 / h)

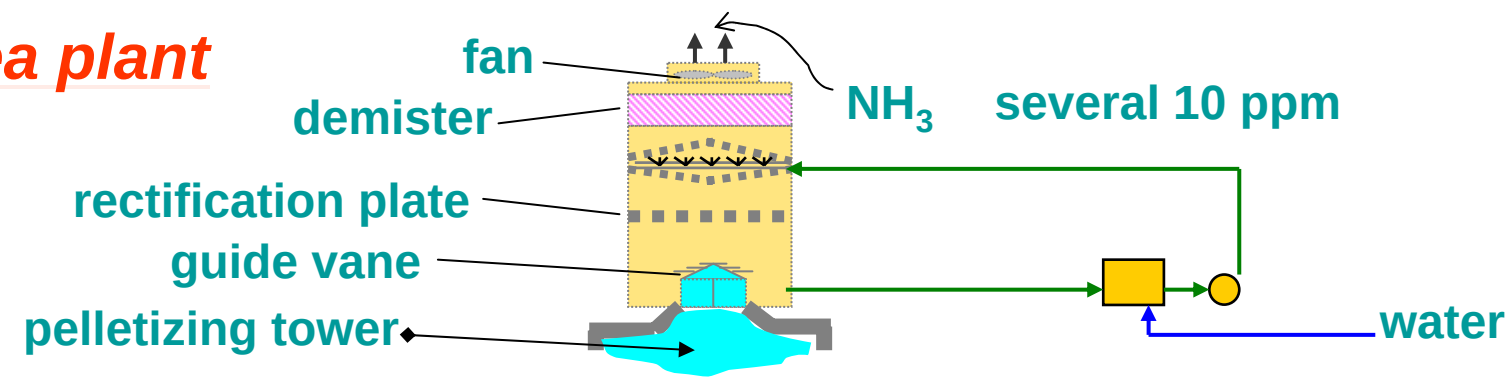
He : effective height of exhausting outlet (m)

Cm: concentration at boundary line of premise (ppm)

2. In compound fertilizer plant :

Process	Origin	Abatement
pelletizer & drying	$(NH_4)_2SO_4$ $(NH_4)_3PO_4$ $CO(NH_2)_2$	reservoir type wet scrubber pressurized water scrubber packed bed water scrubber (NH_4 removal 70~90%, 20~50ppm)

3. In urea plant



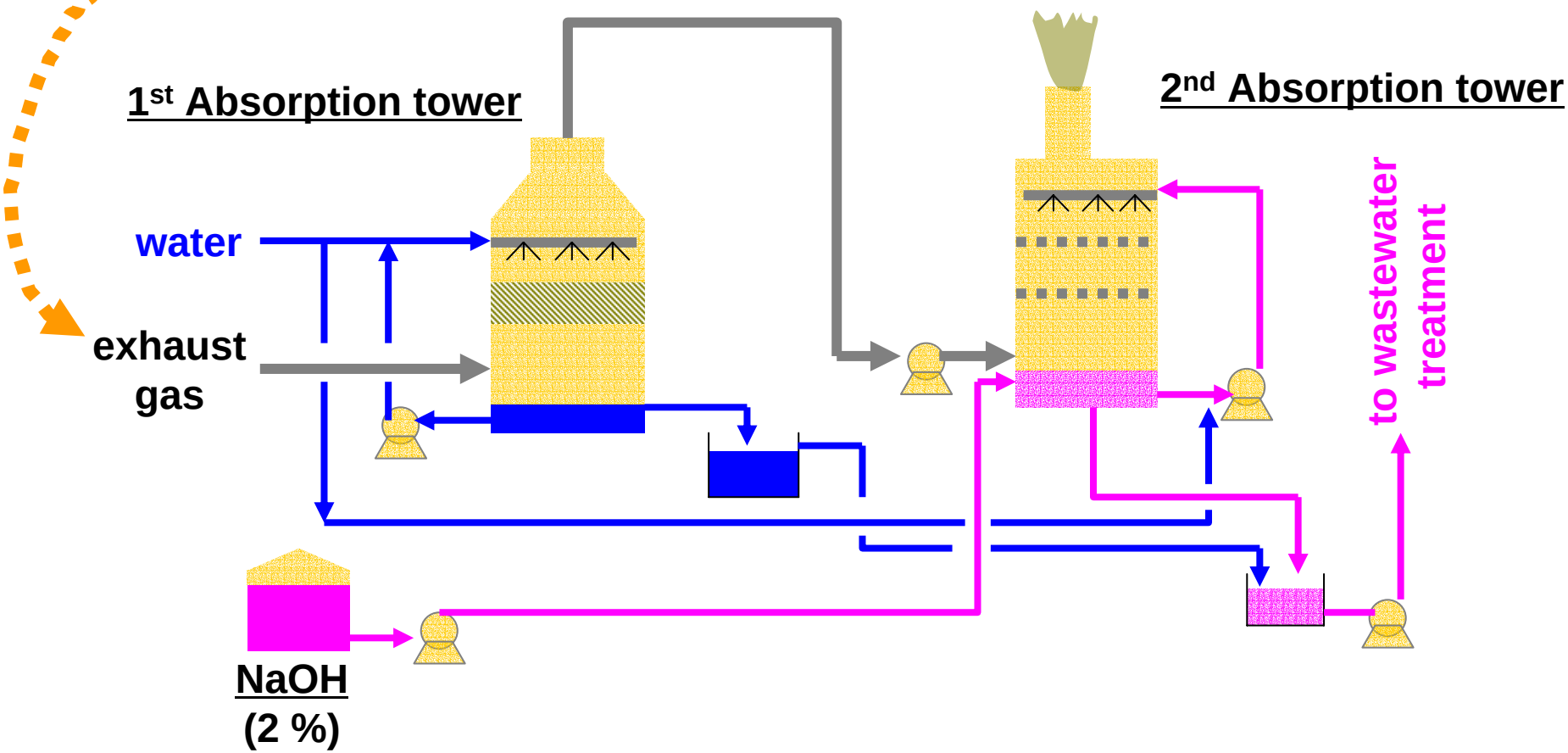
7. F Removal Technology

Generation of F

- reaction & condensation process for H_3PO_4 production
- reaction process for $Ca(H_2PO_4)_2$ production
- reaction furnace for fused P and calcined P production

HF, SiF_4

(with greater hydrophile property)



8. Odors Abatement technology

8-1 Abatement Processes

Deodorizing Method	Process
Incineration method	*decompose to CO_2, H_2O by heat*
direct incineration	*at 800℃*
regenerative thermal oxidizer	regeneration, heat efficiency ＞80%
catalytic incineration	using catalysis at 200~ 350 ℃, rem.＞99%
Scrubbing method	scrubbing by chemical solution water, acid, alkaline, oxidant, etc.
Adsorption method	
recovery type	
fixed bed	activated carbon, steam regeneration
fluidized bed	activated c., heat regeneration by N_2 gas
concentration type	
honeycomb	separating odor from low concentration gas
replacement type	replacing saturated adsorbent or oxidant
Biological method	biodegradation by microorganisms
soil bed	using soil bacteria
packed tower	using bio-film on the media
Deodorizer, masking agent	deodorize or easing offending gas

8. Odors Abatement technology

8-2 Troubles in Abatement Processes (examples)

Deodorizing Method	Trigger	Trouble
Combustion method		
direct incineration	NOx ↑	permission level ↑
regenerative thermal ox.	mixture of Cl_2, paint, etc.	HCl ↑, clogging
catalytic incineration	mixture of Cl_2, paint, S, etc.	catalyst deterioration
Adsorption method		
recovery type		
fixed bed	mixture of ketone, high B.P. substance	firing, deterioration of activated carbon
fluidized bed	high temp. of exhaust gas	A.C. deterioration
concentration type		
honeycomb	mixture of cyclohexane	firing
replacement type	conc.> several ppm	short term A.C. replacement
Biological method		
soil bed	drying of soil	malfunction
packed tower	slow acclimatization	slow starter
Scrubbing	less sprinkling water	malfunction
	dust in gas	clogging internals

9. Solvent Recovery & Abatement technology

1. *Sources of Generation*
   coated fertilizer (thermoplasticity resin)

2. *Abatement*
   recovery of solvent brings profit ⇒ production cost reduction
   residual solvent value ≪ recovery cost ⇒ pollution control

3. *Abatement Process*
   - cooling condensation method
     cool down flue gas below vapor pressure

   - absorption & dispersion method
     absorbing of solvent to absorbent with lower vapor pressure

   - adsorption & dispersion method
     ☆ applicable to compositions with low vapor pressure and non-existence of antagonist. Adsorbed at under pressure or lower temp..
     ☆ adsorber: fixed bed, moving bed, fluidized bed
     ☆ adsorbent: A.C., silica gel, molecular sieve, aluminum gel
     ☆ regeneration method: heated gas, steam, heat transfer, extraction under decompression

10. Environmental Management System

1. Environmental Management System
   - Organization for Environmental Control
   - ISO 14000 series----- PDCA cycle
   - Responsible for environmental protection

EMS

ISO 14000

2. Environmental Control Manual
   - Operation Standard Manual

3. Education & Training
   - legally qualified expert of environment control
   - training program and preparation of manual

4. Environmental Control at Work Shop

5. Environment Monitoring
   - maintaining monitoring system
   - monitoring of air pollution state
   - legal emission permissible level