

Contracted project – 2003
with Ministry of the Environment, Japan



環境省

Ministry of the Environment

Treatment of Industrial Wastewater

January 2004

Overseas Environmental Cooperation Center, Japan



Industrial Wastewater Treatment

– Food Processing Wastewater–

Committee Members

Chairman; Dr. M. Sugahara, Professor, Osaka Sangyo Univ.

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- 1. Environment Control & Measures for Industrial Wastewater Treatment**
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- 4. Examples of 9 Practical wastewater Treatment Plants**

Original sources; Technology Transfer Manual of Industrial Wastewater
Treatment, March, 2003, OECC



1. Environmental Control & Measures for Industrial Wastewater Treatment

History

'40's Industrial rehabilitation ('45~'55)

Industrial Pollution

'50's Fisheries damages by paper mills w.w. ('58)

Water Quality Conserv. Law + Control of Effluent Emission from Factory Law ('59)

'60's Basic Law for Environmental Pollution Control ('67)

'70's Water Pollution Control Law ('70)

Inauguration of the Environmental Agency ('71)

Areawide Total Pollution Load Control Law ('78)

Living Environment

'80's Law / Special Measures for Conserv. Of Lake Water Quality ('84)

'90's Practical Environmental Assessment started ('92)

Basic Environment Law ('93)

Environmental Assessment Law ('99)

Global Environment

'00's 5th Total Effluent Control System ('02) - - - COD + N, P

1. Environmental Control & Measures for Industrial Wastewater Treatment
Measures for Water Quality Conservation (1/3)

Laws

Protecting
Human Health

Preserving
Living Standards

**Environmental
Quality
Standards**

- 26 items
Heavy Metals,
Toxic Sub. Solvents,
Agriculture chem.
Nitrogen.....
- Nationwide

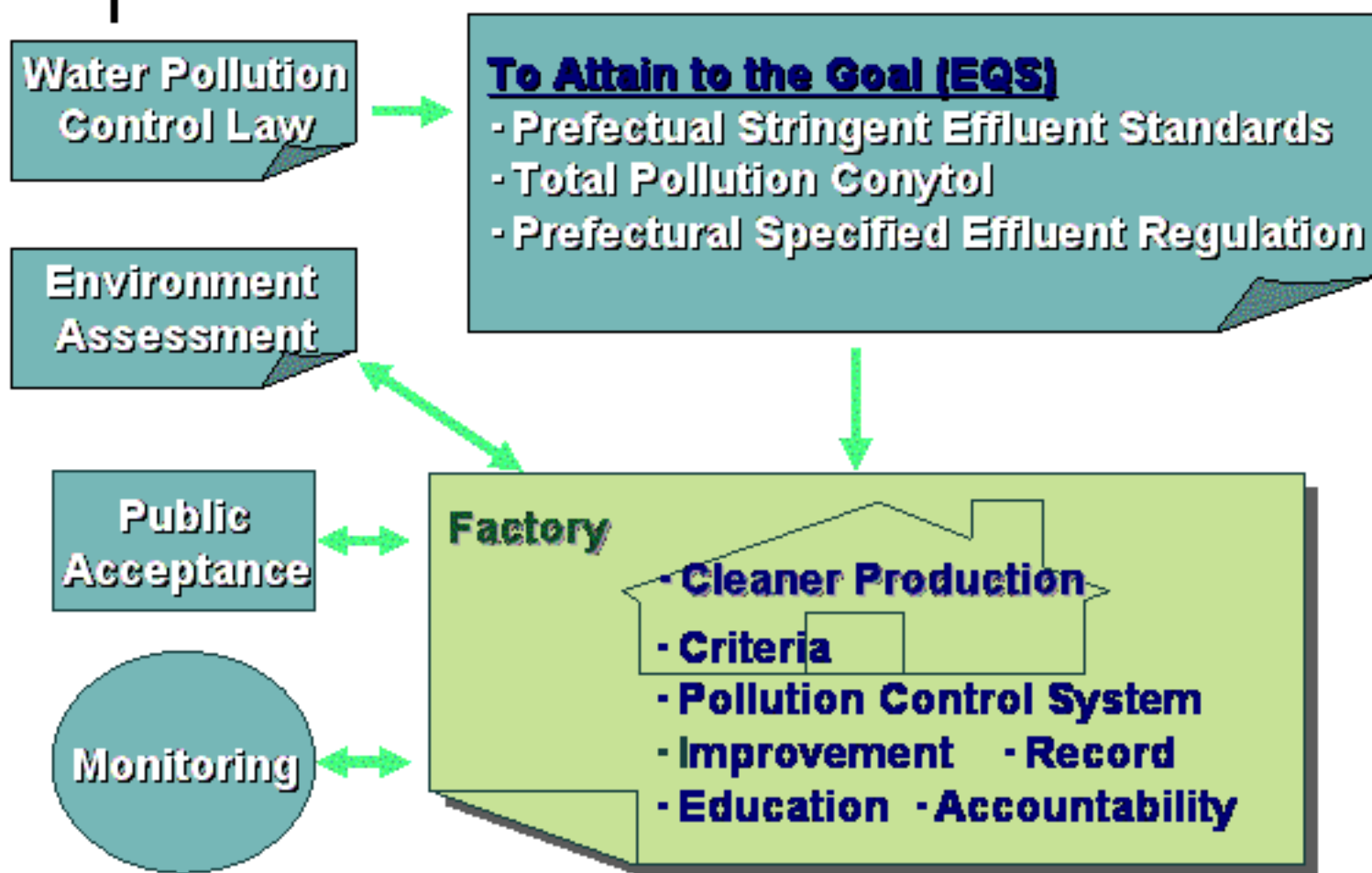
- 9 items
pH, BOD, SS, DO,
Oil, T-N, T-P.....
- Lake, Pond, Coast

**Effluent
Standards**

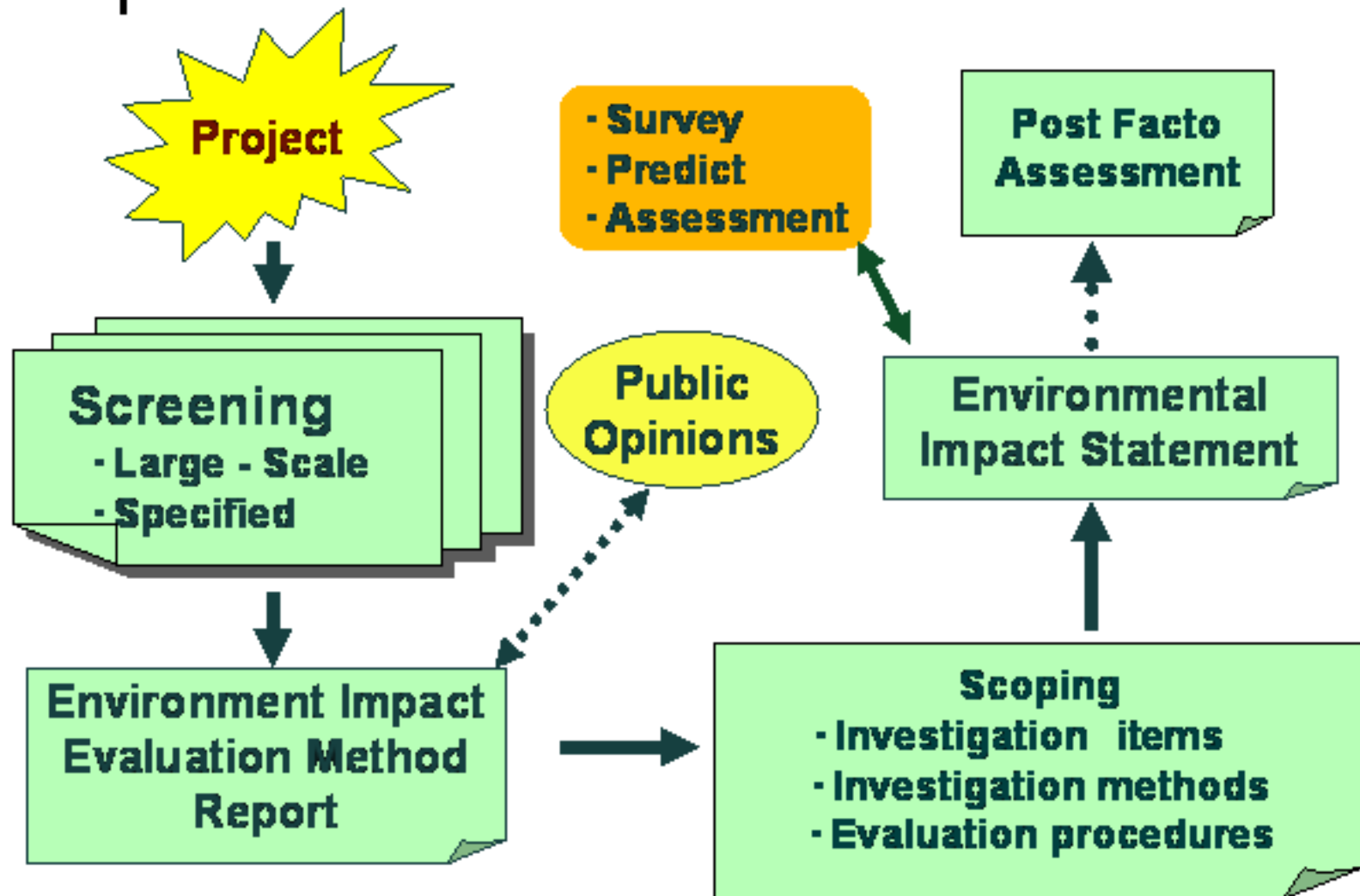
- 27 items
ditto + Org. P
- Nationwide

- 15 items
ditto + phenols,
Cu, Cr, F.....
- Nationwide

1. Environmental Control & Measures for Industrial Wastewater Treatment
Measures for Water Quality Conservation (2/3)
Wastewater treatment

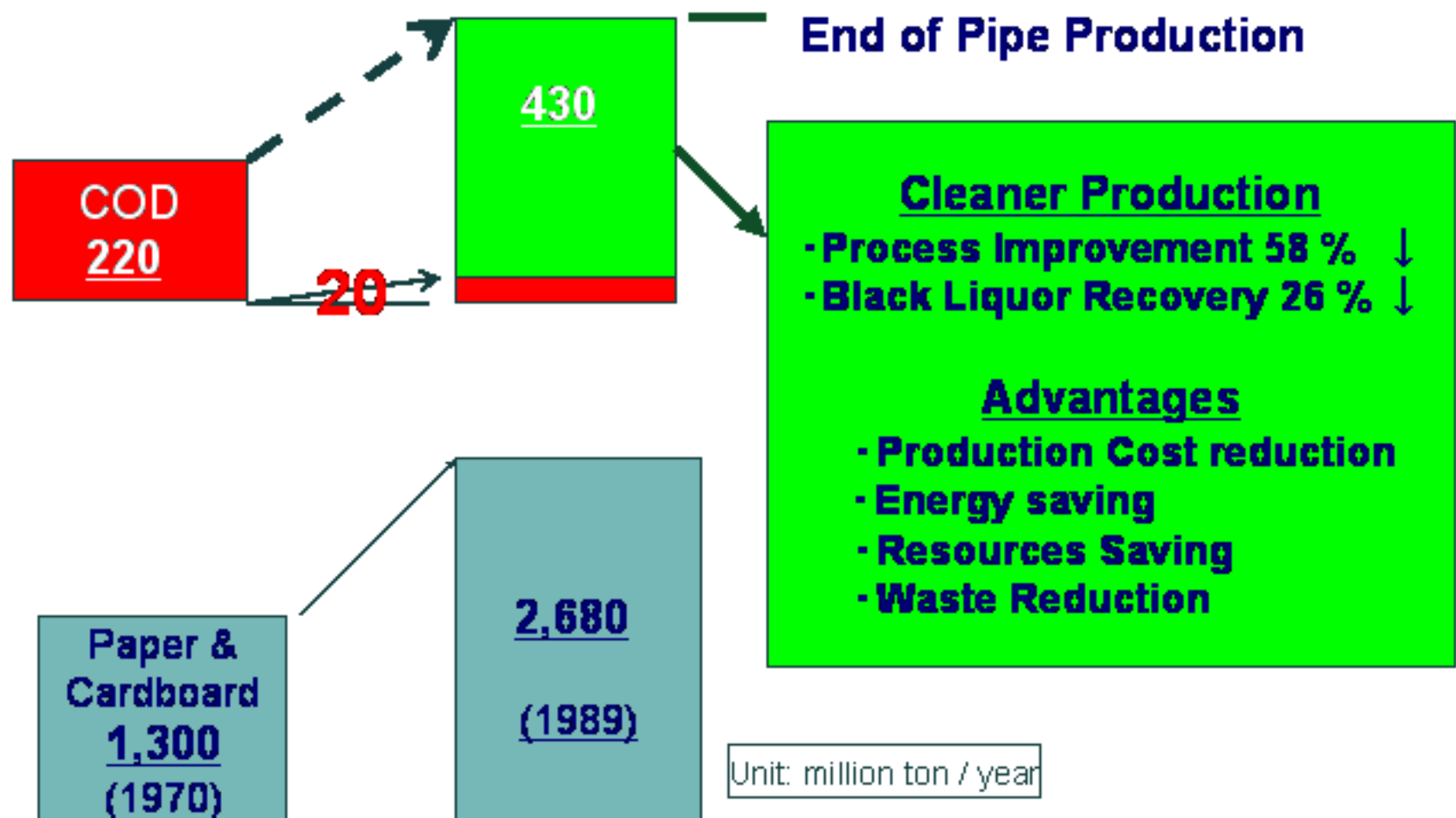


1. Environmental Control & Measures for Industrial Wastewater
Measures for Water Quality Conservation (3/3)
Environmental Assessment System



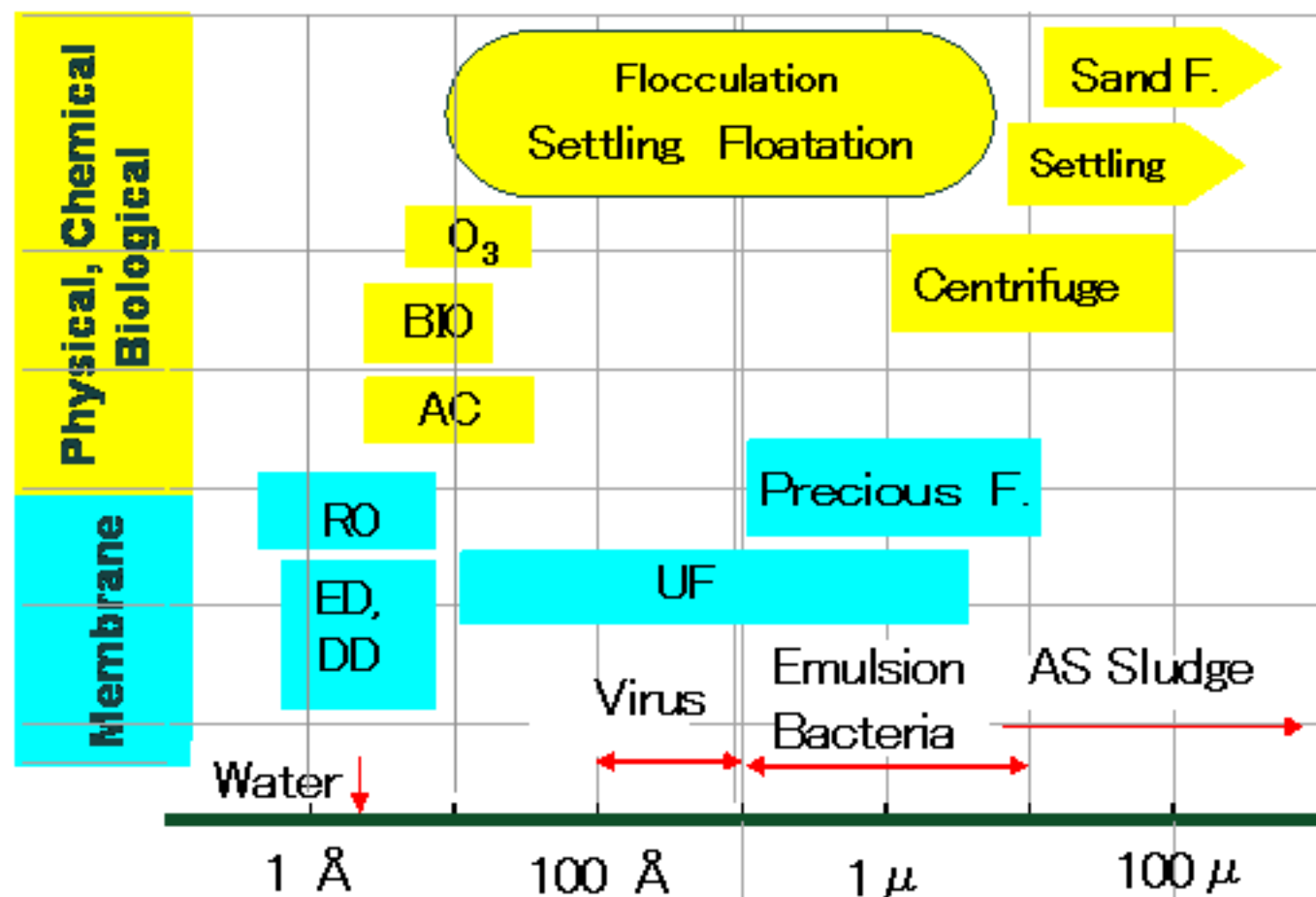
2. Considering Aspects on W.W. Treatment Plant Design

(1) Cleaner Production



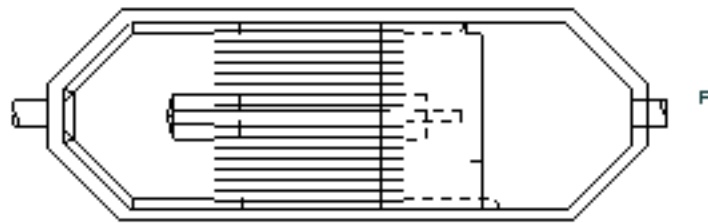
2. Considering Aspects on W.W. Treatment Plant Design

(2) Selection of Treatment Process

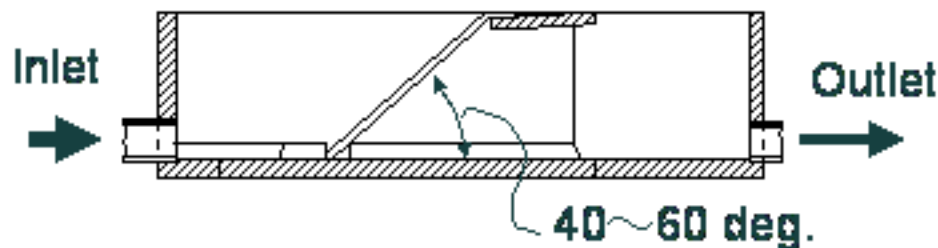


3. Wastewater Treatment Technologies

(1) Screening : Remove Floating Material



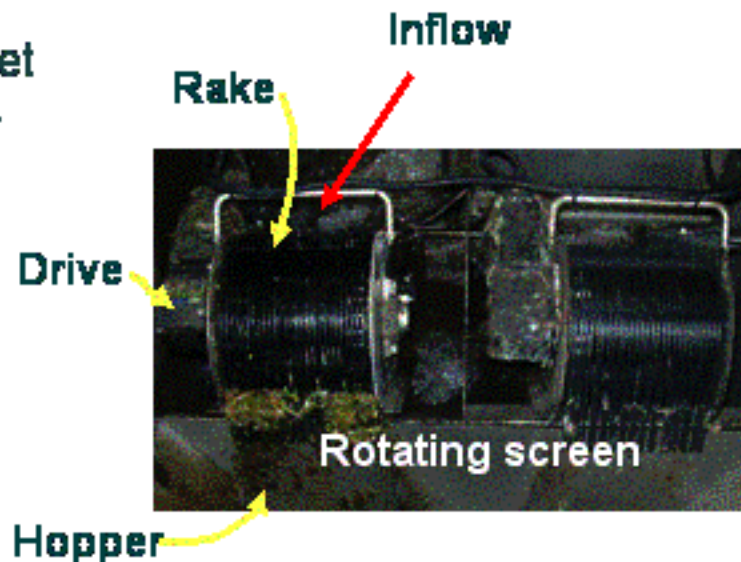
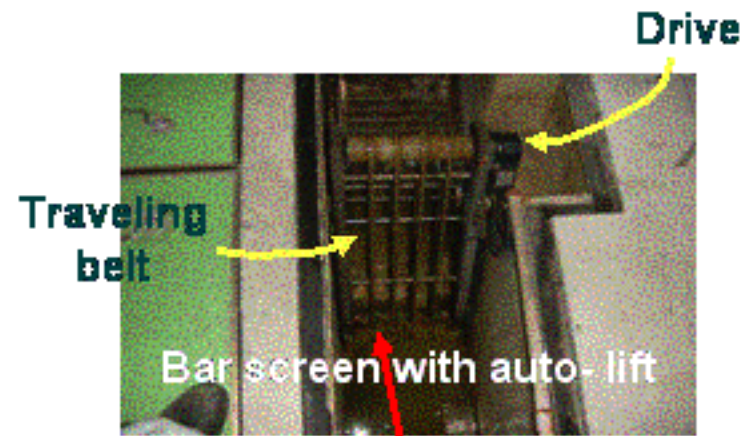
Bar Screen



40~60 deg.

Grid Effective Spacing

- ◆ Coarse Screen: $> 50\text{mm}$
- ◆ Normal Screen $15 \sim 50\text{ mm}$
- ◆ Fine Screen $< 15\text{ mm}$



3. Wastewater Treatment Technologies

(2) Separation of settling & floating particles

Stokes' Law

$$V_r = (g/18 \mu)(P_w - P_o)D^2$$

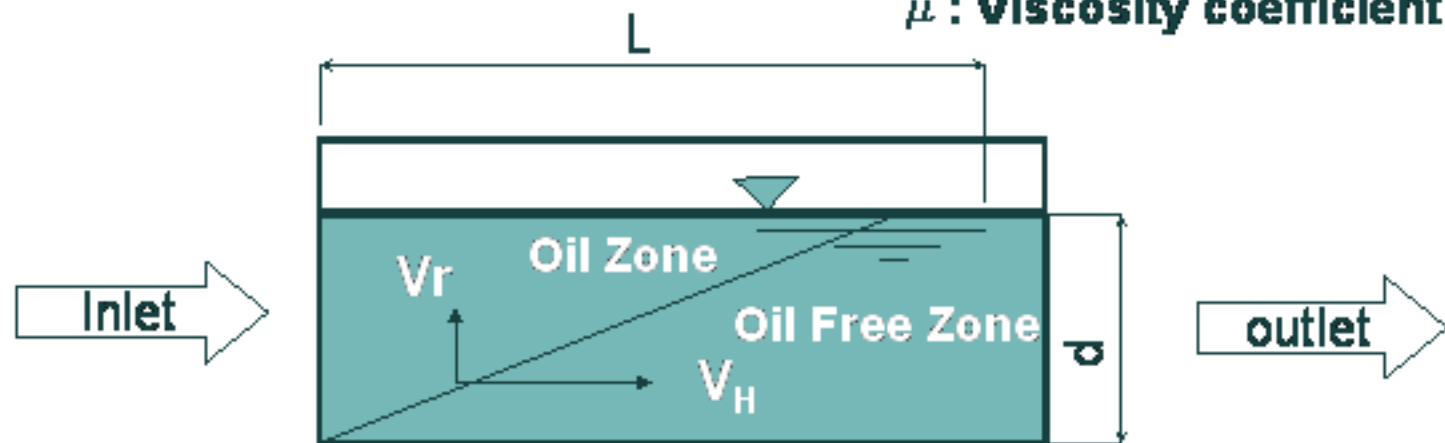
g: Gravity, m/s^2

P_w: Water density, kg / m^3

P_o: Oil density, kg / m^3

D: ϕ / particle, m

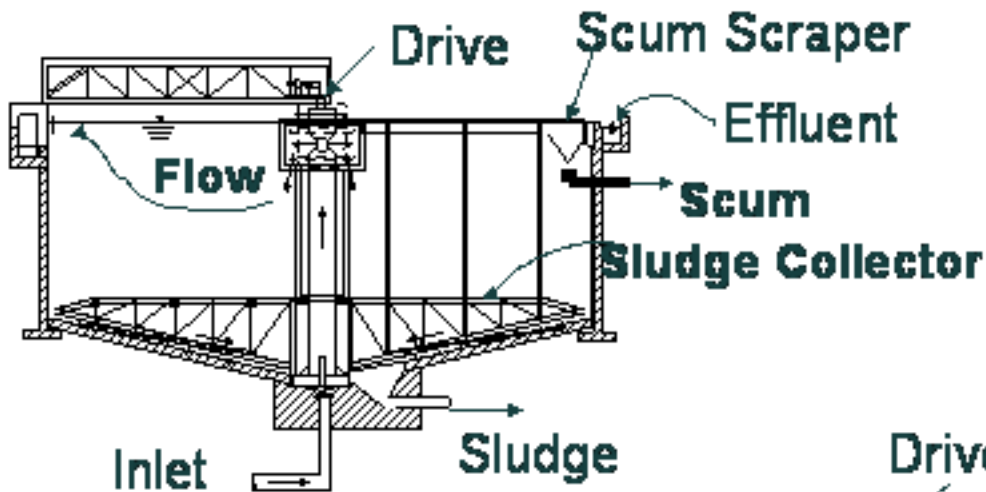
μ : Viscosity coefficient



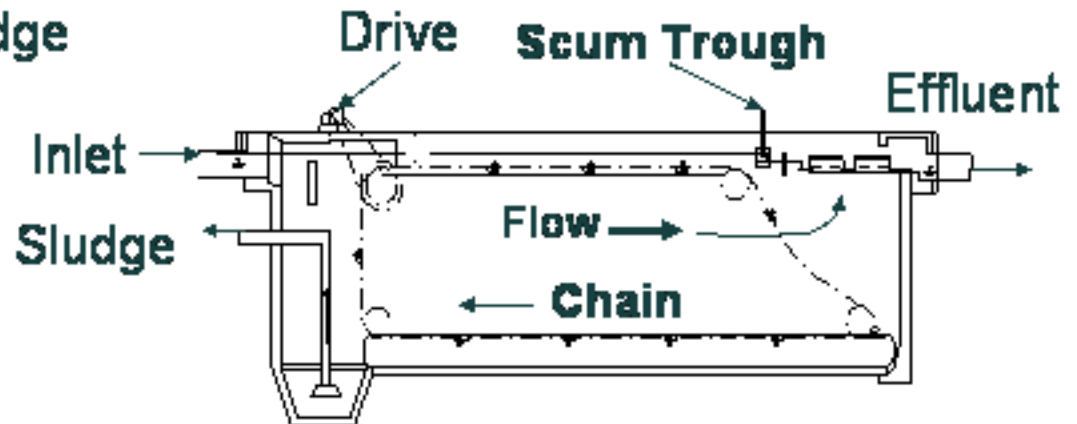
$$L = (V_H / V_r) d$$

3. Wastewater Treatment Technologies

(3) Sedimentation: Removing SS



Circular

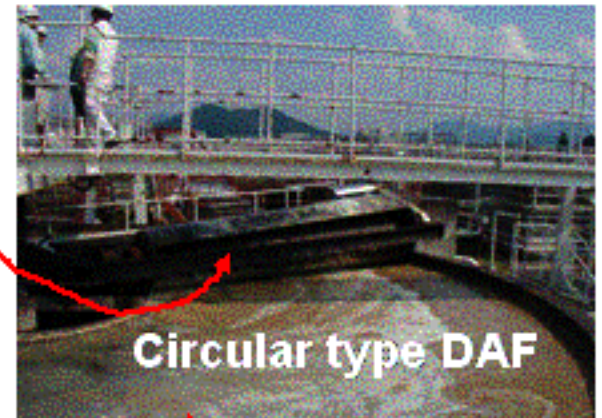
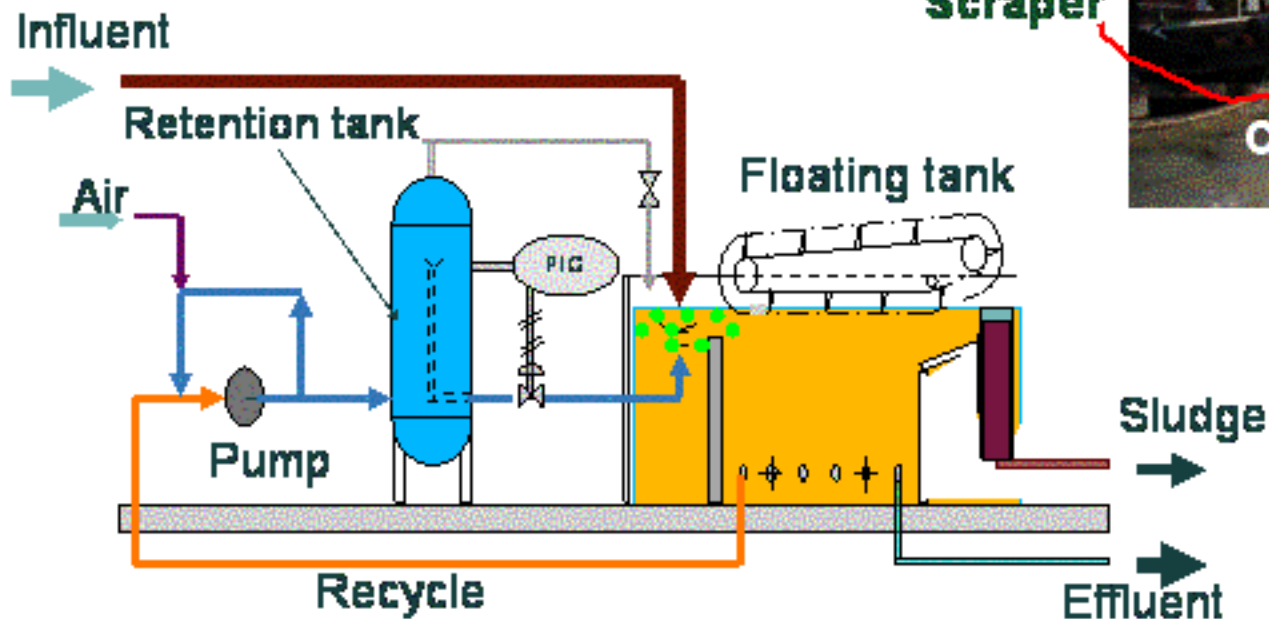


Rectangle

3. Wastewater Treatment Technologies

(4) Floatation: Removing SS & Oil

Dissolved Air Floatation



Scraper

Circular type DAF

Floated scum

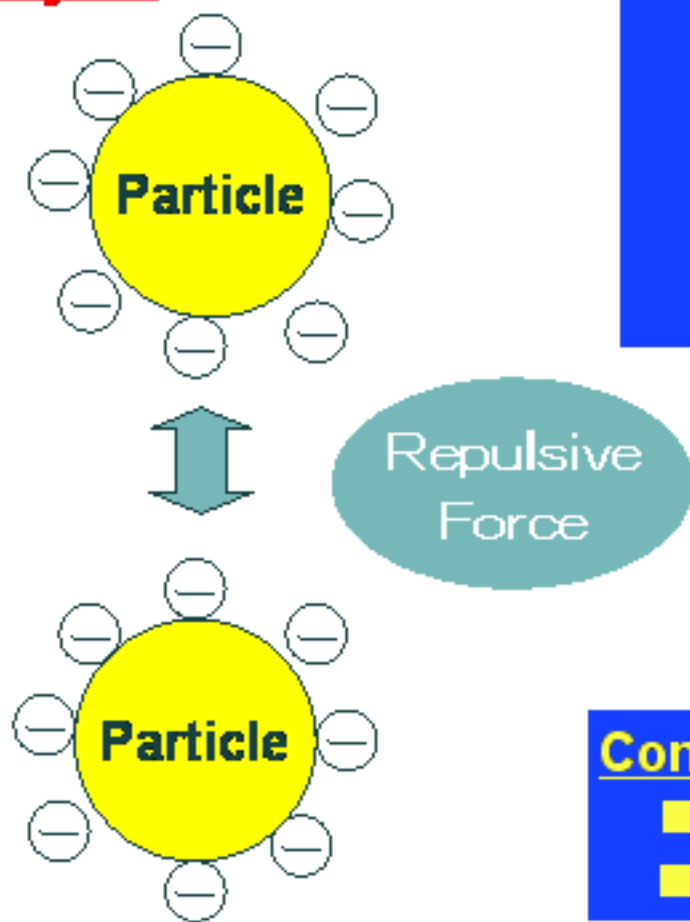
Sludge

Effluent

3. Wastewater Treatment Technologies

(5) Coagulation: Enlargement of Particle

Why ?



How to connect ?

- Electric Neutralization
- Bonding opposite Charged Ions
- Physical Adsorption
- Bridging



Coagulants

- Electrolyte
- Hydrated Metal Oxide
- Polyelectrolyte

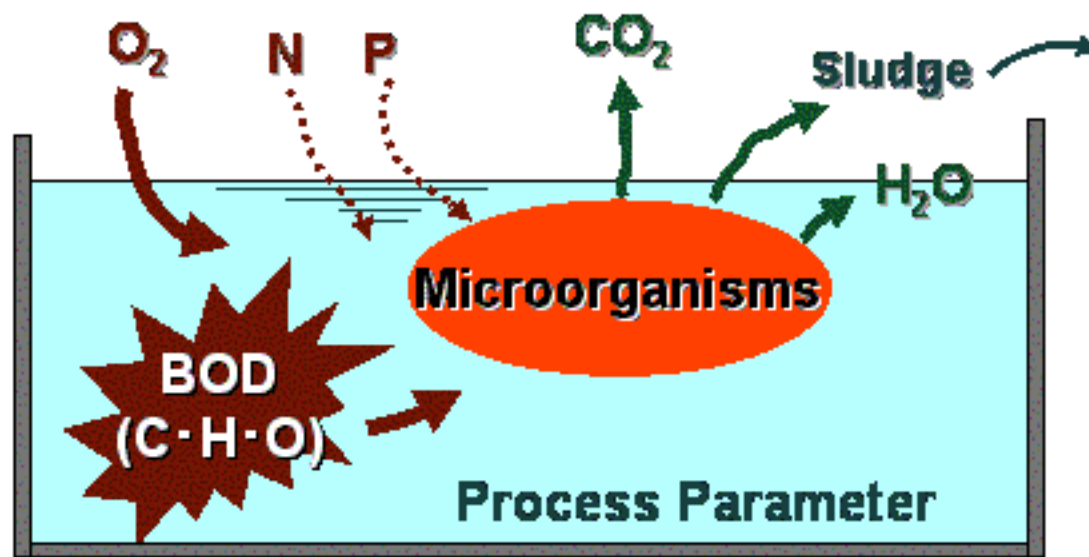


Conditioning

- Mixing
- pH

3. Wastewater Treatment Technologies

(6) Aerobic Biological process (1/2)



BOD / MLSS / D
 $0.4 \div 30\%$
 $0.02 \div \text{SS in Effluent}$



- Temp : 5~40°C
- pH: ~ 7 ~
- DO: > 0.2~
- BOD:N:P=100:5:1
- BOD /MLSS /D = 0.02~0.4



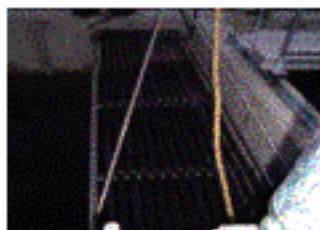
3. Wastewater Treatment Technologies

(6) Aerobic Biological Process (2/2)

Process

- Conventional Activated Sludge
- Modified: Extended Aeration, Lagoon
- Biofilm: Floating Media, Rotating Contactor
- Hybrid: Membrane

Aerators

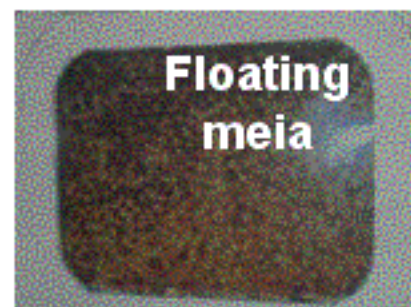
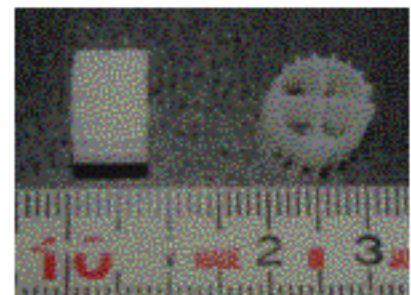


Fine bubble
difuser



Mechanical aerator
Fixed bed type

Media

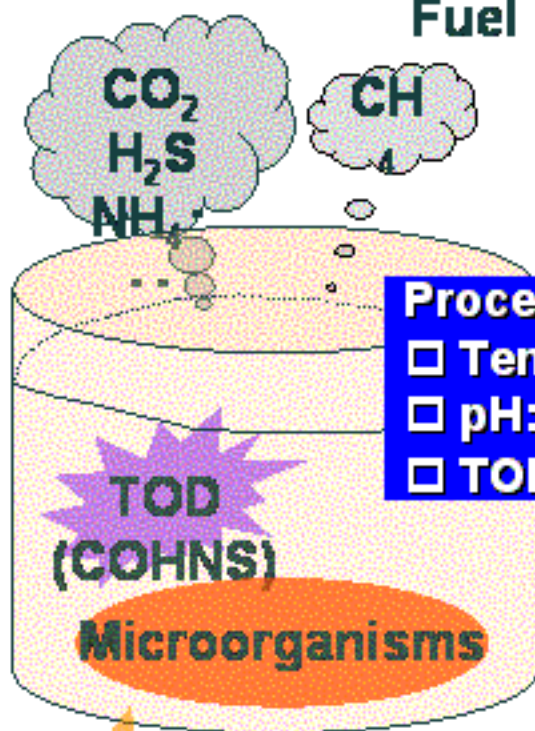


Floating
meia

3. Wastewater Treatment Technologies

(7) Anaerobic Biological Process (1/2)

Fuel $0.35\text{Nm}^3 / \text{kg TOD}$

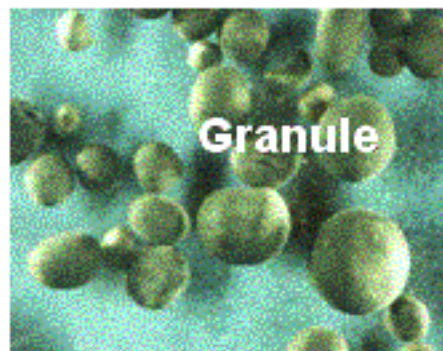


Process Parameter

- ☐ Temp: $\sim 36^\circ\text{C} \sim 55^\circ\text{C}$
- ☐ pH: $4.0 \sim 7.8$
- ☐ TOD / VSS / D

Sludge

3~12% / COD Removed

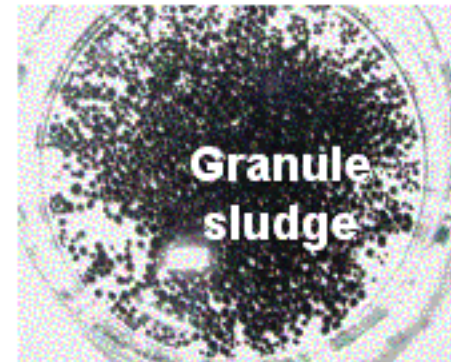
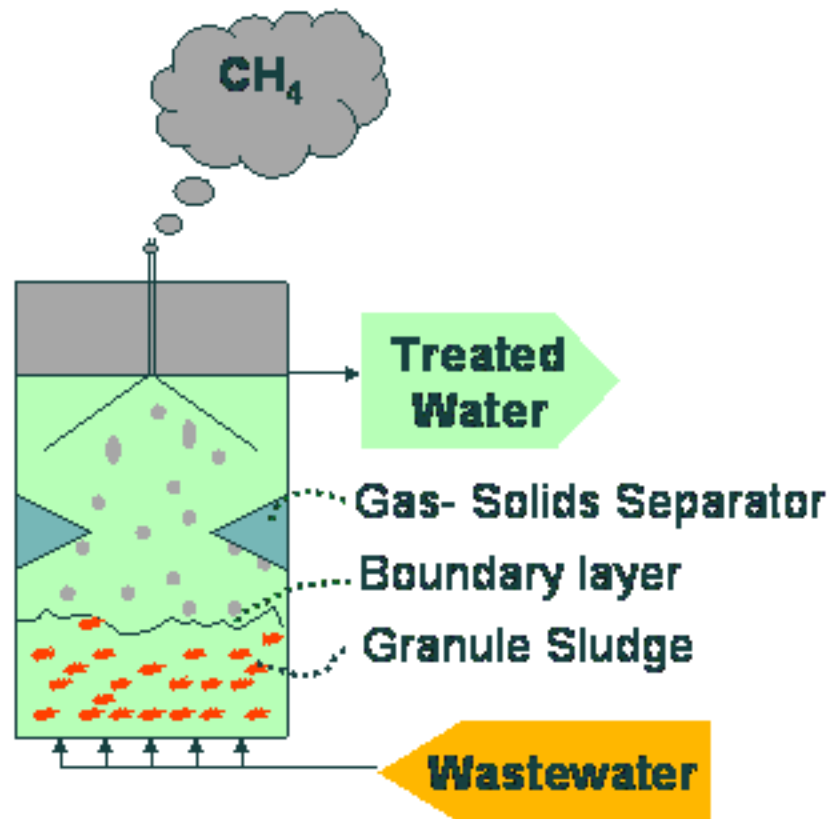


3. Wastewater Treatment Technologies

(7) Anaerobic Biological Process (2/2)

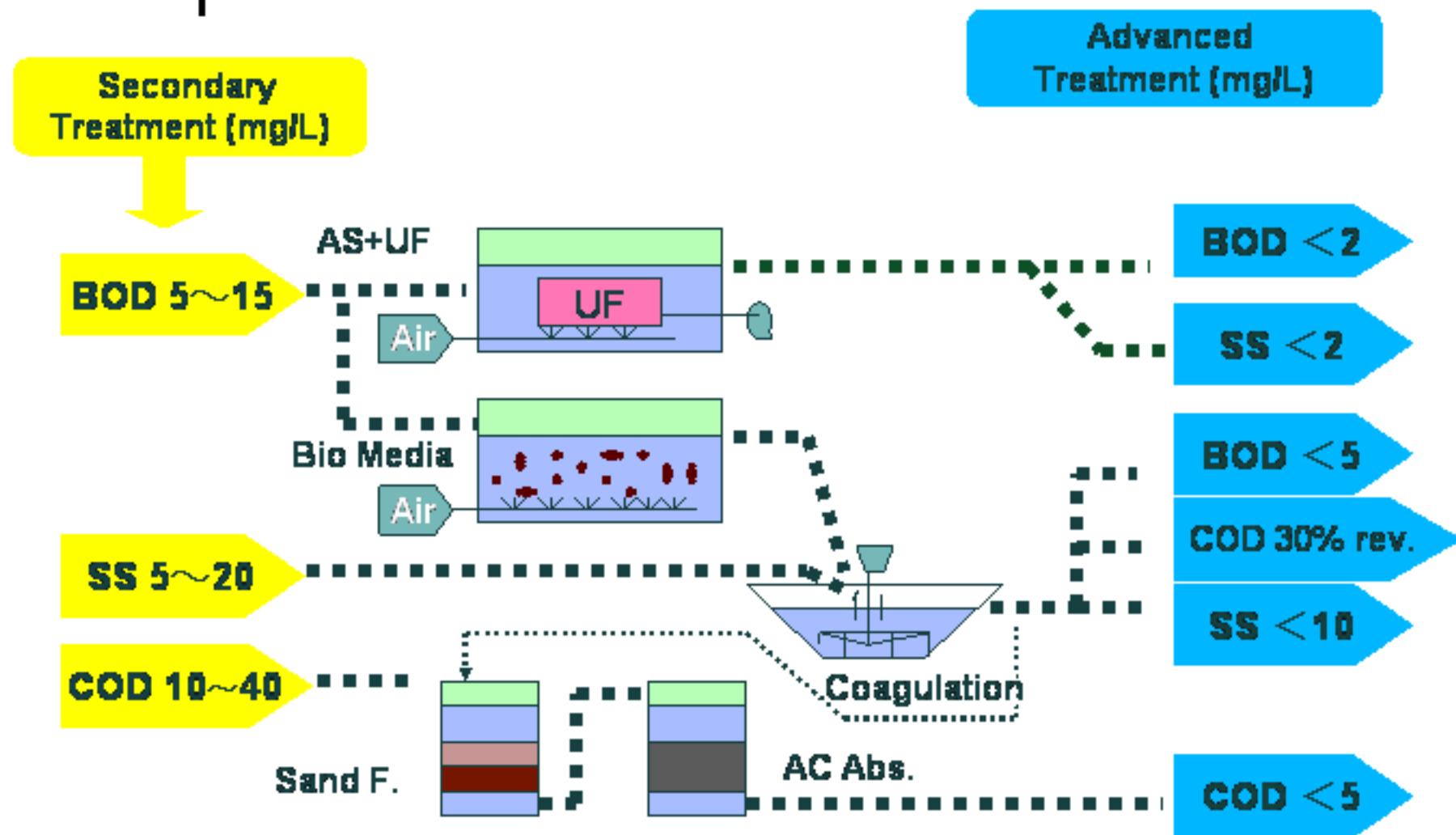
UASB

Upflow Anaerobic Sludge Blanket



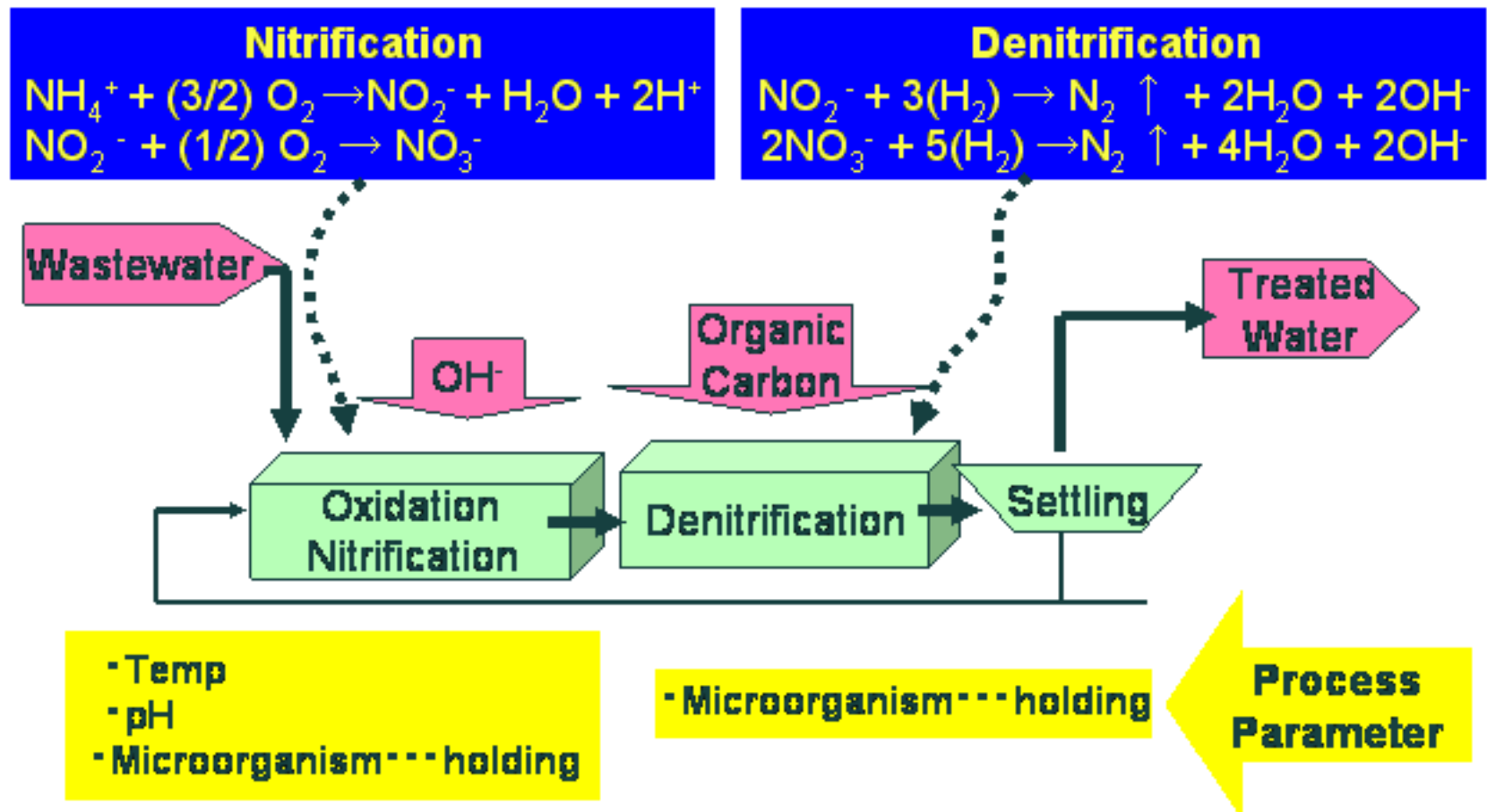
3. Wastewater Treatment Technologies

(8) Advanced Treatment – BOD, COD, SS



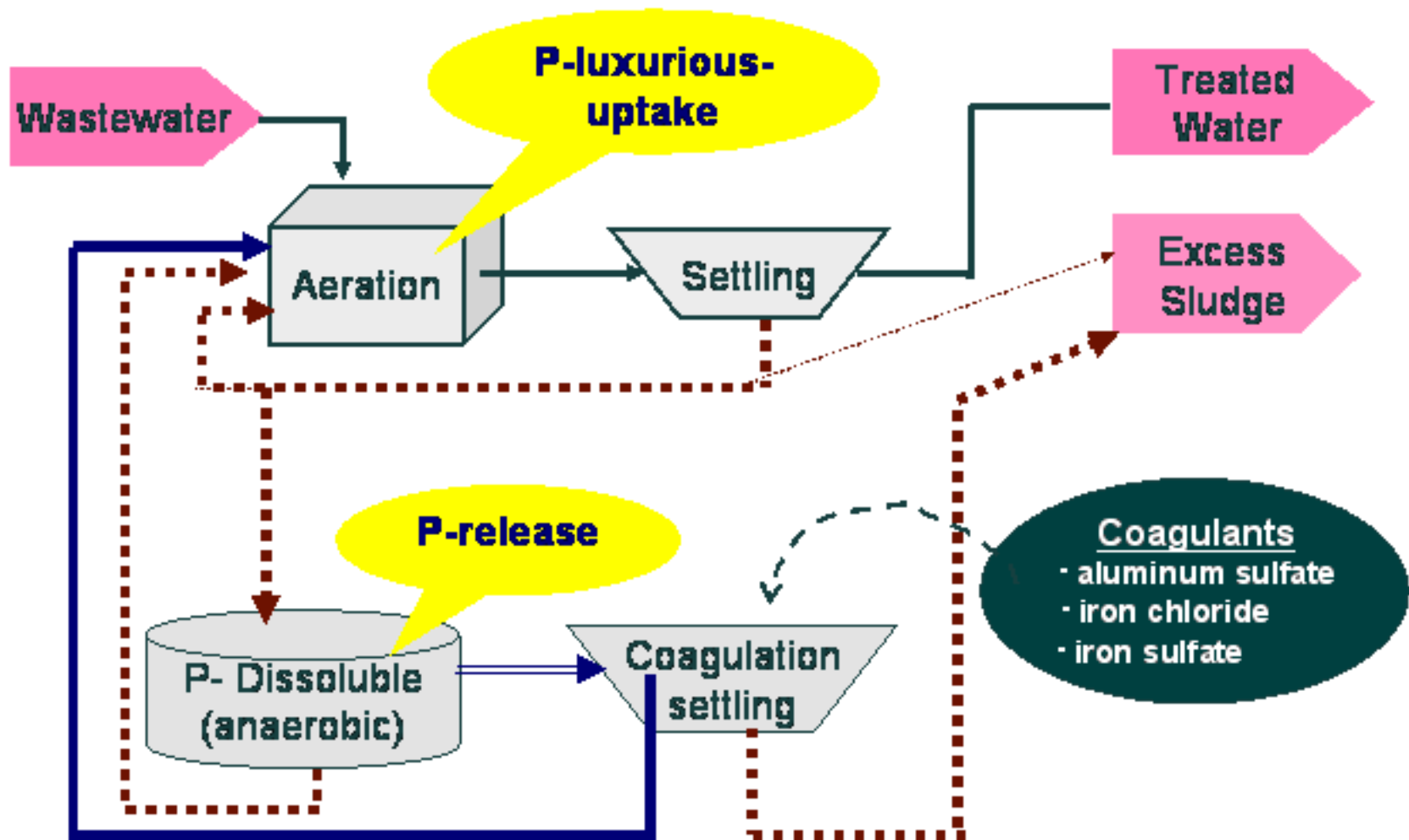
3. Wastewater Treatment Technologies

(8) Advanced Treatment – N Removal



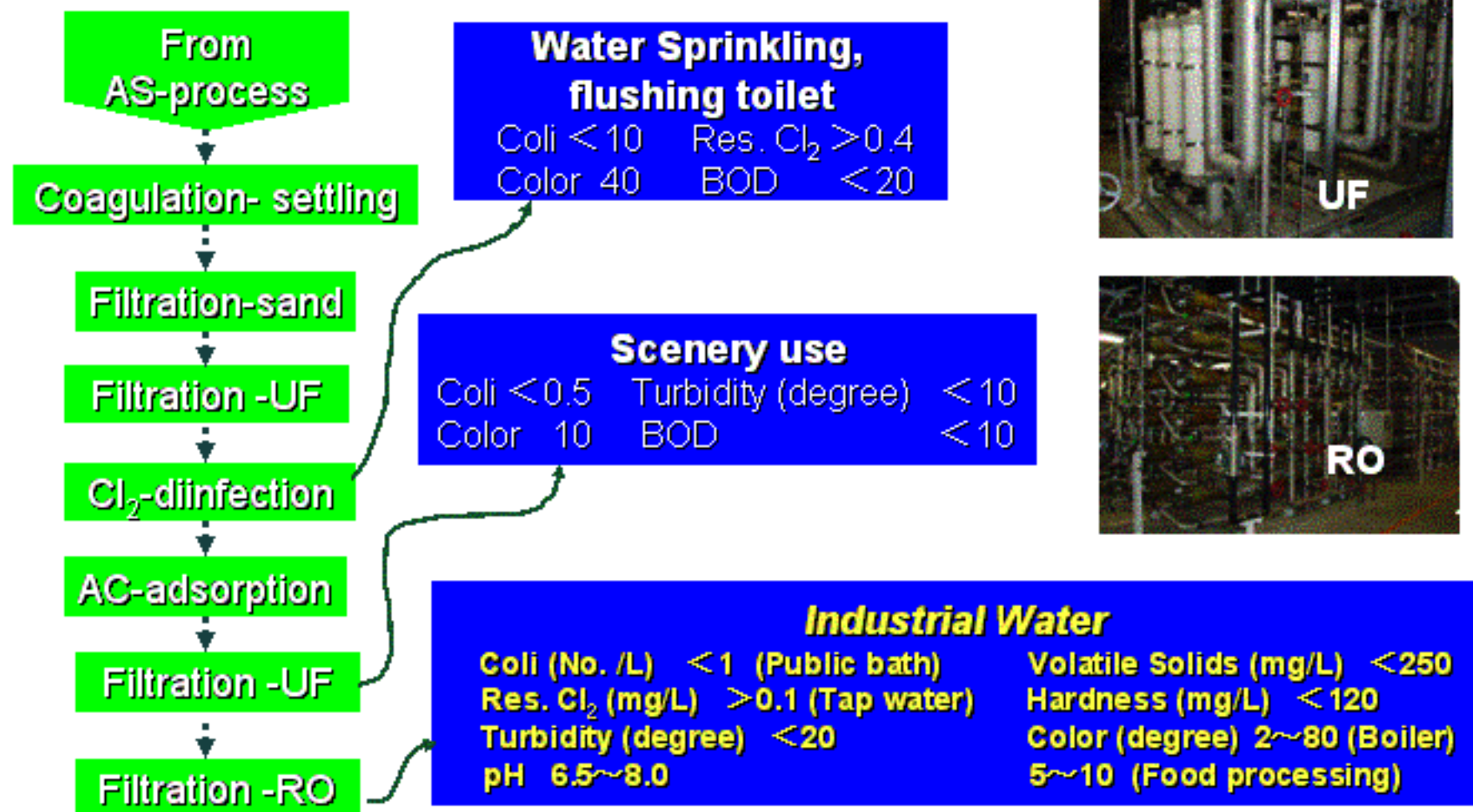
3. Wastewater Treatment Technologies

(8) Advanced Treatment – P Removal



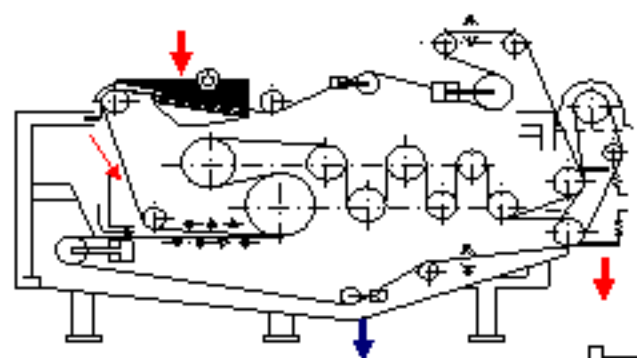
3. Wastewater Treatment Technologies

(9) Reusing Treated Water

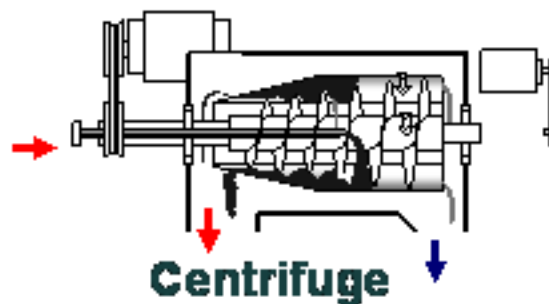


3. Wastewater Treatment Technologies

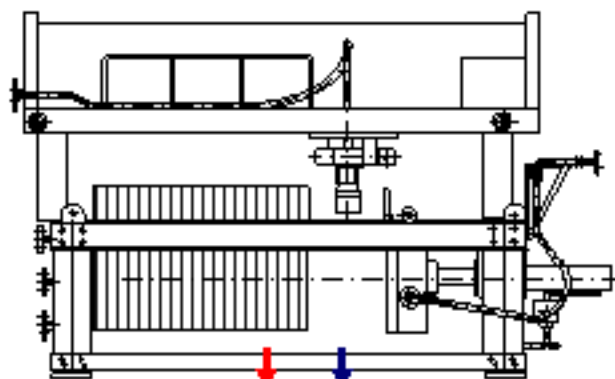
(10) Dehydration - Dehydrators



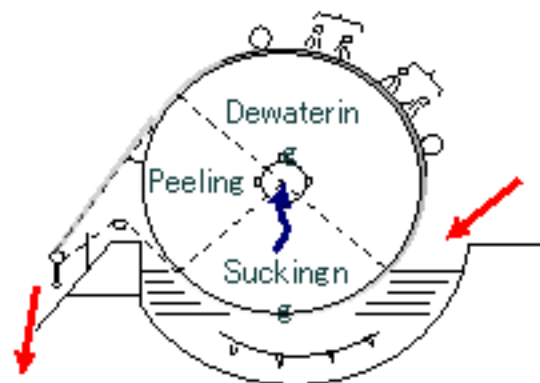
Belt Press



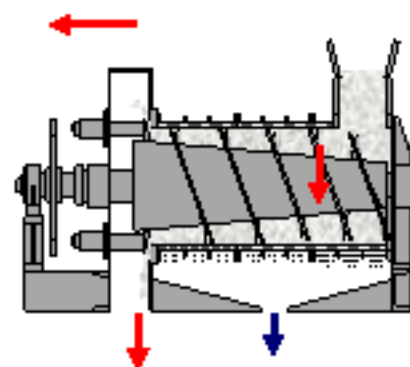
Centrifuge



Filter press



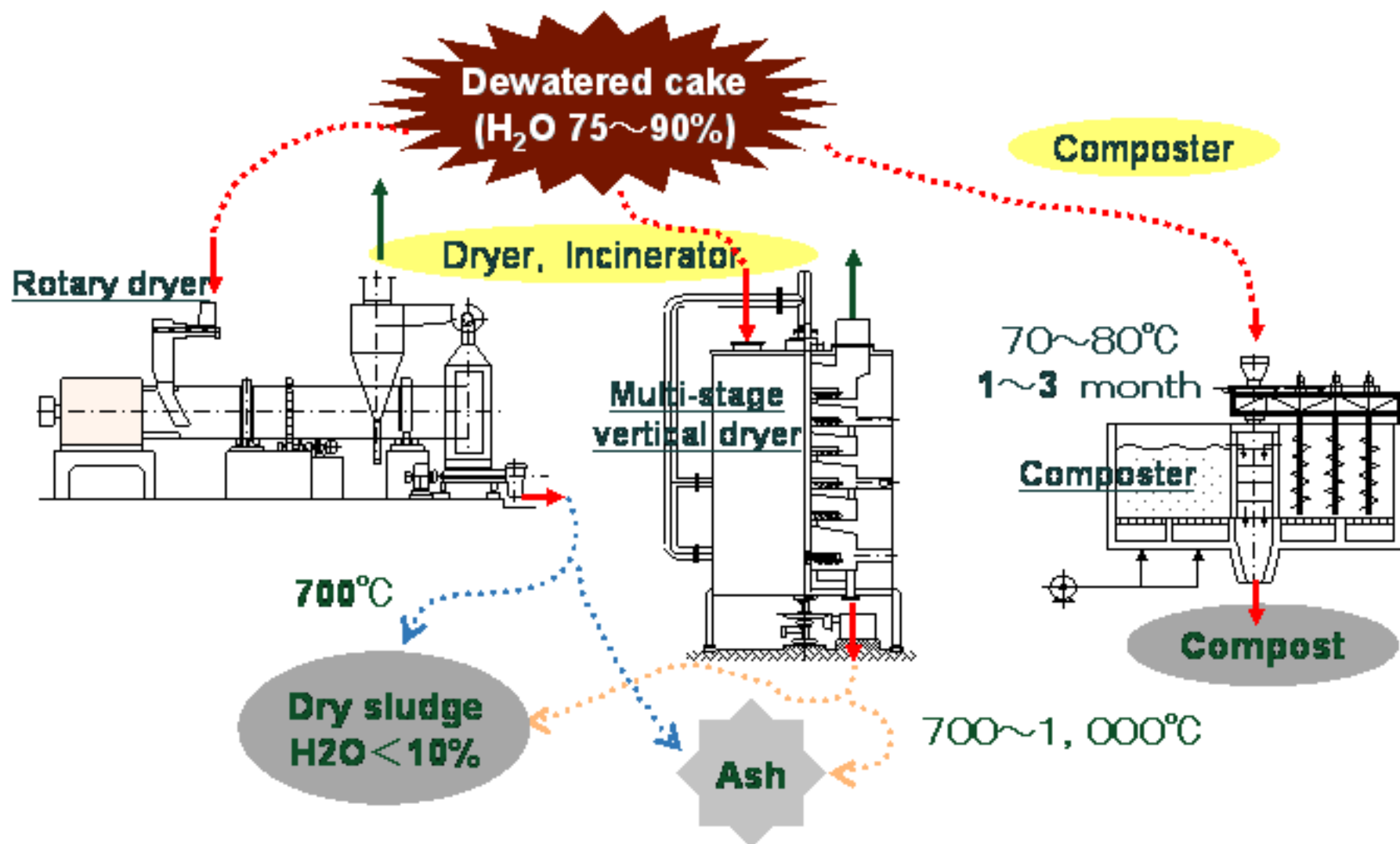
Vacuum filter



Screw press

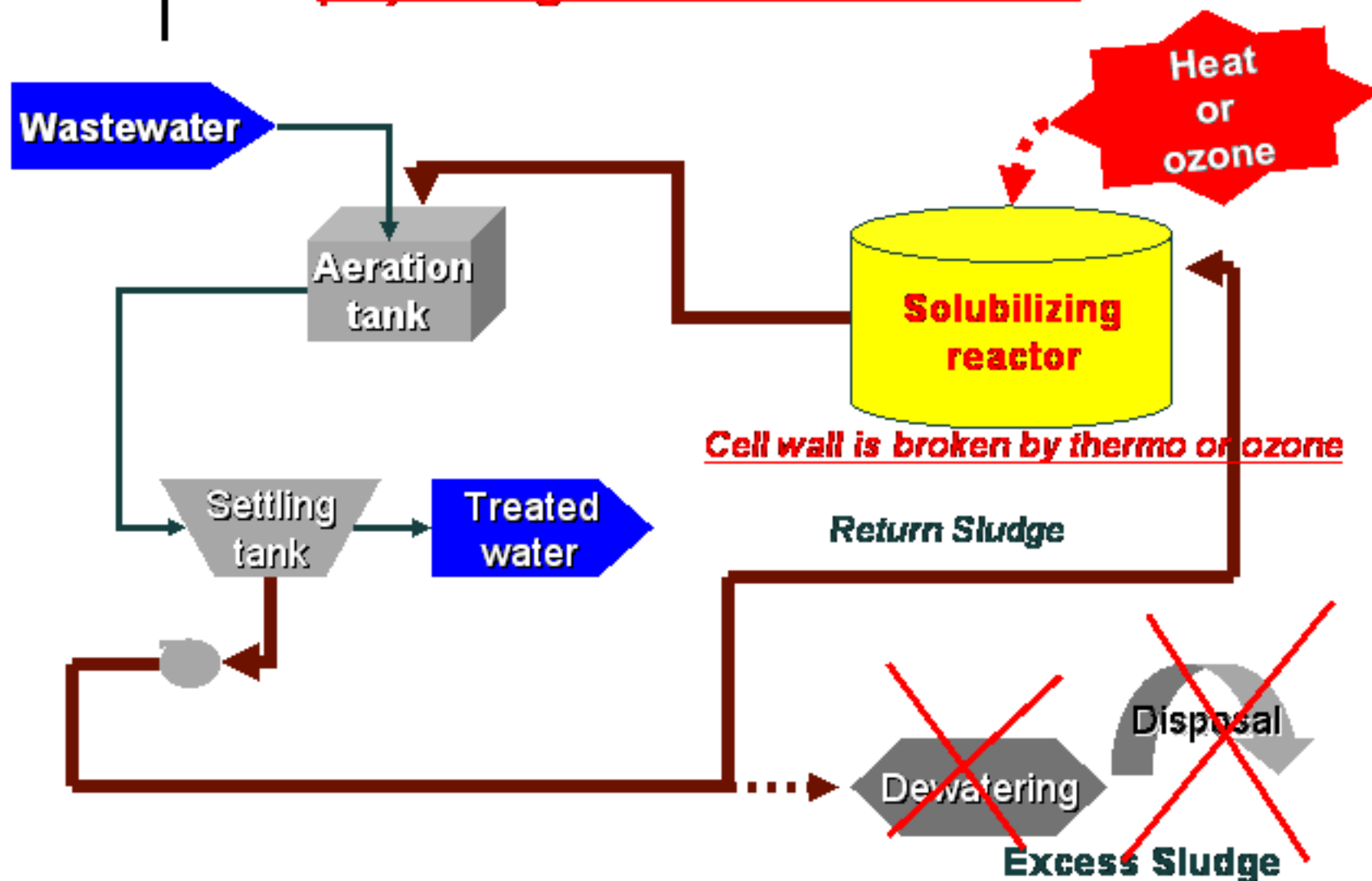
3. Wastewater Treatment Technologies

(11) Drying, Incineration, Composting



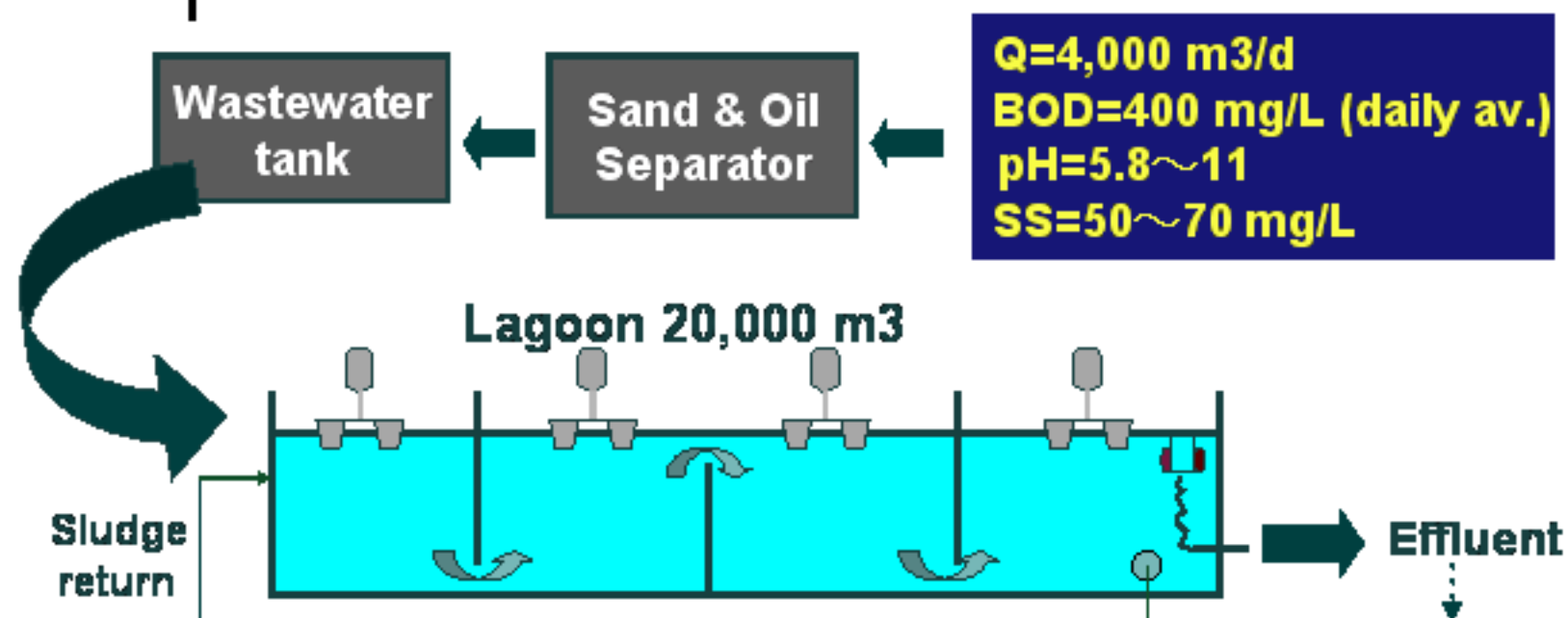
3. Wastewater Treatment Technologies

(12) Sludge Reduction Process



4. Examples of Food Processing WW Treatment

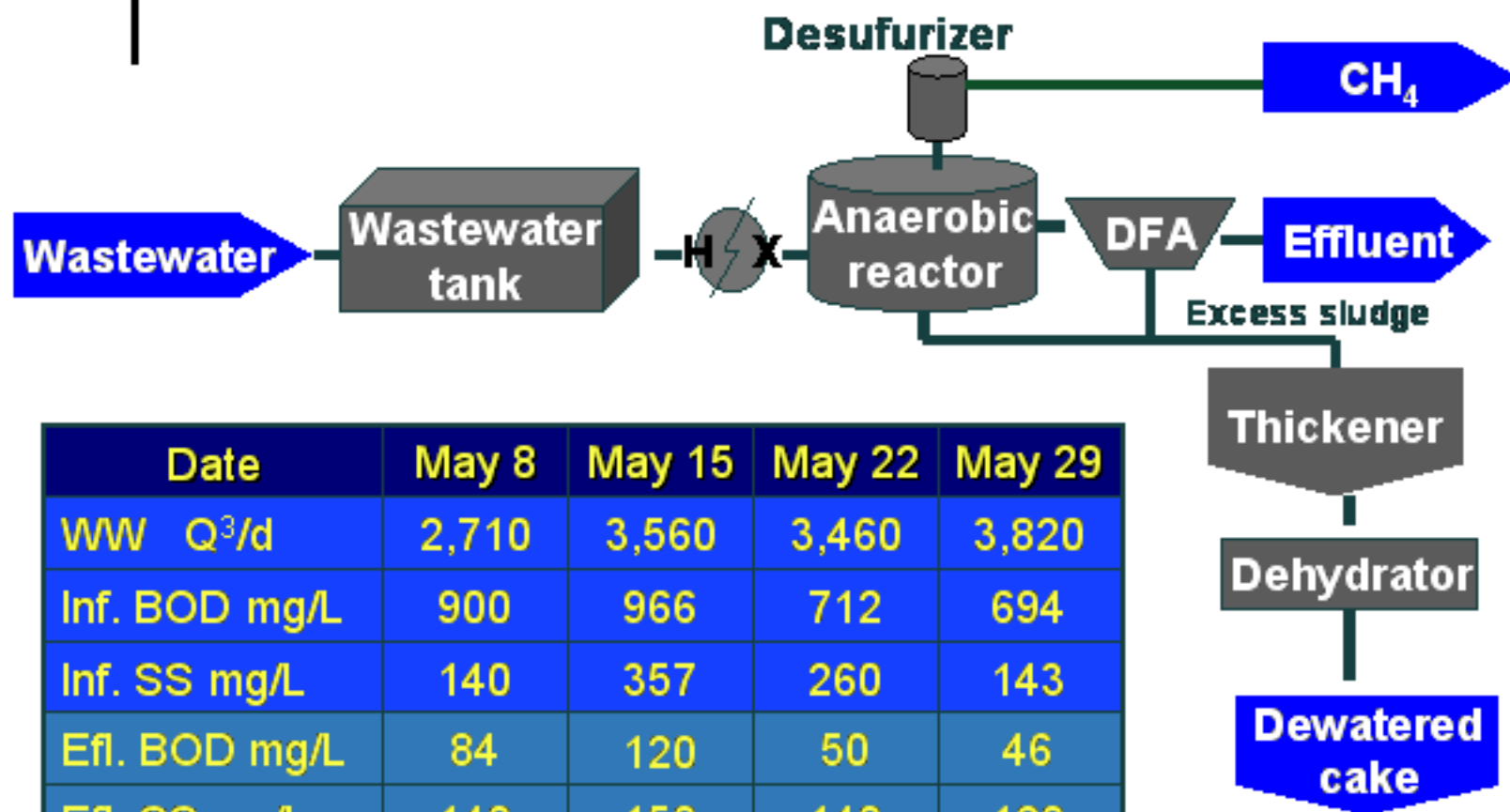
(1) Beverage -----Coke



Yearly	Temp. (°C)	Water (°C)	pH	BOD (mg/L)	DO (mg/L)	SS (mg/L)	Trsp. (cm)
Av.	10.7	16.7	9.0	2.6	4.5	4.3	40
Max	33	25.4	11.3	5.4	9.2	11.3	50
Min	- 15	7.1	7.8	1.6	1.7	2.4	20

4. Examples of Food Processing WW Treatment

(2) Breweries — Beer (1/3)



Date	May 8	May 15	May 22	May 29
WW Q^3/d	2,710	3,560	3,460	3,820
Inf. BOD mg/L	900	966	712	694
Inf. SS mg/L	140	357	260	143
Efl. BOD mg/L	84	120	50	46
Efl. SS mg/L	140	150	140	120
CH_4 m^3/d	1,100	1,210	924	969

WW: Wastewater, weekly average

4. Examples of Food Processing WW Treatment

(2) Breweries — Beer (2/3)

Cost comparison – Anaerobic vs. Aerobic

Item	Price ¥	Anaerobic + DAF		Aerobic process	
		Cons. /d	¥ /d	Cons. /d	¥ /d
Power	18/kWh	3,200kWh	57,600	6,800kWh	122,400
Steam	3/kg	12,000kg	36,000	-	-
45% NaOH	40/kg	1,600kg	64,000	-	-
Coagulants	1,400/kg	4kg	5,600	15kg	21,000
Desulfer	170/kg	4.2kg	714	-	-
Sludge disp.	10,000/m ³	1.5m ³	15,000	6m ³	60,000
CH ₄	28,000/kL	2kL	▲56,000	-	-
Total			122,914		203,400
Economics		+ ¥ 80,486/ d			

DAF: dissolved Air Floatation unit, CH₄: converted to A-heavy oil

4. Examples of Food Processing WW Treatment

(2) Breweries — Beer (3/3)

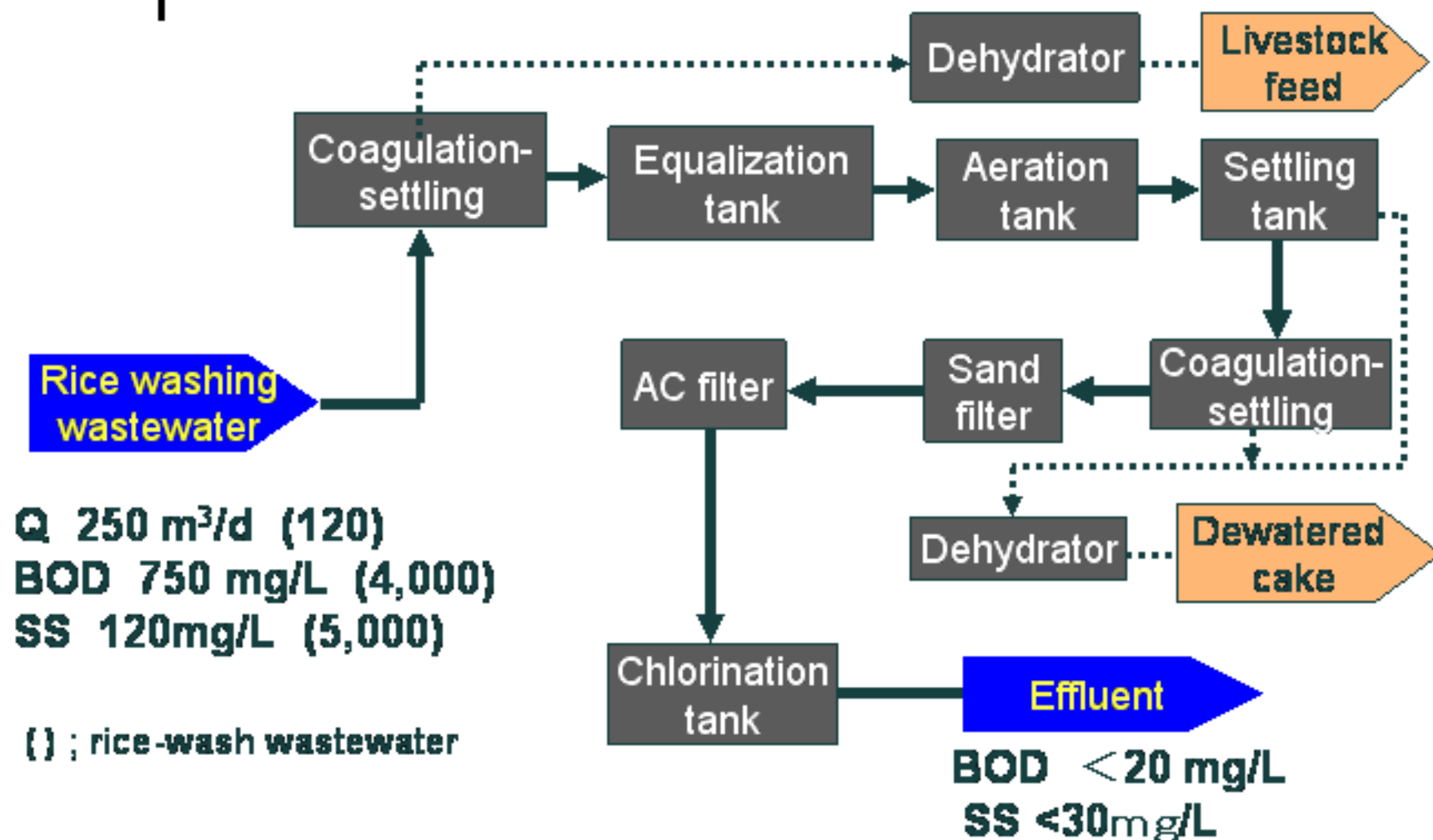


**Centrifuge
dehydrator**



4. Examples of Food Processing WW Treatment

(2) Breweries — Sake (1/2)



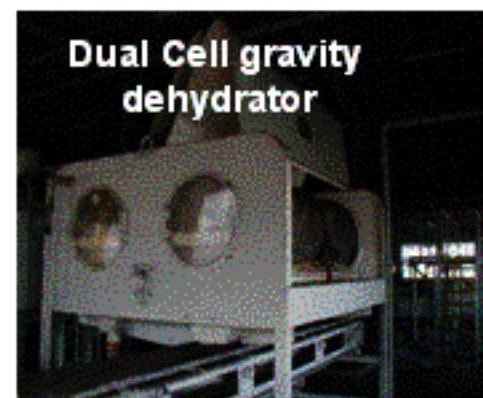
4. Examples of Food Processing WW Treatment

(2) Breweries — Sake (2/2)

Purification of rice-washing wastewater by coagulation

	pH	SS (mg/L)	BOD (mg/L)
Raw WW	6.6	717	1,250
Effluent	6.8	< 30	185

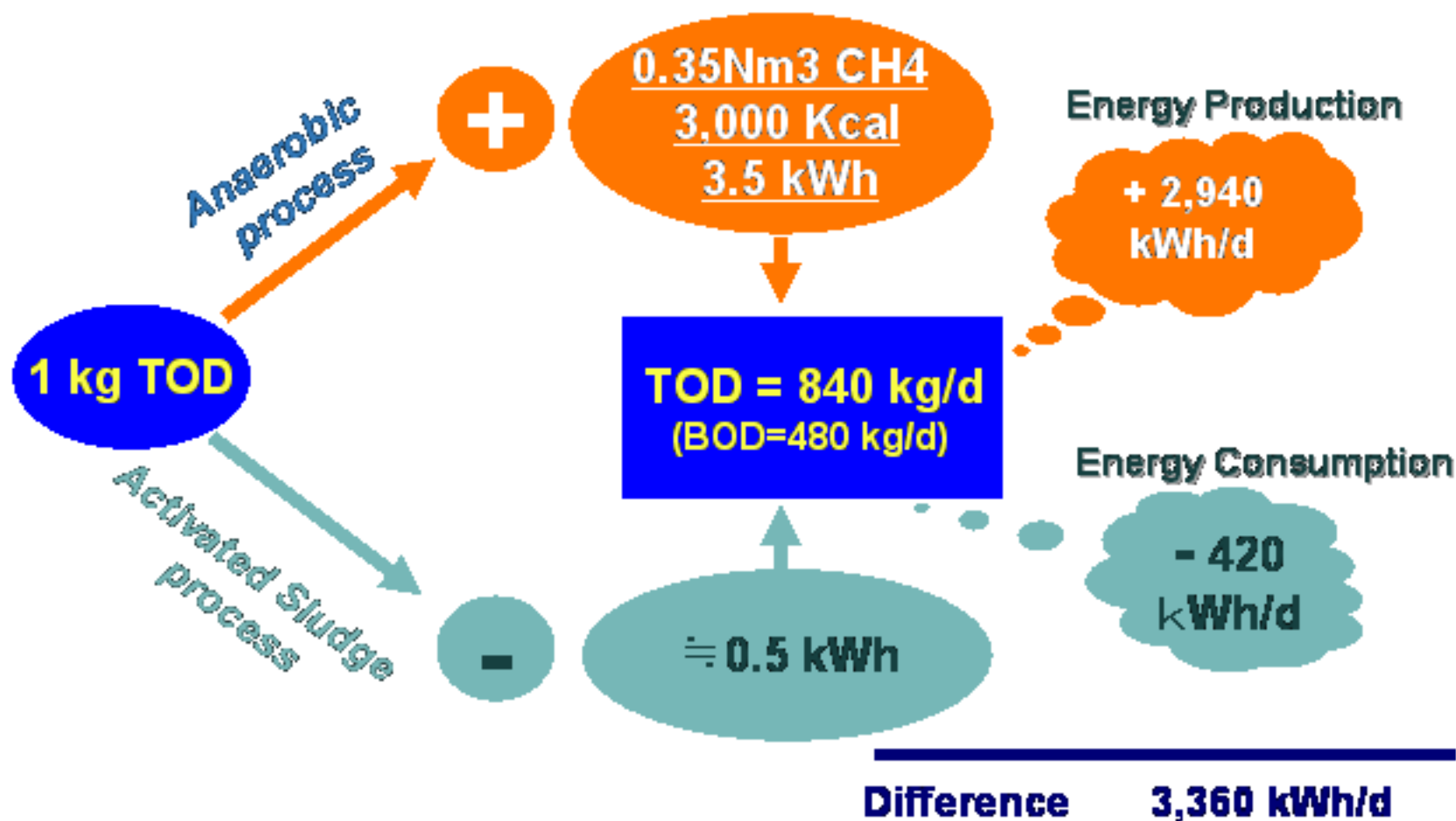
Coagulants: alum; 1,000 NaOH; 365 Polymer; 10 (mg/L)





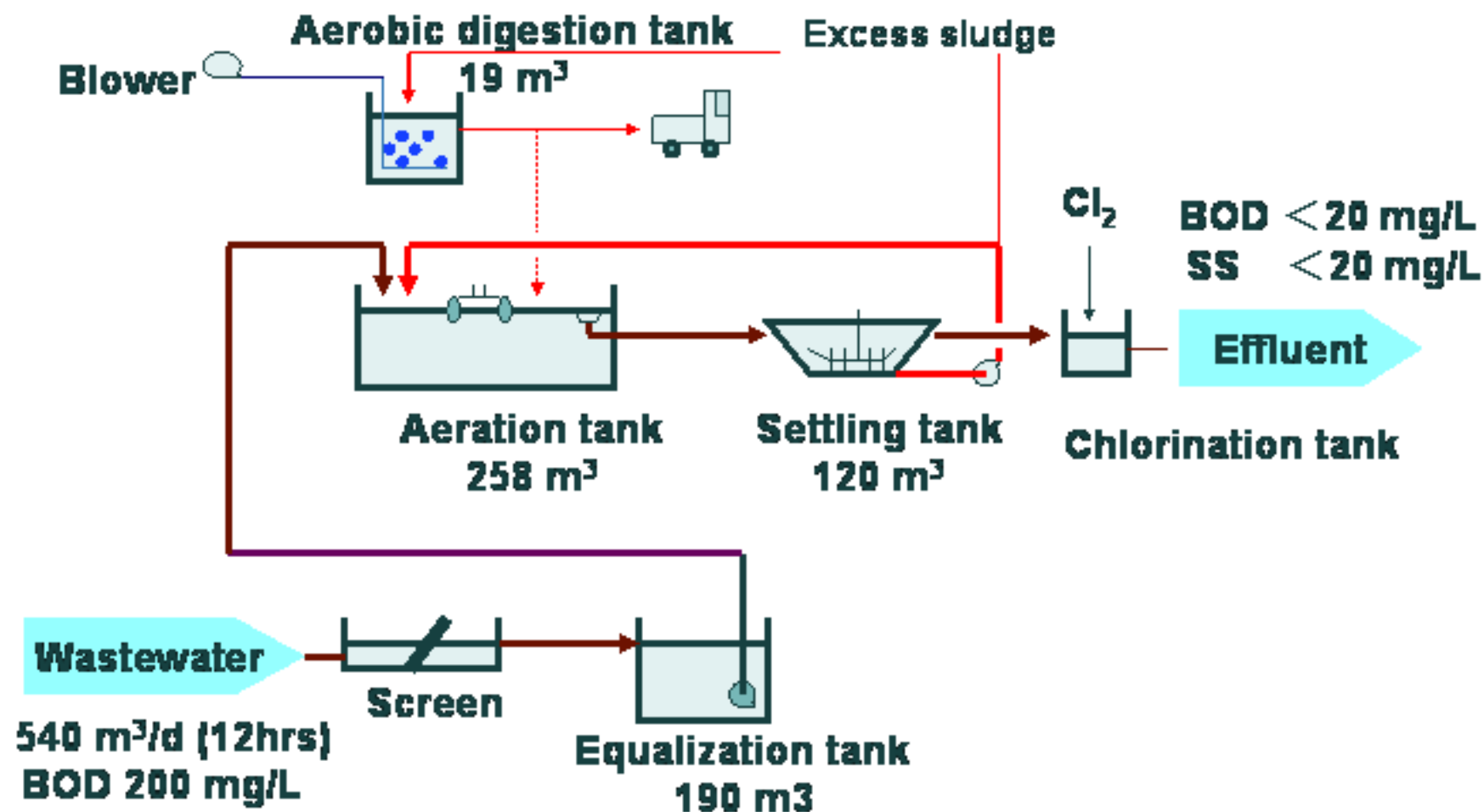
4. Examples of Food Processing WW Treatment

(3) Oil & Fat (2/2)



4. Examples of Food Processing WW Treatment

(4) Milk & Dairy Product (1/2)



4. Examples of Food Processing WW Treatment

(4) Milk & Dairy Product (2/2)

Sludge Bulking

Causes

Operation

Wastewater

- Low molecular hydr. C
- Reduced sulfur
- Shortage-N, P & Fe
- Toxic materials

- Low load- $< 0.2\text{kgBOD/kg SS/d}$
- High load $> 0.4\text{kgBOD/kg SS/d}$
- Low DO $< 0.2\text{mg/L}$
- Abnormal pH $< 6.5 \sim 8 <$
- Short SRT

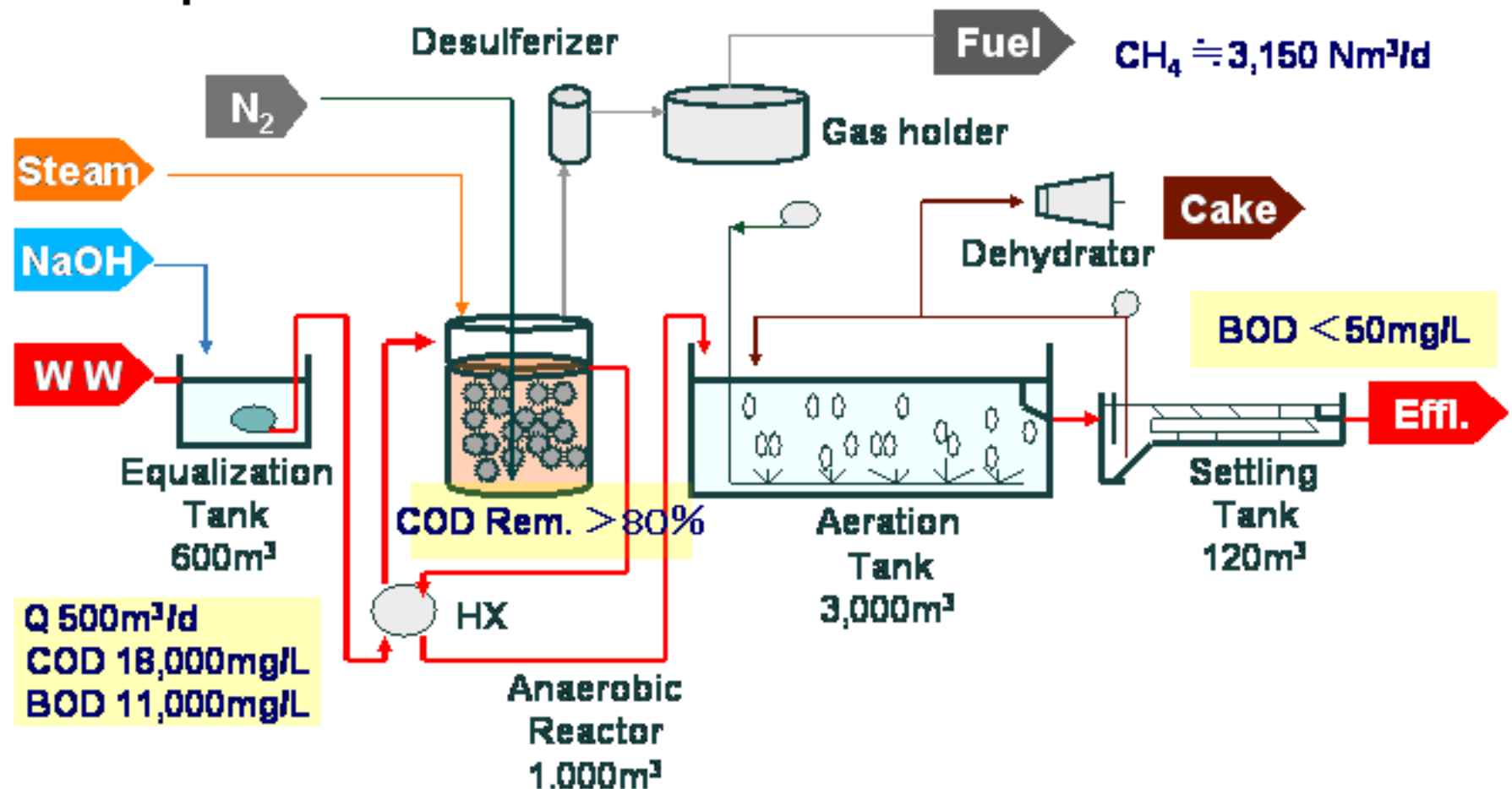
Temporally measure: **Coagulant**

For Chronic bulking:

- ✓ **Plug-flow**
- ✓ **Batch-wise operation**
- ✓ **Pre-treatment-Anaerobic process**

4. Examples of Food Processing WW Treatment

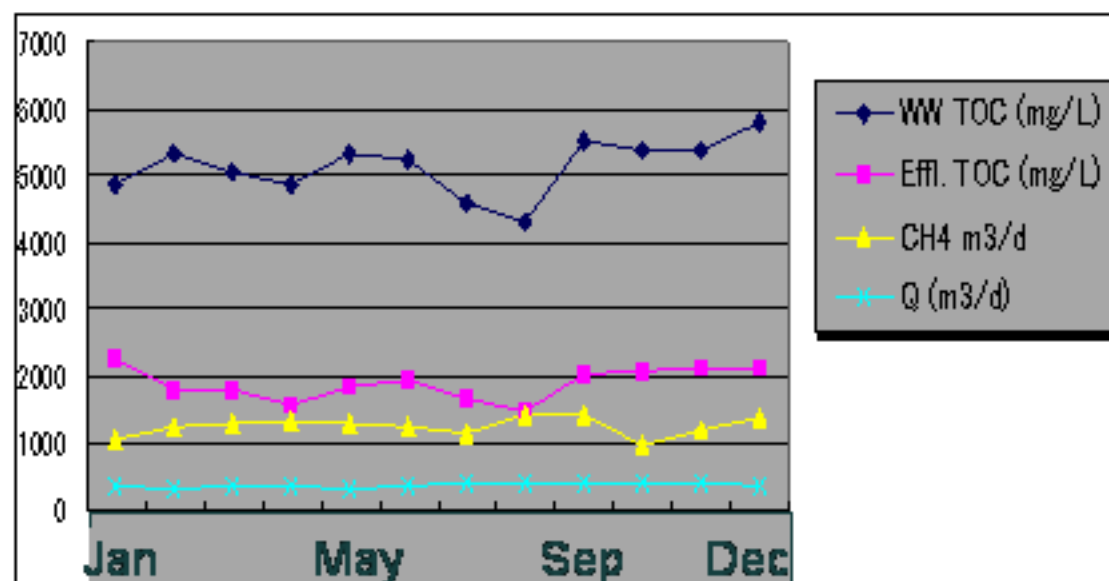
(5) Wheat Starch (1/2)



4. Examples of Food Processing WW Treatment

(5) Wheat Starch (2/2)

Anaerobic Process Performance (Monthly av.)



Oper. parameter

Anaerobic

WW Volume
°C in reactor
Gas volume
CH₄ Conc.
pH
SS

Aerobic

MLSS
pH
°C in AT
DO

Advantages of Anaerobic Treatment

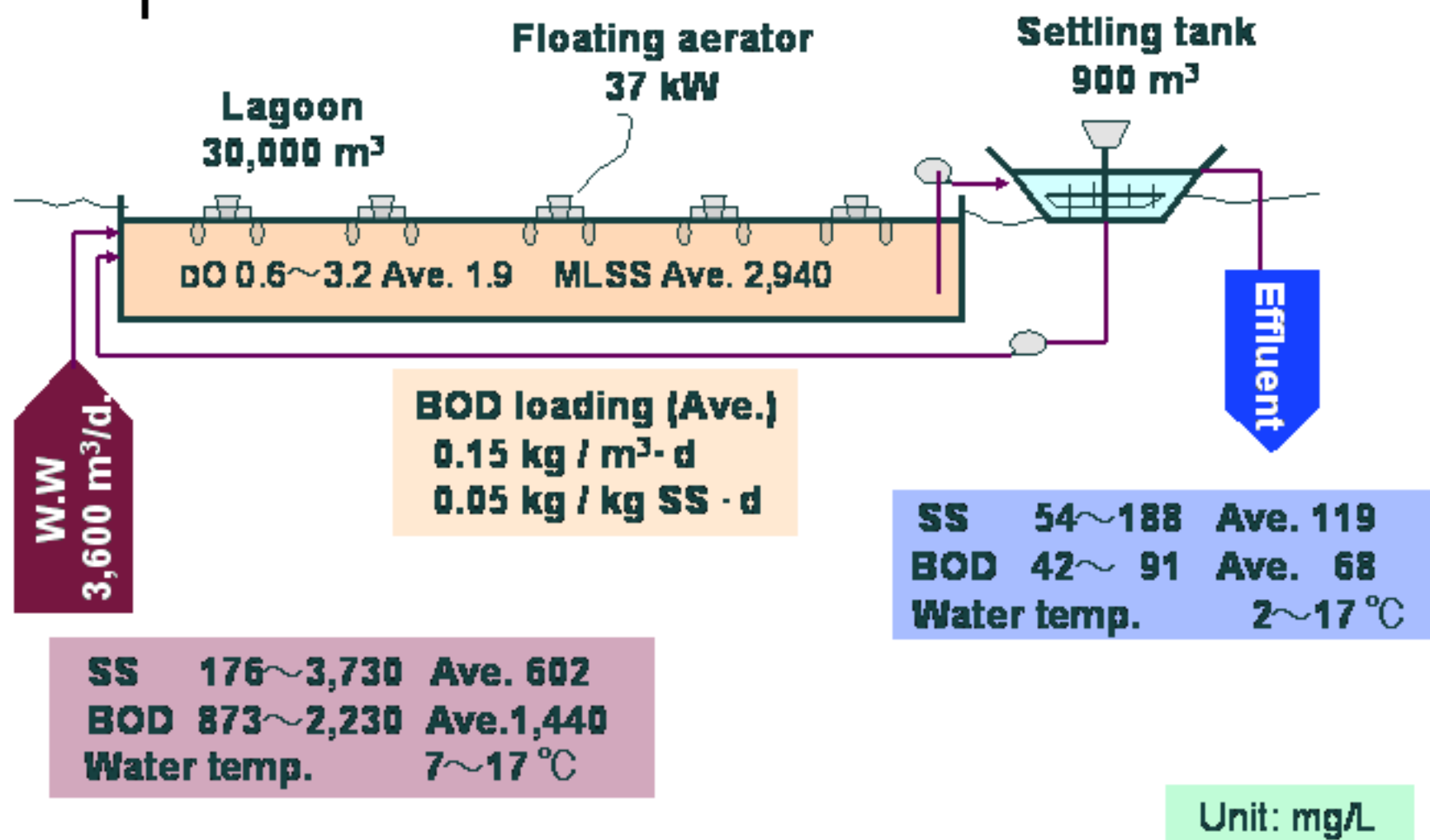
CH₄ → Fuel for Starch drying process

Sludge bulking in activated sludge process → Disappeared

Excess sludge generation → Reduced to about 1/5

4. Examples of Food Processing WW Treatment

(6) Potato starch(1/2)



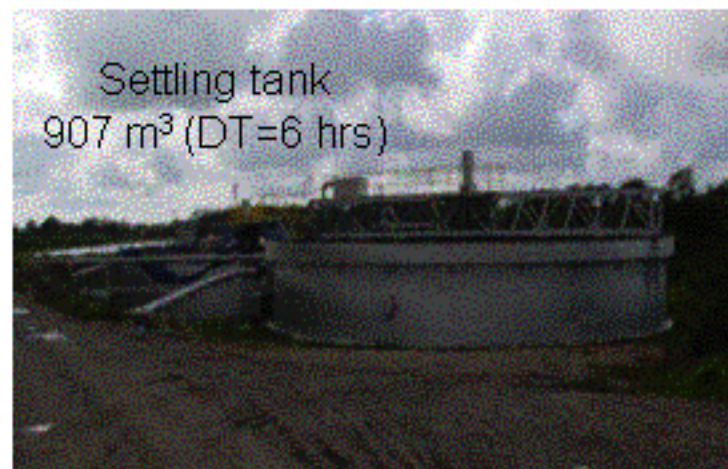
4. Examples of Food Processing WW Treatment

(6) Potato starch(2/2)

Operation: End of summer~early of winter

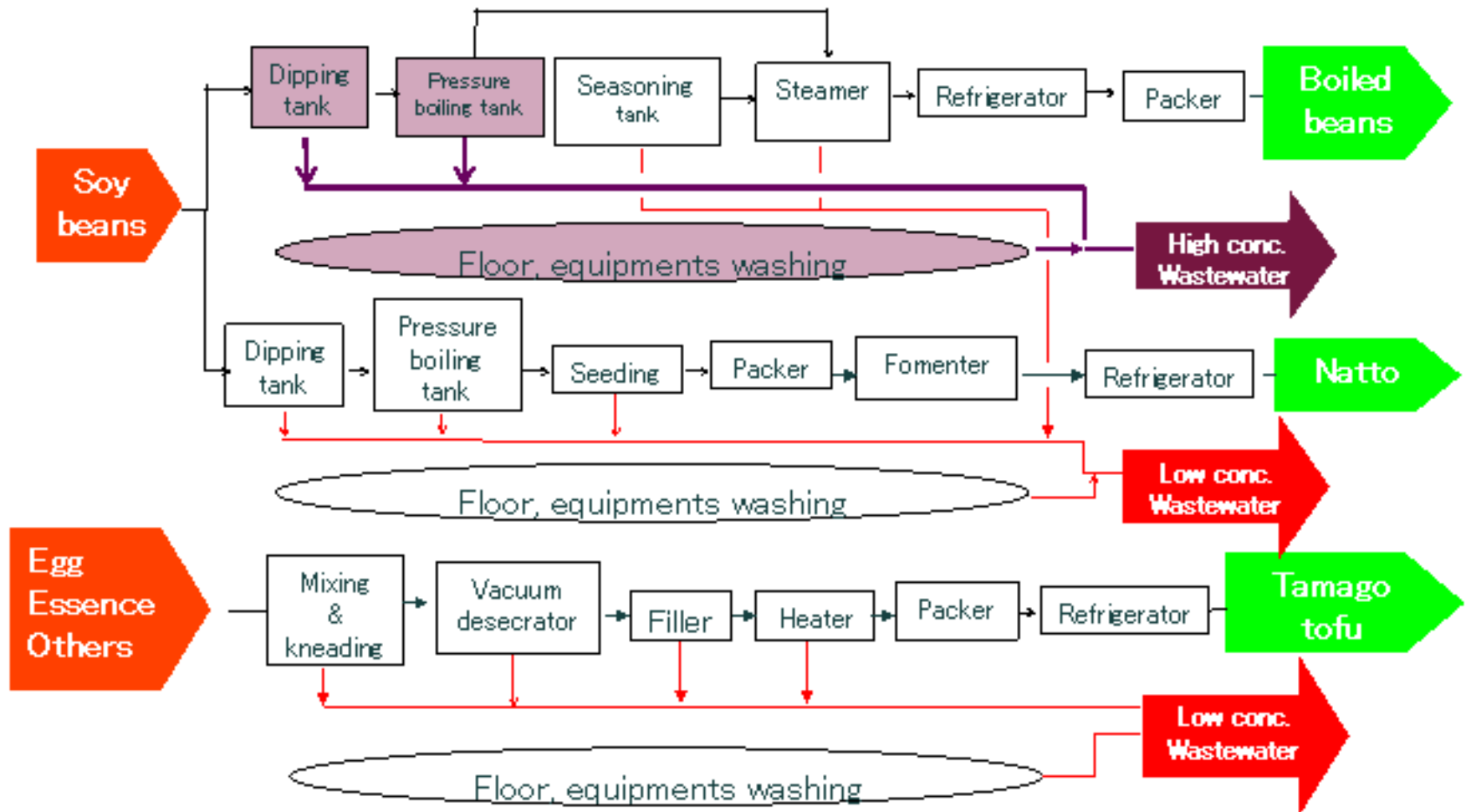
Problem at restart-up: filamentous bacteria bulking

- **Maintain sludge activity** → Intermittent wastewater feed
- **Dispersing AS** → coagulants feed
- **New sludge seeding** → from sewage treatment plant
- **Control of sludge septicity** → minimum aeration



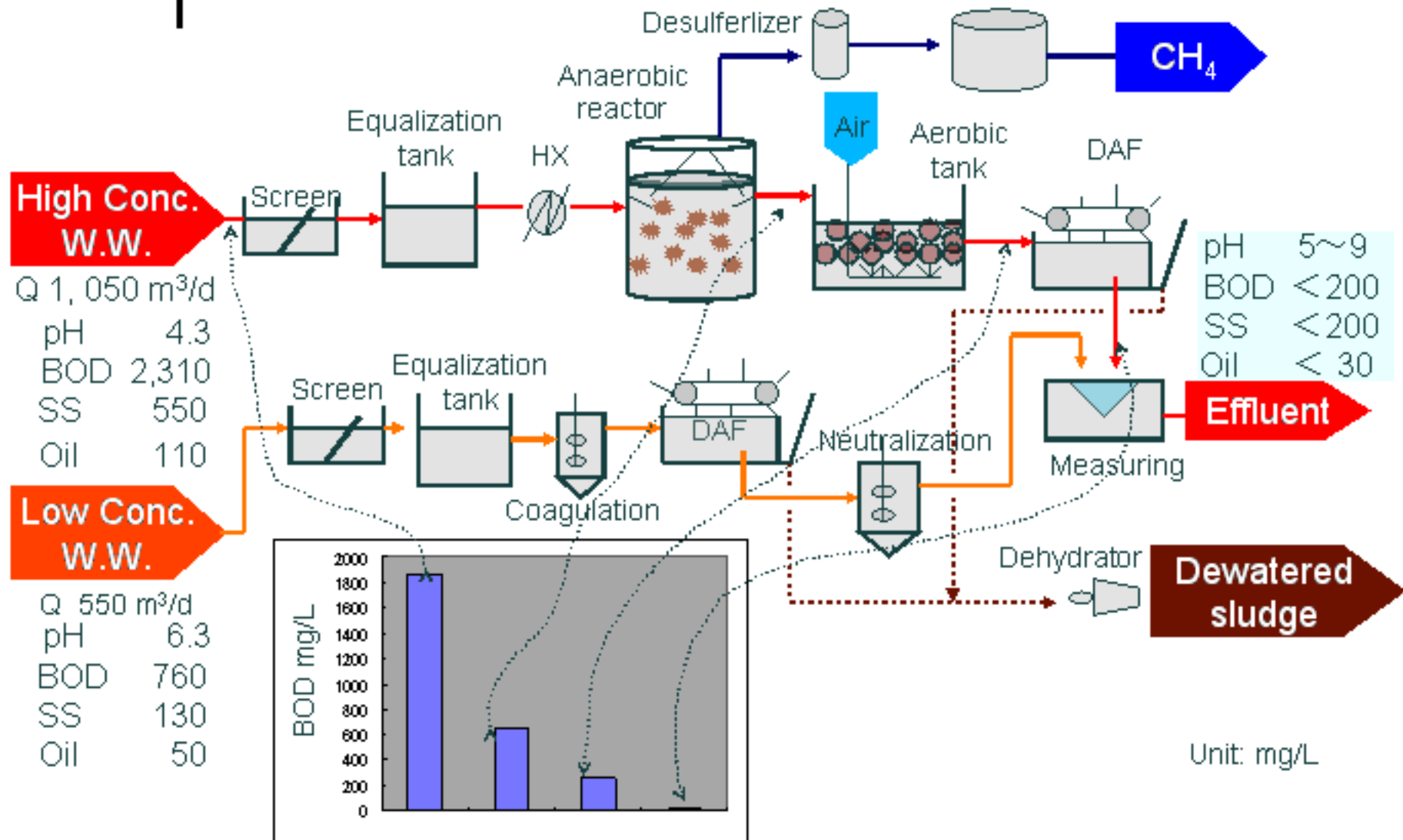
4. Examples of Food Processing WW Treatment

(7) Takeout dishes (1/2)



4. Examples of Food Processing WW Treatment

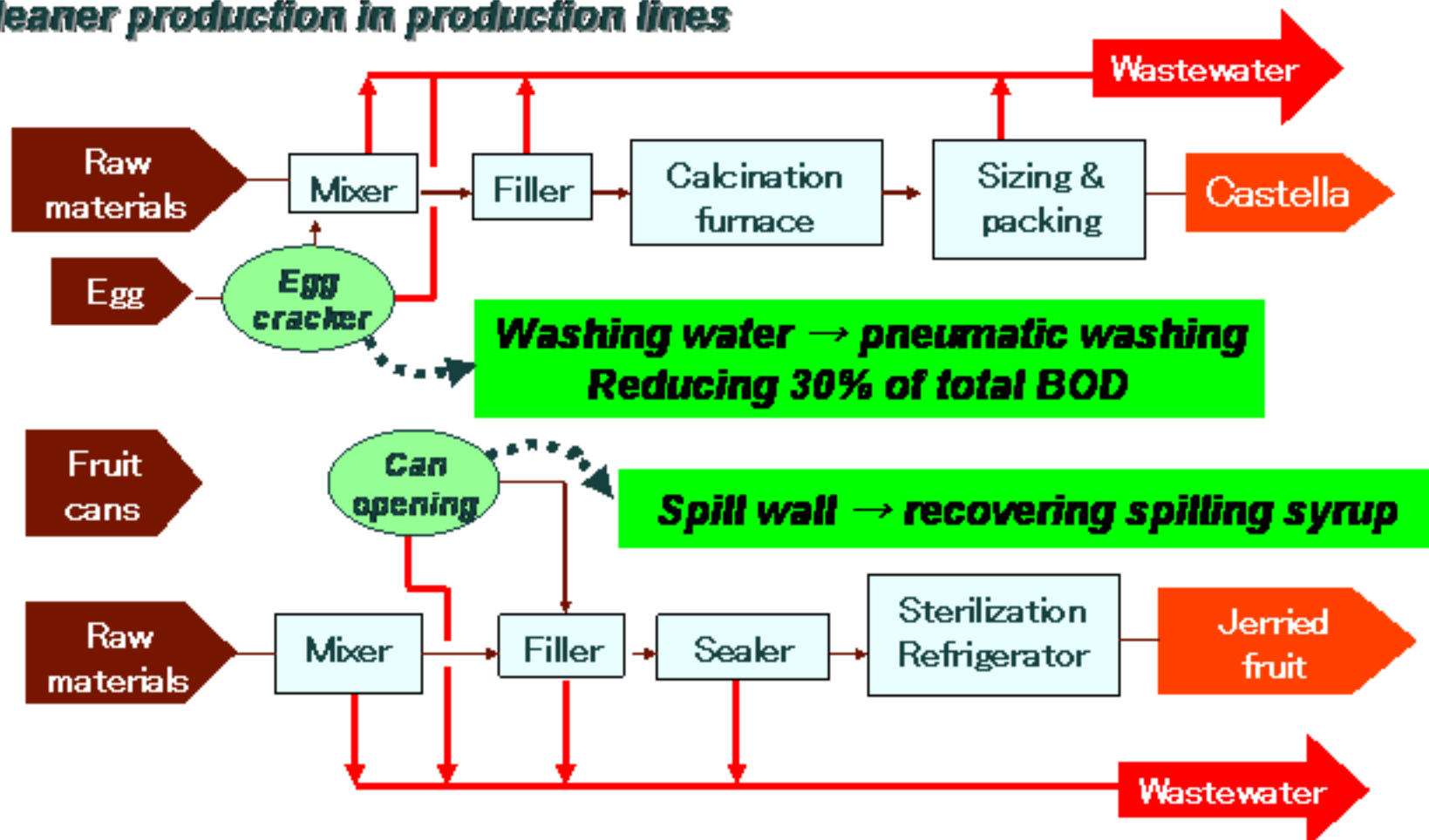
(7) Takeout dishes (1/2)



4. Examples of Food Processing WW Treatment

(8) Confectionaries (1/2)

Cleaner production in production lines



4. Examples of Food Processing WW Treatment

(8) Confectionaries (2/2)

