FUNDAMENTALS AND TECHNOLOGY OPTIONS FOR THE ANAEROBIC TREATMENT OF LIQUID WASTES

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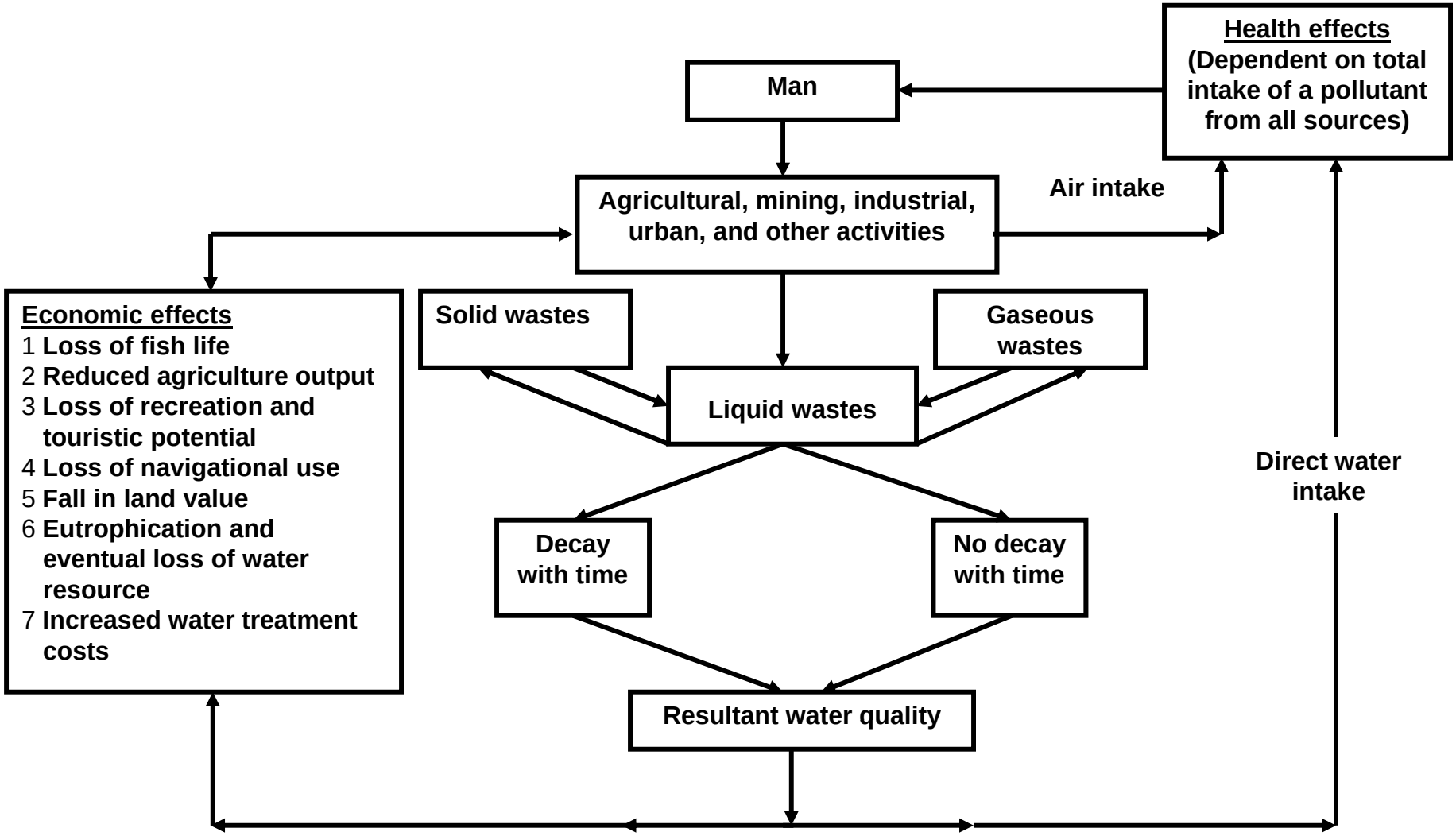
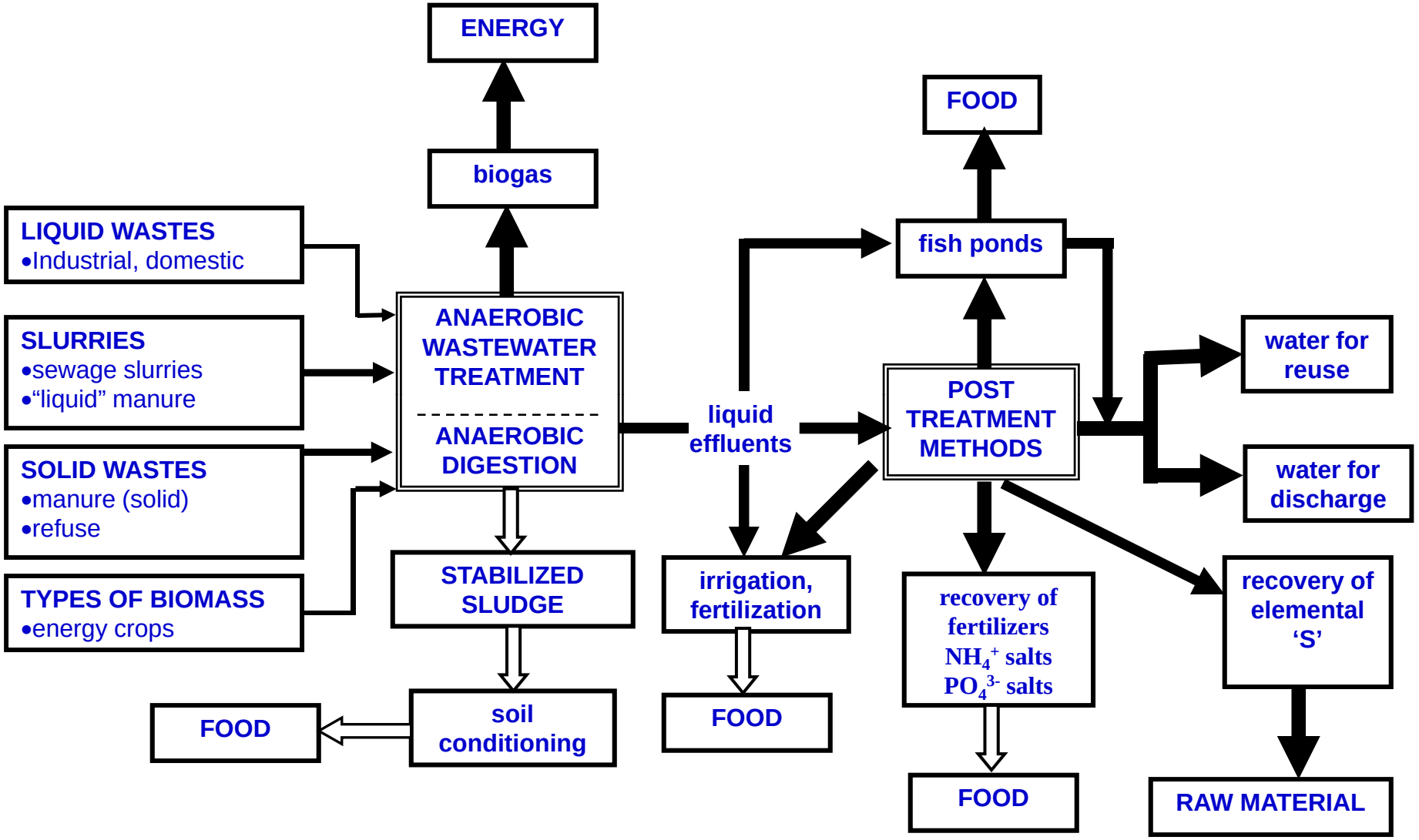


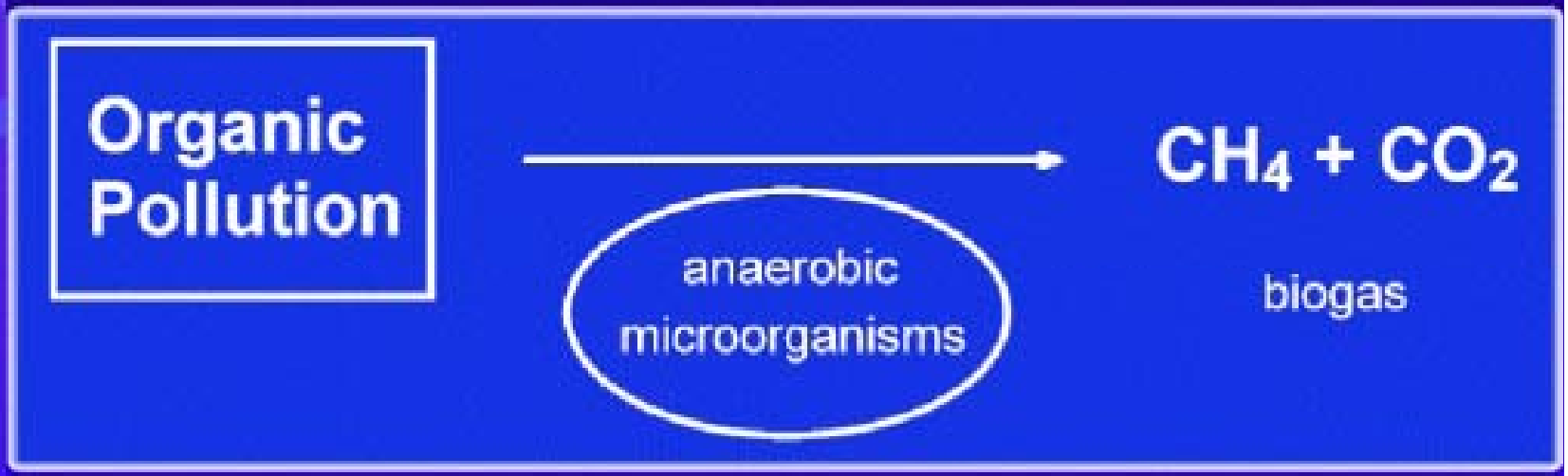
EFFECTS OF WASTEWATER



LIQUID AND SOLID WASTE MANAGEMENT

AEROBIC PROCESS

What is Anaerobic Biodegradation?

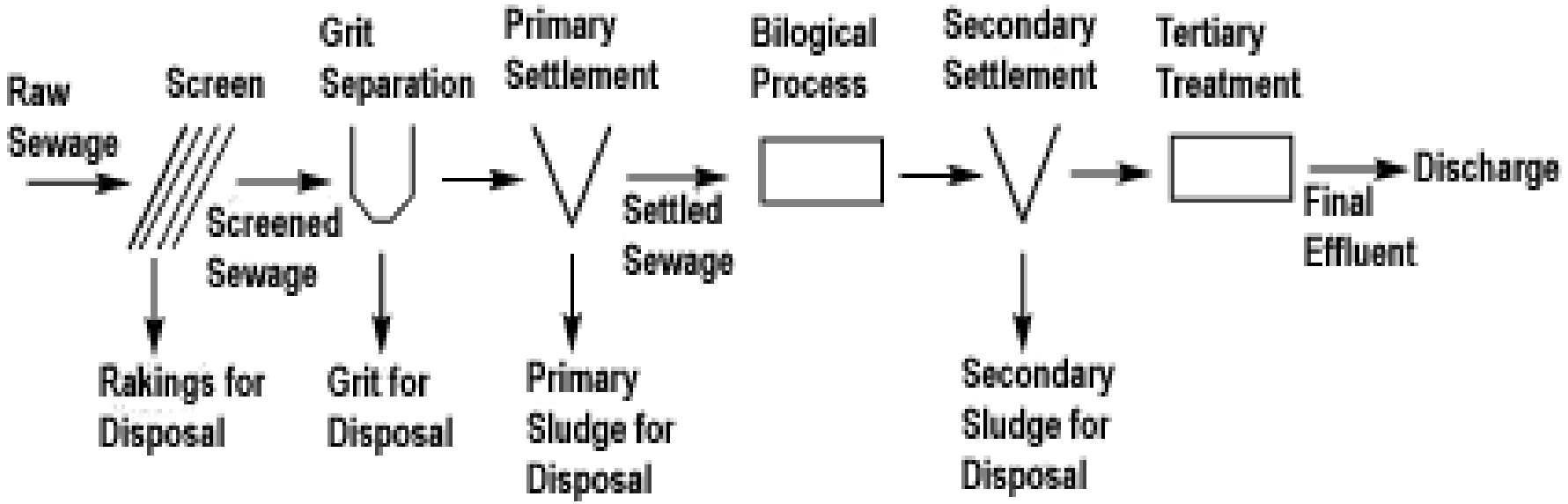


UNIT OPERATIONS

a) Physical unit operations

b) Chemical unit operations

c) Biological unit operations



Typical Flow Diagram of Treatment Plant

Biological processes for wastewater treatment

Type	Common Name
Aerobic processes Suspended growth	Activated-sludge process Aerated lagoons Aerobic digestion
Attached growth	Trickling filter Rotating biological contractors Packed-bed reactors
Anaerobic processes	
Suspended growth	Anaerobic contact processes
Attached growth	Anaerobic digestion
Sludge blanket	Anaerobic packed and fluidized bed
Hybrid	Upflow anaerobic sludge blanket

Biological treatment systems adopted for treating wastewater

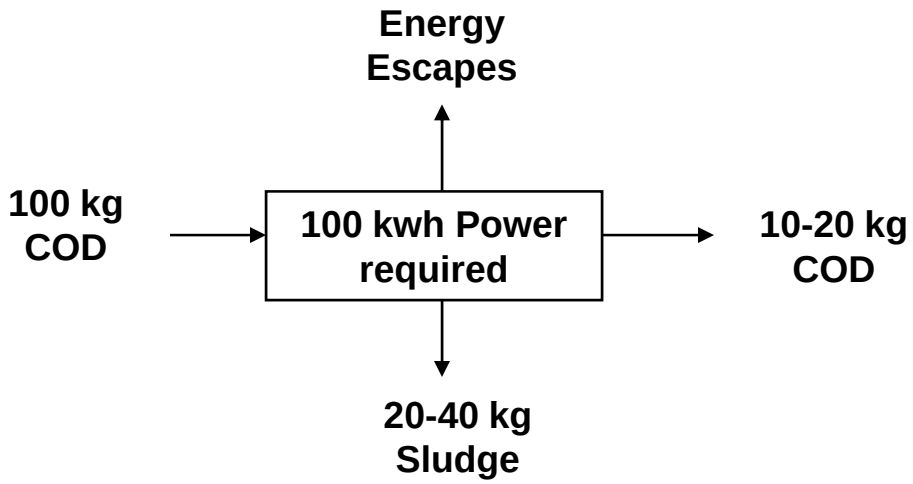
ANAEROBIC

- ♊ Septic tank
- ♊ Anaerobic lagoon
- ♊ Imhoff tank
- ♊ Anaerobic filter
- ♊ UASB

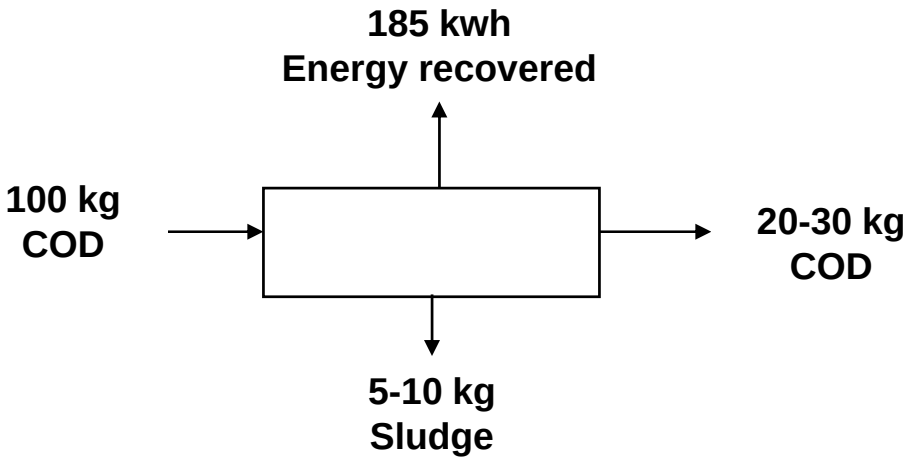
AEROBIC

- ♋ Activated sludge process
- ♋ Oxidation ditch
- ♋ Oxidation pond
- ♋ Aerobic lagoon

AEROBIC REACTOR



ANAEROBIC REACTOR



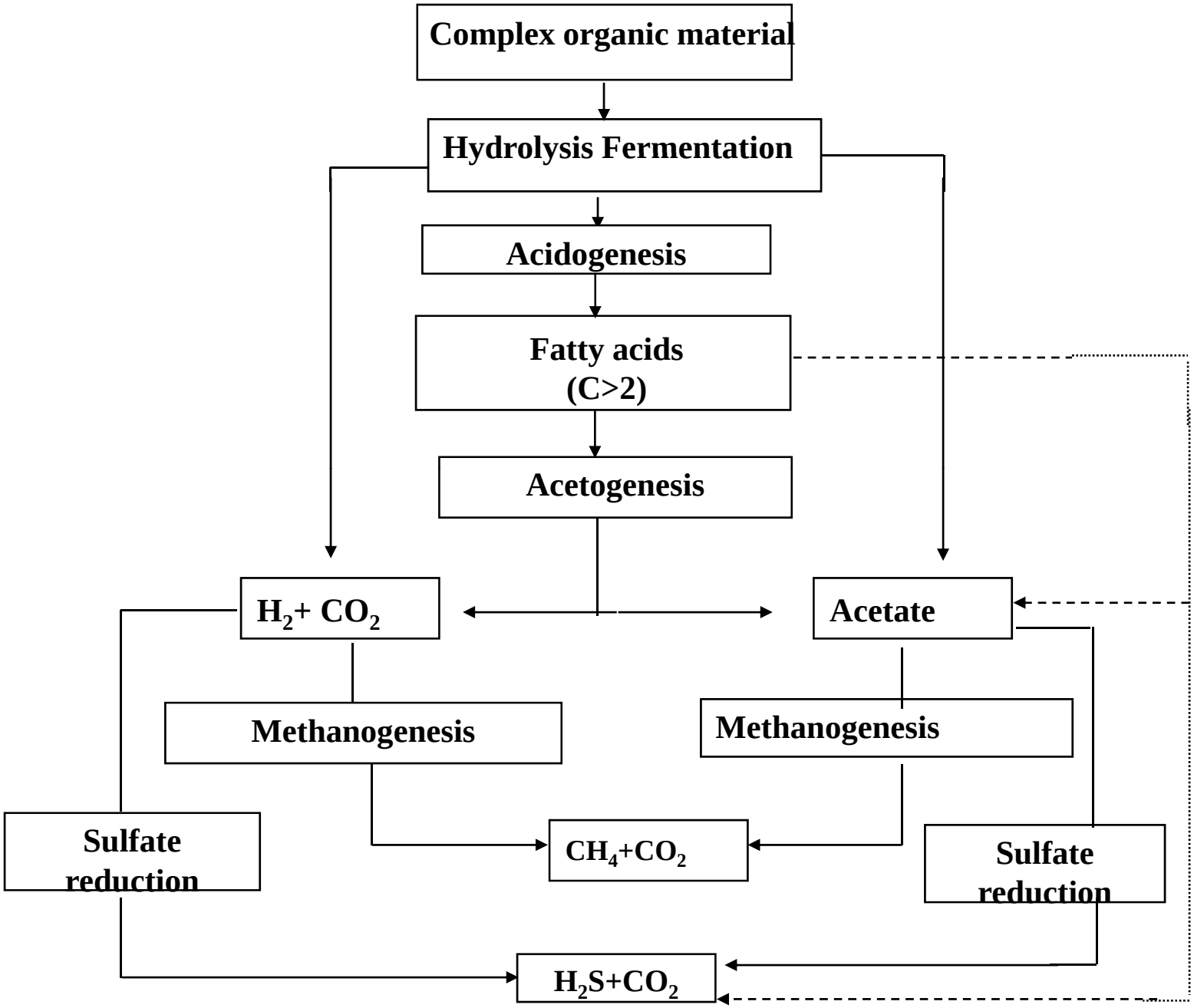
ADVANTAGES OF ANAEROBIC REACTORS

- Low energy cost
- Less bio-mass generation
- Less solid waste to dispose
- Stable digested sludge is produced
- Less N&P requirement
- Less space required
- Off-gas air pollution eliminated

DISADVANTAGES OF ANAEROBIC LAGOON

- LAND AREA REQUIRED IS HIGH
- DEGRADATION IS SLOW
- PERIODICAL CLEANING REQUIRED
- LESS EFFICIENT

ANAEROBIC LAGOON



Flow Chart: Anaerobic Digestion of Sulfate Rich Waste

HYDROLYSIS

In the hydrolysis step large organic molecules such as proteins, poly-saccharides and fats are degraded into small and soluble components (sugars, amino-acids, fatty acids) by enzymes excreted by fermentative bacteria.

ACIDOGENESIS

In the Acidification step soluble compounds are converted into a number of simple, low-molecular compounds: volatile fatty acids such as acetic acid, propionic acid, butyric acid, etc., alcohols, aldehydes, mercaptanes, CO_2, H_2, NH_3. New biomass is also formed.

ACETOGENESIS

Products of the acidification step can be converted into acetate, H_2 and CO_2 by acetogenic bacteria. New biomass is formed as well. The organic loading rates applied in the treatment of domestic wastewater are so low that the concentrations of the products of acidogenesis and acetogenesis are only present in very low concentrations.

METHANOGENESIS

In the final phase of anaerobic decomposition, the products of the first three phases: acetic acid, H_2 and CO_2, formic acid and methanol are converted into methane and CO_2 as well as new biomass. In this phase the actual COD-removal takes place.

ATTACHED GROWTH ANAEROBIC REACTOR

- **Upflow contact filter**
- **Downflow contact filter**
- **Fluidized Bed Reactor**

SUSPENDED GROWTH REACTOR

- **Anaerobic Lagoon**
- **Up flow Anaerobic Sludge Blanket (UASB)**

DEVELOPMENT OF ANAERPIC REACTORS

1. Septic Tank
2. Imhoff Tank
3. Single stage anaerobic reactors
4. Anaerobic Filter (AF)
5. Anaerobic Fluidized Bed Reactor
6. Upflow Anaerobic Sludge Blanket

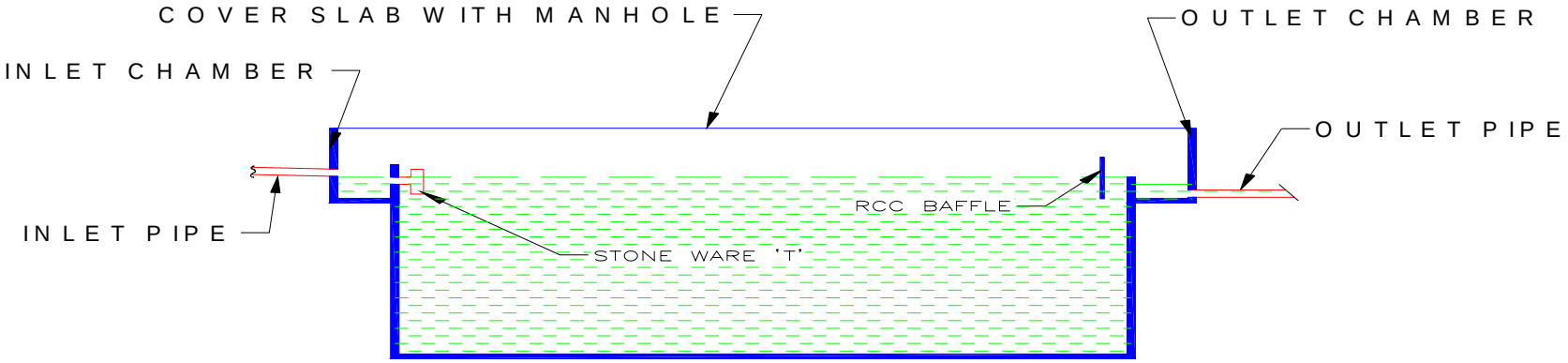


FIG 1 SEPTIC TANK

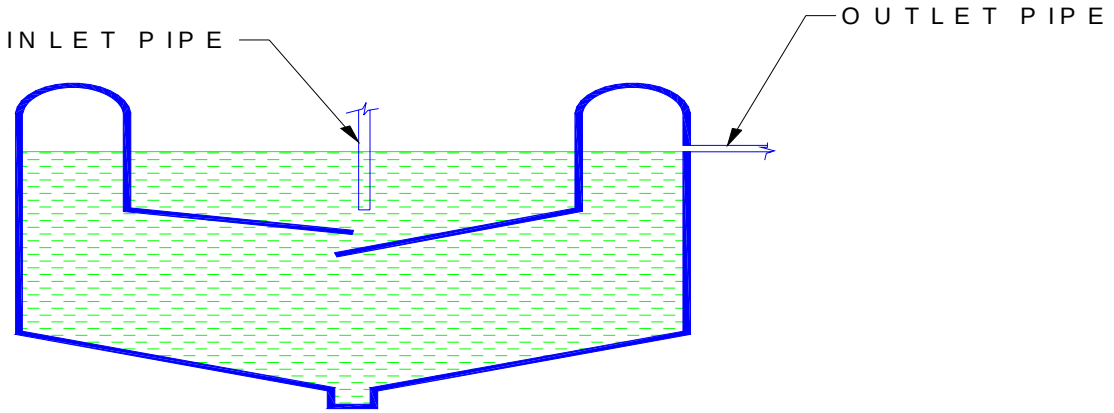


FIG 2 IMHOFF TANK

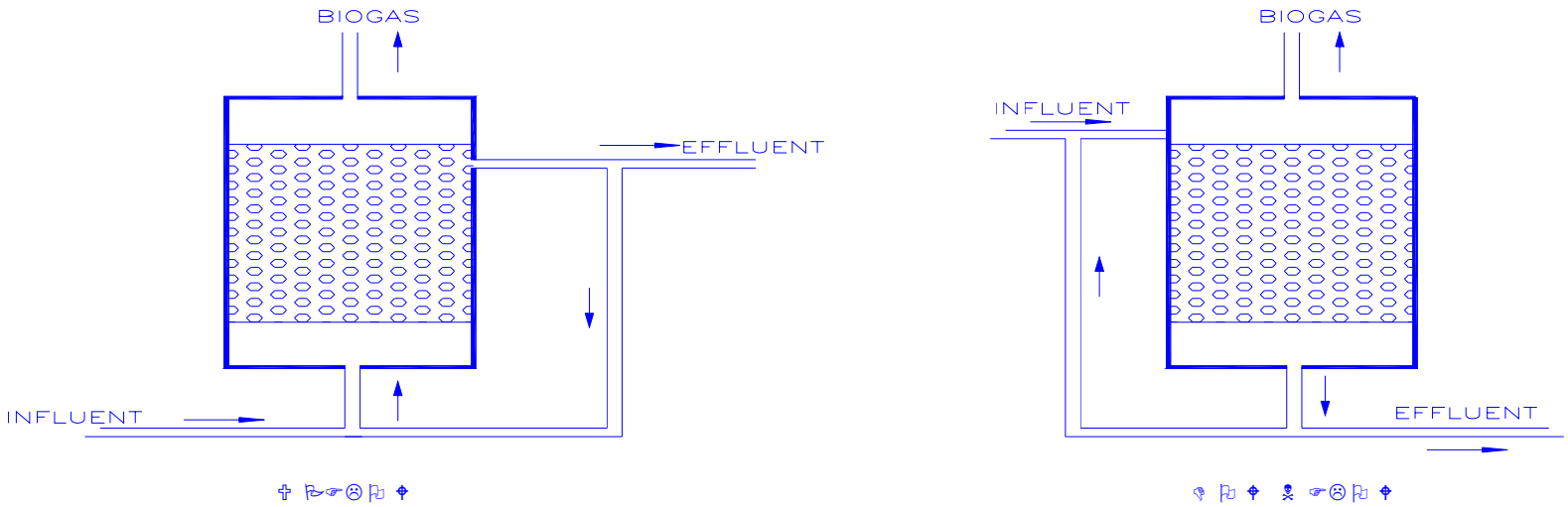


FIG 3 ANAEROBIC FILTERS

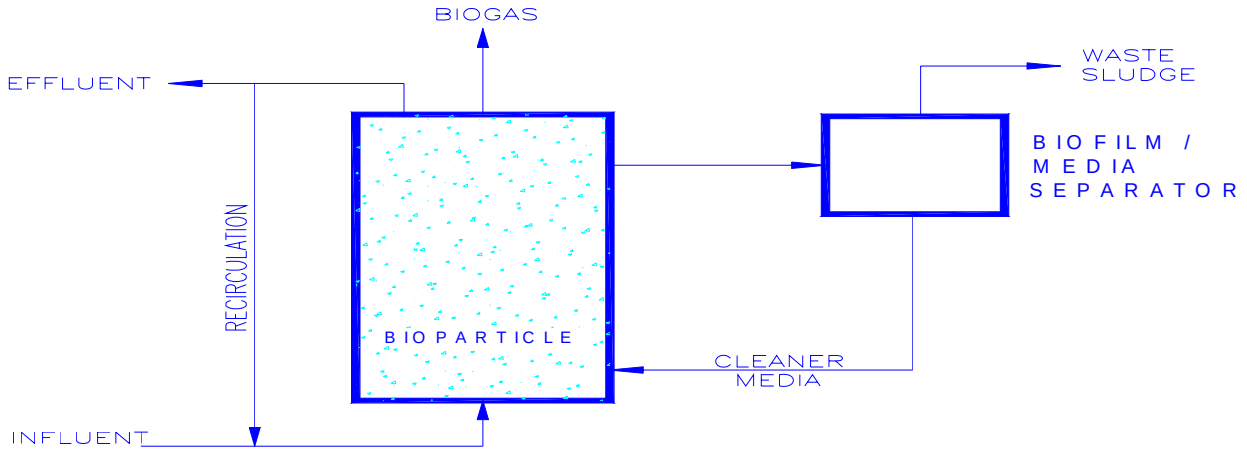
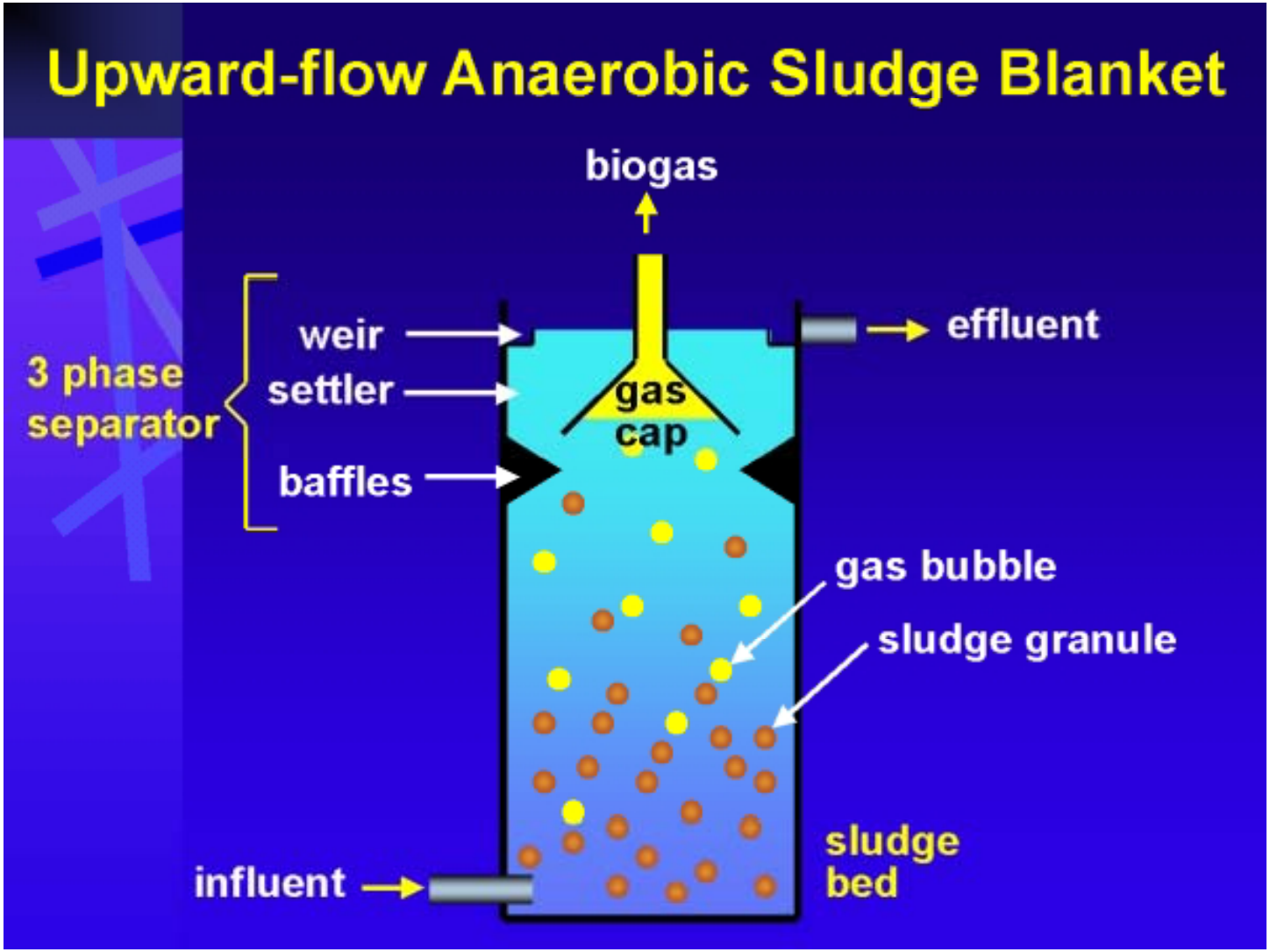


FIG 4 ANAEROBIC FLUIDIZED BED REACTOR


Upward-flow Anaerobic Sludge Blanket
biogas
3 phase separator
weir
settler
baffles
gas cap
effluent
gas bubble
sludge granule
sludge bed
influent

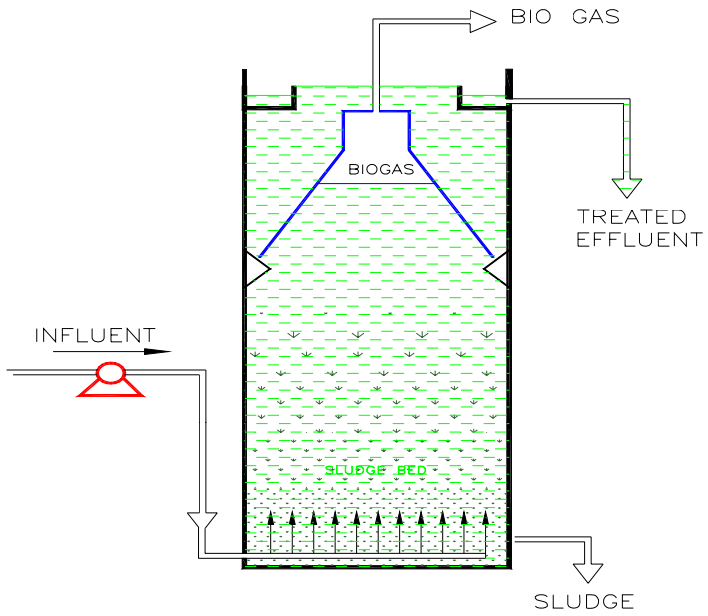


FIG 5 UPFLOW ANAEROBIC SLUDGE BLANKET

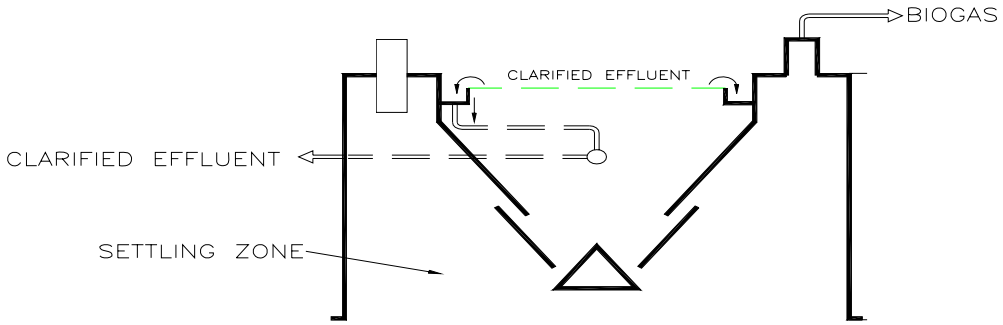
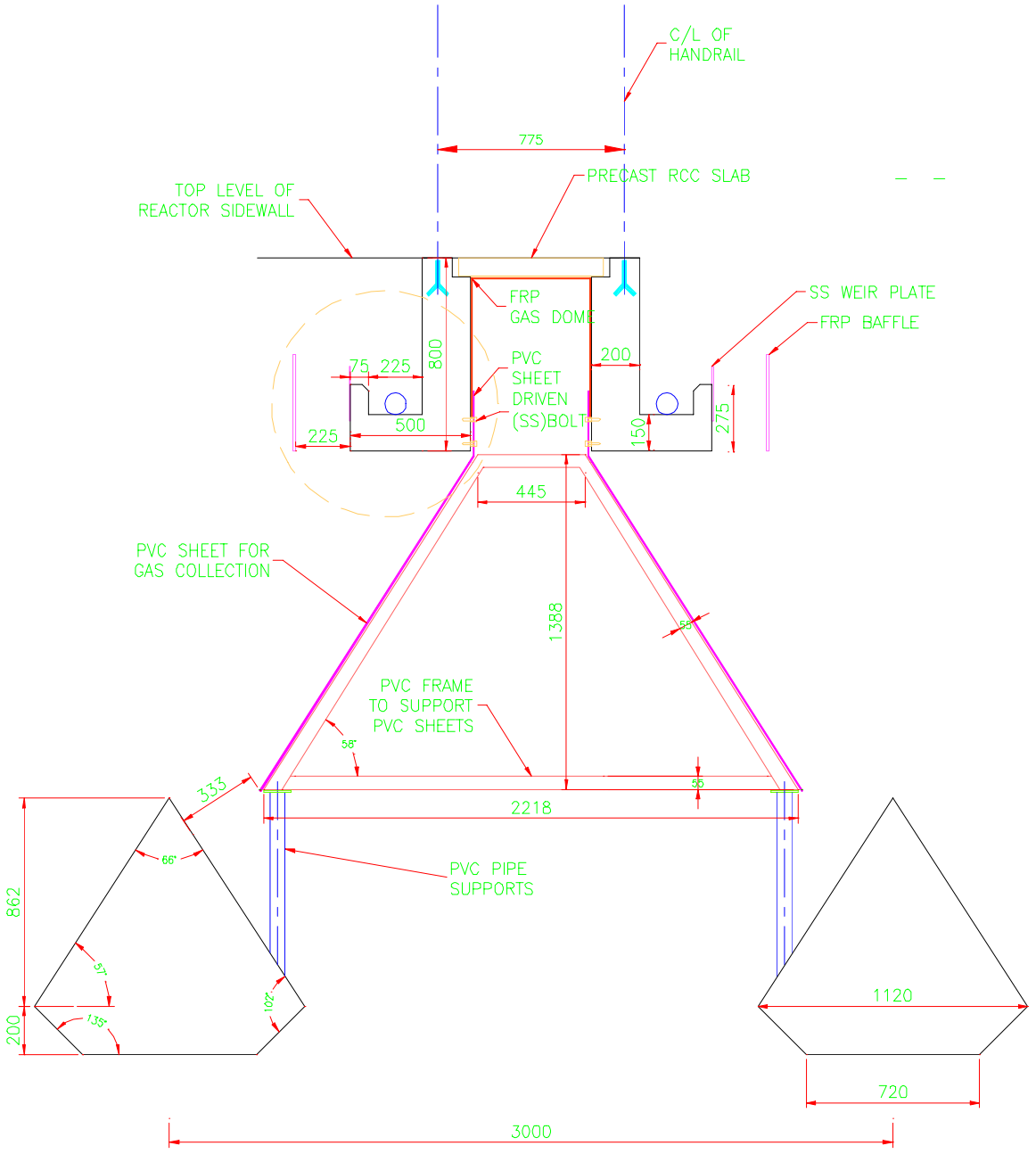
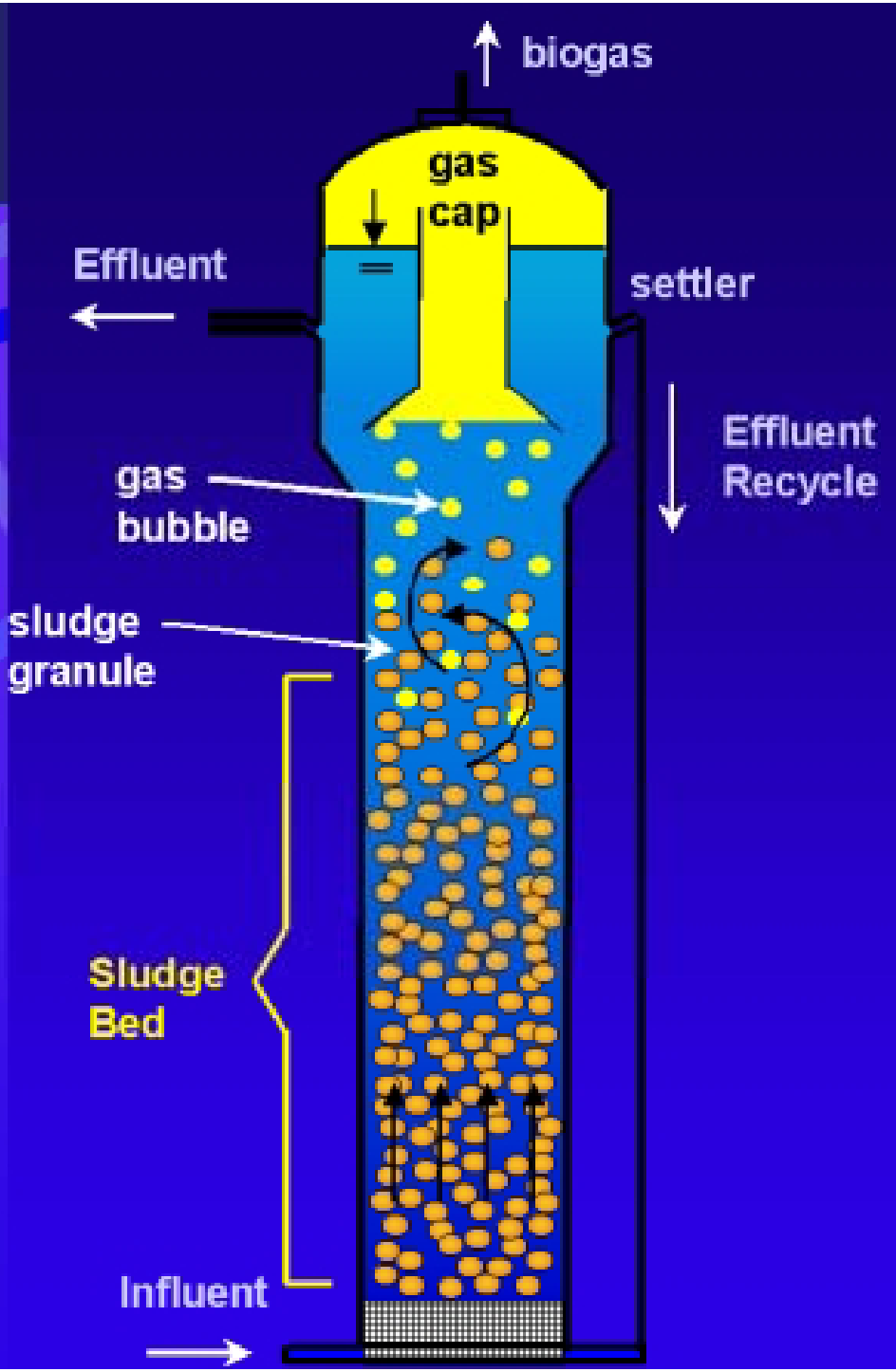


FIG 6 GLS SEPARATOR


C/L OF
HANDRAIL
775
PRECAST RCC SLAB
TOP LEVEL OF
REACTOR SIDEWALL
FRP
GAS DOME
SS WEIR PLATE
FRP BAFFLE
75
225
800
PVC
SHEET
DRIVEN
(SS)BOLT
200
225
500
150
275
445
PVC SHEET FOR
GAS COLLECTION
1388
55
PVC FRAME
TO SUPPORT
PVC SHEETS
58°
333
55
2218
66°
PVC PIPE
SUPPORTS
862
57°
135°
200
1120
720
3000

Expanded Granular Sludge Bed



EGSB

Gist Brocades (yeast, pharmaceuticals) The Netherlands

UASB

DESIGN CRITERIA FOR UASB REACTOR

- **LD in UASB Reactor** — **5 – 5.5 m**
- **Hydraulic retention Time** — **6 - 10 hrs**
- **Sludge Production** — **COD x 0.75x 0.08**
- **Organic loading rate** — **1.5-2 Kg/m^3/day**
- **Biogas yield** — **0.20 – 0.25 m3/kg of COD removed**
- **Hood width** — **0.45m**

TYPICAL DESIGN OF UASB REACTOR

- **Flow** **10MLD**
- **BOD Conc.** **350 mg/L**
- **COD Conc.** **700 mg/L**
- **COD Load** **7000 kg/day**

REACTOR VOLUME BASED ON ORGANIC LOADING RATE

- **Vol. of Reactor :**

$$\frac{\text{COD load/day}}{\text{COD load per m}^3\text{ of reactor}}$$

$$\frac{7000}{1.5} = 4666\ \text{m}^3$$

REACTOR VOLUME BASED ON HYDRAULIC RETENTION TIME

- **Vol. of Reactor :**

$$= \frac{\text{Flow x HRT}}{} = \frac{10 \times 10 \times 10^3}{24} = 4166\ m^3$$

FLOOR AREA OF THE UASB REACTOR

- **Area of the reactor:**

$$= \frac{\text{Volume}}{\text{Height}} = 933\ m^2$$

LENGTH AND BREADTH OF THE REACTOR

- **Area of the reactor:**

$$\frac{\text{Area}}{\text{Width}} = \frac{933}{16}$$

$$\text{Length} = 58 \text{ m}$$

NUMBER OF REACTORS

- **Assuming 1:2 ratio Divide the length of the Reactor into two**
- **Fix the length of the reactor as 32 m**
- **The length of the reactor may be in the multiples of four**
- **Size of each reactor: 3**

Design of GLS separator

- **Assume 4 m centre to centre gas dome**
- **Assume 18% aperture length**
- **Width of the Gas collector: 4 x 0.82 = 3.28 m**
- **Angle of Gas dome: 45^0**

Design of GLS separator

- **Overlap** **0.15 mm**
- **Width of Gas Dome:** **0.45 m**
- **Length of projection:** **1.41 m**

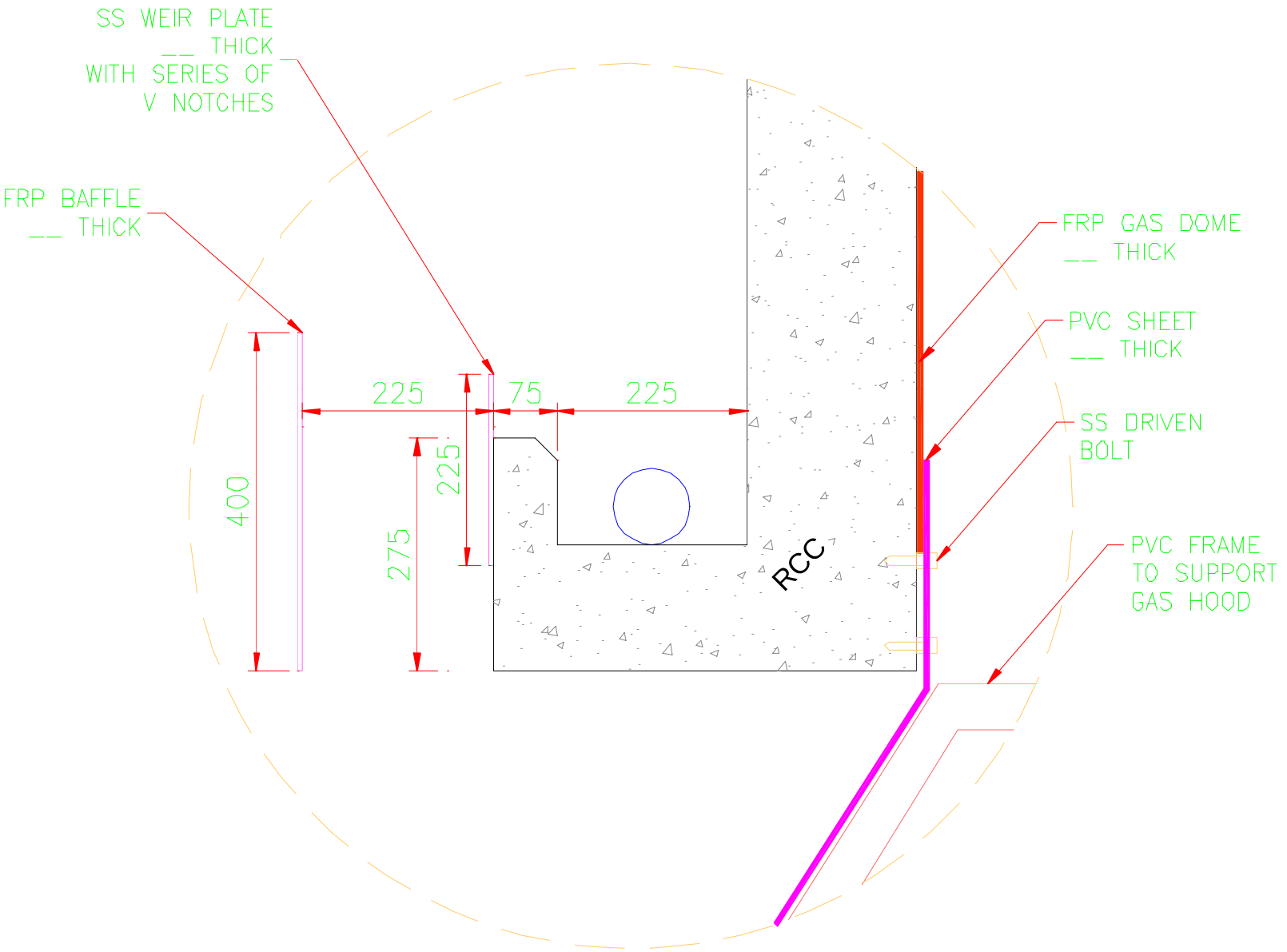

NO SMOKING


1 15:35

FEED INLET ARRANGEMENTS

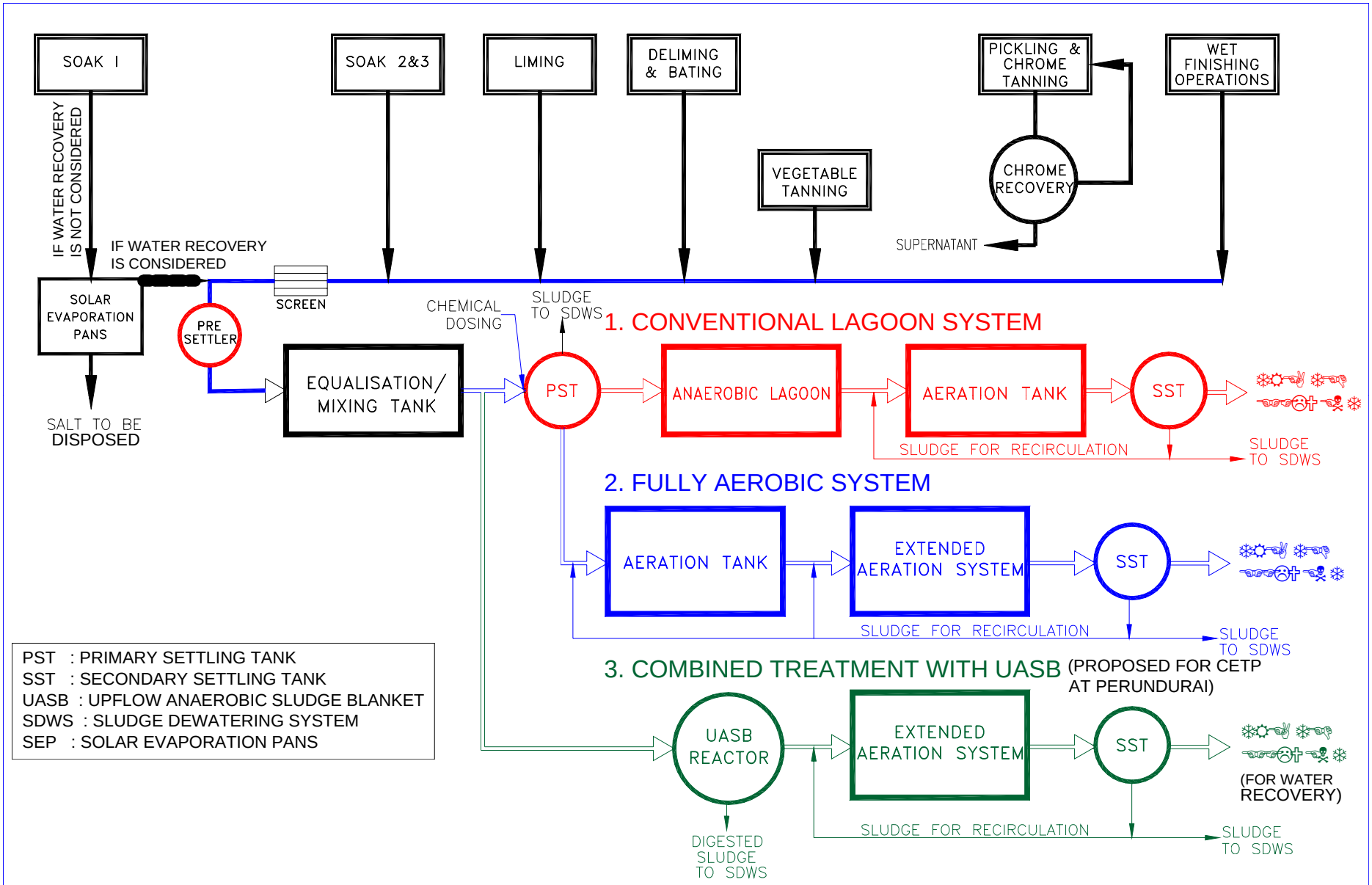
FEED INLET PIPES IN UASB

FEED INLET POINT & DEFLECTOR BEAM

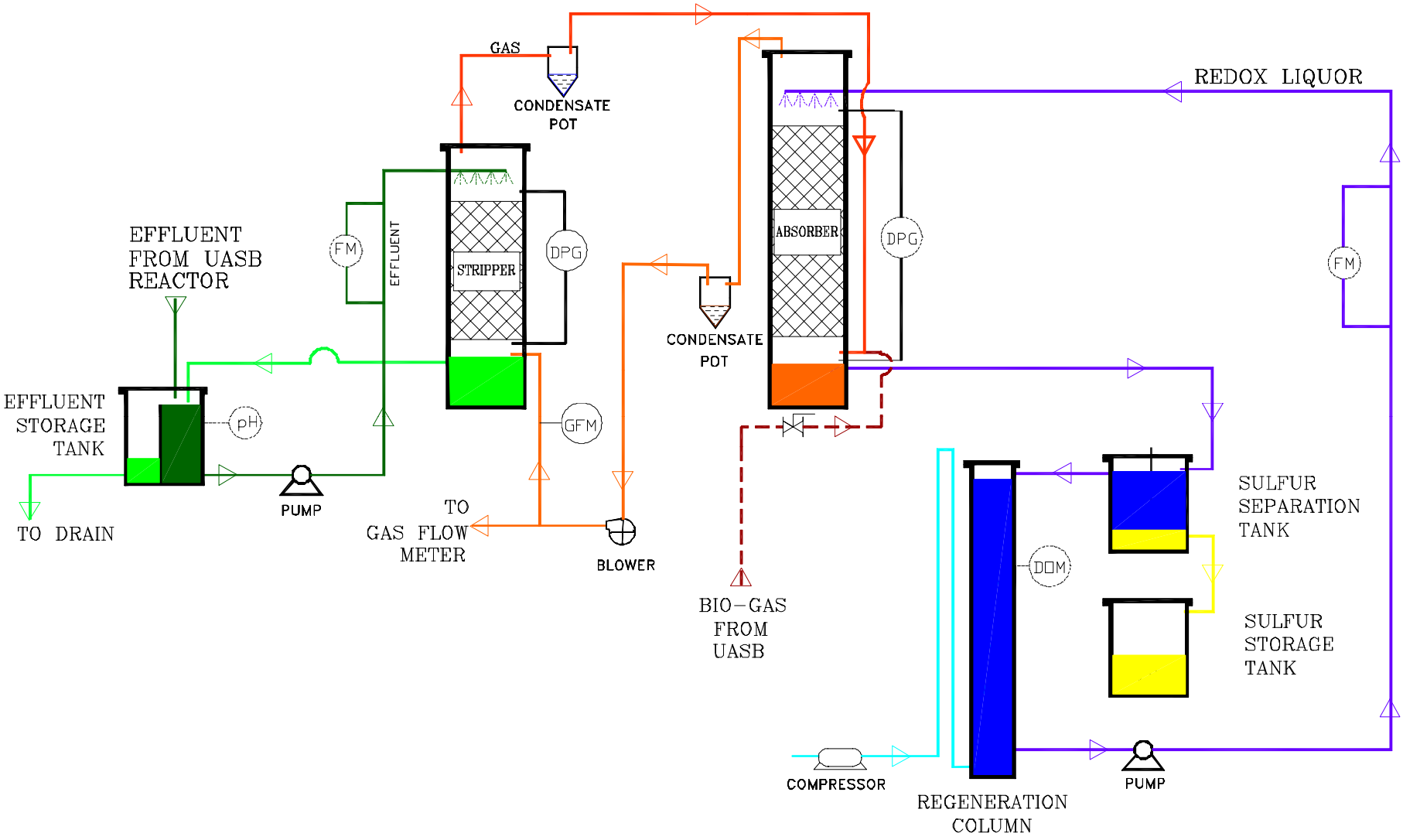

SS WEIR PLATE
__ THICK
WITH SERIES OF
V NOTCHES
FRP BAFFLE
__ THICK
FRP GAS DOME
__ THICK
PVC SHEET
__ THICK
SS DRIVEN
BOLT
PVC FRAME
TO SUPPORT
GAS HOOD
225
75
225
400
225
275
RCC


1 15:36

SLUDGE WITHDRAWAL PIPES



TANNERY EFFLUENT TREATMENT SYSTEMS



FLOW DIAGRAM OF PILOT SCALE SULFUR RECOVERY UNIT

CLRI, CHENNAI, INDIA

SULPHUR RECOVERY UNIT


RECOVERED
SULFUR
FROM
TANNERY
WASTEWATER
RECOVERED
SULFUR
FROM
TANNERY
WASTEWATER

LIMITATIONS OF UASB

- **Post Aerobic Treatment is required (one day polishing pond for sewage).**
- **To meet coliform level in the treated effluent maturation pond or chemical treatment is required.**

THANK YOU