INDUSTRIAL WATER MANAGEMENT

TREATMENT OPTIONS

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Wastewater Treatment Options

- *Treatment processes*
- *End of pipe treatment*
- *Segregation of waste streams*
- *At source treatment*

Treatment Processes

- *Physical*
- *Chemical*
- *Biological*
- *Advanced Oxidation Processes*

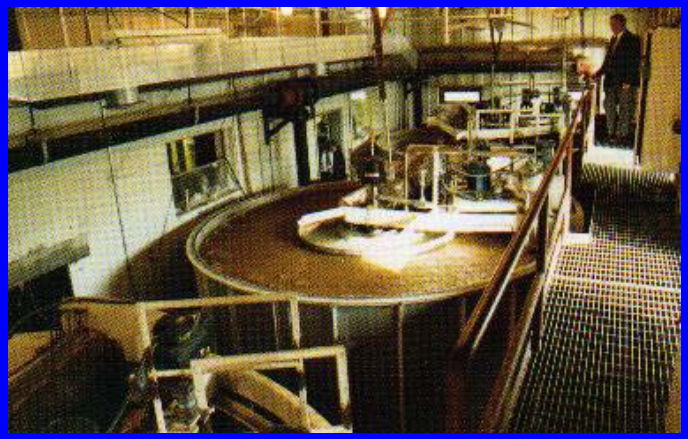
Treatment Processes

- *Diluting a wastewater to comply with discharge standards is not treatment*
- *Removing a contaminant from one phase into another is not the same as destroying it*

Treatment Processes

- *Physical*
  - *membrane separation (MF, UF, RO)*
  - *adsorption (GAC, silica, synthetics, etc)*
  - *clarification*
  - *stripping*
  - *evaporation*

Treatment Processes



DAF plant - dairy effluent

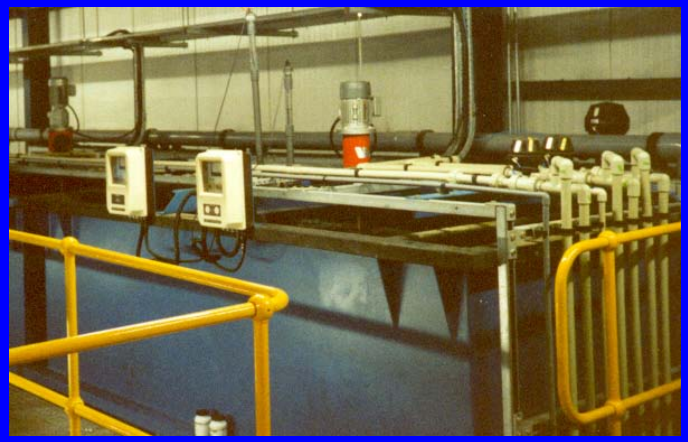
Evaporator - utility effluent

UF Module

Treatment Processes

- *Chemical*
  - *neutralisation*
  - *precipitation*
  - *coagulation*
  - *oxidation/reduction*
  - *ion exchange*
  - *electrodialysis*

Treatment Processes



Reduction - copper plating effluent

Ion exchange plant

Lime neutralisation plant

Treatment Processes

- *Biological*
  - *aerobic*
    - *activated sludge*
    - *nitrification*
    - *N and P removal*
    - *"designer bugs"*
    - *fungi*
    - *PACT*
  - *Anaerobic*

Treatment Processes

Membrane bioreactor

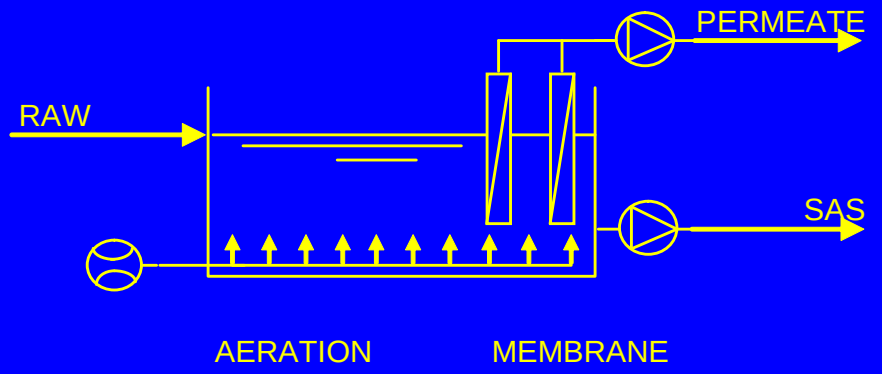
Activated sludge plants

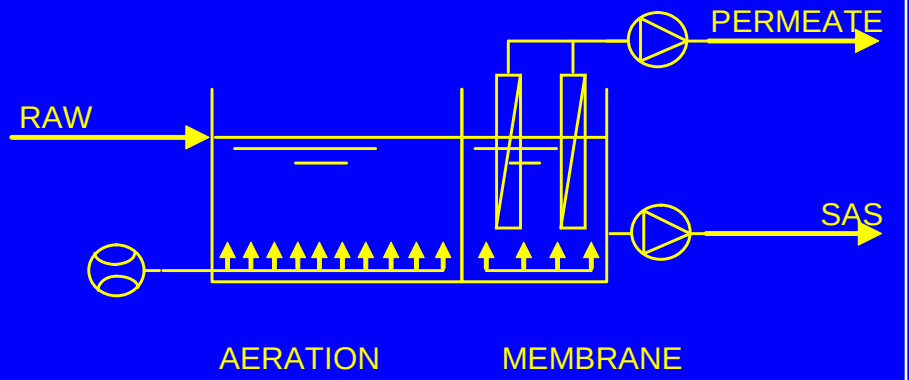
Treatment Processes

- *Membrane bioreactors*
  - *Activated sludge biology*
  - *Biomass separation by membrane*
  - *UF or MF*
  - *MLSS 5000-10000mg/l*
  - *Reduced footprint*
  - *Low turbidity permeate*
  - *Disinfected by filtration*
  - *Permeate suitable for re-use or RO feed*

Treatment Processes

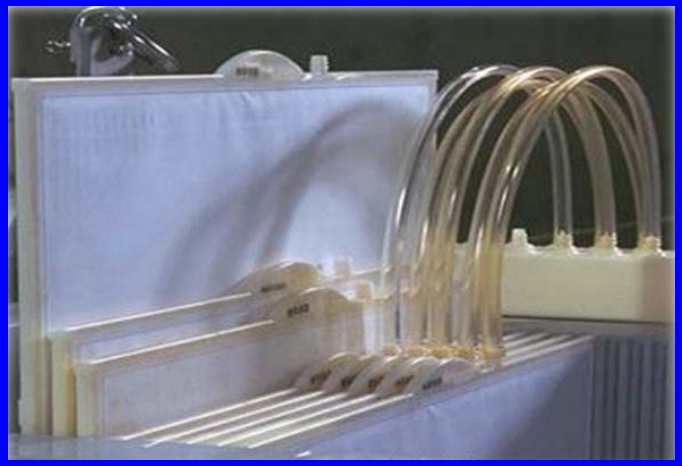
- *Submerged*
  - *Flat sheet*
    - *Usually in aeration tank*
    - *Aeration air reduces fouling*
  - *Hollow fibre*
    - *Usually separate tank with coarse bubble aeration for fouling control*





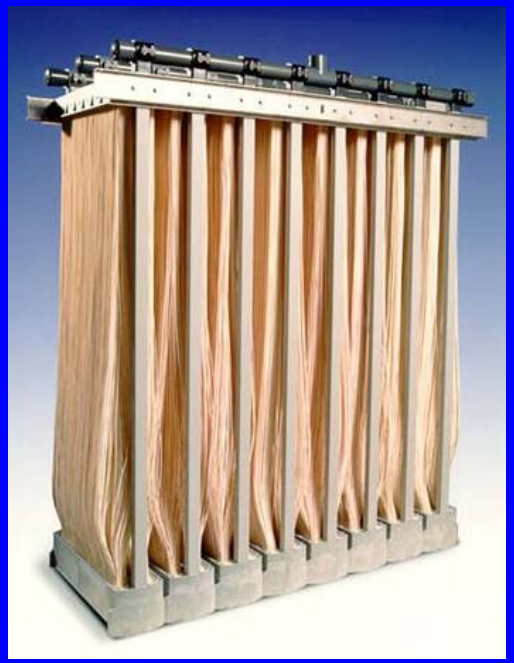
Treatment Processes

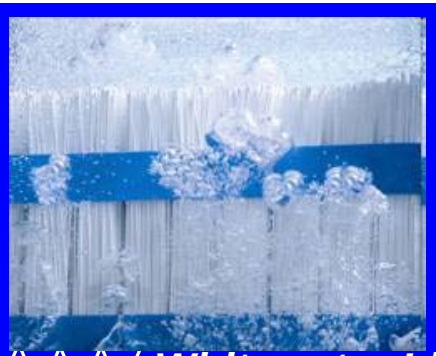
- *Flat sheet*
  - *Polyethylene*
  - *Formed as plate*
  - *Air bubbles keep surface clean*
  - *0.4 μm pores*



Treatment Processes

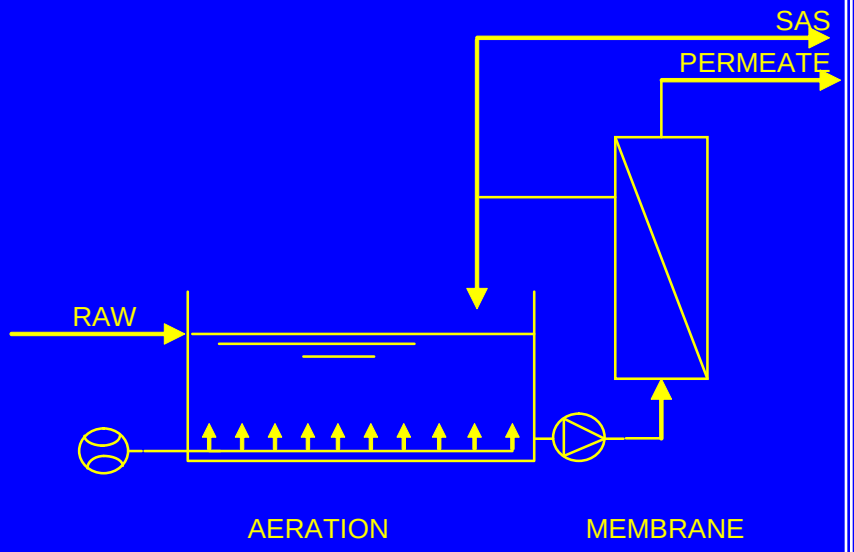
- *Hollow fibre*
  - *Formed as loose bundles*
  - *Air bubbles keep surface clean*
  - *May be in aeration tank or in a separate tank*
  - *0.4-2.8mm OD*
  - *Predominantly PVDF*





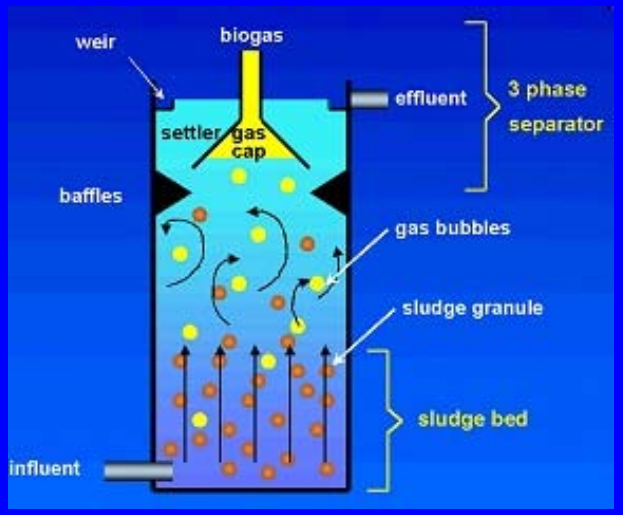
Treatment Processes

- External
  - Hollow fibre
  - Formed as loose bundles
  - Air bubbles keep surface clean
  - May be in aeration tank or in a separate tank
  - 0.4-2.8mm OD
  - Predominantly PVDF



Treatment Processes

- *Upflow Anaerobic Sludge Blanket (UASB)*
  - *First Biothane plant at Gist Brocades, Delft 1985 Low sludge production*
  - *Mainly used in industrial wastewater treatment*
  - *Fast settling granular sludge*



Treatment Processes

- *Advanced Oxidation Processes*
  - *generation of $OH^{\bullet}$*
  - *Fenton's Reagent ($H_2O_2 + Fe^{2+}$)*
  - *ozone/peroxide/UV*
  - *UV/TiO_2*
  - *Ultrasonics*
  - *Wet air oxidation*
  - *Supercritical water oxidation*

Treatment Processes

Ozone generator

UV irradiation chamber

UV/Ozone reactor

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Treatment Processes

Pilot plant results for W3T ozone/UV unit
April 2012 treating Bandar Tun Razak STW FE

Worldwide Water Technologies

Sample	COD (mg/L)	TOC (mg/L)	BOD (mg/L)	TOTAL COLIFORM (MPN)	E.COLI (MPN)	SUSPENDED SOLID (mg/L)	TURBIDITY (NTU)	pH	CONDUCTIVITY (µS/cm)
Raw IWK's effluent	16	5.9		198,630	54,750	5	2.12	7.08	261
Filtrate effluent	14	6.9		Not measured	Not measured	3.5	1.04	7.17	246
Effluent at W3T outlet (Treated effluent)	4	4.2		0	0	0.6	0.68	7.17	237
Treated effluent after 1 hour in product tank	3	4.7		Not measured	Not measured	1.4	0.42	7.22	217

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Treatment Processes

Wet air oxidation

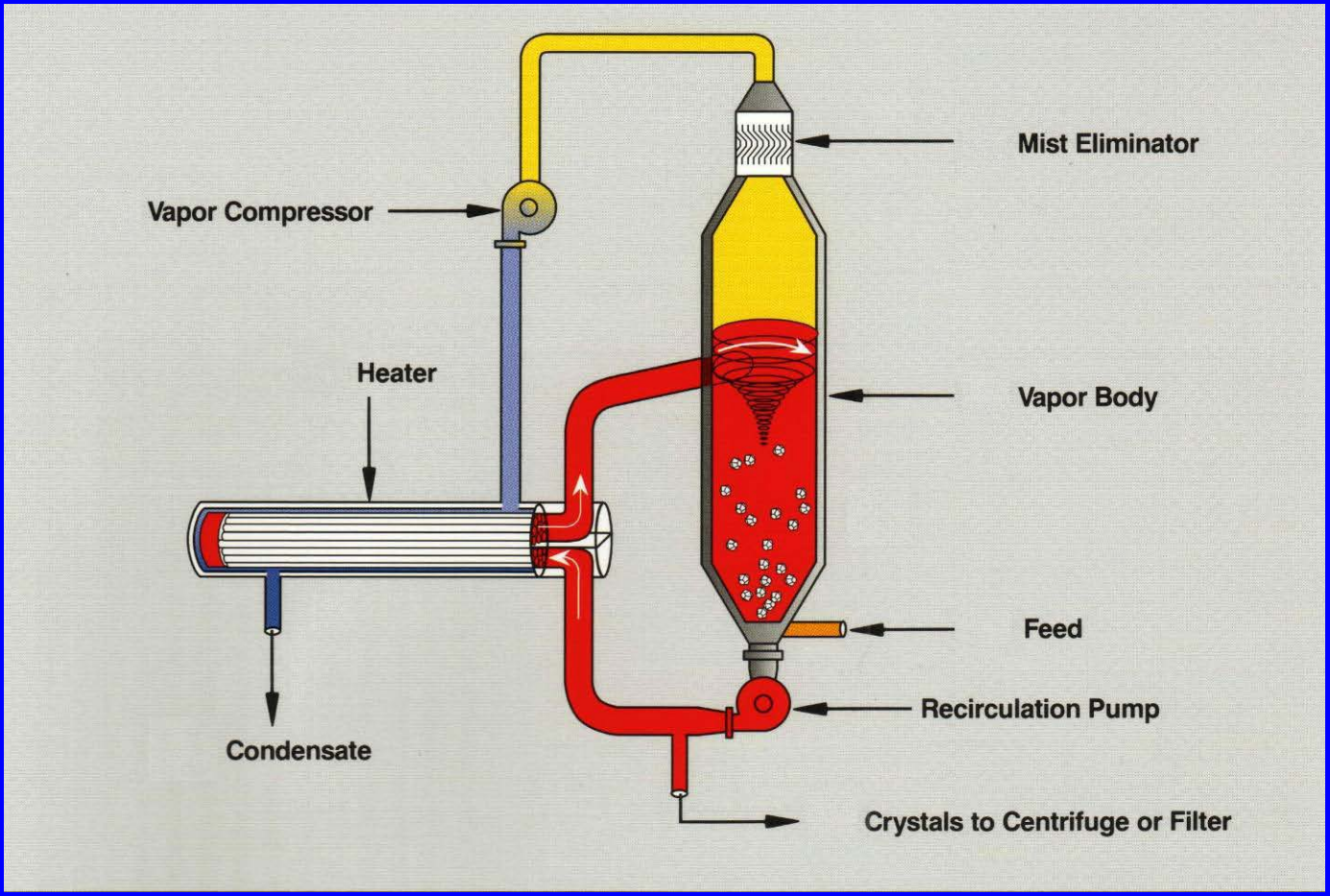
Loprox® wet air oxidation plant at Bayer treating 190tpd of pharmaceutical manufacturing wastewater commissioned 1993

150 - 320ºC
100 - 220 barg
Oxidation to CO_2, N_2, water
High capex and opex

ZERO LIQUID DISCHARGE

- *Technology*
  - *membrane separations*
  - *evaporation*
- *Limitations*
  - *atmospheric emissions*
  - *disposal of solid residue*
- *Economics*

ZERO LIQUID DISCHARGE

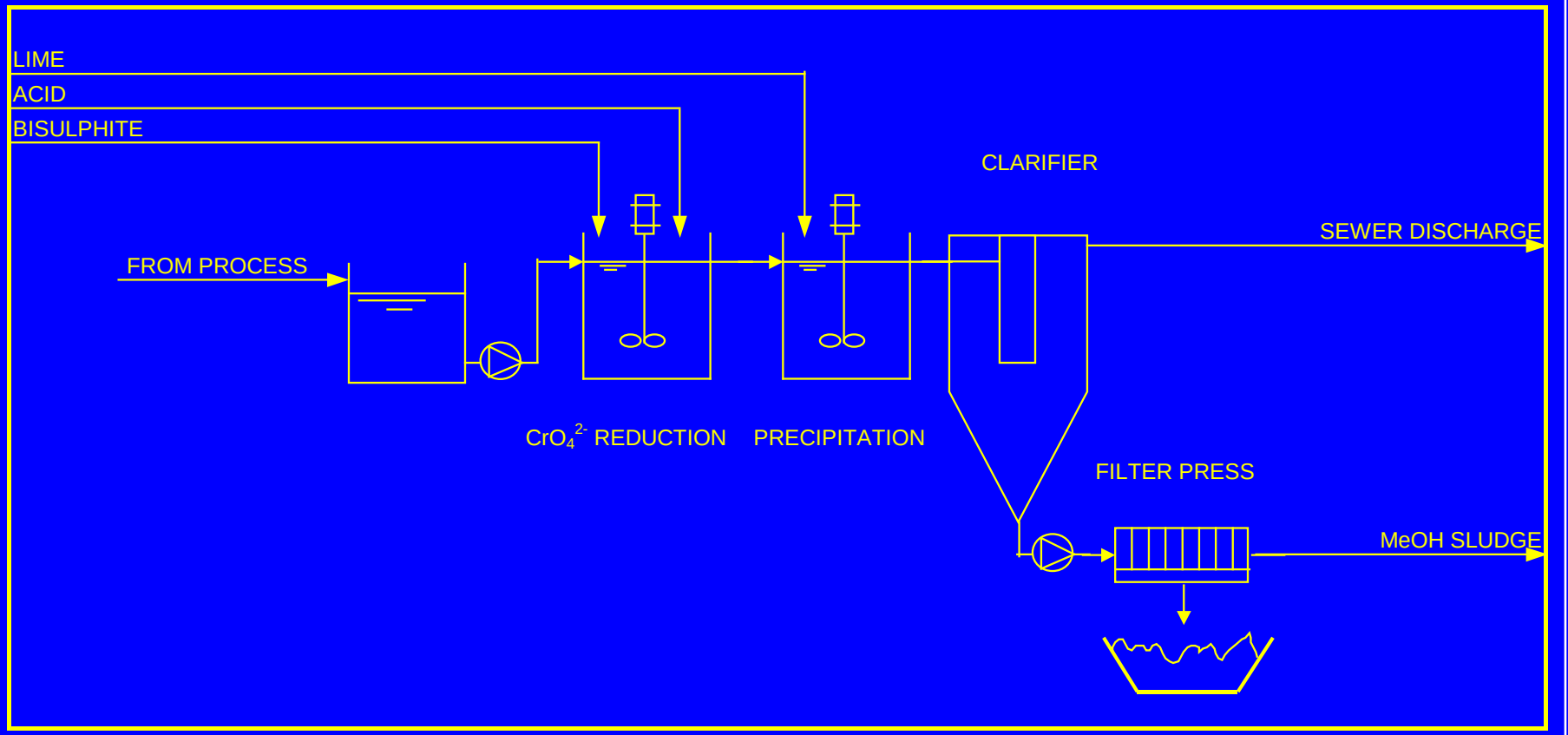


ZERO LIQUID DISCHARGE

End of Pipe Treatment

- *Simple to install*
- *High flow*
- *Mixture of contaminants*
- *Contaminant concentration may be low*
- *Difficult to achieve low residuals of specific contaminants*
- *Usually produces waste (eg sludge)*

End of Pipe Treatment



End of Pipe treatment for plating shop wastewater

Segregation of Wastes

- *Allows "at source" treatment*
- *Easy to implement on new build*
- *Identification of drains may be difficult in existing factories*
- *Problems of batch process industries*
  - *intermittent flows*
  - *varying composition in "campaigns"*

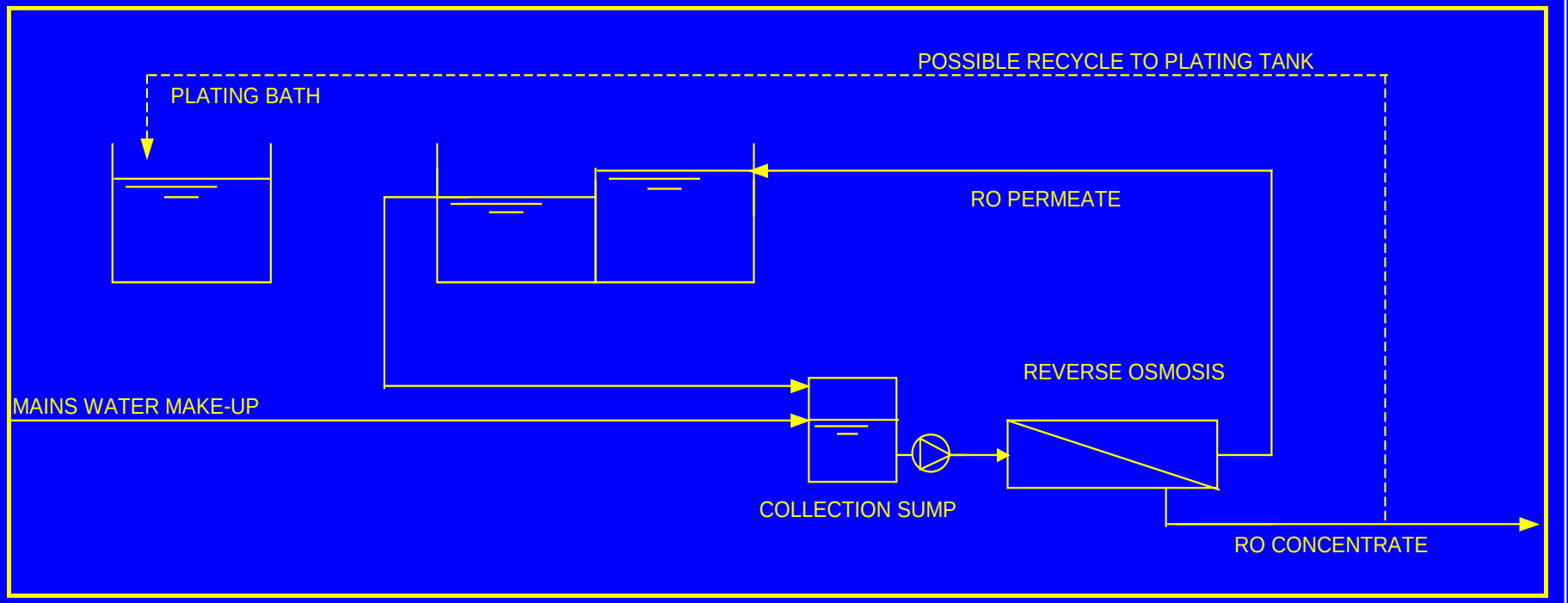
At Source Treatment

- *Flows are smaller*
- *Specific to individual contaminants*
- *Contaminants are present in lower volumes therefore higher concentration*
- *Plant is smaller*

At Source Treatment

- *At source treatment provides opportunities for recovery*
  - *water*
  - *raw materials*
  - *energy*
    - *biogas from anaerobic digestion*
    - *heat recovery from evaporation*

At Source Treatment



RO used at source to recover rinse water and plating solution

Wastewater Treatment Options

SELECTING THE RIGHT TREATMENT PROCESS

CAN REDUCE COSTS !!!