Two days training on the operation and management of WWTPs

9-10 September, Murcia

Industrial wastewater treatment plants design

Presented by: Ricardo Egea

Index

bionet
ENGINEERING

BIONET technology company specialized in:

- Digestion and fermentation process
- Membrane filtration/separation processes
- Bio-process engineering

We apply this knowledge to solve PRODUCTION AND ENVIRONMENTAL NEEDS for companies in the energy, food, chemistry, pharma and other process industries.

We have an independent central facilities of 2500 m2 with engineering area, process development center, a workshop and a FAT area for the start-up and quality control of many of our developments.

AENOR ER Empresa Registrada UNE-EN ISO 9001

CERTIFIED IQNet MANAGEMENT SYSTEM

bionet ENGINEERING

Bioreactors/Fermentors

BIONET we engineer and build bioreactors and digestors for R&D, Environmental and Production uses.

R&D bioreactors

Industrial fermentation

Environmental treatment

Membrane filtration

BIONET we engineer and build membrane clarification and filtration systems for bio-products. We have our own process development center

What is industrial wastewater?

What is industrial wastewater?

- It includes all waterborne waste from facilities except sewage.

Quality and quantity

- Raw process material.
- Industrial process that generates the water: raw material washing, finished goods wash water, boiler and cooling tower blowdown, etc.
- Number of times the water has been reused (potential increasing or decreasing the concentration level of contaminants).
- Reactions that occur during the industrial process.
- Temperature or additives such as biocides, antiscalants or pH adjusters used.

Potential reuse of industrial waste water

With appropriate management, which may include treatment, industrial wastewater can be reused for a wide range of purposes:

Industrial uses

- ❑ Material washing
- ❑ In production line (dilutions)
- ❑ Cooling
- ❑ Boiler or cooling tower blowdown

Non-industrial uses

- ❑ Crop/landscape irrigation
- ❑ Dust suppression
- ❑ Fire protection
- ❑ Commercial car washing facilities
- ❑ Construction (i.e. road compaction)

Any proposed use of industrial wastewater must be underpinned by a specific health and environmental risk assessment.

Potential reuse of industrial waste water

Wastewater reuse potential for industries

High potential	Medium potential	Low potential
•Pulp and paper •Cotton textile •Glass and steel	•Slaughterhouse •Meat processing •Dairy •Canning and food processing •Distillery •Wool textile •Chemical •Fertilizer •Petroleum/Oil refining	•Tanneries & leather finishing •Pesticide •Rubber •Aluminium •Explosives manufacturing •Paint manufacturing

High volume of wastewater + low pollutant concentration → High potential

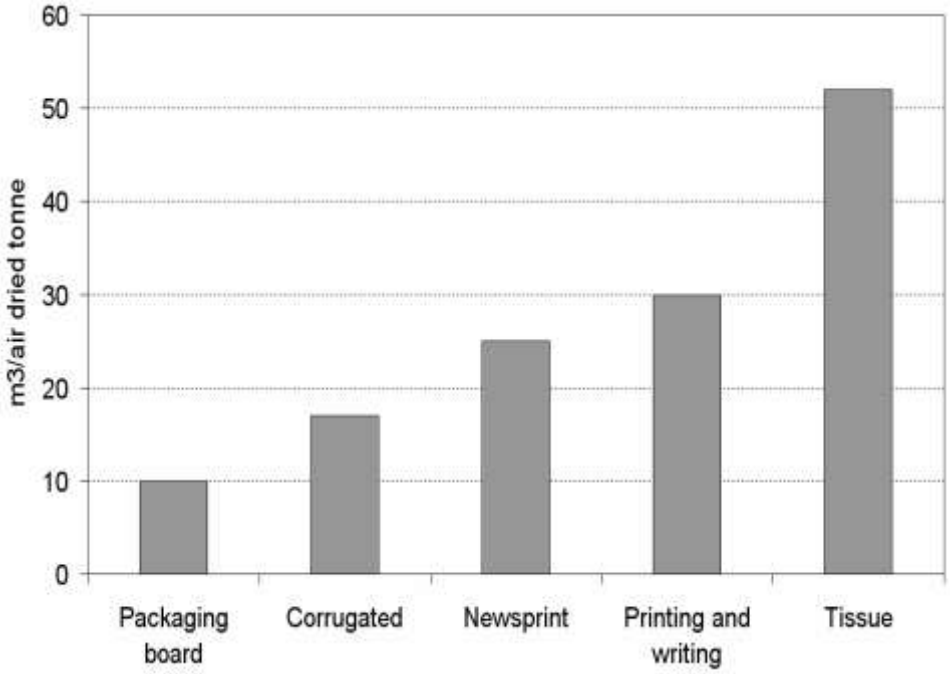
Low volume of wastewater + high pollutant concentration → Low potential

Pulp and paper

Wastewater sources

- Rejects from stock cleaning
- Excess whitewater
- Temporary and accidental discharges
- Cooling and sealing waters

Volume of effluent VS type of paper



Typical contaminant charges (kg/tonne of product)

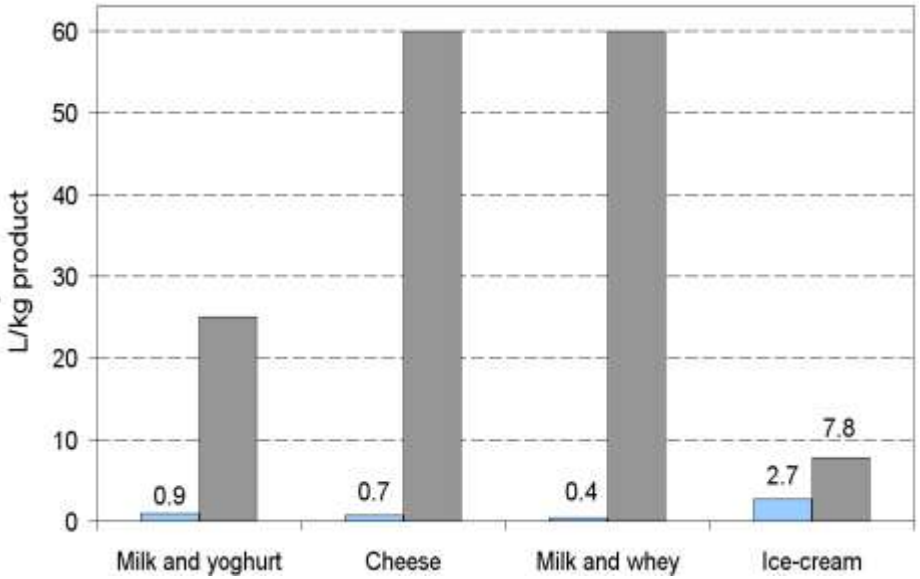
Type of paper	TSS	BOD5
Packaging board	22-30	9-18
Corrugated	22-30	11-26
Newsprint	9-26	4-9
Printing & writing	22-45	9-22
Tissue	13-45	4-13

Dairy industry

Wastewater sources

- Cleaning water: equipments, line purging at product change-over
- Product loss during start-ups, shut-downs, accidental spills
- Losses of condensates during production of milk whey or dried whey

Volume of effluent VS type of product

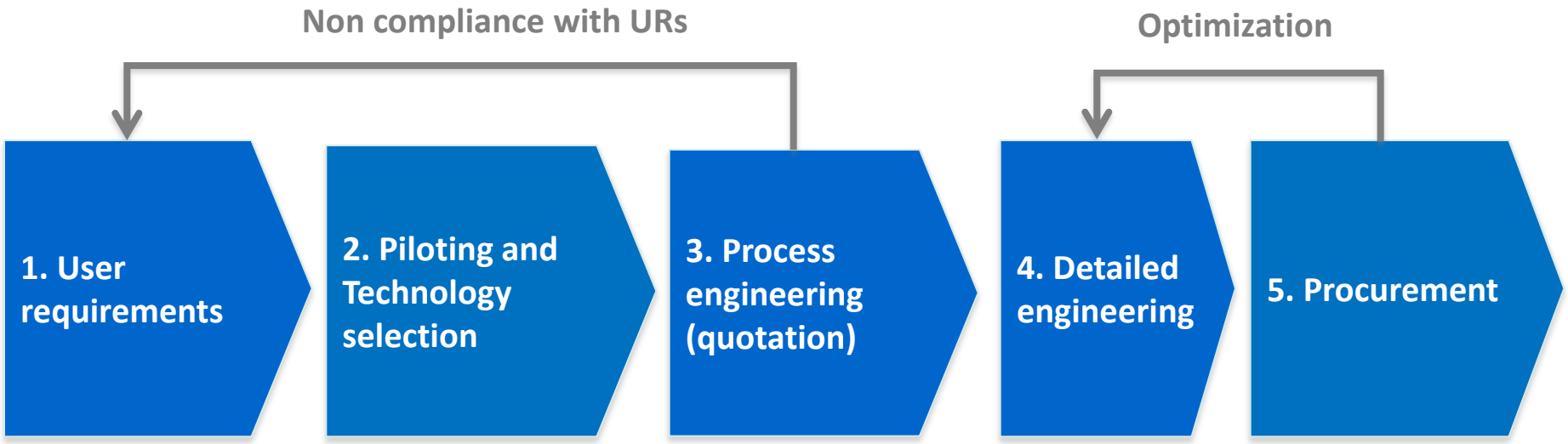


Typical contaminant charges (kg/tonne of product)

Type of product	BOD5
Whole milk	104,000
Skimmed milk	67,000
Whey	34,000
Yoghurt	91,000
Ice-cream	292,000

Do not rush to define a solution!!

Engineering design is an iterative process with some key stages



First stages are the critical ones

1. User requirements

- Waste water quality, components, variations, volumes, etc.. Good identification of contaminants and scenarios. REUSE POTENTIAL?
- Type of user: advanced, medium, low skilled in automation and complex technologies
- Working shifts: 1, 2, 3, 5? Continuous or with weekend stop?
- Cost preferences: Are they focused on optimize investment or operating costs? Highly automated or mostly manual?
- Future production and expansion
- Space available for foot-print and operation (sludge management)

First stages are the critical ones

2. Piloting and technology selection

- COD, BOD5 and TS are just a small part of what problems you may find when treating industrial waste water. So LAB TRIALS OR PILOTING SHOULD BE A MUST!!
- Do not commit to a single technology in your first approach. Compare different alternatives even if there is a strong candidate
- No magic solutions. Thermodynamics and other laws of nature are waiting you round the corner
- Technology are sold on their first day yields. Have a long run vision when selection and dimensioning
- An advanced technology well operated is almost always the best alternative

Process is the key for success

3. Process engineering (quotation)

- Focus on the process and performance. The dimension of your key equipment and reactors are the critical design issues and take a big part of the cost. Focus on that.
- Do not be greedy and too optimistic, and design with a long run vision.
- Based on a clear strategy define soon your electrical-automation design and ask for professional quotations. Big surprises
- Interfaces and service provision (electricity, tap water..) are very important and many times a difficult issue to solve. The sooner the better
- GET THE OWNER INVOLVED!!!!

Process is the key for success

4. Detailed engineering

- Start with interfaces and services. It takes many actors to agree on that so takes long to decide on a shared solution.
- Prepare and specific annex of interferences with the existing site and its normal operation. Industrial plants are not “green field” projects and are integrated in existing facilities with intense activity.
- Keep and eye of what technologies and providers the industry has and put that on your priority list. Do not try to change the way the work or import alien solutions.
- Be aware of the skills of the construction team to define your level of detail.

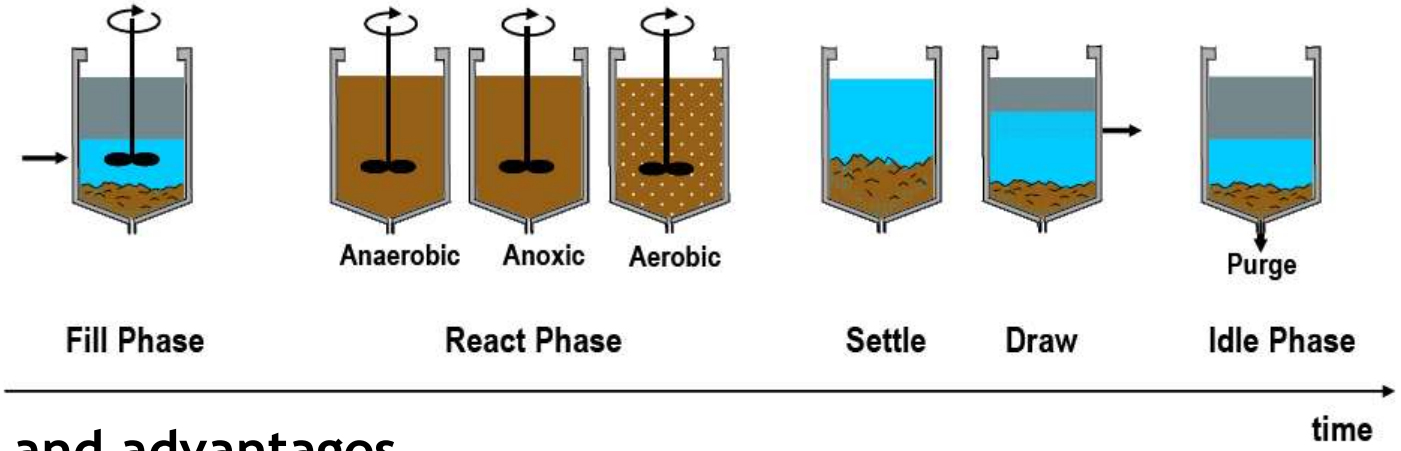
First stages are the critical ones

5. Procurement

- No magic providers. Good technologies and equipment and a right price come together.
- The human resource cost of low quality components rapidly overtakes the possible savings in procurement
- Industry existing providers are always the best choice. If they are below your technology needs go back to point 4.
- Delivery dates are always too optimistic. They are provided by a sales person

SBR (Sequencing batch reactor)

- Systems based on activated sludge, operated on a sequence of fill-draw cycles.
- Main difference compared to conventional activated sludge systems: reaction and settling take place in the same reactor.



Benefits and advantages

- Capable of handling wide swings in hydraulic and organic loads
- Less land required than conventional methods
- Less equipment to maintain/less operator attention required/highly automated
- Powdered activated carbon can be added

SBR (Sequencing batch reactor)

- Can be used for a wide variety of applications where the wastewater is biologically degradable:
  - Food, beverage and confectionery
  - Paper, board and textile
  - Wineries and breweries
  - Petrochemical, refinery and paint
  - Anaerobically pre-treated effluents
  - Electronics and manufacturing
  - Pharmaceutical, perfume and personal care

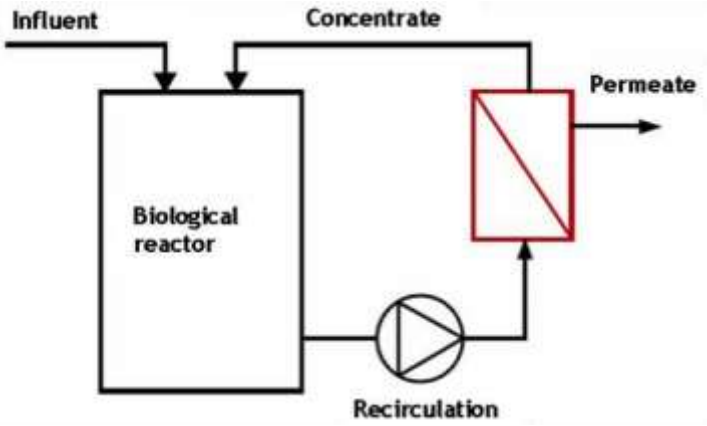
Removal efficiencies of this technology by industry

Type of effluent	BOD (%)	COD (%)	TKN (%)	TP (%)	TSS (%)	TS (%)
Winery wastewaters	97.5	93-96	50	88	n.a.	n.a.
Dairy wastewater	97	93	n.a.	n.a.	97	76
Slaughterhouse wastewaters	n.a.	95	92	90	94	n.a.
Piggery wastewaters	94.5	88.7	n.a.	61	93.4	n.a.

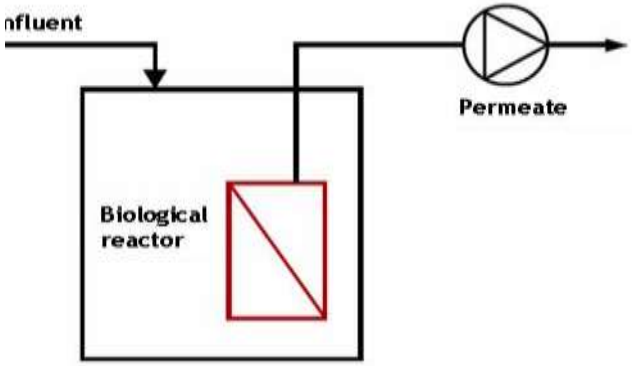
MBR (Membrane bioreactor)

- It is based on a combination of conventional activated sludge system with membranes of micro or ultrafiltration to retain biomass. Configurations:

Sidestream (sMBR)



Immersed (iMBR)



Benefits and advantages

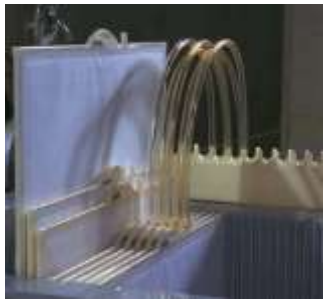
- Compactness and small layout size of the plant
- High load effluents/low retention times required
- Highly automated
- Constant effluent quality, regardless of the influent
- No risk of biomass loss

MBR (Membrane bioreactor)

Membrane modules compatibility

Hollow fiber

Flat-sheet



Ceramics

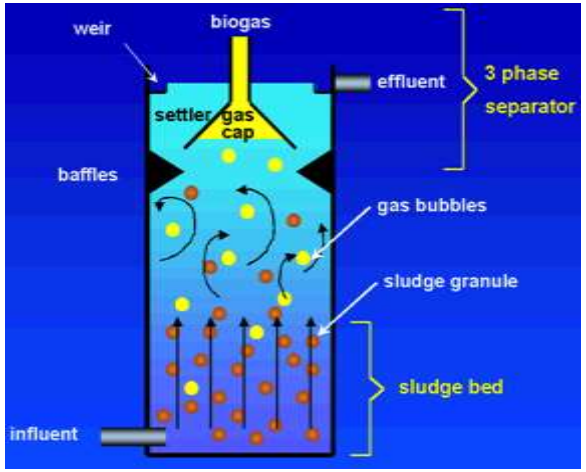
- It effectively produces a clarified (free of SS) and substantially disinfected effluent that can be reclaimed within the specific industry:
  - Food, beverage and confectionery
  - Paper, board and textile
  - Wineries and breweries
  - Anaerobically pre-treated effluents
  - Electronics and manufacturing
  - Pharmaceutical, perfume and personal care
- Reclaimed water applications: cooling, cleaning or within the process (i.e. dilutions). Previously, it must be checked if water quality meets with the standards for the specific use.

Anaerobic reactor

- In anaerobic systems many different groups of anaerobic bacteria "work" together, in the absence of oxygen, to degrade most of the biodegradable organic matter present in wastewater to biogas, CH_4 and CO_2, mainly.

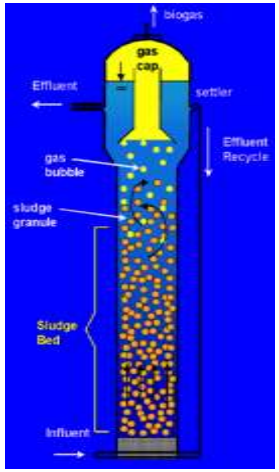
Anaerobic configurations:

UASB



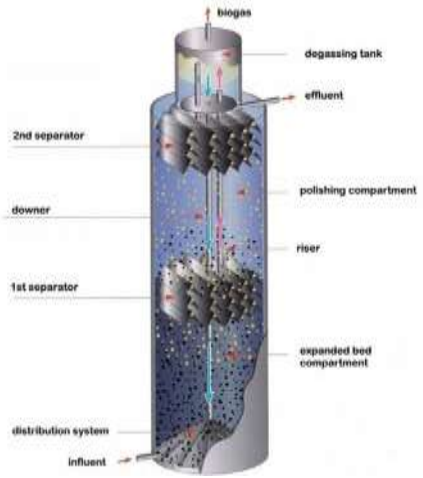
- Low h/D
- 0.5-1.5 m/h
- 4-15 kg COD/m3d

EGSB



- h/D = 4-5
- 5-10 m/h
- 5-25 kgCOD/m3d

IC



- h/D = 4-8
- 5-10 m/h
- 15-30 kgCOD/m3d

Anaerobic reactor

- Industries with highly organic loaded effluents (agricultural, pulp and paper, food, dairy, beverage, etc.) are the best candidates for this technology.

Removal efficiencies of this technology by industry

Type of effluent	COD (%)	m3CH4/kg COD
Potato processing	78-92	n.a.
Confectionery	92.4	n.a.
Sugar	> 90	0.355
Slaughterhouse	80	n.a.
Pulp and paper	80	0.34
Winery	90-95	0.4-0.6

bionet ENGINEERING

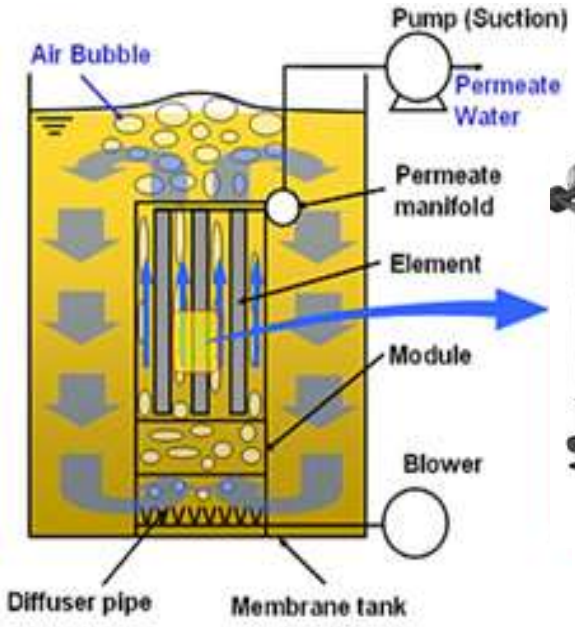
Industry: Dairy
Location: Murcia Region
Volume: 80-120 m^3 per day
Calidad del agua:

Parameter	Raw water	Discharge limit
TSS, mg/L	2000	< 500
COD mg/L	8-10.000	< 1000
BOD_5, mg/L	5-6.000	< 400
Conductivity mS/cm	4.5	< 5.0
NKT, mg/L	126	<50 (como NT)
Total P, mg/L	43.5	-

Requirements: Minimal foot print with HRT < 1,2 días. High variability in volume and charge. The plant has to work with the existing maintenance and operation personnel.

Treatment: MBR with flat membrane on frame

SCREENING → HOMOGENEIZATION → FLOTATION



Parameter	Raw water	Discharge
TSS, mg/L	2000	< 2
COD mg/L	8-10.000	< 20
BOD_5, mg/L	5-6.000	< 5
Conductivity mS/cm	4.5	< 5,5
NKT, mg/L	126	<2
Total P, mg/L	43.5	<1

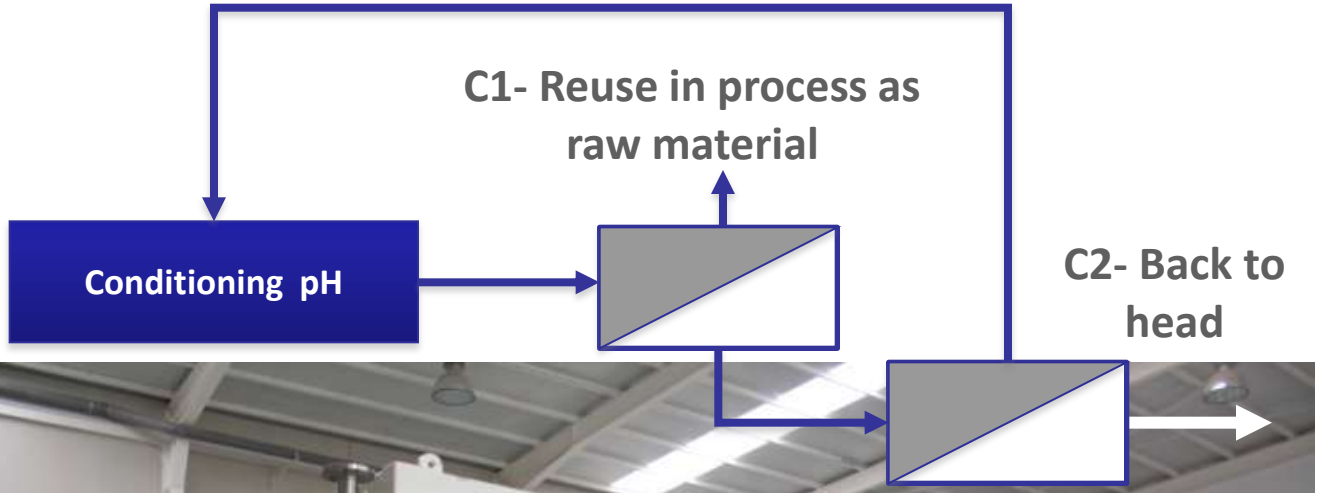
Industry: Ammonium Nitrate production factory
Localition: France
Volume: 600 m^3/day

Requirements: High percentage of elimination of nitrate for river discharge. Explosive environment. High variability of volume and pH. Very aggresive environment in-doors and extreme weather conditions out-doors

Water quality:

Parameter	Raw water	Discharge
pH	9	6,5-8,5
Conductivity mS/cm	3,6	<-
Nitrates, mg/L	3000	<25
Amonia, mg/L	250	<1

Treatment: Double pH control and reverse osmosis with doble step



Paremter	C1- Concentrate	P2- Permeado
pH, mg/L	4.8	7.6
TDS, g/L	33.6	0.023
Nitrates, g/L	26	0.018
Amonia, mg/L	--	--

مع خالص شكري وامتناني

Thank you for your attention

Merci pour votre attention

For additional information please contact:
Sustainable Water Integrated Management - Support Mechanism: info@swim-sm.eu
Website: www.swim-sm.eu