

Chemistry at the service of Industry



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NCR Biochemical Lux



ADVANCED BIOLOGICAL TREATMENT

Chemical solutions for biological treatment
provided by NCR BIOCHEMICAL

P-P-P

- **Purpose:** Solve problems resulting from changes in the biological wastewater treatment process
- **Process:** Review typical WWTP problems and solutions and review NCR-tools and NCR-biotechnologies available for troubleshooting
- **Payoff:** More capable of solving customer problems giving a sustainable solutions (NCR-biotechnology, NCR-hardware and NCR-consulting)

TROUBLESHOOTING

Monitoring and Troubleshooting Biological Systems

- Mechanical problems: Physical Plant Deficiencies
- Design problem: High load, low HRT, low DO
- Influent Problems: quantity/quality
- **Operational Problems** ← 
- Environmental Problems

TYPICAL OPERATIONAL PROBLEMS

- Biomass Quality Problems;
 - Sludge Age Too Old/Too Young
 - Bulking Sludge (filamentous/non-filamentous)
 - Nutrient deficiency
 - Microorganism Imbalance
- Foaming
 - Chemically Induced
 - Mechanical Induced
 - Biologically Induced
- Improper Operational Strategy
 - Over/Under Wasting (MCRT)
 - Over/Under Return Sludge Rate (F/M)
 - Over/Under Aeration

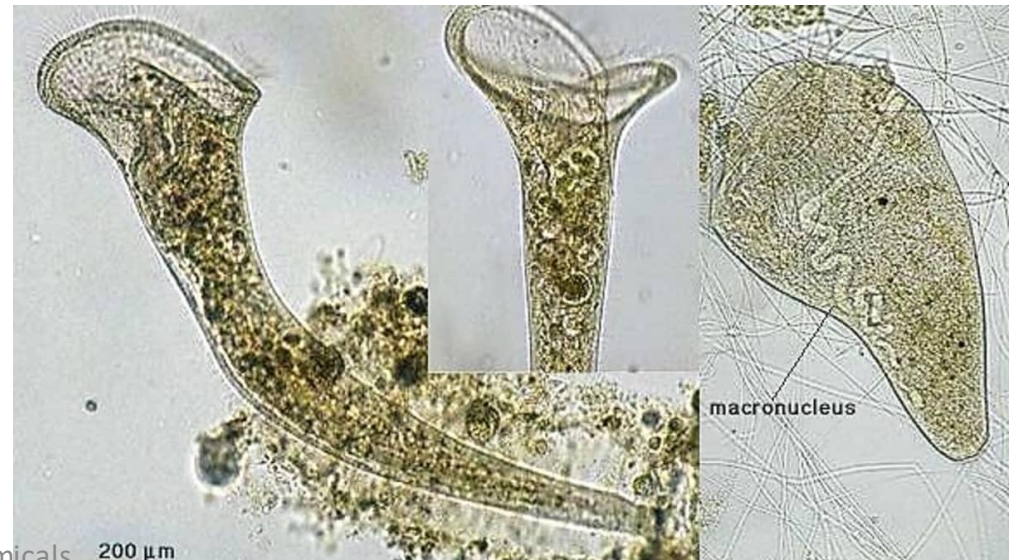
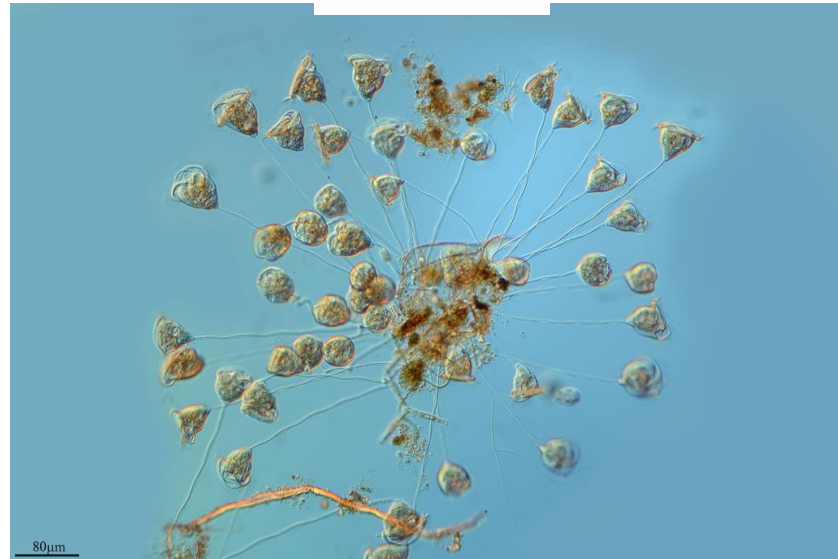
ACTIVATED SLUDGE VITAL INFORMATION

Flowrate & Volume	HRT, hydraulic issues
COD load & MLVSS	F/M, sludge production and energy consumption
Wasting rate, TSS effluent, clarifier sludge bed, TSS in RAS	Age of the sludge opr SRT, sludge production
Temperature & pH	Operational control
OUR, SOUR, DO	Biomass Healty
NH₃-N, TKN, alkalinity	Nitrification
RAS flow rate	Operational control
SVI	Sludge settlability
P-PO₄, NH₃-N in filtered sample aeration tan outlet	Nutrient balance/imbalance
Microscopic analyses of the sludge	Filamentous growth, flocs size, settling

HOW TO MEASURE THE HEALTH OF THE BIOMASS

- Microscopic analyses can help prevent critical upsets. We should be use routinely to check changes:
 - in floc structures,
 - In higher life forms,
 - filamentous presence and identification,
 - polysaccharide coating of the bacteria.
- Respirometry test

HOW TO MEASURE THE HEALTH OF THE BIOMASS



RESPIROMETRY

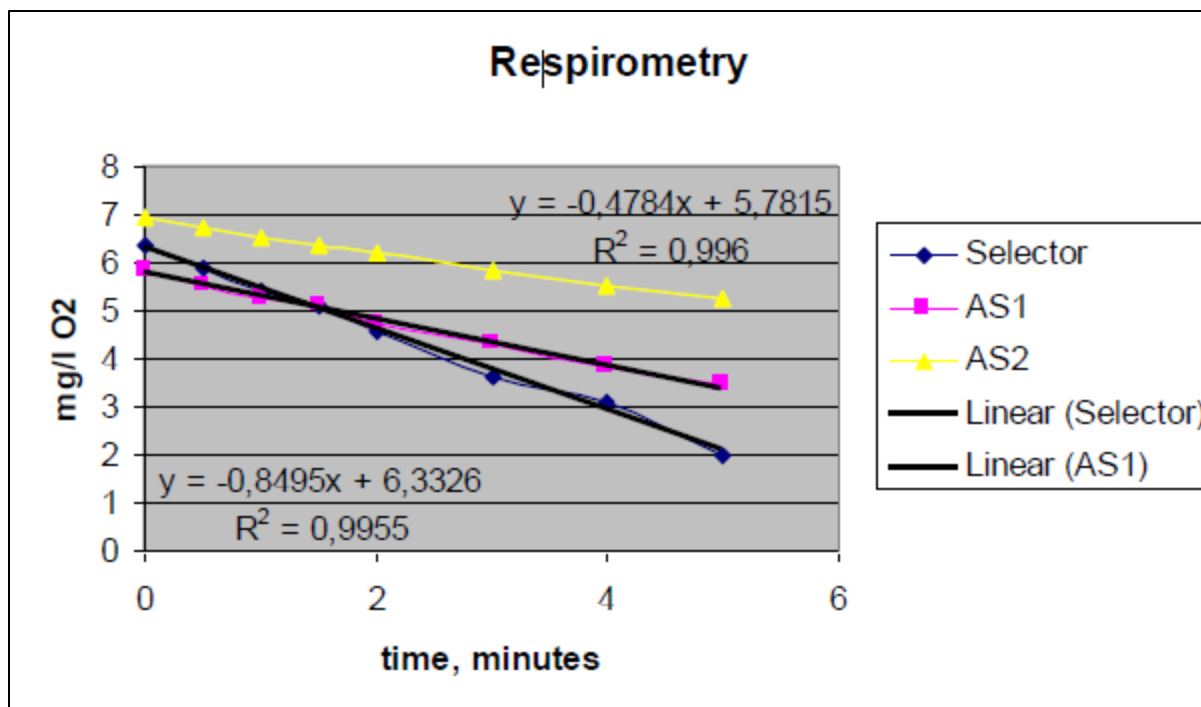
- Tool to assess biomass health & loading
- Predicts toxicity of specific streams to waste plant
- OUR – Oxygen Uptake Rate
 - mg/l of oxygen consumed per unit time (h)
 - Represents oxygen supply needed in basin
- SOUR – Specific Oxygen Uptake Rate
 - **Respiration Rate per unit biomass**
 - Tell us how active and health is the biomass.
 - Young sludge with high BOD gives high Respiration Rate (RR)
 - Old sludge or starving condition will give a low RR
 - Temperature influences biological activity. RR greater during warm periods than cold months
- AUR – Ammonium Uptake Rate
 - mg/l of ammonia oxidized per unit time
- Very quick test, use for troubleshooting

OUR TEST PROCEDURE

- Fill a sample bottle to 50% of the volume with fresh aeration basin sample
- In the lab, saturate sample with oxygen (~8 mg/l)
- Fill BOD bottle with the aerated sample.
- Put DO probe in bottle making sure to eliminate any air bubbles. Start the magnetic stirrer.
- Allow the DO reading to stabilize, then take DO reading every minute until <1 mg/l
- Plot mg/l vs time and trend the line
- Slope of trendline is the OUR (mg/l O₂/min)
- Calculate to mg/l/h if needed



RESPIROMETRY TEST RESULTS

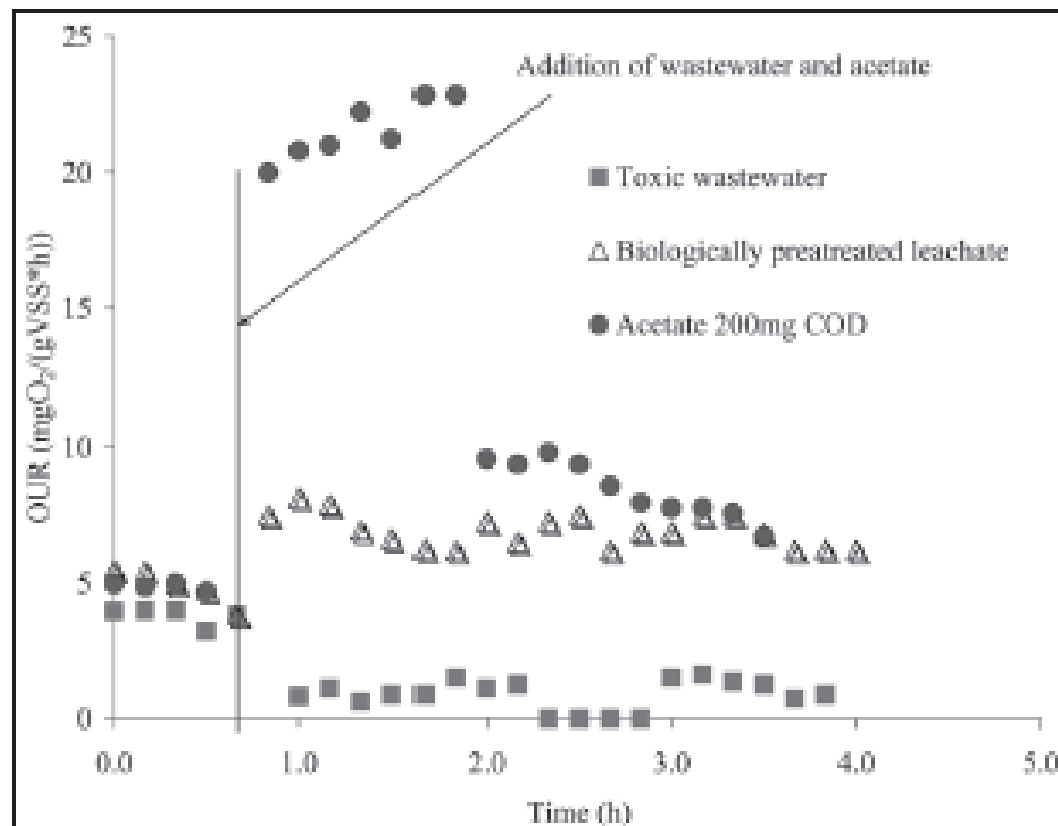


DOUR, in mg O₂/L/hr = (DO_{initial} – DO_{final}) * 60 / Length of test in minutes

RESPIRATION RATE (RR)

- Function of BOD and COD
 - High COD concentration gives RR above normal
 - High BOD/COD: RR above normal (easy food)
 - high F/M, young sludge underoxidized. This can lead to denitrification in secondary (COD available), bulking and the sludge return anaerobic
 - Low F/M, high SRT, low SVI RR below the normal. Sludge overoxidized. Pin floc
- Function of nitrifiers count
 - Nitrification can be selectively inhibited (Allylthiourea (ATU))
- Function of temperature
- Function of wastewater toxicity
 - RR below the normal
- Test every day or every week to have historical data

SOUR TO DETECT TOXICITY



SOUR in municipal wastewater with acetate addition, toxic water and pre-treated wastewater

TOXICITY BY H₂S

Hydrogen Sulphide can inhibit the activated sludge at different levels of its overall metabolism.

Very common in the treatment of petrochemical wastewater, landfill leachates, pharma wastewater.

Biotechnology:

**ECOSANA L
PROGEN FL200**

**PROBIOS 95 (combining
probiotics and S-complexing
agents)**

HIGH OXYGEN CONSUMPTION

High oxygen consumption may be due to:

- Excessive MLVSS content (high endogenous respiration),
- Excessive temperature of mixed-liquor (tropical climate zone),
- High incoming load,

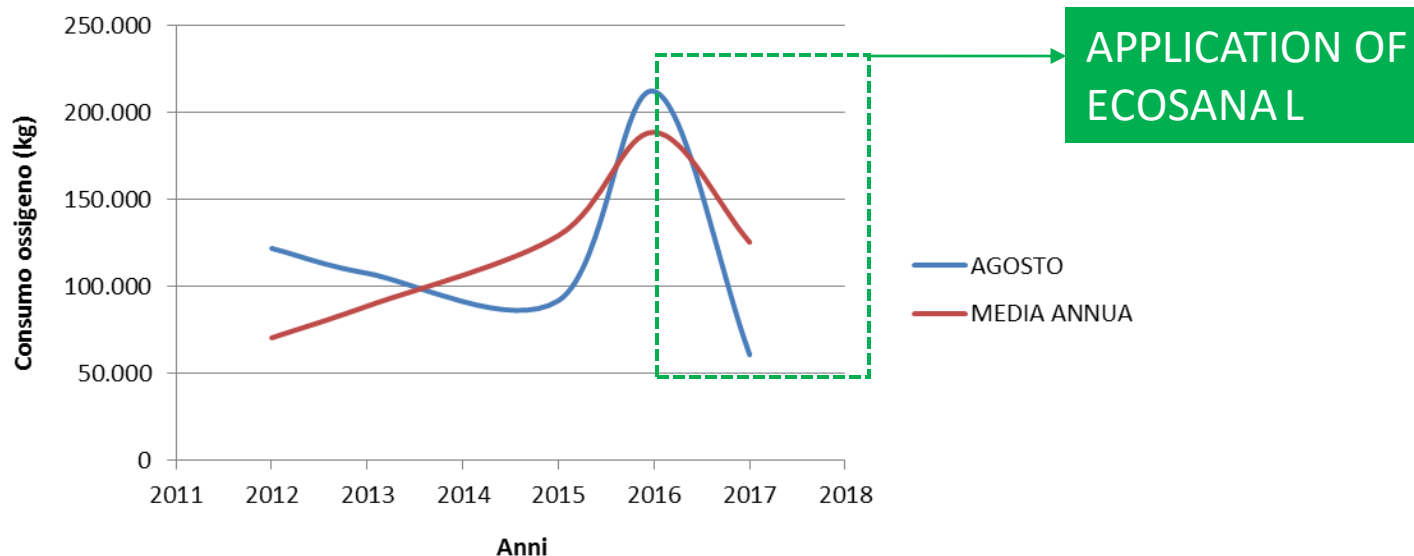
Biotechnology:

**ECOSANA L
PROBIOS range**

**Technical assistance:
Sludge wate management**

HIGH OXYGEN CONSUMPTION

An example of oxygen consumption reduction by using of ECOSANA L (approx -30%)



TEMPERATURE & pH

- Temperature range for mesophilic bacteria is between 4°C to 40°C.
- Optimum range is 25 °C to 38 °C.
- Above 38°C, the floc could begin to disperse, causing high effluent TSS



- System pH ideally 6.8 to 8.3
- 6.0 to 9.0 if no nitrification
- COD and ammonia oxidation require alkalinity

NUTRIENT REQUIREMENTS

- Rules of Thumb
 - BOD: N : P ratio is 100: 5 : 1
- Objective:(effluent)
 - 1.0 mg/l of $\text{NH}_3\text{-N}$
 - 0.5 mg/l of soluble $\text{PO}_4\text{-P}$
- Nitrogen sources
 - Influent Ammonia or amines
 - Added Urea or Ammonium Phosphate
- Phosphate sources
 - Phosphoric Acid
 - Tri-, di-, or mono-sodium Phosphate

NUTRIENT SHORTAGE

- Check dose based on mass balance
- To prevent shortages:
 - 1 mg/l of $\text{NH}_3\text{-N}$ in effluent
 - 0.5 mg/l of soluble P-PO_4
- Ensure analysis sample is filtered and test the biox outlet
 - suspended biomass release P in anaerobic condition
 - The biomass is composed by N&P
- Correct analysis (communication!)
 - TKN is not all bio-available,
 - $\text{PO}_4 > \text{P-PO}_4$
- Ferric or lime dosing can reduce bio-availability of PO_4 by precipitation

INDUSTRIAL COD & BOD RATIO'S & NUTRIENTS

Wastewater composition

Industry	BOD : COD	Nitrogen	Phosphorous
Petroleum Refining	0.30 - 0.40	medium	low
Chemical Process	0.20 - 0.50	low-high	low
Pulp	0.20 - 0.40	low	low
& Paper	0.35 - 0.50	low	low
Coke plants	0.15 - 0.20	very high	low
Brewing	0.45 - 0.60	medium	medium
Food Processing	0.45 - 0.80	high-high+	medium-high
Textile	0.25 - 0.40	low-medium	low

FACTORS AFFECTING NUTRIENT REQUIREMENTS

Type of wastewater:

more readily degradable organics (e.g. organic acids from opportunity crudes)
require higher amounts of nutrients

System sludge age:

younger sludge requires higher amounts of nutrients

Temperature:

colder temperatures require higher amounts of nutrients

Inorganic water chemistry and pH:

High pH and metal ions can cause PO_4 to precipitate or form a complex, rendering it non-bio available.

PROBLEMS

- Foaming
- High effluent total
suspended solids
- High effluent BOD or COD
- Low effluent pH
- Algae

**Nutrients deficiency - Bio-compatible chemistry:
PROFOOD range**

**Nutrients excess Bio-compatible chemistry:
POLYREN 1534**

**Nutrients excess Bio-technology:
...see next slides 33, 34, 35**

TYPES OF FOAM

White billowy foam

- Associated with surfactants and/or detergents. If due to non-degradable surfactants, antifoam may be required. Check with bottle test
- Can be caused by very young sludge. Check BOD load, RR high, young bugs consume oxygen very quickly, high level of single cell bacteria, loss of higher life form or shift from rotifer to flagellate and amoebae.



Biotechnology:
PROGEN ST
PROGEN A100 / L100
PROGEN SC
ECOSANA L
PROGEN FL200

**Bio-compatible
chemistry:**
BIOFOAM 280 / 282

TYPES OF FOAM



Dark brown, thick greasy foam

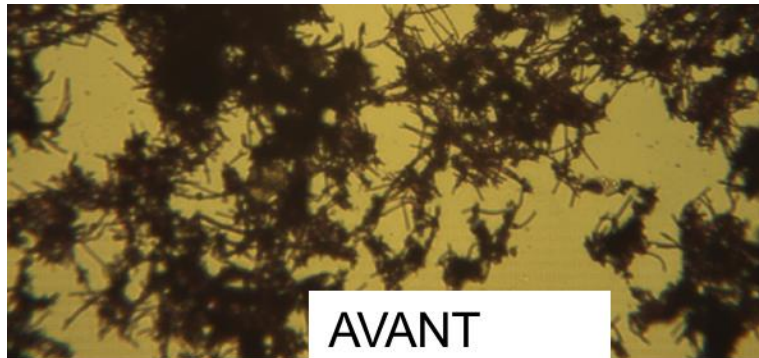
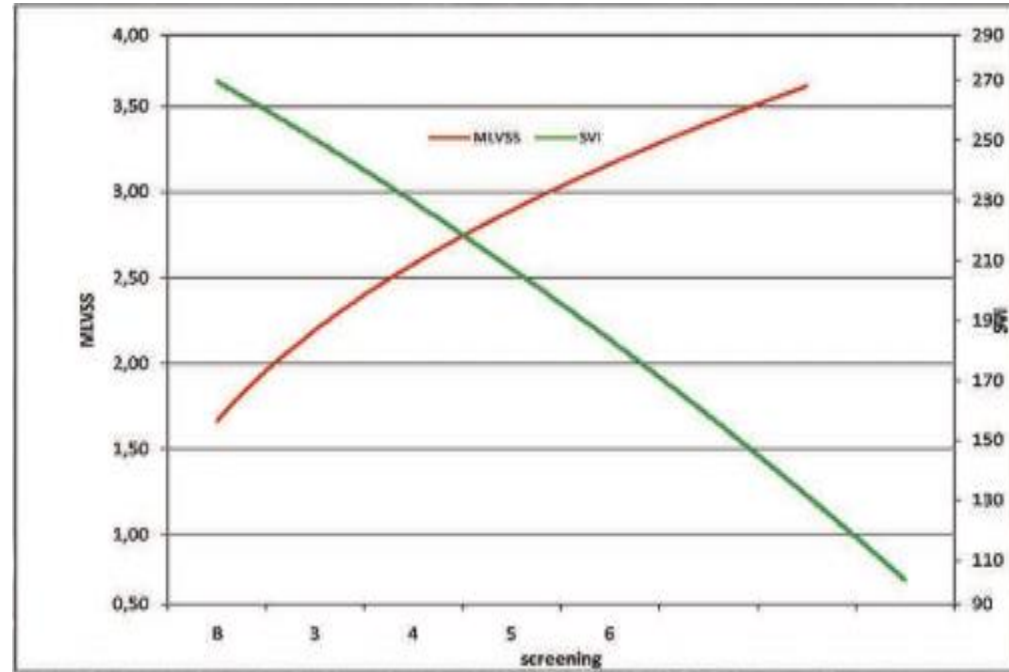
- Likely Nocardia/M.Parvicella. Identify filaments. Possibly associated with oils and greases in the influent.
- Microscopy analyses of the foam and the mixliquor for filament identification.
- Optimise pretreatment & Waste the foam, not the RAS.

Biotechnology:
PROBIOS range
PROFOOD range

Technical assistance:
RAS
F/M
SRT
Selectors

TYPES OF FOAM

Example of filamentous bulking
solving by
PROBIOS technology



TYPES OF FOAM

Pumice-like foam

- Gray with a large number of dark specks.
- Presence of fines probably due to poor solids capture in dewatering when the grey water is send back to the aeration basin



Biotechnology:
PROBIOS range
PROFOOD range

Technical assistance:
RAS
F/M
SRT
Selectors.....

TYPES OF FOAM

Slimy foam (zooglea bulking)

- May accompany slime bulking and likely due to nutrient deficiency and polysaccharides material
- Check nutrients balance
- Microscopy examination with India test ink
- Can be due to recent high
- BOD load

Biotechnology:

PROGEN A100 / L100

PROBIOS 60

PROFOOD range

HIGH SOLUBLE EFFLUENT BOD

Respirometry: measure SOUR

- Zero - Total kill; remove toxic material and increase total sludge units via less wasting
- Very low - Inhibited or partial kill; reduced wasting
- Medium to high - Hard to degrade substrate; increase MLVSS via reduced wasting
- High - Hydraulic overload; reduce RAS, increase

MLVSS

Horizon Chemical for Special Chemicals

Biotechnology:

PROGEN A100 / L100
PROGEN SZ
ECOSANA L
PROFOOD range

HIGH EFFLUENT SUSPENDED SOLIDS

Solids wash out - Hydraulic overload

- Check design parameter/reduce flow
- Insufficient solids removal from clarifier/
check pumps



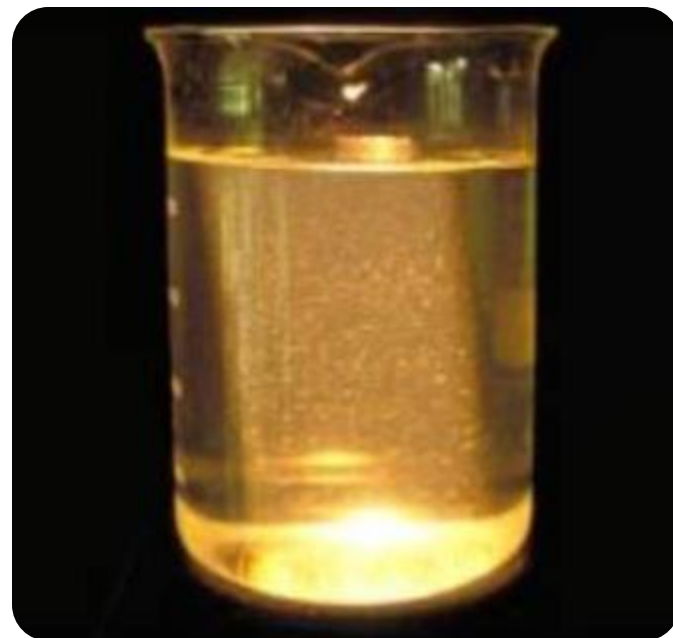
**Bio-compatible chemistry:
POLYREN range**

**Technical assistance:
RAS
Sludge blanket level**

HIGH EFFLUENT SUSPENDED SOLIDS

Poor clarity: straggler Floc

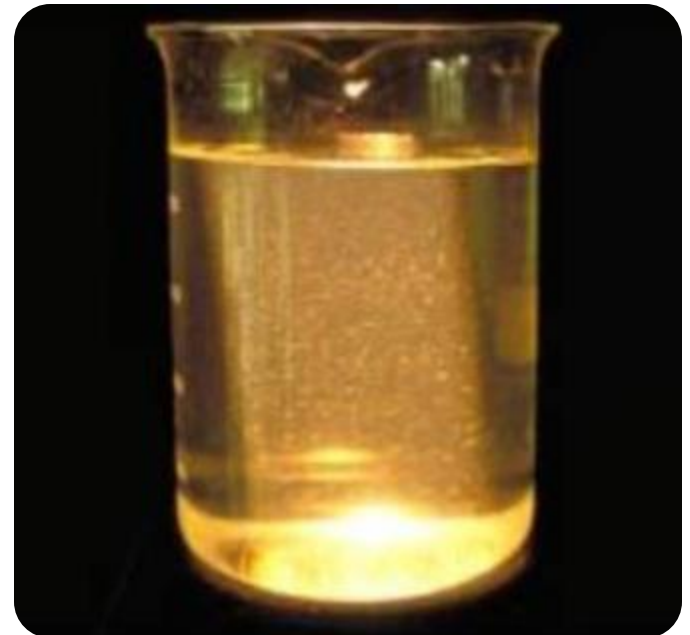
- Young sludge Usually caused by increased BOD loading or too much wasting
- Sludge settle slowly leaving light, fluffy particles
- Can be intensify by short circuiting and hydraulic overloads
- Reduce wasting, reduce RAS
- Polymer can be used as a chemotherapy



HIGH EFFLUENT SUSPENDED SOLIDS

Poor clarity: Pin Floc

- Old sludge that settle too fast leaving many particles and turbid effluent
- Particle are usually darker, heavier and granular



HIGH EFFLUENT SUSPENDED SOLIDS

Poor clarity: dispersed growth

- free swimming - Use microscope to identify the problem
- High temperature (>40 °C) prevent floc forming growth
- High surfactants or salts (>2000 mg/l)
- A toxic shock; increase population of healthy bacteria by decreasing wasting, once toxicity has passed.
- High F/M!! Floc-forming species may grow in a dispersed and non-settleable form if the growth rate is too fast. Increase MLSS
- Free floating filaments can cause a dispersed growth problem. Identify the filamentous.

HIGH EFFLUENT SUSPENDED SOLIDS

Poor Settling: Bulking

- Slime bulking, usually nutrient deficiency cause by a recent spike of BOD. Check P-PO₄ and N residual.
- Foam trapping (floating sludge)
Associated with *Nocardia* and *M. parvicella*.
- Filamentous bulking

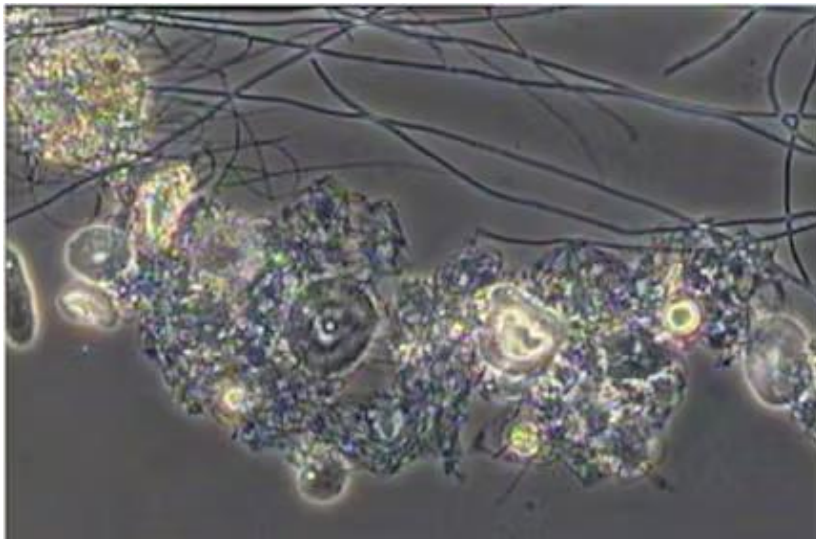


HIGH EFFLUENT SUSPENDED SOLIDS

Poor clarity: toxic shocks

- Sulfides is commun, can be originated outside the system or «in house»
- Sulfide toxicity is high at pH 7 to 8 (H_2S form predominant)
- Can be recognised by:
 1. an initial flagellate "bloom";
 2. die-off of protozoa and other higher life forms;
 3. biomass deflocculation, often accompanied by foaming;
 4. loss of BOD removal;
 5. filamentous bulking upon process recovery.

EXCESSIVE SOLIDS Production



Biotechnology:

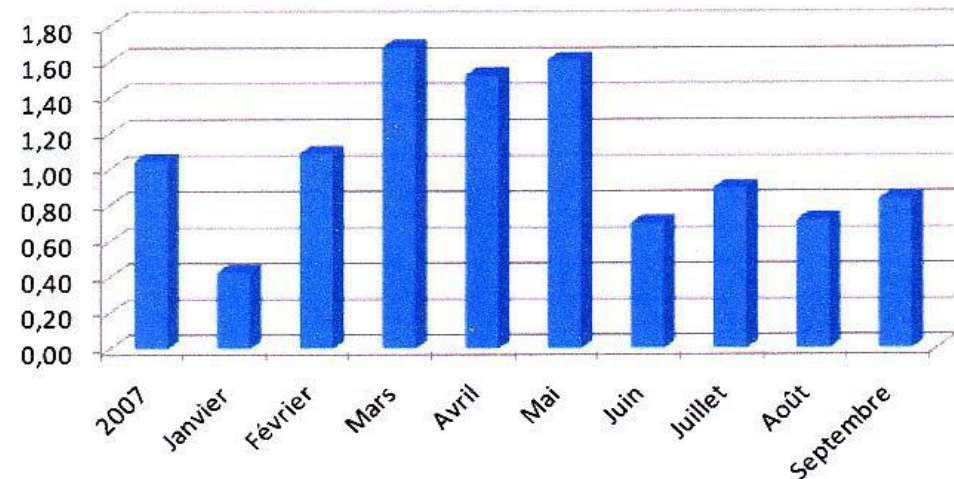
PROGEN FL 200
PROGEN FL 400

EXCESSIVE SOLIDS Production

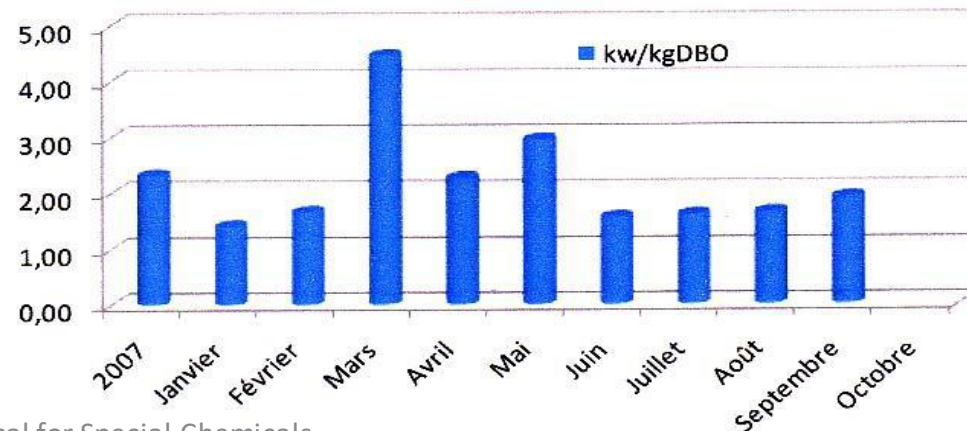
*Sludge production from 1,27 to
0,9 kg SSV/kg BOD*

*Energy consumption from 2,3 to
1,7 kw/h kg BOD⁻¹*

Ratio de production de boue



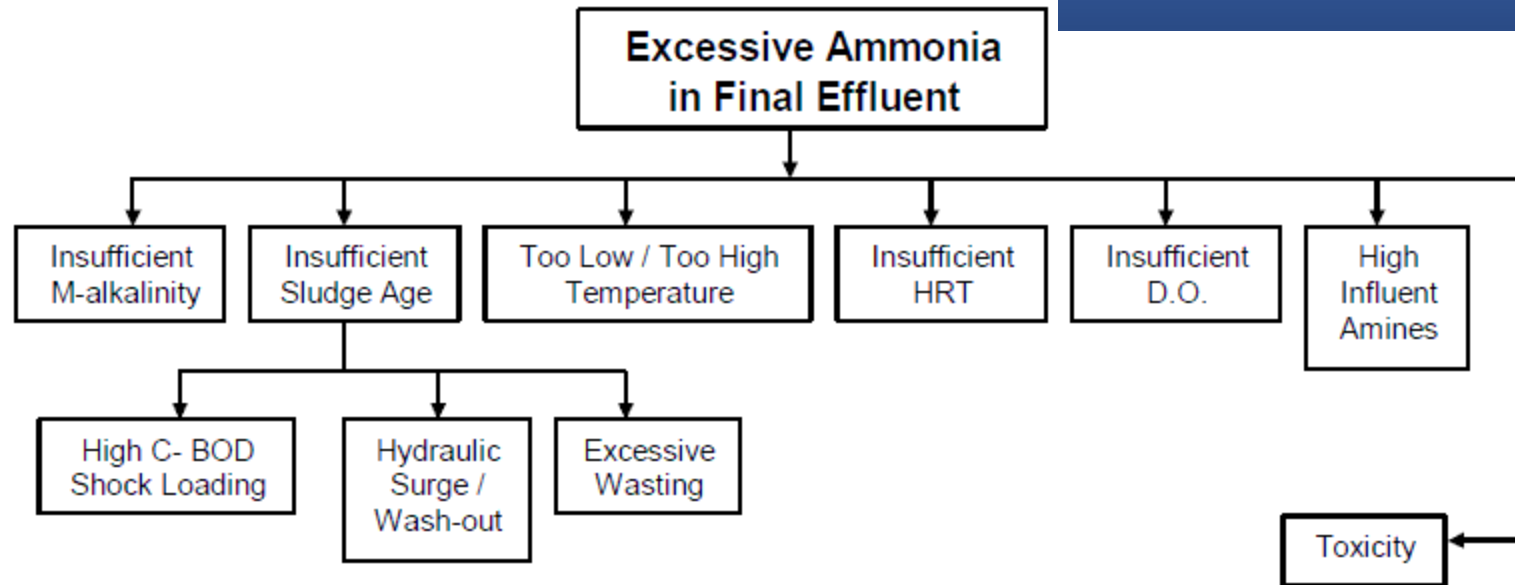
Ratio de consommation électrique



HIGH AMMONIA

Biotechnology:
PROGEN LN
ECOSANA L
Bio-reactors
B.A.S.S. plug and play
system

Excessive $\text{NH}_3\text{-N}$ Problems



HIGH AMMONIA

Bio Augmented Selected Strains

B.A.S.S. System



HIGH AMMONIA

Bio Augmented Selected Strains

B.A.S.S. System

Environmental advantages	Economical benefits
Increase of depuration efficiency Improving of water's quality Ability to treat a higher pollutant load Ability to receive higher hydraulic load Oxygen consumption reduction Reduction of SVI index Reduction of sludge production Increase nitrification yield	Energy saving Saving sludge disposal costs Increase waste treatment capacity Less chemicals used Less maintenance Low install cost Simple installation