Simultaneous removal of COD, phenol and ammoniacal nitrogen from industrial wastewaters

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Industrial sectors: Wastewater with Ammonical Nitrogen(AN), phenol & COD Effluent

- Bulk drug industry
- Petrochemical industry
- Petroleum Refinery
- Steel plants
- Chemical industry

Wastewaters from these industries characterized by high concentration of COD, ammoniacal nitrogen and phenolic compounds

Ammoniacal nitrogen (AN) and phenols are the most hazardous water pollutants discharging into water receptors through industrial effluents along with COD

NEGATIVE EFFECTS OF AN
(Eutrophication)

- **Eutrophication is a result of nutrient pollution**
- **Eutrophication generally promotes excessive plant growth**
- **In aquatic environments, enhanced growth of choking aquatic vegetation or algal blooms disrupt normal functioning of the ecosystem, causing problems such as a lack of oxygen in the water, needed for fish and other aquatic life to survive. The water then becomes cloudy, colored a shade of green, yellow, brown, or red.**

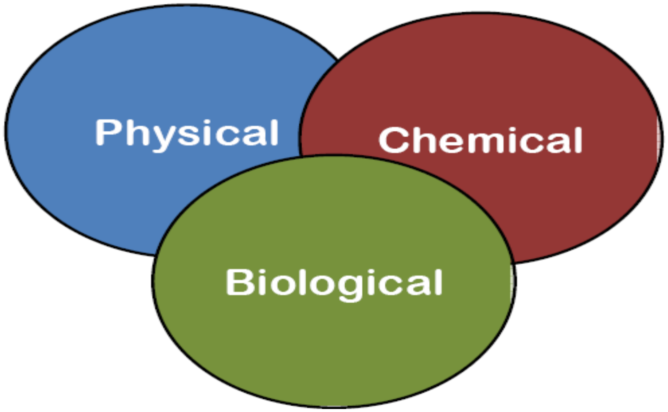
NEGATIVE EFFECTS OF AN
(Soil Acidification)

- When ammonia reaches the soil surface, it usually reacts with water in the soil and is converted into its ionic form, ammonium (NH_4^+) and absorbes to the soil
- The ammonium in the soil eventually disassociates or is nitrified into nitrite (NO_2^-) or nitrate (NO_3^-) by nitrifying bacteria, releasing H^+ ions into the soil (3, 4)
- The surplus H^+ ions eventually lead to the formation of an acidic soil environment.


INDUSTRIAL WASTEWATER TREATMENT
CHEMICAL
PHYSICAL
BIOLOGICAL
Chemical Oxidation
Chemical Precipitation
Coagulation
Dissolved air flotation
Electrochemical oxidation
Flocculation
Hydrolysis
Neutralization
Solvent Extraction
Ion Exchange
Carbon adsorption
Distillation
Filtration
Steam Stripping
Oil and grease skimming
Oil/water separation
Sedimentation
Membrane technologies
Biological nitrogen removal
Bioaugmentation
Activated sludge
Extended aeration
Anaerobic processes
Rotating biological contactors
Sequencing batch reactors and trickling filters

REMOVAL OF AMMONIACAL NITROGEN FROM INDUSTRIAL WASTEWATERS

- PCB Norms for disposal :
- AN = 50 ppm
- Phenol = 0.5 ppm
- COD = 250 ppm



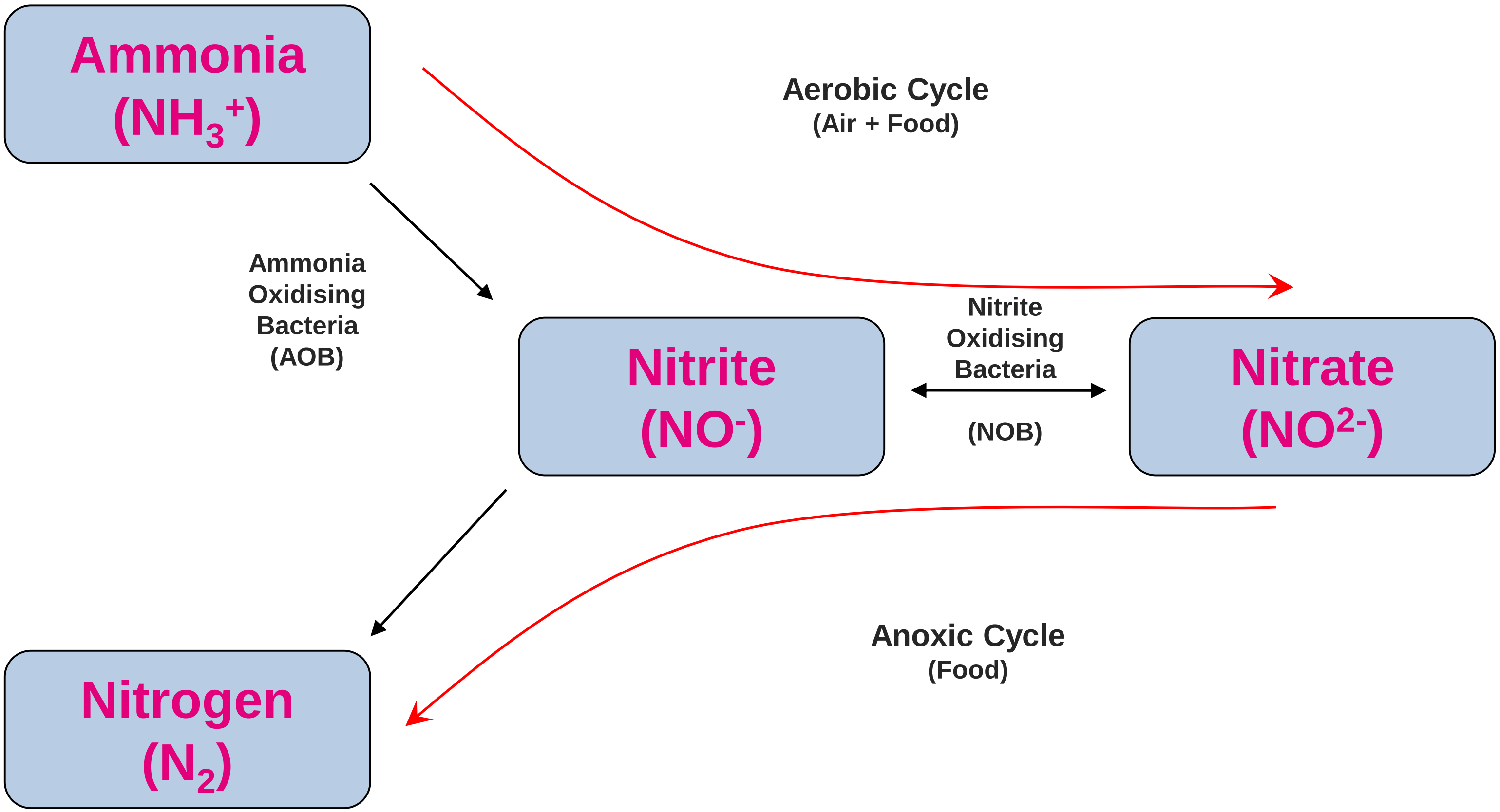
Present practices

- Physico-chemical
- Chemical Precipitation
- Ion exchange
- Catalytic process
- Nitrification & De-nitrification

Concerns

– Cost prohibitive
– Energy intensive
– Generation of secondary pollutants
– Could not PCB Norms

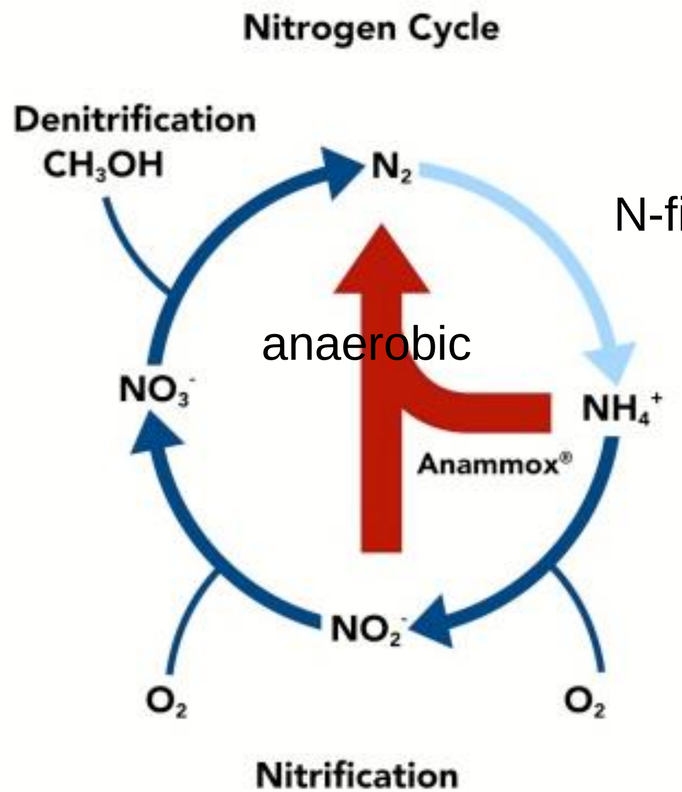
Mechanism



Ammonia
(NH_3^+)
Aerobic Cycle
(Air + Food)
Ammonia
Oxidising
Bacteria
(AOB)
Nitrite
(NO^-)
Nitrite
Oxidising
Bacteria
(NOB)
Nitrate
(NO^{2-})
Anoxic Cycle
(Food)
Nitrogen
(N_2)

ANAMMOX PROCESS PROCESS

Anammox- anaerobic **amm**onia **ox**idation



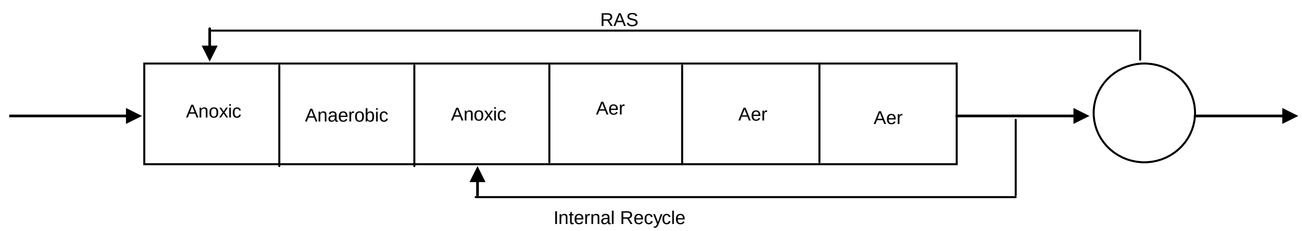
N-fixation & Ammonification

anaerobic

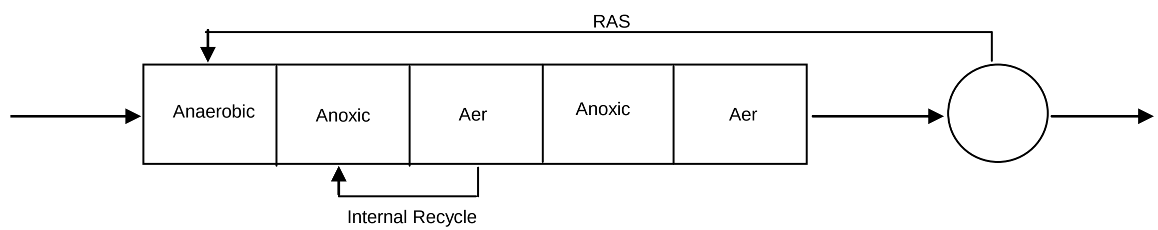
aerobic

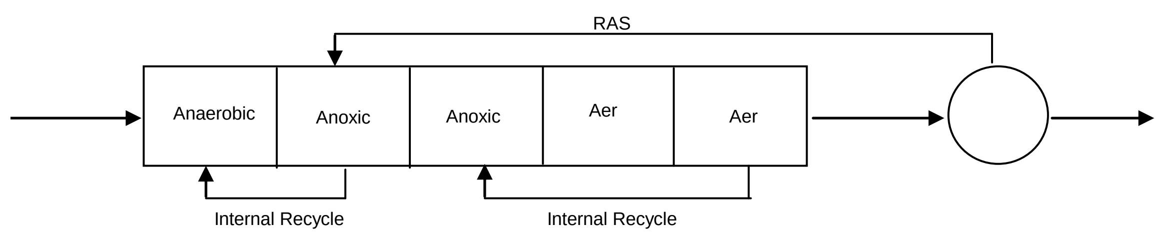
Biological Nutrient Removal processes

- Anaerobic Ammonia Oxidation
- SHARON process
- SHARON-Anammox Combined
- CANON process
- Johannesburg Process
- 5 stage Bardenpho process
- Modified University of Cape Town (MUCT)



Underlying Process Configuration





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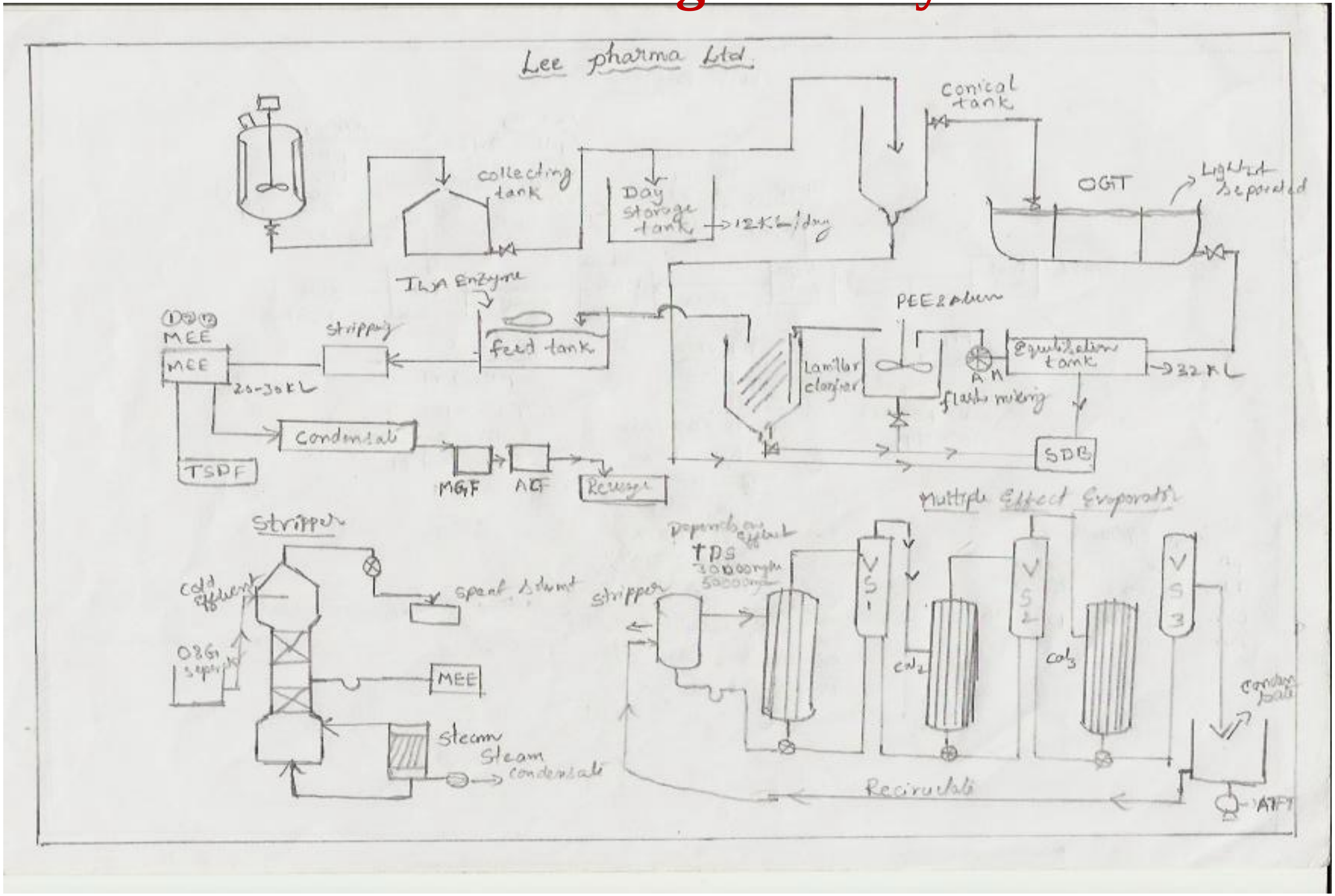
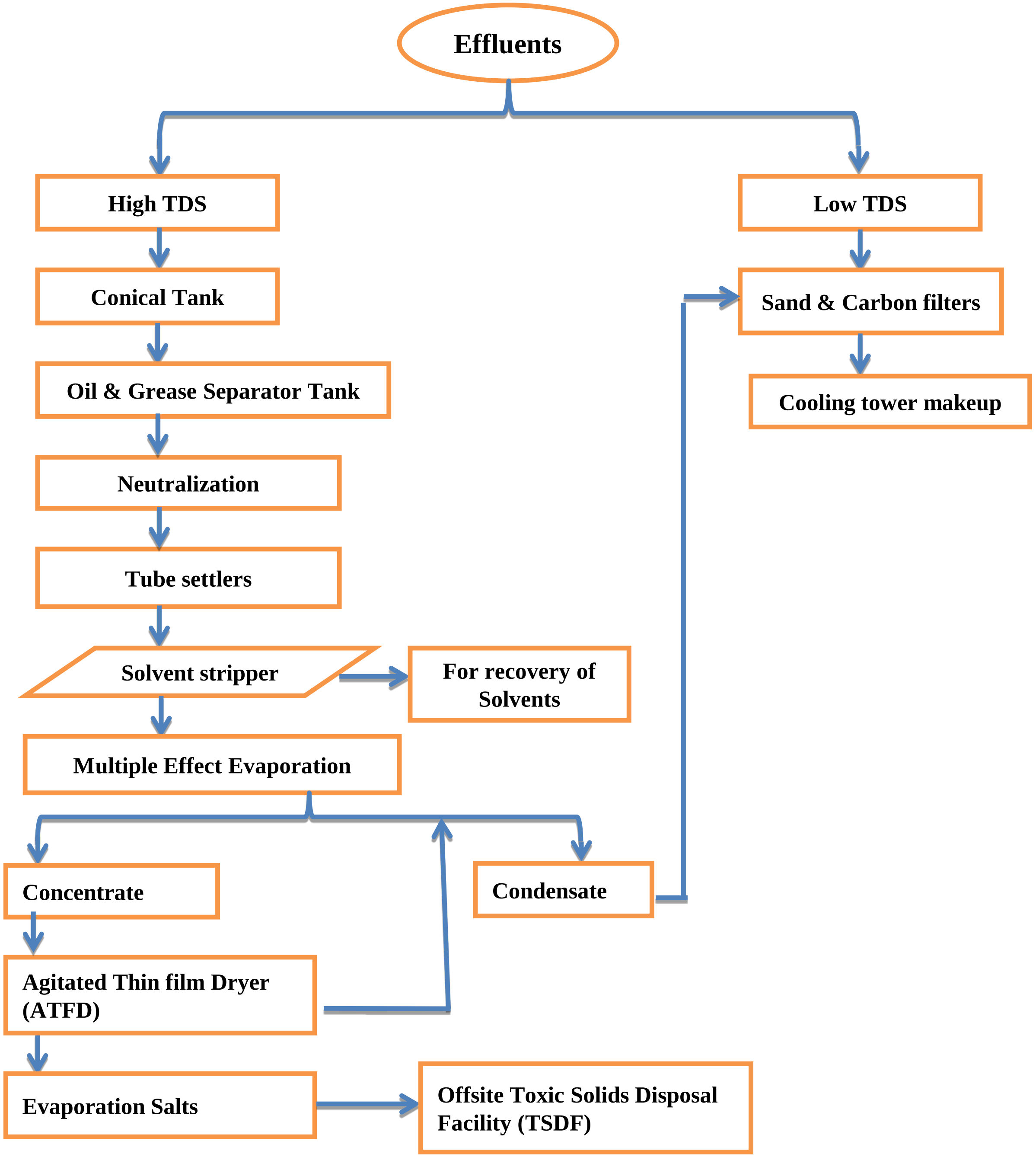
-MICROBIAL PROCESS

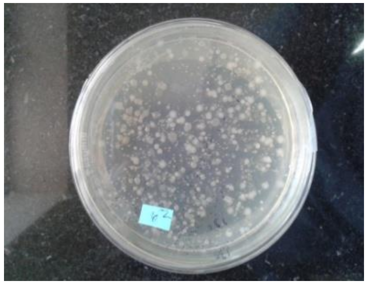
Existing Effluent Treatment plant at Bulk drug Industry



Existing schematic diagram for Effluent Treatment plant



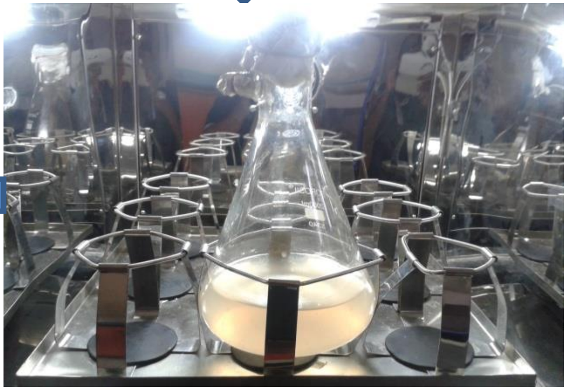
Development of Inoculum
: Isolation, Enrichment, Characterization and Seeding



Culture isolation by specific media

Culture enrichment

Shake flask culture



Seed culture

Reactor

Pilot Scale Studies

PROCESS CONFIGURATION

Air stripping followed by
sequential
aerobic , anoxic & anaerobic cyclic
process
with industrial effluent

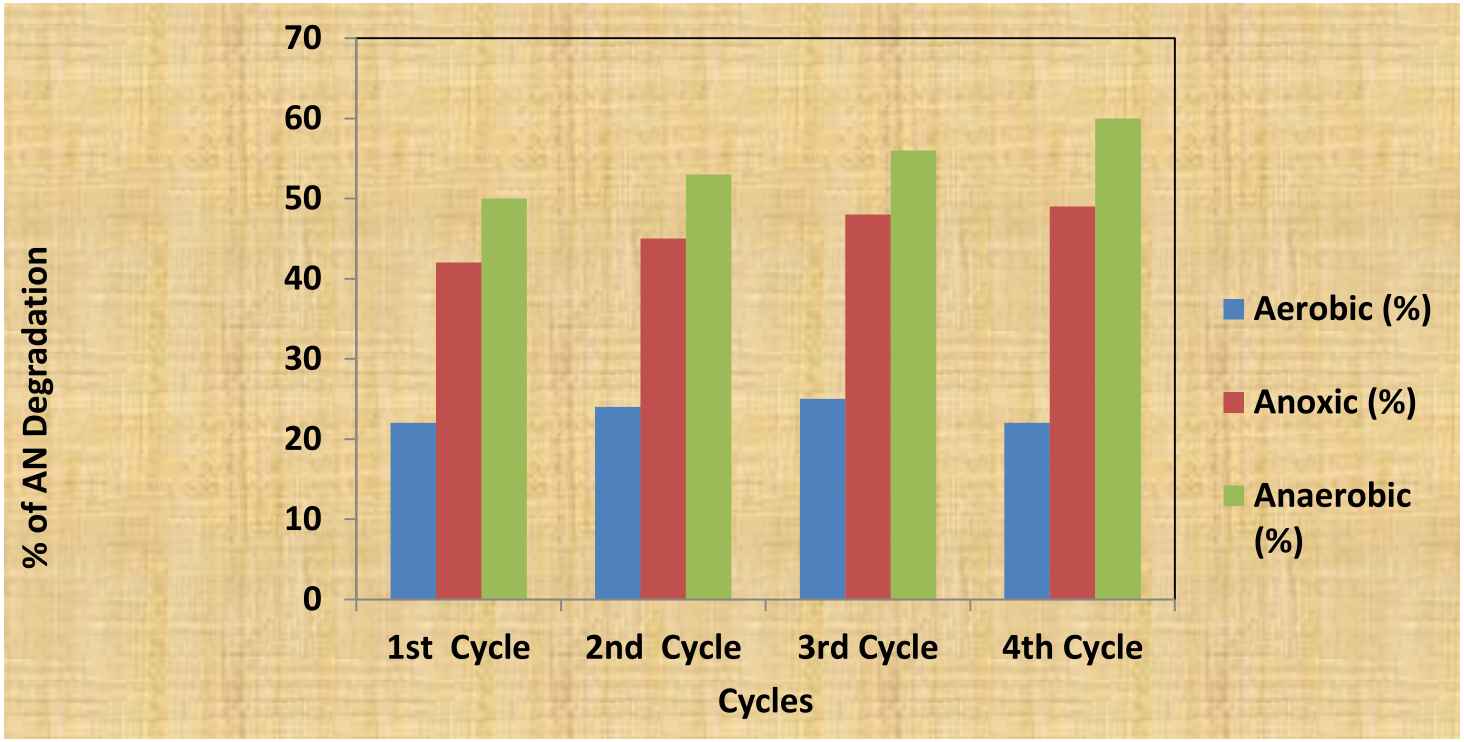
Critical aspects

Feed to recycle ratio
pH management
F/M Ratio
Adaptation of microbial consortia
HRT in each phase

Initial characteristics of industrial waste water Case-I

Parameter	Sample
pH	7.8
TS (%)	1.7
VS (%)	0.77
COD (mg/l)	3,900
Ammoniacal nitrogen (mg/l)	150
Phenol (mg/l)	145
VFA (mg/l)	3,607
Alkalinity (mg/l)	1,000
Sulfide (mg/l)	-
sulfate (mg/l)	1.67

Results: Case-I



Cycles	1st Cycle	2nd Cycle	3rd Cycle	4th Cycle
Aerobic (%)	22	24	25	22
Anoxic (%)	42	45	48	49
Anaerobic (%)	50	53	56	60

Results summary: Case-I

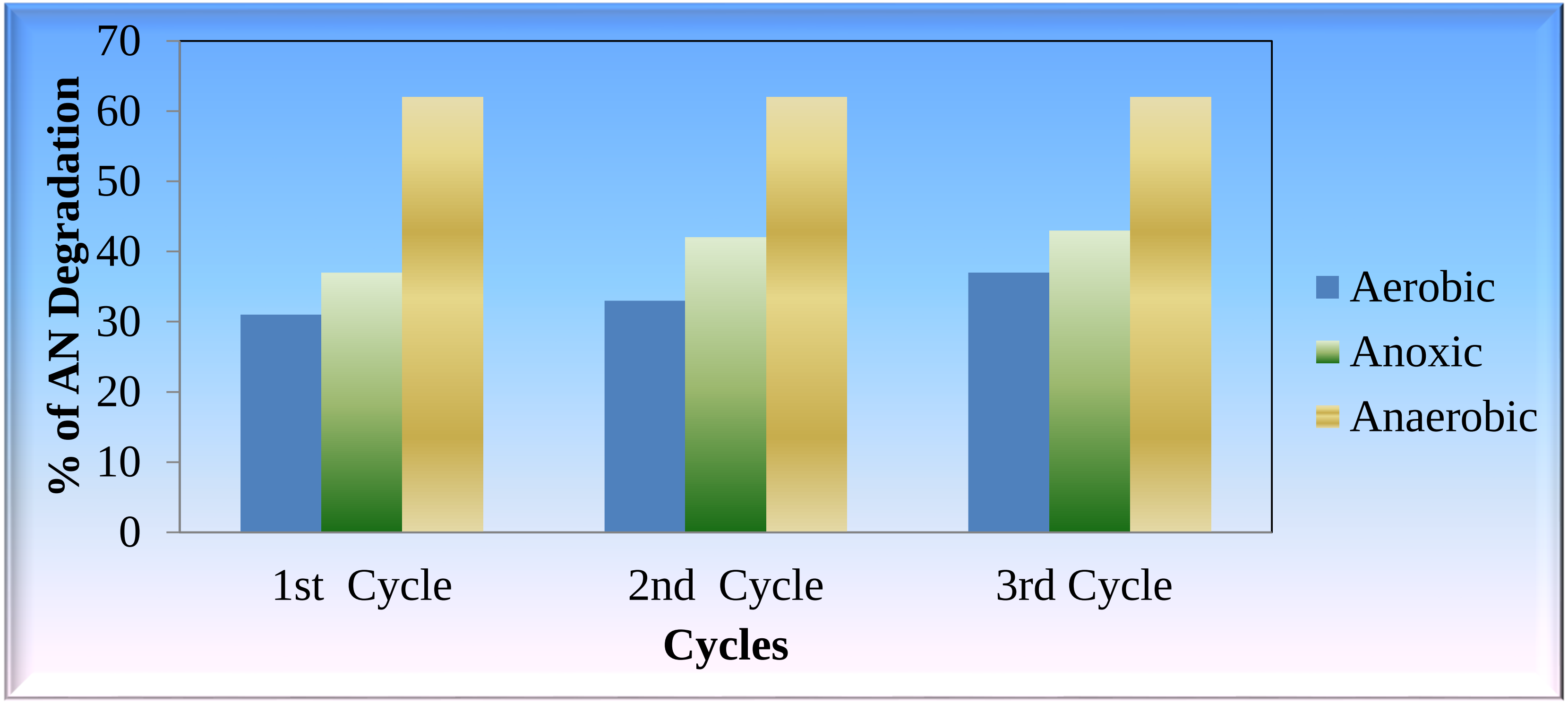
Parameters	Initial (mg/lit)	Final (mg/lit)	variation
pH	7.5	7.2	-
COD	3900	585	85 % Reduction
Ammoniacal Nitrogen	150	60	60 % Reduction
Phenol	145	36	75 % Reduction

HRT=1 Day

Initial characteristics of industrial waste water Case-II

Characteristics	
pH	6.5
TS (%)	0. 19
TS (mg/L)	1910
VS (%)	0.12
VS (mg/L)	1205
Ammonia (kjeldahl) (mg/L)	240
Moisture (%)	99
COD (mg/L)	41,000
Alkalinity (mg/L)	1600
VFA (mg/L)	2069
Nitrate(mg/L)	260
Nitrite	-
Sulphite (SO_3)(mg/L)	10
Sulphate($S0_4$) (mg/L)	87

Results: Case-II



Cycles	1^{st} Cycle	2^{nd} Cycle	3^{rd} Cycle
Aerobic (%)	**31**	**33**	**37**
Anoxic (%)	**37**	**42**	**43**
Anaerobic (%)	**62**	**62**	**62**

Results summary: Case-II

Parameters	Initial (mg/lit)	Final (mg/lit)	variation
pH	4.3	7.1	-
COD	42,000	3200	92 % Reduction
Ammoniacal Nitrogen	224	84	62 % Reduction

HRT=1 Day

Oxygen requirements

Conventional process

COD (Activated sludge process)

1.175 g/g of COD degradation

NOD (Nitrification)

4.57 g/g of AN degradation

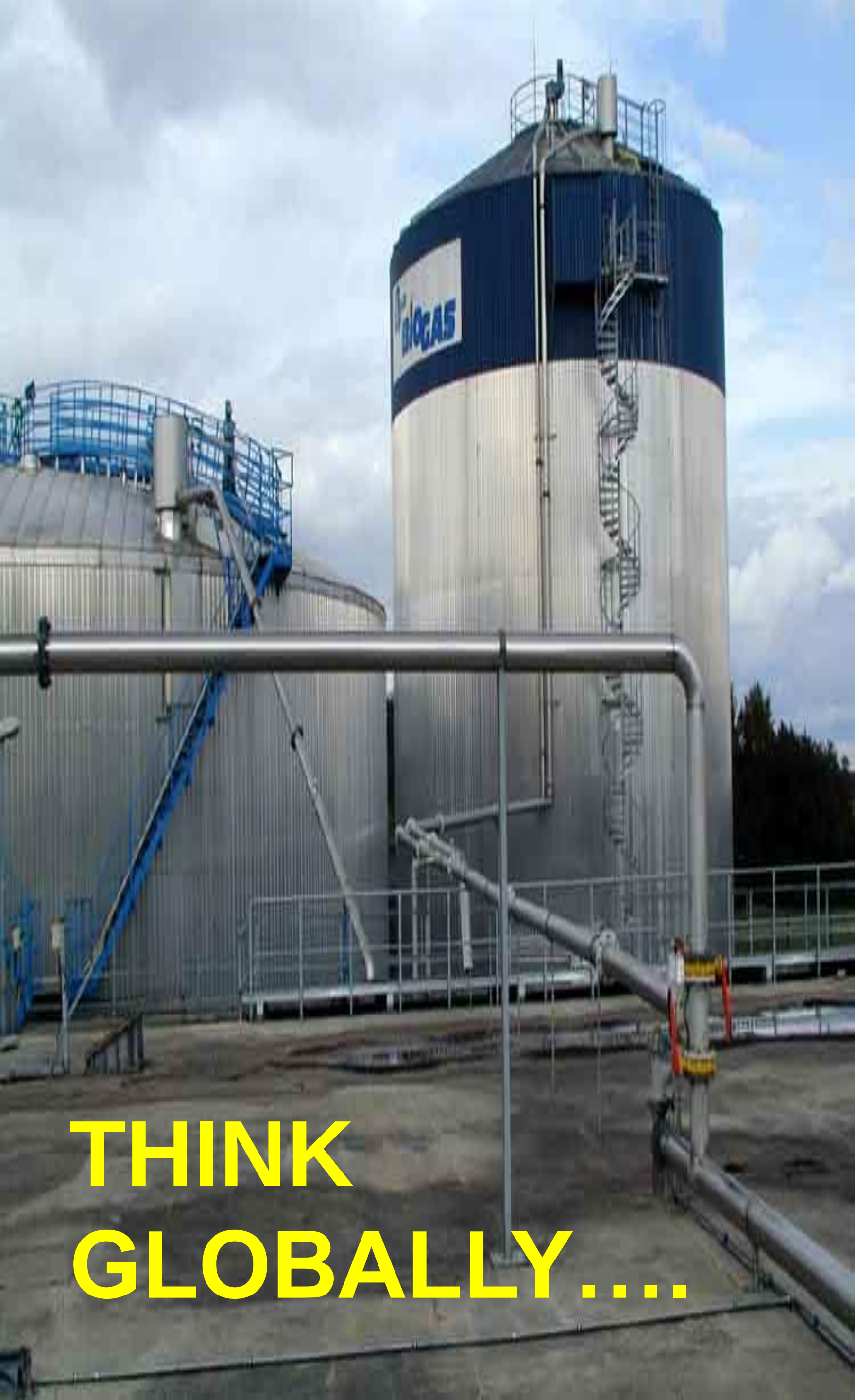
Oxygen consumption

- 0.0025 g/g of COD degradation
- 0.0024 g/g of AN degradation
- 0.0024 g/g of Phenol degradation

Technology

- **Simultaneous removal of COD, phenol and ammoniacal nitrogen from industrial wastewaters**

Total Oxygen requirement =0.155/63.25=0.0024 g/g of substrate degradation



THANK YOU