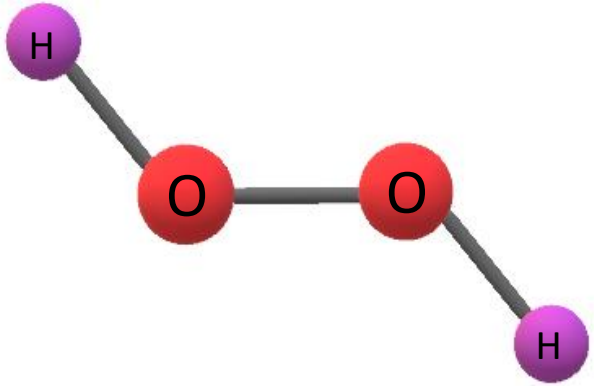
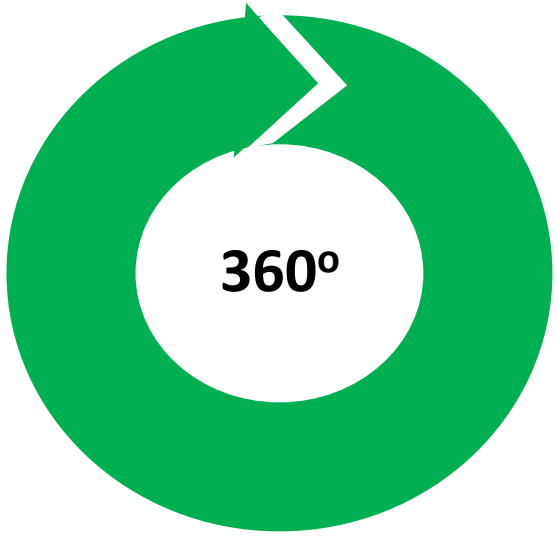
Paper Industry towards Green Manufacturing

Hydrogen peroxide - a quick solution to rectify foul conditions in activated sludge process.



GREEN MANUFACTURING

It is beyond pollution control and beyond sustainability.



Perfect Ideal

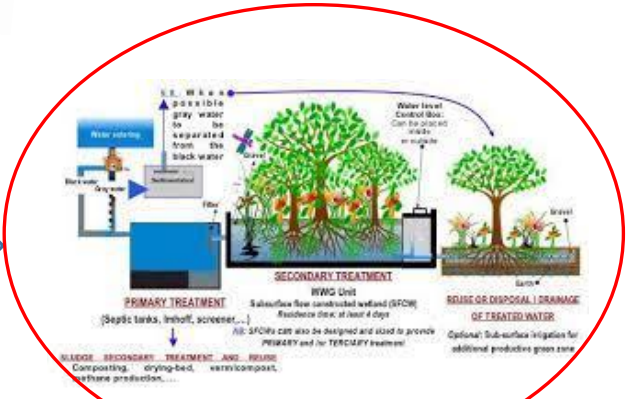
<u>The 5 principles of Green Manufacturing</u>

- Lesser energy consumption
- **Use the least natural resources**
- **Reduce pollution and waste**
- Moderate emission
- Recycle and reuse materials (through out the life cycle of product)

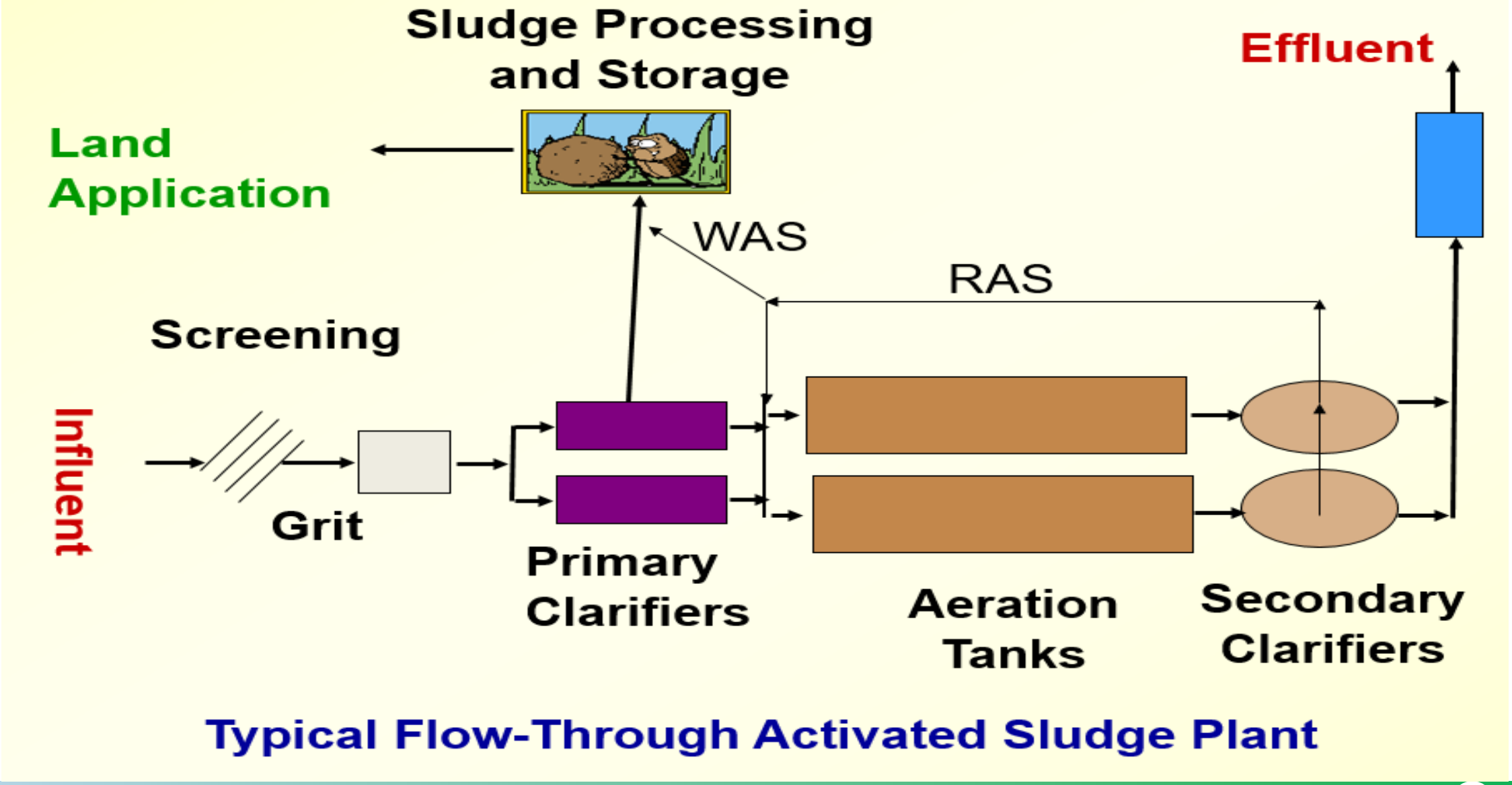
PAPER INDUSTRY TOWORDS GREEN MANUFACTURING

Image of Paper Industry then ……..

Image of Paper Industry now ……..



ACTIVATED SLUDGE PROCESS



Typical Flow-Through Activated Sludge Plant

FUNCTIONS OF AERATION TANK / ACTIVATED SLUDGE

- Flocs of active bacteria suspended in aerobic sludge.
- Aerated by pumping air/oxygen or by surface aerators.
- Organic carbons oxidized to produce new cells, carbon dioxide and water.

✓ **Organic material + O_2 + nutrients → CO_2 + H_2O + New Cells + nutrients + Energy**

- Another important reaction occurs
  i.e. Nitrification and Denitrification.

✓ • Nitrification: $NH_3 + O_2 \rightarrow NO_2^- + 3H^+ + 2e^-$ & $NO_2^- + H_2O \rightarrow NO_3^- + 2H^+ + 2e$

✓ • Denitrification: $NO_3 + R\text{-}OH \rightarrow N_2 + CO_2 + H_2O + OH^-$

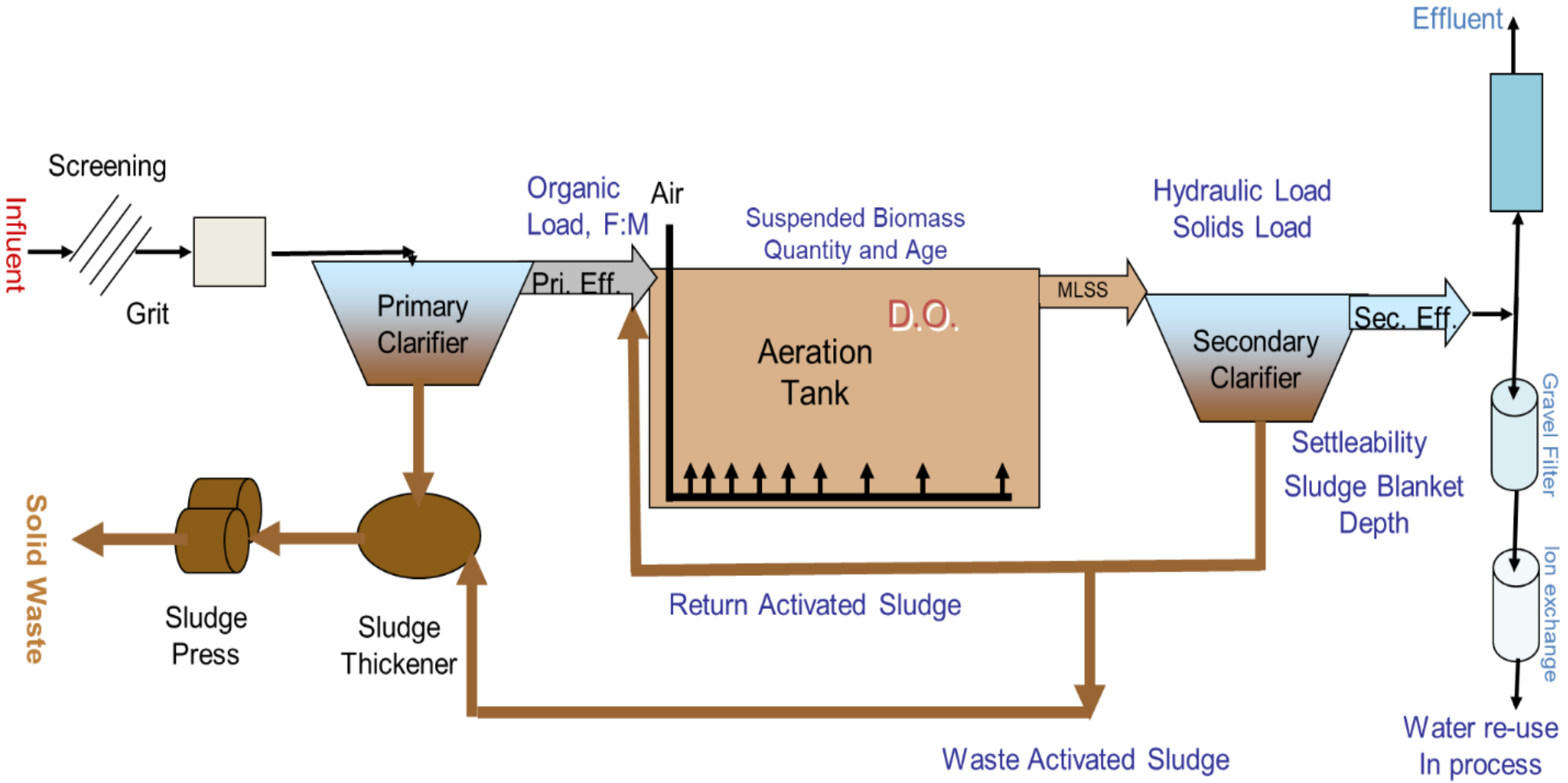
FOUL / SEPTIC CONDITION

- Aerobic functions come to a halt.
- Nitrification-denitrification stops.
- DO reduces and anaerobic activities started.
- Rotten egg or fishy smell comes out.
- Lot of foam seen on the lagoon.

CAUSES OF FOUL / SEPTIC CONDITION

- Organic overloading.
- Short circuiting or short hydraulic detention.
- Overgrowth of SRB.
- Old sludge accumulation.
- pH shock.
- High temperature and or temperature shock.
- Partial nitrification.

ETP SET-UP AT CLIENT'S PLANT

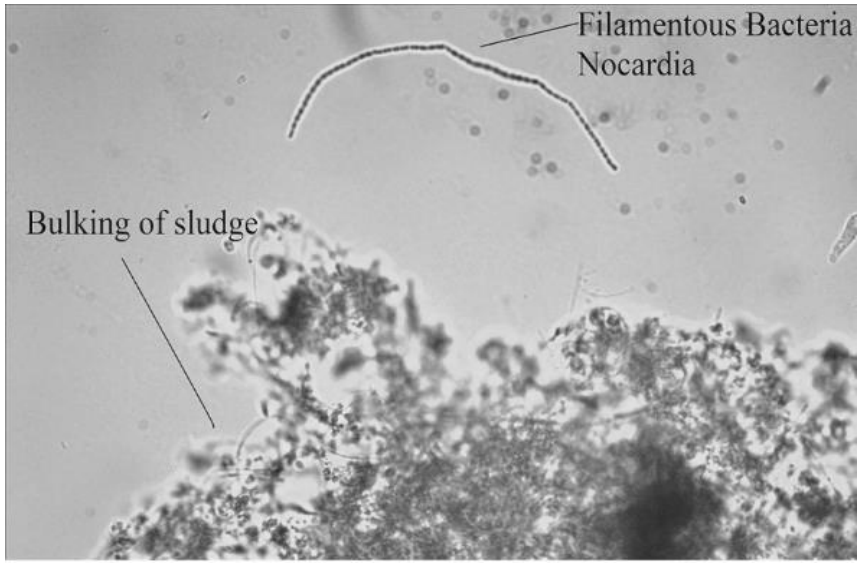


CONTROL DATA DURING NORMAL OPERATION

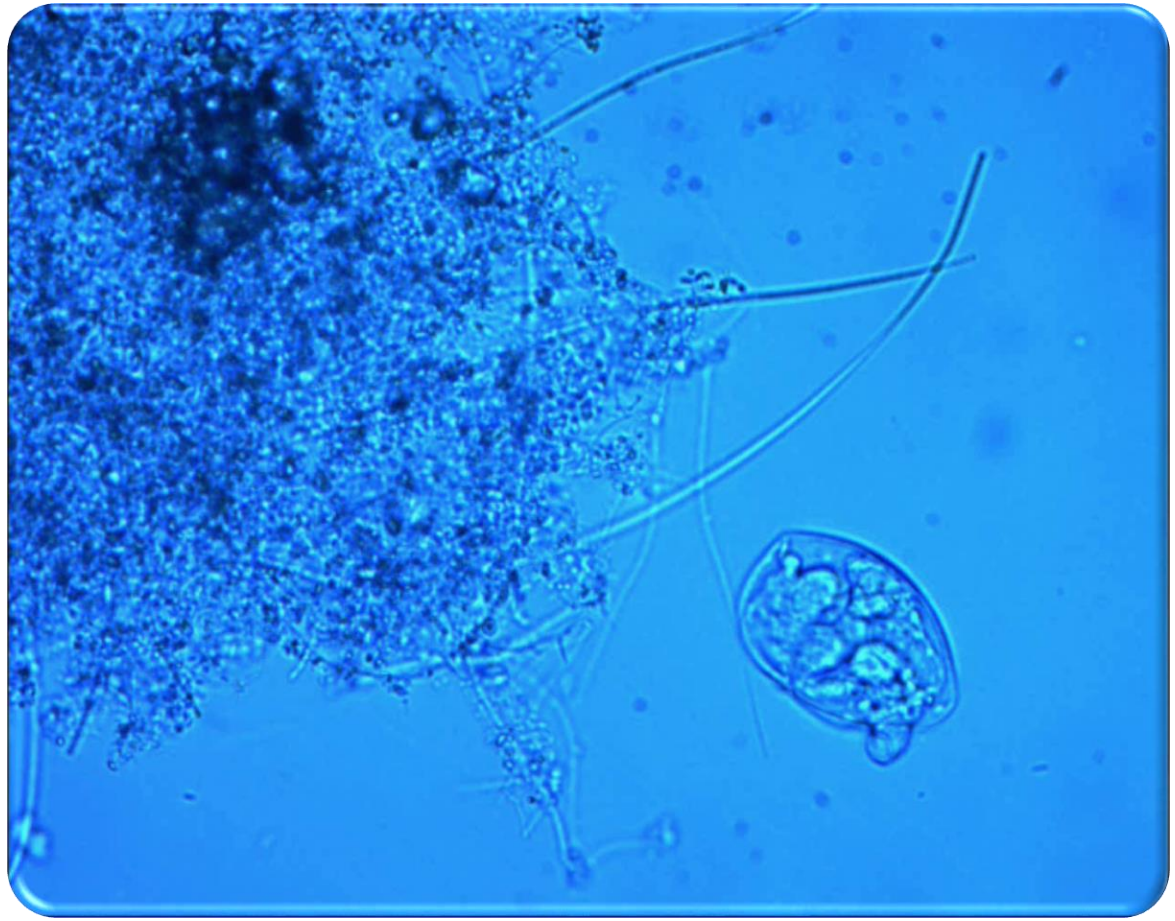
Sl. No.	Control Parameters	UOM	Entry 1° clarifier	Exit 1° clarifier / Entry Aeration Tank	Effluent Exit 2° clarifier	Aeration tank
1	TSS	mg/l	2885 (1540 – 3460)	190 (105 – 300)	67 (36 – 90)	
2	COD	mg/l	2490 (1216 – 3164)	513 (280 – 650)	153 (66 – 200)	**70.2%** COD reduction
3	BOD	mg/l	1159 (670 – 1490)	262 (176 – 310)	22 (13 - 28)	**91.6%** BOD reduction
4	pH	-	6.6 - 7.0	6.8 - 7.2	7.1 - 7.3	
5	DO	mg/l				**0.7** (0.4 - 2.8)
6	MLSS	mg/l				1700 (1520 – 1860)
7	MLVSS	mg/l				1213 (1098 – 1365)
8	MLVSS/MLSS	Ratio				**0.71**

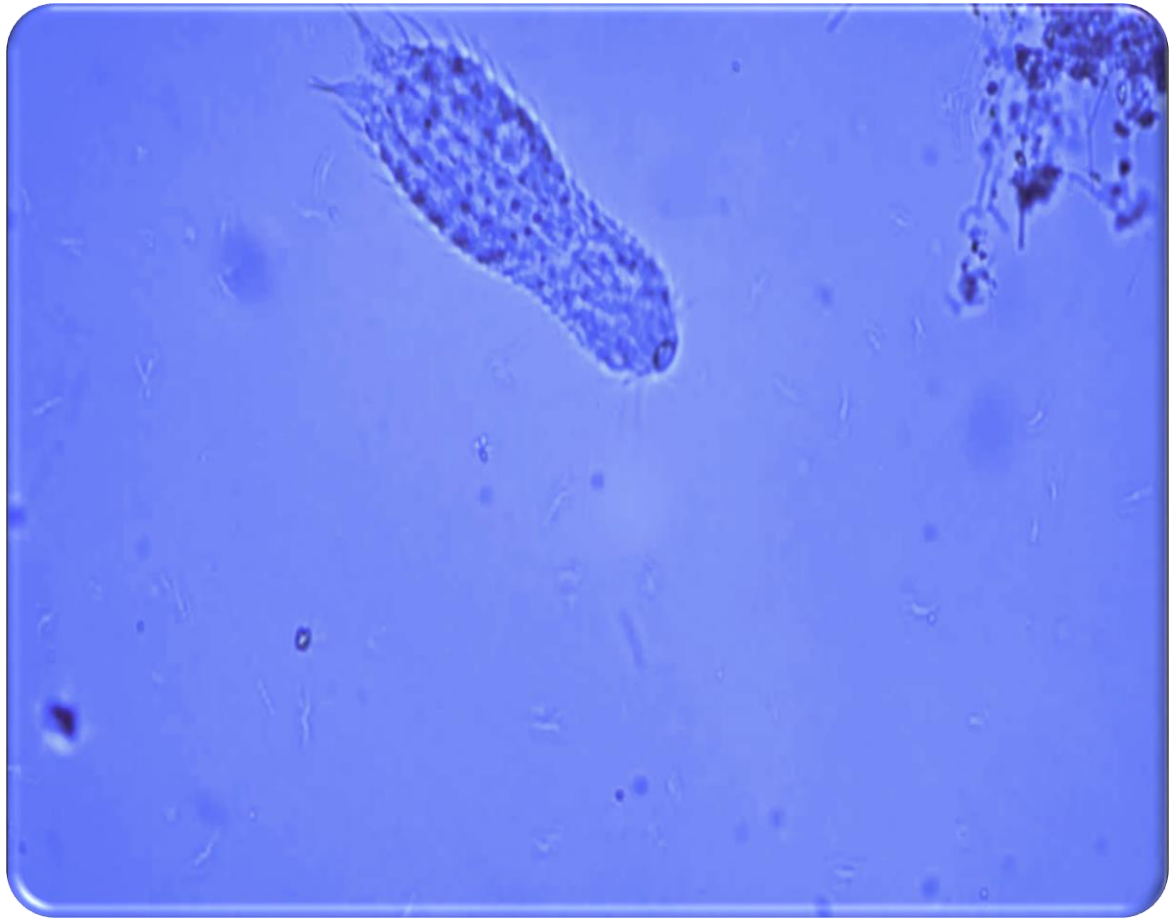
Table-1

MICROBES FOUND DURING MICROSCOPIC ANALYSIS



MICROBES FOUND DURING MICROSCOPIC ANALYSIS contd.....





CONTROL DATA DURING TROUBLED PERIOD

Sl. No.	Control Parameters	UOM	Entry 1º clarifier	Exit 1º clarifier / Entry Aeration Tank	Effluent Exit 2º clarifier	Aeration tank
1	TSS	mg/l	4863 (3554 – 7260)	256 (174 – 364)	113 (92 – 160)	
2	COD	mg/l	3462 (2741 – 4060)	667 (548 – 802)	219 (193 – 249)	**67.0%** COD reduction
3	BOD	mg/l	1365 (1110 – 1670)	275 (257 – 310)	38 (34 - 40)	**86.1%** BOD reduction
4	pH	-	6.7 - 7.0	6.9 - 7.2	7.1 - 7.4	
5	DO	mg/l				**0.2** (0.0 - 0.2)
6	MLSS	mg/l				2240 (1758 – 2852)
7	MLVSS	mg/l				1130 (881 – 1386)
8	MLVSS/MLSS	Ratio				**0.50**

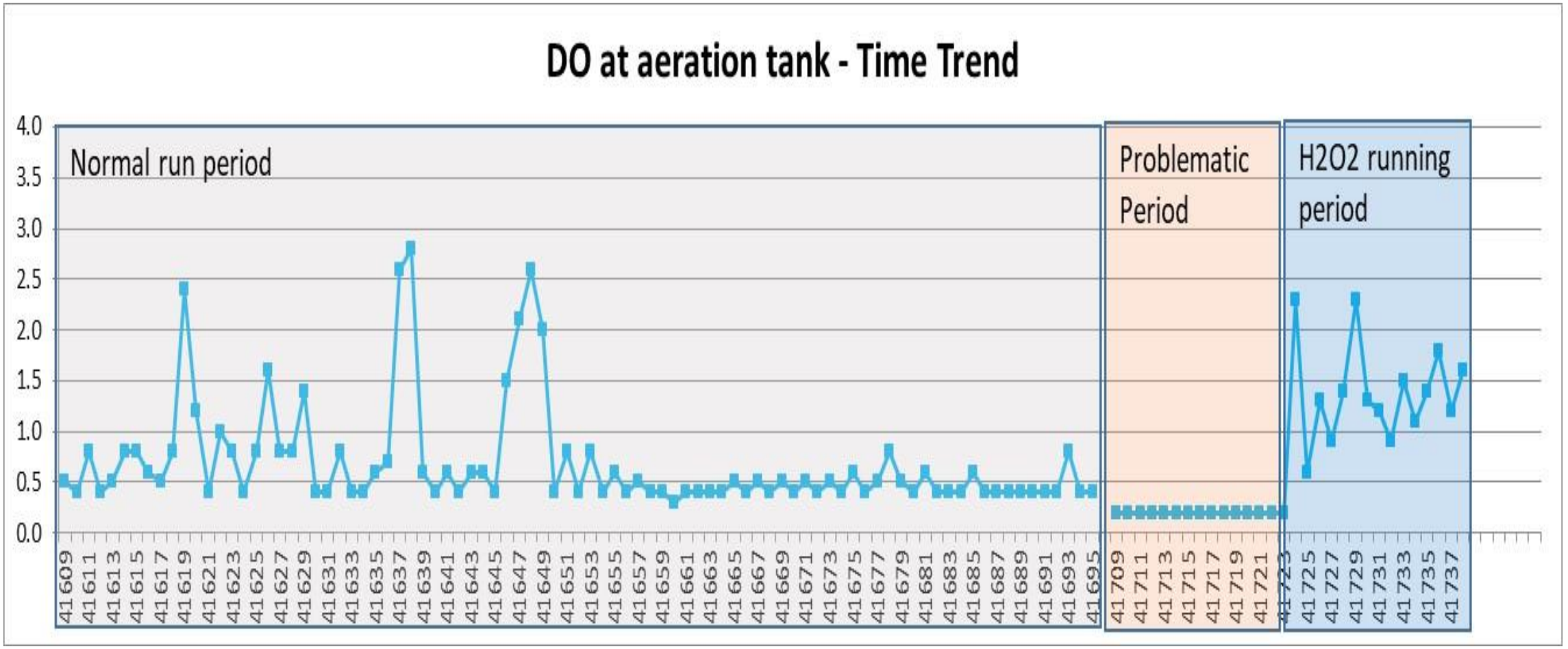
Table-2

CONTROL DATA DURING H_2O_2 DOSING

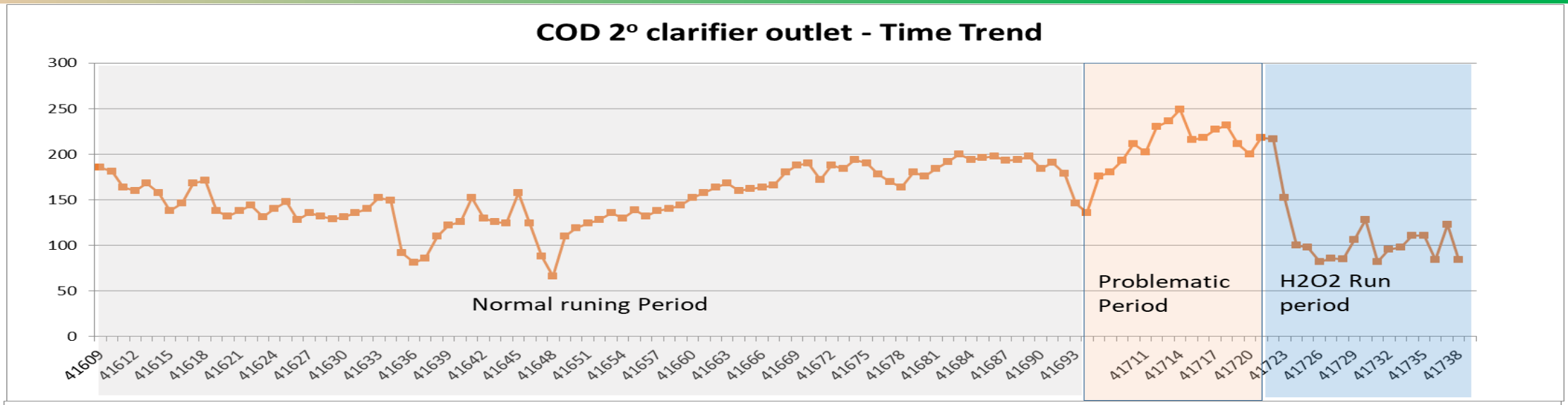
Sl. No.	Control Parameters	UOM	Entry 1° clarifier	Exit 1° clarifier / Entry Aeration Tank	Effluent Exit 2° clarifier	Aeration tank
1	TSS	mg/l	4112 (2108 – 5860)	82 (44 – 89)	53 (33 – 104)	
2	COD	mg/l	3697 (4114 – 5400)	361 (287 – 512)	98 (82 – 128)	**72.9%** COD reduction
3	BOD	mg/l	767 (640 – 1021)	183 (140 – 253)	15 (10 - 22)	**91.8%** BOD reduction
4	pH	-	6.7 - 7.2	6.5 - 6.8	6.8 - 7.1	
5	DO	mg/l				**1.4** (0.6 – 2.3)
6	MLSS	mg/l				1570 (1160 – 1987)
7	MLVSS	mg/l				1320 (1028 – 1622)
8	MLVSS/MLSS	Ratio				**0.84**

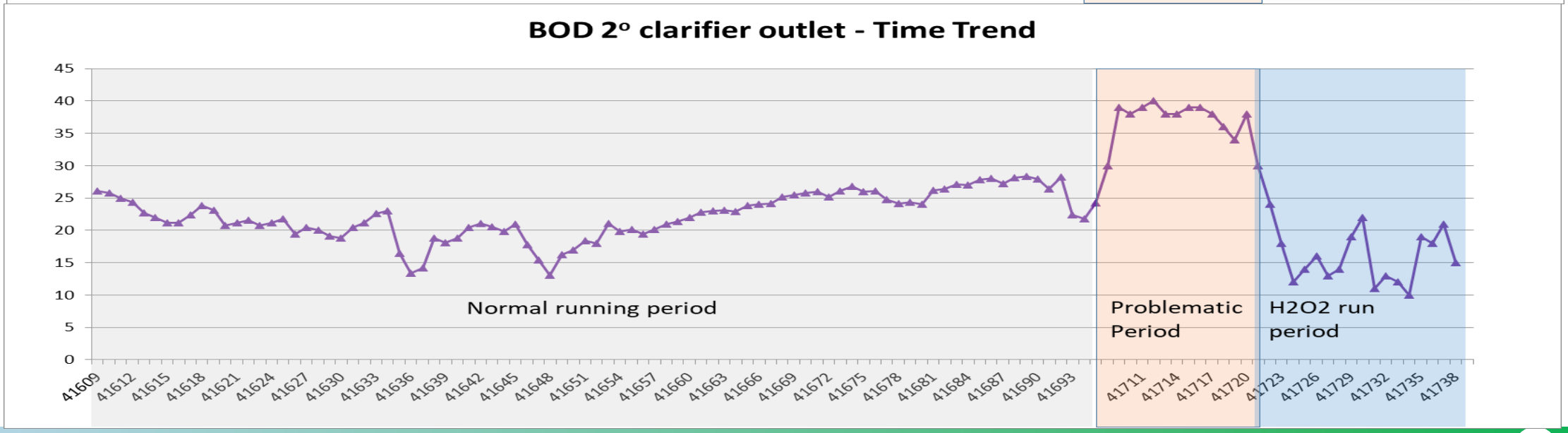
Table-3

DO IN AERATION TANK - TREND CHART

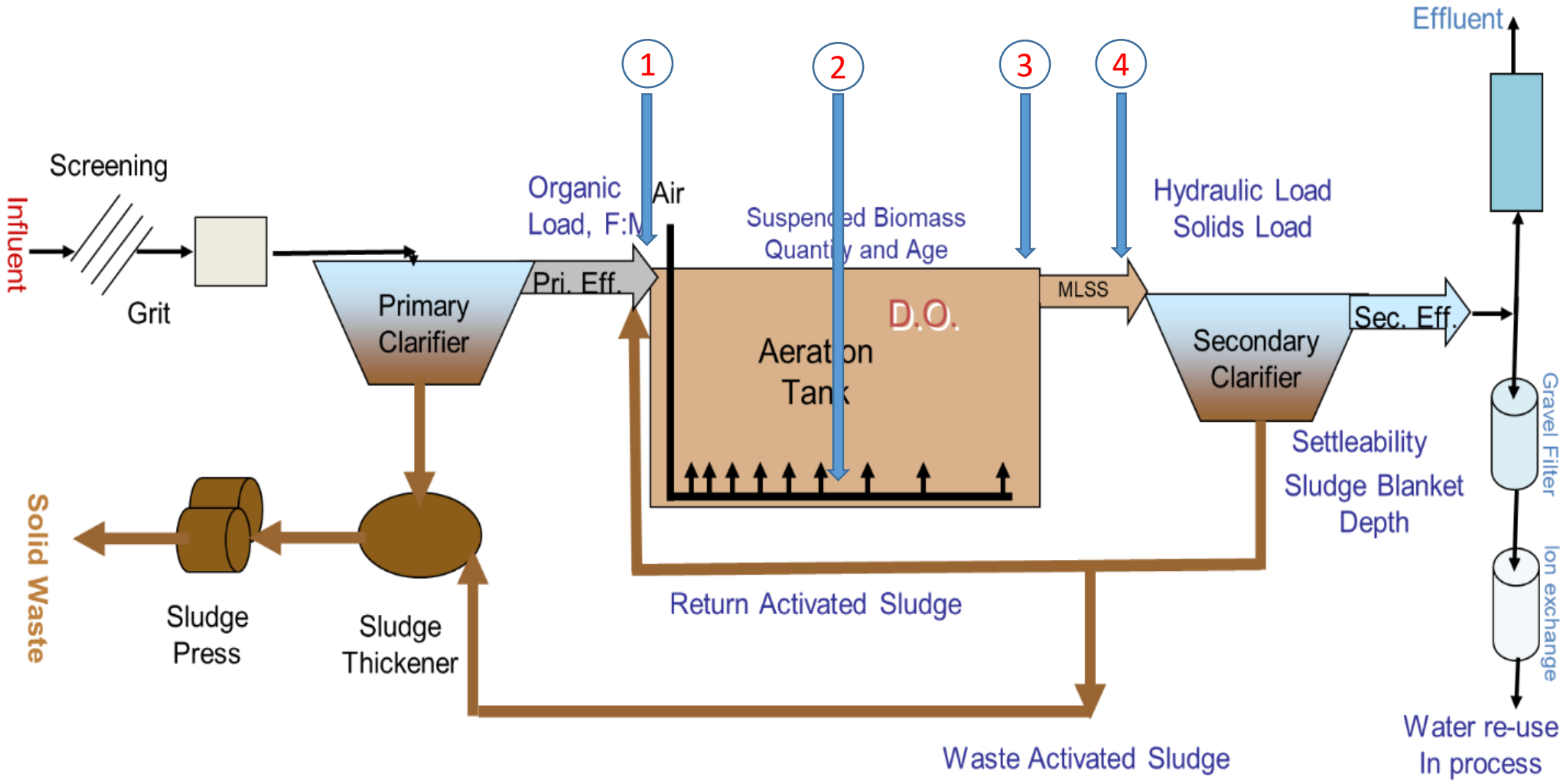


BOD & COD IN SECONDARY CLARIFIER OUTLET : TREND CHART





H_2O_2 DOSING POINT



DECOMPOSITION OF H_2O_2 IN ACTIVATED SLUDGE

- Equation: $2H_2O_2 \xrightarrow{catalase\ enzyme} 2H_2O + O_2\uparrow$
- Molecular wt.: 68.02936 g ----------> 36.03056 g + 31.9988 g
- Percentage (%): 100% ----------> 52.96% + 47.04%
- Oxygen (O_2) generated is 47.04% from one mol of H_2O_2 at 100% conc.
- In 50% H_2O_2 concentration, the oxygen availability is 23.52%.
- Similarly in 35% H2O2, the oxygen availability is (47.04 x 0.35) 16.46%

OXYGEN AVAILABILITY IN DIFFERENT CONCENTRATION OF H_2O_2

H_2O_2 solution strength	3%	27%	35%	50%
O_2 availability % in solution	1.41%	12.70%	16.46%	23.52%
Specific Gravity (SG)	1.0059	1.10	1.13	1.20
H_2O_2 g/l	1008.94	1098.81	1128.77	1199.46
O_2, kg/l	0.014	0.140	0.186	0.282
O_2, g/l	14	140	186	282

COUNTER ACTIONS BY H_2O_2 TO THE ACTIONS BY SRB

- SRBs reduce sulfates to sulfide in low DO condition.
- $H_2S + H_2O_2 \rightarrow S + 2H_2O$
- At acidic/neutral pH, H2O2 follow above stoichiometry.
- Since waste streams often contain other reactive materials, it may require more H_2O_2.
- In alkaline solution (> pH 8), the dominant reaction is:
  $Na_2S + 4\ H_2O_2 \rightarrow Na_2SO_4 + 4\ H_2O$
- H_2O_2 consumption can be lowered in combination with air.
- There could be sulfur oxidizing bacteria like *Beggiatoa*.
- They convert sulfur in to sulfates like sulfuric acid and lower the pH.
  $ROH_2 + S + 2CO_2 + 2H_2O \rightarrow H_2SO_4 + 2(CH_2O)$
- pH observed low during H_2O_2 dosing. pH may be improved in presence of Fenton's solution.
- Beggiatoa consume 85% of oxygen due to sulfide oxidation.
- Only 15% are consumed by rest of the microorganisms.

CONCLUSION / SUMMARY

- H_2O_2 proved to be the best solution to get out of septic conditions.
- Up to 100 mg/l of H_2O_2 can be dosed without any fear of inhibition to microorganisms.
- H_2O_2 increases DO level in the aeration tank, which inhibits SRBs.
- It may be used regularly along with diffused or surface aeration.
- Simultaneously, it reduces COD and BOD from the effluent.
- H_2O_2 may be used as pre-treatment to oxidize complex organic maters to simpler.
- For reusing of treated water in system, H_2O_2 is dosed before gravel filter and ion exchange.
- 100% of treated water can be used for agriculture as toxicity is reduced by H_2O_2.
- Hence, it is a strong pillar towards Green Manufacturing.
- Only one drawback is it’s cost of operation.

Thank you for your attention

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