

Cyanide, Thiocyanate and phenol removal from wastewater in steel plant by BactaServe bacterial culture.

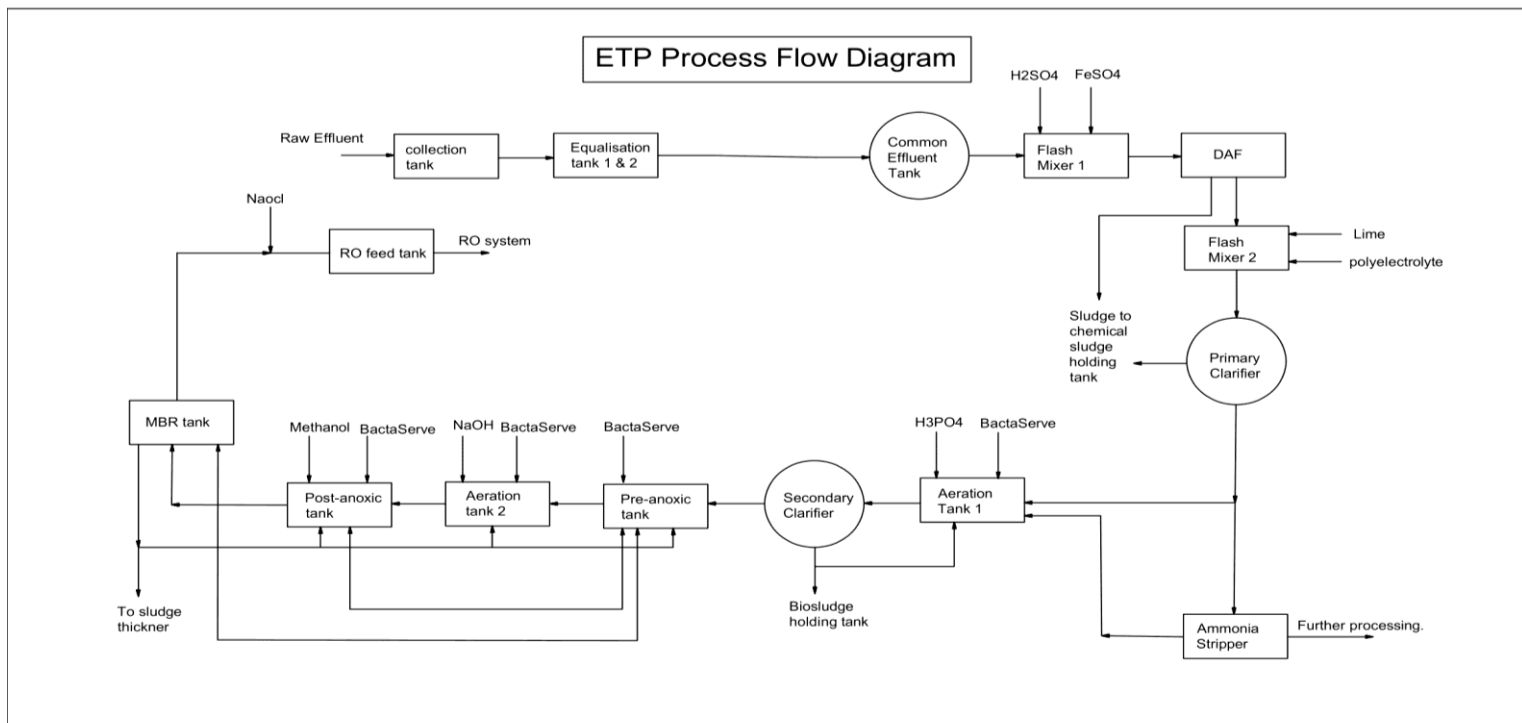
1. Background: -

In the steel industry, toxic materials like Cyanide, Thiocyanate and Phenol are produced in industrial processes during the production of coke. This steel plant is located in the eastern part of India. It is one of the largest manufacturers of Plate Mill plates, HR plates and coils, ERW pipes, SW pipes, CR sheets and coils, Galvanised sheets (GP & GC), and silicon steel sheets.

1.1 Plant Specifications: -

The capacity of this ETP is 3600 m³/day, having two aeration tanks in series along with pre-anoxic and post-anoxic tanks followed by a membrane bioreactor. ETP-treated effluent is then fed to R.O. for effluent recycling.

1.1.1 Process Flow Diagram: -



2. Challenges: -

The coke manufacturing process generates cyanide and thiocyanate which comes in the effluent. Cyanide at 6.5 ppm is a toxic molecule that requires adequate safety measures for 100% degradation. Thiocyanate at 350 ppm is relatively more stable than cyanide, requiring a higher degree of biodegradation efficiency. Phenol at 250 ppm also is a big challenge. NH₃-N at 300 ppm further increases to 400 ppm after bacterial action on the thiocyanate molecule. Stage-2 NH₃-N and subsequent denitrification requires 2 stages of bacterial anoxic denitrification.

Table 1: Inlet parameters- Routine.

Sr No.	Parameter	Values (mg/Lit.)
1	pH	9 – 9.5
2	Colour (Hazen)	< 20
3	Temperature (°C)	35 – 38
4	Total suspended solids (TSS)	20 – 30
5	Total dissolved solids (TDS)	4200 – 4500
6	Conductivity (uS/cm)	6700
7	Oil & Grease	< 5
8	Iron	3 – 5
9	Total chromium	< 0.05
10	Silica	13.6 – 14.14
11	Fluorides	< 8

Table 2: Inlet parameters- Critical.

Sr No.	Parameter	Values (mg/Lit.)
1	Chemical oxygen demand (COD)	1300 – 1800
2	Biological oxygen demand (BOD)	500 – 800
3	Ammoniacal nitrogen (NH ₃ -N)	250 – 300
4	Nitrate (NO ₃)	25 – 30
5	Total Kjeldahl nitrogen (TKN) (As provided)	150 – 200
6	Cyanide (CN)	2.5 – 6.5
7	Thiocyanate (SCN)	300 – 350
8	Phenol (C ₆ H ₅ OH)	150 – 250

3. Special Technical Solution: -

As a solution, we dosed BactaServe Aerobic along with special strains of paracoccus and pseudomonas species for the removal of cyanide and thiocyanate. Pseudomonas species worked exceptionally well for phenol reduction from 250 ppm to 2.5 ppm.

Table 3: Bacterial cultures required over 45 days period.

Sr No	Types of bacterial culture required	Where to add	Targeted pollutants	Strains added
1	BactaServe- Aerobic	Aeration tank 1	Thiocyanate	Paracoccus species & other mixed culture consortia.
			Phenols	Pseudomonas species.
			COD, BOD	Bacillus species like megatherium, amyloliqueficans & others.
2	BactaServe- Aerobic	Aeration tank 2	NH ₃ -N, Nitrification, Nitrate N ₂	Nitrobacter & Nitrosomonas species.
3	BactaServe- Nutrient Removal	Anoxic Tank	Denitrification	Thiobacillus Species.

For the degradation to occur, we have provided them with a Bioculture dosing protocol as below:

Table 4: Dosing protocol.

Dosage BactaServe – Aerobic & nutrient removal.						
Sr no.	Days		A.T -1 (kg/Day)	A.T -2 (kg/Day)		Anoxic Tank (kg/Day)
1	Day 1 - Day 5	BactaServe- Aerobic.	10	5	BactaServe- Nutrient Removal	7
2	Day 6 - Day 10		8	3		6
3	Day 11 - Day 20		5	2.5		5
4	Day 21 - Day 30		4	1.5		3.5
5	Day 31 - Day 45		2	1		2

BactaServe nutrient removal containing nitrifiers ensures the conversion of 400 ppm NH₃- N to nitrates. The De-nitrifiers in an anoxic tank convert the NO₃-N to N₂ gas.

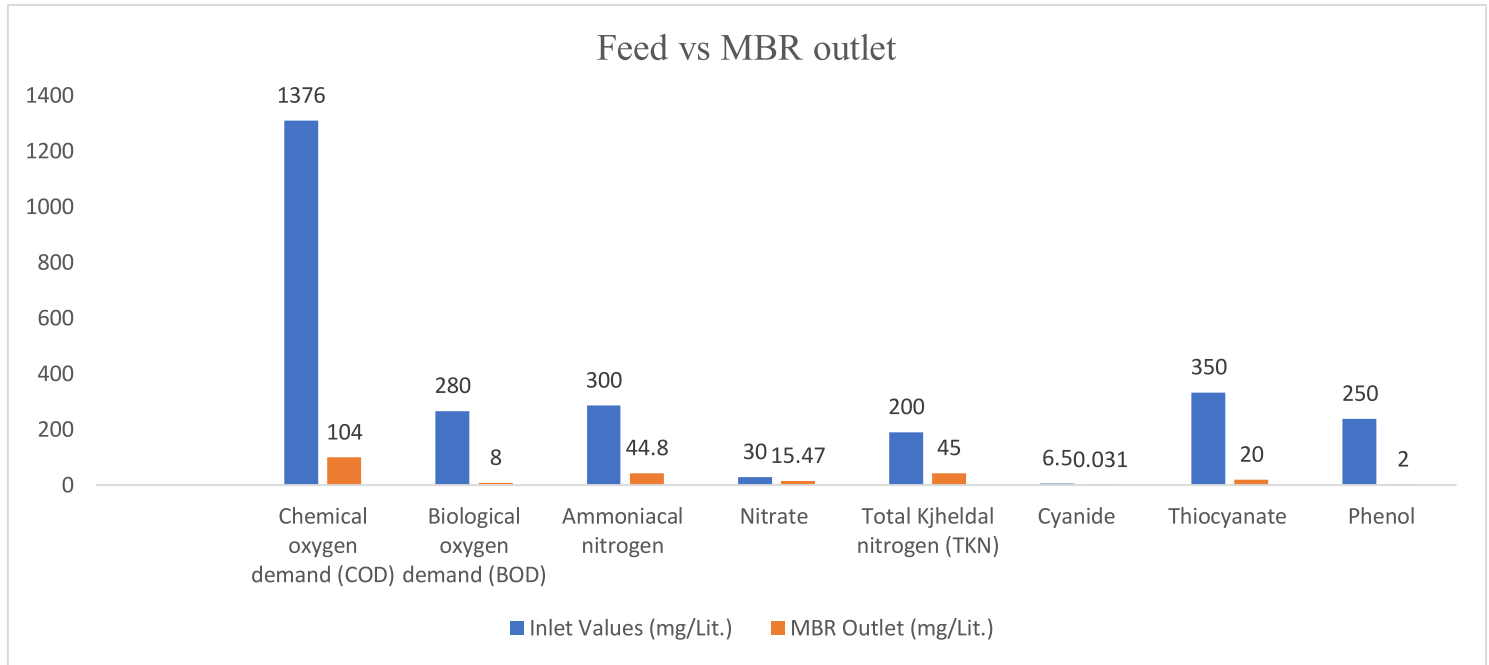
3.1 Photographic presentation of site performance: -



Table 5: Results.

Sr No.	Parameter	Inlet Values (mg/Lit.)	MBR Outlet (mg/Lit.)
1	Chemical oxygen demand (COD)	1376	104
2	Biological oxygen demand (BOD)	280	8
3	Ammoniacal nitrogen (NH ₃ -N)	300	44.8
4	Nitrate (NO ₃)	30	15.47
5	Total Kjeldahl nitrogen (TKN)	200	60
6	Cyanide (CN)	6.5	0.031
7	Thiocyanate (SCN)	350	20
8	Phenol (C ₆ H ₅ OH)	250	2

3.2 Graphical Presentation of Parameters: -



% REDUCTION WITH INLET AND OUTLET PARAMETERS

■ Inlet Values (mg/Lit.) ■ MBR Outlet (mg/Lit.) ■ Percentage Degradation

8	PHENOL	250	2	99.2
7	THIOCYANATE	350	20	94.3
6	CYANIDE	6.50	0.031	99.5
5	TOTAL KJHELDAL NITROGEN (TKN)	200	45	77.5
4	NITRATE	30	15.47	48.4
3	AMMONIACAL NITROGEN	300	44.8	85.1
2	BIOLOGICAL OXYGEN DEMAND (BOD)	280	8	97.1
1	CHEMICAL OXYGEN DEMAND (COD)	1376	104	92.4

4. Executive Summary: -

This assignment presented us with challenges like high inlet COD, Cyanide, Thiocyanate, Phenols, and NH₃-N. Low inlet BOD further complicated the situation. BactaServe Bioculture could solve the issue since it was incorporated with specific bacterial strains which were pre-acclimatized for cyanide, Thiocyanate, Phenol, and NH₃-N degradation.

A tailor-made Bioculture of Amalgam Biotech could only solve this with the help of our indigenous strain bank.