

PROCESS DESIGN BASIS **(PLOT PLAN AND WATER DEPARTMENT)** ***EFFLUENT TREATMENT PLANT***

PROJECT : EFFLUENT TREATMENT PLANT AT TENGAKHAT, ASSAM.

OWNER : OIL INDIA LTD. (OIL)

PMC : ENGINEERS INDIA LTD.

JOB NO. : A843

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Rev. No	Date	Purpose	Prepared by	Reviewed by	Approved by

1.0 INTRODUCTION

OIL INDIA LIMITED (OIL) is engaged in Exploration, Production and Transportation of crude oil & natural gas with its Headquarters at Duliajan, Assam. The major Oil & Gas producing assets of the Company are located in Upper Assam Basin of North East India. Produced water or the formation water from oil collection system (OCS) to be treated prior to its disposal or reinjection to ensure stipulated guidelines and maintain parameters.

M/s EIL has been retained by M/s OIL for providing PMC services for the construction of new Effluent Treatment Plant to meet the stipulated guidelines.

2.0 PROJECT PROFILE

The Produced water (a mix of oil and water in emulsion form) and associated gas is handled by about 40 production installations of various capacities and non-associated gas is produced through about 26 installations. In order to ensure stipulated guidelines and maintain parameters of produced water to be treated prior to its disposal or reinjection, an Effluent Treatment Plant (ETP) is proposed to be installed for the same.

Produced Water after oil water separation in process units will be routed to the existing Formation Water Tanks of different Gas Gathering Stations and then pumped to the new equalization tanks in the ETP intermittently. Inlet lines from different formation water tanks shall be provided by OIL up to ETP battery limit with flange connection.

The treated effluent from the proposed ETP will be reused in water injection wells\water disposal wells. The sub-surface Water Disposal Wells are of 1,200 to 1,500 m deep and Water Injection Wells are of 2,500 to 3,000 m deep.

3.0 SITE CONDITIONS

The ambient conditions are:

1. Maximum Ambient Temperature : 42°C
2. Minimum Ambient Temperature : 5°C
3. Maximum Humidity at 21°C : 100%
4. Maximum Humidity at 35°C : 95%
5. Maximum Humidity at 41°C : 70%
6. Maximum Altitude above sea level : 150 Meter

4.0 DESIGN BASIS

The quantity of Produced Water to be treated in the new ETP shall be 5000 m³/day for reuse as injection water. The effluent shall be treated in two chains of 2500 m³/day capacity each to meet the quality (oil, TSS etc.) required for re-injection as mentioned in Table 1.

Table No. 1 Desired Water Quality for Well Disposal / Re-injection

S. No.	Parameter	Inlet parameters range (Note 1)	Outlet parameters required for re-injection (Note 2)
1	p ^H	7-9	6.5-8.5 *
2	Temperature	Ambient – 50°C	Not more than Inlet temperature
3	Total Suspended solids	Up to 150 ppm	98% removal of suspended solids > 10 microns *
4	Dissolved Oxygen (DO)	Up to 7 ppm	<0.2 ppm *
5	SRB	10 ³ to 10 ⁶ CFU/ml	NIL *
6	Any other Bacterial Activity like GAB, IRB, & APB	Not Measured	NIL *
7	Oil and Grease (the upper limit corresponds to occasional flush of free crude oil along with formation water)	Total oil: 100-1600 mg/l Emulsified oil: 100-500 mg/l	< 10 mg/l *

Notes:

- 1) For Design, contractor to consider the maximum figures.
- 2) (*) Parameters to be guaranteed by the contractor in final treated water quality throughout the year. Dissolved oxygen to be guaranteed by the contractor at mechanical de-oxygenation system outlet (without any dosing of chemical scavenger) throughout the year.
- 3) Additional Water Quality Parameters:
BOD:80-135 ppm; COD: 180-1400 ppm; TDS: 3500-5000 ppm; Zinc: 0.1-0.7 ppm; Chlorides: 400-2400 ppm; Sulphates: 70-125 ppm; Sodium: 60-85 ppm; Phenolics: 2-10 ppm; Cyanides: 0.002-0.04 ppm; Fluorides: 0.1-0.3 ppm; Sulphides:0.07-0.3 ppm; Chromium (Cr+6): 0.01-0.06 ppm; Copper: 0.02-0.4 ppm; Lead: 0.7-2.0 ppm; Nickel: 0.2-1.6 ppm.

Design Conditions:

- Hydraulic turndown requirement : 50% (only 1 chain in operation)
- On-stream factor : Plant shall be able to operate round the year

5.0 TREATMENT SCHEME

The Treatment Scheme is broadly divided into five treatment sections, namely

Section-1	:	Pre-treatment (for bulk removal of Oil and TSS)
Section-2	:	Oil Polishing Section (for final polishing of Oil and TSS)
Section-3	:	Re-injection water treatment (de-oxygenation and bacteria control)
Section-4	:	Sludge and Chemical Handling
Section-5	:	Slop Oil Handling

Section-1 Pre-Treatment Section:

This section shall treat the 5000 m³/day (2 x 2500 m³/day chains) produced water influent for removal of bulk oil and TSS and will primarily consist of the following units:

- Equalization tank- 2 tanks with effective capacity of combined 2 days storage of produced water effluent along with provision of removal of settled sludge from bottom of the tank and slop oil collection from top.
- TPI Separator- removal of free oil particles of size 60 microns and above.
- DAF system- removal of emulsified oil particles of size 20-60 microns
- VOC System- VOC collection and treatment system will be provided in the ETP and a lean VOC (normal emissions) and air mixture shall be considered for the design of the VOC collection and treatment system.

Section-2 Oil Polishing Section:

Walnut Shell Filtration System is envisaged for final polishing of Oil and TSS to the desired levels.

The Walnut Shell Filters are a re-generable/back-washable type units consisting of Walnut Shell media for removal of the Oil and TSS to desired specifications. The design/ engineering/supply of Walnut Shell Filters shall be carried out by one of EIL approved suppliers.

Section-3 Re-injection water treatment:

To achieve the desired dissolved oxygen in the produced water for re-injection, the DO in water shall be removed in a mechanical de-oxygenation system (1 No.). Further to control the SRB & other bacterial activity in the water, biocide dosing shall be provided before the produced water is sent for re-injection/ well disposal.

The contractor can provide mechanical de-oxygenation system consisting of any one of the following four (4) options to achieve 0.2 ppm of dissolved oxygen in treated water at mechanical de-oxygenation system outlet:

Option-1: Mechanical de-oxygenation (Stripping by Steam)

Option-2: Mechanical de-oxygenation (Stripping by Nitrogen Gas/Instrument Air and catalytic burning)

Option-3: Mechanical de-oxygenation (Stripping by Natural Gas)

Option-4: Mechanical de-oxygenation (Vacuum De-oxygenation: single stage or multi stage)

Also, a provision shall be mandatorily kept for dosing of oxygen scavenger at the outlet of Mechanical De-oxygenation system to meet any eventuality of non-compliance to treated water specification. The chemical dosing system shall be designed for reduction of DO from 1 ppm to 0.2 ppm. However, the EPC/LSTK contractor shall be responsible for providing guarantee of 0.2 ppm DO at mechanical de-oxygenation system outlet during PGTR and during O&M of the plant for 10 years.

Section-4 Sludge and Chemical Handling:

The chemicals required in the plant (acid, biocide, oxygen scavenger, etc.) shall have a separate storage and dosing area.

The sludge generated in the plant will be Oily and chemical sludge. The oily and chemical sludge shall be sent to the sludge thickener and further processed in bio-reactor and centrifuge for dewatering. The dewatered oily sludge will be taken for final disposal by M/s OIL.

Section-5 Slop Oil Handling:

The slop oil from the top level of Equalization Tanks and TPI separators shall be collected in Wet Slop Oil sump and then pumped to Dry Slop Oil Tanks for oil & water separation. The water shall be drained from the bottom of Dry Slop Oil Tanks and the dry slop oil shall be pumped to OSBL.

The safety concerns related to connection of Dry Slop Oil transfer line from ETP B/L to OSBL location shall be taken care of by M/s OIL.

All internal liquid wastes (including sludge handling system, walnut shell filters, de-oxygenation system, etc.) generated in any section of the treatment plant shall be recycled and treated within the ETP itself. There shall be no liquid waste disposal from the ETP.

6.0 CHEMICALS HANDLING

Tentative list of chemicals proposed to be used in Effluent Treatment Plant are as follows:

- | | |
|-------------------------------------|-----------------------------------|
| • Demulsifier | • Deoiling Polyelectrolyte (DOPE) |
| • HCl | • Biocide |
| • Caustic | • Oxygen Scavenger |
| • PAC | • Nutrient |
| • Dewatering Polyelectrolyte (DWPE) | • Surfactant |

As far as possible it is desirable to provide ready mix chemicals, which can be diluted & dosed.

7.0 UTILITIES

- No utility (except natural gas) shall be made available to ETP Contractor at ETP Battery Limit.
- The following shall be Free-Issue to the ETP Contractor (however, tapping from existing header outside ETP B/L and pipe routing up to and within ETP is in ETP contractor's scope):
 - Bore-well water (maximum 72 m³/day)
 - Fire Water

- Electric Power (not exceeding 1200 KW) shall be available to the ETP Contractor on chargeable basis. ETP Contractor's Scope regarding electrical cabling & works shall be as per Electrical Specifications attached in the tender document.
- An air compressor of suitable capacity shall be installed within the new ETP battery limit to meet the Plant Air and Instrument Air requirement by the ETP Contractor. Instrument Air drier shall also be in the scope of this package.
- The ETP Contractor shall take a connection from the existing fire water network of M/s OIL at the location identified by M/s OIL (outside ETP Battery Limits) to provide fire water network for the new ETP.
- Service water and drinking water requirements for ETP shall be sourced from the existing bore well of M/s OIL. The ETP Contractor's scope shall include taking a connection from the existing bore well water header of M/s OIL from the location identified by M/s OIL (outside ETP Battery Limits). Suitable treatment of the bore well water for use as drinking water shall also be in the scope of the ETP Contractor. Maximum bore well water which shall be made available to the bidder shall not exceed 72 m³/day to meet the service water, drinking water and cooling water requirement. If required, a package cooling tower with all the facilities shall be considered by the ETP Contractor in his scope.

The design for drinking water treatment package shall include iron removal filters, post dis-infection using hypochlorite dosing and any other filters as required to obtain the design outlet quality as mentioned below:

S. No.	Component	Unit	Design Inlet	Outlet-max acceptable limits as per BIS
1.	Odour	-	Agreeable	Agreeable
2.	Turbidity	NTU	46.1	1.0
3.	p ^H	-	7.0	6.5-8.5
4.	Total Hardness (as CaCO ₃)	mg/l	94	200
5.	Iron (as Fe ⁺²)	mg/l	0.91	0.3
6.	Chloride (as Cl ⁻)	mg/l	12	250
7.	Free Chlorine	mg/l	Nil	0.2
8.	Total Dissolved Solids	mg/l	112	500
9.	Calcium	mg/l	22.7	75
10.	Manganese	mg/l	BDL	0.1
11.	Sulphate	mg/l	4.0	200
12.	Fluoride	mg/l	0.04	1.0
13.	Nitrate	mg/l	4.3	45
14.	Arsenic	mg/l	BDL	0.01
15.	Cyanides	mg/l	0.01	0.05
16.	Phenolic Compounds	mg/l	BDL	0.001
17.	Lead	mg/l	0.01	0.01
18.	Zinc	mg/l	1.6	5.0
19.	Chromium (Cr ⁺⁶)	mg/l	BDL	0.05
20.	Alkalinity (as CaCO ₃)	mg/l	95	200

21.	Aluminum	mg/l	BDL	0.03
22.	Boron	mg/l	0.002	0.5
23.	Copper	mg/l	0.02	0.05
24.	Mineral oil	mg/l	Nil	0.5

Note:

BDL: Below Detectable Limit

- Natural Gas shall be available to the contractor on chargeable basis. As an additional precautionary measure to check possibility of Gas Supply failure, OIL will provide two inlets of Gas, one LP (30 PSI) and one HP (250 PSI) so that in case of LP gas supply failure, it may change over to HP with a regulator. Possibility of failure of both gas supplies is very remote.

S. No.	CONSTITUTION	Range by % Volume
a)	Methane	85.7 - 93.52
b)	Ethane	2.45 - 6.55
c)	Propane	1.28 - 3.12
d)	Nitrogen	0.53 - 1.21
e)	Carbon-dioxide	0.01 - 0.57
f)	Iso-Butane	0.31 - 0.75
g)	N-Butane	0.40 - 1.14
h)	Iso-Pentane	0.19 - 0.47
i)	N-Pentane	0.17 - 0.38
j)	Hexane	0.34 - 1.16
k)	Gravity	0.6204 -0.6919
l)	Gross Calorific Value	9636.8- 10590.8 Kcal/SCUM
m)	Net Calorific Value	8704.3- 9595.4 Kcal/SCUM
n)	Moisture content	21.0-120.0LB/MMCFT (336.0-1992.0 KG/MMSCM)
The source of natural gas is well-head which is wet associated gas in its crude form. The associated gas flowing directly from oil well is taken through servo scrubber before its use as gas fuel for engines.		

8.0 BATTERY LIMIT PRESSURES

Battery Limit pressures for the Feed effluent lines, treated effluent lines, and various other incoming and outgoing lines from the ETP shall be as follows:

S. No.	Stream	Pressure Normal
1	All Inlet effluent lines	3 kg/cm ² .g
2	Treated water for reinjection	25 kg/cm ² .a
3	Slop Oil Transfer	11 kg/cm ² .a

9.0 UNITS OF MEASUREMENT

All engineering specifications shall be issued in the MKS system of measurement, with the exception of piping/tubing sizes, which shall be reported in inches.

Parameter	Unit
Temperature	°C
Pressure (Gauge)	Kg/cm ² .g
Pressure (absolute)	Kg/cm ² .a
Mass	Kg
Length	Meters
Relative density (Sp. Gravity)	-
Density	Kg/m ³ or g/l
Vacuum	MmH ₂ O or mmHg
Flowing mass	Kg/hr
Flowing liquid	M ³ /hr
Flowing vapor	Nm ³ /hr or kg/hr
Heat rate	K Cal/hr
Viscosity	Cp
Kinematic viscosity	Cst
Composition	Vol %
Power	KWh/KW

10.0 REFERENCE DRAWINGS/DOCUMENTS

S. No.	Drawing / Document No.	Drawing/Document Title
1.	A843-806-17-44-1001 & 1002	Process Flow Diagram
2.	-	Oil & TSS Particle Size Distribution Charts