COSIA CHALLENGE

Delivering accelerated improvement in environmental performance through collaborative action and innovation

cosia CANADA'S OIL SANDS INNOVATION ALLIANCE

New High Efficiency Industrial Gas Boiler

Created: **October 8, 2014** **Expiry: March 31, 2015**
(High potential projects will be actioned when received)

Type of Solutions Needed:
Existing Technology/Solution, Expertise/Advice/Consulting, Facilities, Equipment, Services (Analytical, Sample Preparation etc.), leading edge technologies.

Financials:
Projects of interest to members will be funded as COSIA Joint Industry Projects by COSIA members.

COSIA Sponsor:
COSIA GHG Environmental Priority Area Steering Committee.

COSIA's Greenhouse Gas Environment Priority Area (EPA) is looking for innovative and sustainable solutions to signficantly reduce GHGs at oil sands mining and InSitu (in place) operations without environmental burden shifting (causing negative environmental impacts in other areas).

Our aspiration is to "Produce our oil with lower GHG emissions than other sources of oil"

Canada's Oil Sands Innovation Alliance (COSIA) is an alliance of oil sands producers focused on accelerating the pace of improvement in environmental performance in Canada's oil sands through collaborative action and innovation. We bring together leading thinkers from industry, government, academia and the wider public to improve measurement, accountability and environmental performance in the oil sands in four priority areas. These four Environmental Priority Areas (EPAs) are tailings, water, land and greenhouse gases. This is one of multiple COSIA Challenges that are released on an on-going basis, all of which will range in priority and potential level of environmental benefit.

Technology Need Description

The COSIA GHG Environmental Priority Area Steering Committee has identified **new high efficiency (above ground) industrial gas boilers** as a technology which could improve the GHG performance of the oil sands. The GHG EPA SC is interested in new steam generator technologies to replace existing steam generators in the existing process configuration. Proposals based on work that is a proven concept are desired.

The ideal technology(ies) will:

- Dramatically increase the efficiency of a boiler (e.g. >93% on HHV basis)
- Either be commercially available today or deployable in the next 5 years
- Increase efficiency using current levels of water quality (SiO_2 < 50 mg/L (minimum, < 25 mg/L desired), Ca/Mg <0.5mg/L, 1,000-8,000 mg/L TDS,>25 mg/L TOC)
- Potentially integrate boilers with waste heat utilization for electricity production or other purposes
- Novel configurations could also be considered, including steam generation in the well.
- NOx emissions comparable or lower than existing boilers/burners
- Steam quality and pressure is comparable to existing Once Thru Steam Generators used by Oil Sands producers

Background

The current boiler technology applied in an oil sands operation for in-situ Steam Assisted Gravity Drainage (SAGD) or Cyclic Steam Stimulation facility is a once-through steam generator (OTSG). A typical 33,000 barrel per day SAGD facility would operate six steam boilers requiring 1600 GJ/h (LHV) of combined heat input with radiation losses of 32 GJ/hr and stack losses of 100 GJ/hr. Approximately 95% of the GHG emissions associated with an in-situ facility are from the combustion of natural gas for the production of steam.

Because of the high solids content of the boiler feed water, once thru steam generators (OTSG's) are preferred over drum boilers.

Note that some COSIA members are already investigating or advancing the following:

- Boilers in Series
- Rifle Tubes
- Direct Contact Steam Generation

Current water treatment technology leaves boilers vulnerable to fouling and scaling, which leads loss of efficiency, tube failures and downtime for cleaning and repairing.

Material and energy flow diagrams for a standard 33,000 BPD Steam-Assisted Gravity Drainage (SAGD) facility are provided below.

ANTICIPATED PROJECT PHASES

Phase 1 – Program Development

Promising technologies will be evaluated. Interesting technologies may be combined to form an integrated multi-objective approach to solving this problem.

Phase 2 – Funding for selected technology options.

APPROPRIATE RESPONDERS TO THIS REQUEST

COSIA member companies local or global resources, Associate Members, external companies (small to large), academic researchers, other research institutes, consultants, entrepreneurs, or inventors are welcome. For Example:

You represent an **independent process development/consulting organization** with boiler technology available to transfer from other sectors
Or

You are an **academic researcher** with insights into the energy efficiency of boilers and have applied this knowledge to generate a novel technology appropriate to this request
Or
You represent **a manufacturer of a component** of the required boiler technology that possesses fouling resistance

Members of COSIA should respond to this through their COSIA representative, if you do not know who your representative is please contact COSIA directly at ETAP@COSIA.ca

Non Members should submit their request through the COSIA E-TAP Process, available at http://www.cosia.ca/initiatives/etap/idea-submission-form

RESPONDING TO THIS REQUEST

The COSIA ETAP process is an easy means of responding to this request and a safe framework for best presenting your response to COSIA.

Some items that will be especially important to present in your response are:

- Describe the basic unit operations
- Provide reasons why you believe your approach will work (ie glassware experiments, process modeling, literature precedent)
- Describe utilities that might be required
- Capital and operating cost estimates if available based on described capacity targets
- IP status
- What operating environment restrictions might your technology face?
    - Explosive atmospheres
    - Severe weather
    - Power fluctuations

RESPONSE EVALUATION

COSIA will evaluate the responses using the following criteria:

- Overall scientific and technical merit of the proposed approach
- Approach to proof of concept or performance
- Economic potential of concept
- Respondent's capabilities and related experience
- Realism of the proposed plan and cost estimates

These criteria and others will be used by COSIA to consider proposals for funding.

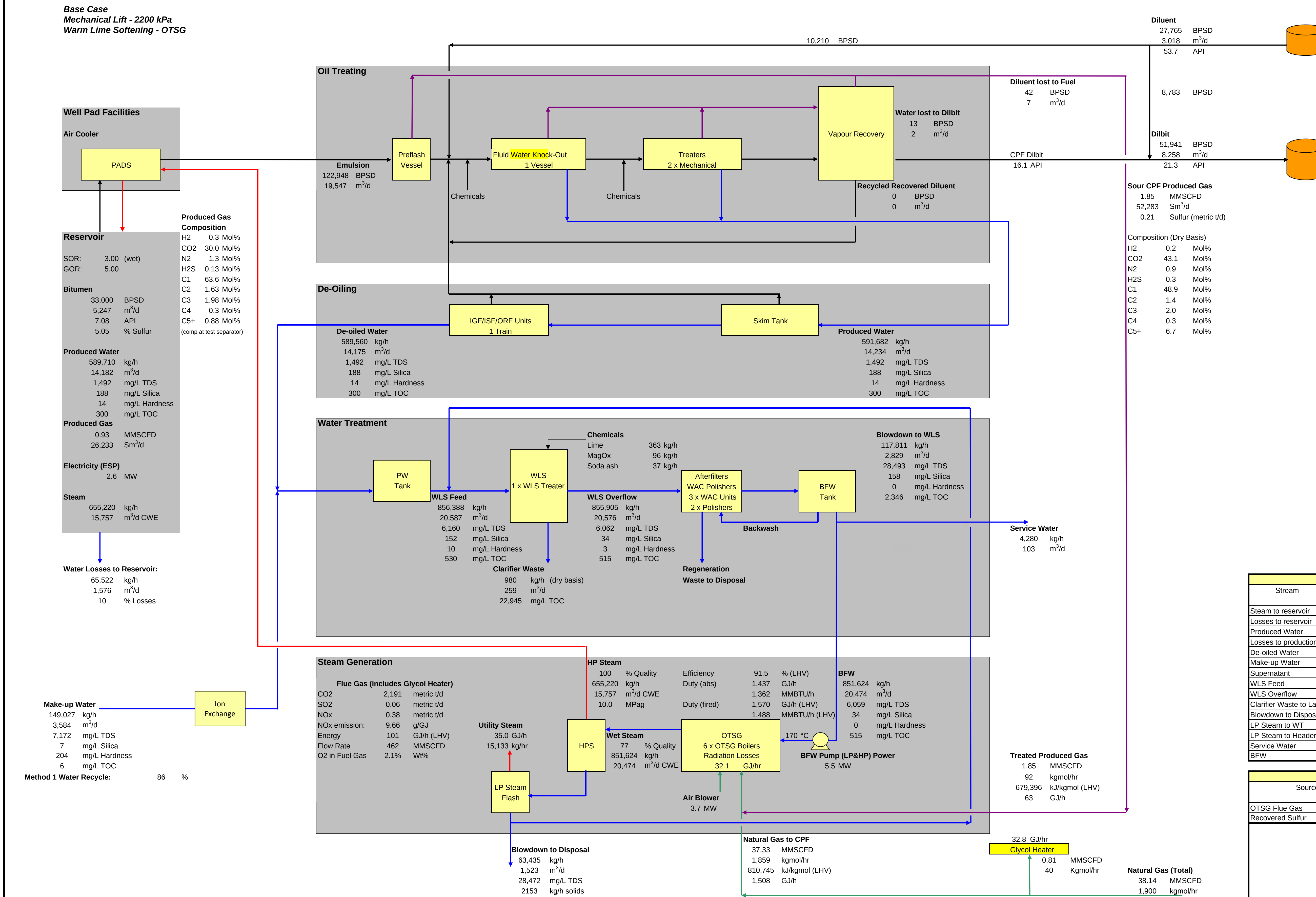
WLS= WATER LAYER SEPARATION

WAC=Weak Acid Cation
OTSG= Once Through Steam Generator
BBD= Boiler Blow Down

SUPPLEMENTAL INFORMATION
Typical In Situ Process Schematics

COSIA SAGD TEMPLATE

Base Case
Mechanical Lift - 2200 kPa
Warm Lime Softening - OTSG



Summary Table	
MU TDS (ppm)	7,172
PW TDS (ppm)	1,492
PW TOC (ppm)	300
LP Flash BD (%)	8%
BD Recycle (%)	60%
TDS to Boiler (ppm)	6,059
Boiler TOC (ppm)	515
MU Flowrate (kg/h)	149,027
WLS Sludge (kg/d)	23,530
Disposal Type (L,S)	L
Disposal Rate (kg/h)	63,435
Disposal Solids (kg/d)	51,662

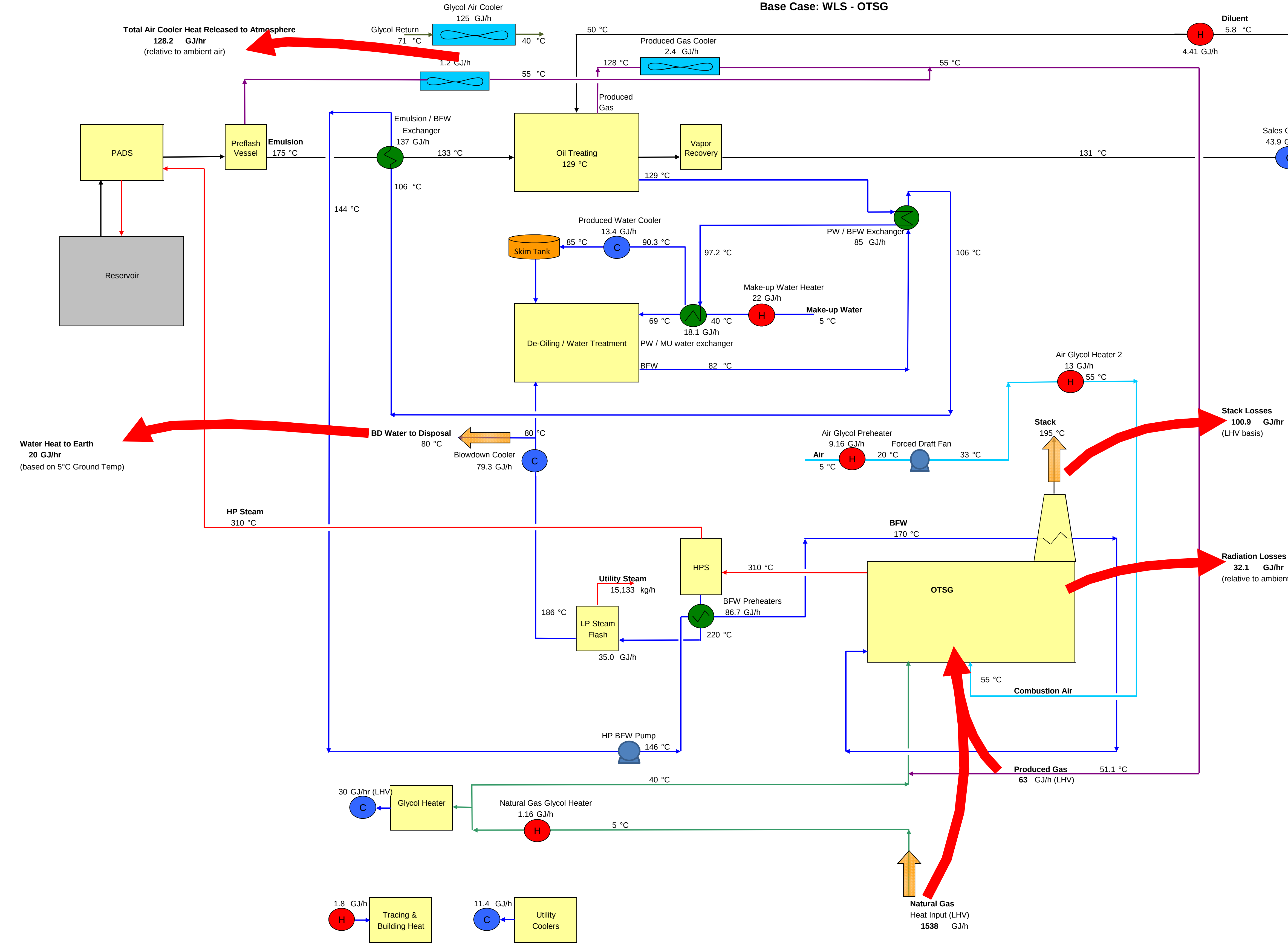
Water Balance

Stream	Flow	Flow	TDS	Silica	Hardness
	kg/h	m^3/d	ppm	ppm	ppm
Steam to reservoir	655,220	15,757	-	-	-
Losses to reservoir	65,522	1,576	-	-	-
Produced Water	591,682	14,234	1,492	188	14
Losses to production	85	2	-	-	-
De-oiled Water	589,560	14,175	1,492	188	14
Make-up Water	149,027	3,584	7,172	7	204
Supernatant					
WLS Feed	856,388	20,587	6,160	152	10
WLS Overflow	855,905	20,576	6,062	34	3
Clarifier Waste to Land	980	259			
Blowdown to Disposal	63,435	1,523	28,472	158	0
LP Steam to WT	0	0	0	0	0
LP Steam to Header	15,133	363,198	0	0	0
Service Water	4,280	103	6,059	34	0
BFW	851,624	20,474	6,059	34	0

Emissions Summary

Source	SO2	S	CO2	NOx
	metric t/d	metric t/d	metric t/d	metric t/d
OTSG Flue Gas	0.06	0.03	2191	0.38
Recovered Sulfur	-	0.00	-	-

ENERGY FLOW DIAGRAM
Base Case: WLS - OTSG



Heat Exchangers Legend

- Process to Process
- Hot Glycol
- Cold Glycol
- Direct Contact/Quench

Exchangers	Duty GJ/h
Emulsion / BFW	136.9
Produced Water Glycol Cooler	13.4
PW / BFW Exchanger	84.5
Produced Gas Air Cooler (s)	3.5
Diluent Glcyol Heater	4.4
Sales Oil Coolers	43.9
Make-up Water Glycol Heater	21.8
PW / MU water exchanger	18.1
Blowdown Glycol Cooler	79.3
BFW Preheaters	86.7
OTSG Air Glycol Heaters (two services)	22.7
OTSG Air Preheater (Flue Gas)	N/A
Utility Coolers	11.4
Glycol Air Cooler	124.7

Electrical Loads	Power MW	Equivalent Heat GJ/h
HP BFW Pump	4.8	31.1
LP BFW Pump	0.8	5.2
Downhole Pumps	2.6	17.0
Pad Auxiliaries	1.3	8.5
Forced Draft Fan	3.7	24.0
Misc Users	1.9	12.2
VRU Compressors	2.1	13.7
WLS/Evaporator	0.5	3.1
Glycol System	0.4	2.5
Total	17.9	117.3

Direct CO2 Generation	2,191	MT/day	417.6	kg/m3 Bitumen
Indirect CO2 Generation	328	MT/day	62.5	kg/m3 Bitumen
Total CO2 Emissions	2,519	MT/day	480.1	kg/m3 Bitumen

Assumes electricity grid CO2 emissivity of 763 kg CO2eq / MW-hr
Direct Emissions from Combustion only

Inputs	Energy GJ/h
Natural Gas	1538
Electrical Power	117.3
Total	1655