AVONMOUTH BC (11800) IED PERMIT APPLICATION

EPR/PP3734LK/V012

ADDITIONAL BAT INFORMATION

30TH SEPTEMBER 2022

ENVIRONMENTAL PERMITTING (ENGLAND AND WALES) REGULATIONS 2018

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BAT 3 inventory / BAT 6 and 7 wastewater emissions sampling

Information provided here is similar to that provided for Poole BC schedule 5 response in July 2022. Following the EA/WaSC workshop on 28th September 2022 further clarity has been provided and so the inventory information can be developed to meet BAT 3 requirements.

Wastewater and Waste Gas Emissions Identification

Asset/ waste treatment process:	Emission Characteristic	Waste type	Flow diagram location
Surplus Activated Sludge (SAS) Gravity Belt Thickeners (GBTs) Waste stream A	Liquor	Filtrate from the thickening of SAS via GBT	Waste stream A
RAW Sludge Gravity Belt Thickeners (GBTs) Waste stream B	Liquor	Filtrate from the thickening of Raw Sludge via GBT	Waste stream B
Centrifuge Including the temporary installation Waste stream C	Liquor	De watering liquors (centrate)	Waste stream C
Gas lines Condensate Traps Waste stream D	Liquor	Process wastewater	Waste stream D
Consolidation Tank (nr 2) Waste stream E	Liquor	Liquor from top of Consolidation Tank	Waste stream E
Digesters biogas Waste Stream F	Gas	Process biogas	Waste stream F

Table 1: Waste Streams identified at Avonmouth BC

There are currently no process integrated techniques for the wastewater or waste biogas streams. the wastewater streams are returned to the head of the adjacent water recycling centre (WRC)

The biogas waste stream enters into the gas to grid, CHPs and flare.

Controls in place to stop pollution

Wastewater streams

Process liquors are captured and discharged to the sealed drainage system for return back to the 'off Installation', but 'onsite' WRC for treatment via a liquor return process. The WRC provides permitted biological treatment via the activated sludge process on the wastewater streams, further mitigating the potential of pollution to water

If waste liquors were to spill or breach permitted containment or pipework, the site drainage will return the flow to the head of the treatment works and the pollution protocol will be completed as documented in Pollution Response guidance (OPSG165).

Waste Gas Streams

Waste gas streams pollution control includes monitoring and maintenance.

The LDAR plan is in place to identify fugitive leaks from pipework and gas assets. The PVRVs are monitored and their operation will trigger an investigation to identify the issue with the gas pipeline and prevent fugitive emissions of biogas.

Substance Concentration, load value and variability of each wastewater and waste gas stream

Wastewater streams

Sludge liquor samples are currently collected from three of the five wastewater emissions, listed above in Table 1. We currently don't take samples from waste streams Condensate (stream D) and Consolidation tank (stream E).

Sample analysis for wastewater was determined using recommended characteristics from BAT conclusions for waste treatment (BAT 6, BAT 7 and BAT 38), alongside the last 3 years of routine wastewater sampling are detailed in table 2.

Asset / waste emission	Parameter	Units	Average Concentration	Average load **(kg/day)**	Typical concentration range *Q1 and Q3 quartiles*
SAS Filtrate Waste Stream A	BOD atu*	Mg O2/L	455	1,426	196.5 - 535.3
	COD	Mg O2/L	1,537	4,819	724.5 - 1920
	Suspended solids	Mg/L	1,095	3,431	575 - 1361.5
	pH	pH	7.2		7.2 - 7.3
	Ammoniacal nitrogen	Mg N/L	40.9	128	29.95 - 51.4
	Total oxidised nitrogen *	Mg N/L	0.13	0	0.1 - 0.1
	Nitrite as N *	Mg N/L	0.025	0	0.02 - 0.02
	Nitrate *	Mg N/L	0.12	0	0.1 - 0.1
	Orthophosphate	Mg P/L	30.2	95	14.77 - 38.50
	Chloride	Mg Cl/L	195.9	614	148 - 235
	Average Flow calculated	M^3/ day	3135		
Raw GBT Filtrate Waste Stream B	BOD atu*	Mg O2/L	1418.7	4,497	849 - 1768.8
	COD	Mg O2/L	3307.8	10,486	1706.5 - 4061.5
	Suspended solids	Mg/L	1621.5	5,140	545.5 - 1971
	pH	pH	6.5		6.3 - 6.7

	Ammoniacal nitrogen	Mg N/L	85	268	69.3 - 94.6
	Total oxidised nitrogen *	Mg N/L	0.3	1	0.1 - 0.1
	Nitrite as N *	Mg N/L	0.21	1	0.02 - 0.2
	Nitrate *	Mg N/L	0.26	1	0.1 - 0.1
	Orthophosphate	Mg P/L	43.2	137	30.86 - 52.59
	Chloride	Mg Cl/L	220.2	698	158.8 - 272.3
	Average Flow calculated	M^3/ day	3170		
Centrifuge Centrate Waste Stream C	BOD atu*	Mg O2/L	109.4	189	69.3 - 109.4
	COD	Mg O2/L	865.7	1494	479.5 - 677
	Suspended solids	Mg/L	455.7	787	120 - 265.5
	pH	pH	7.95		7.9 - 8
	Ammoniacal nitrogen	Mg N/L	1532.8	2646	1230 - 1835
	Total oxidised nitrogen*	Mg N/L	1.24	2	0.1 - 0.6
	Nitrite as N*	Mg N/L	0.21	0	0.02 - 0.2
	Nitrate*	Mg N/L	1.05	2	0.1 - 0.25
	Orthophosphate	Mg P/L	71.4	123	53.3 - 71.4
	Chloride	Mg Cl/L	253	437	224.8 - 2530.0
	Average Flow calculated	M^3/ day	1726		
* Adjusted average value as a significant number of less than results which were subsequently halved					

Table 2: Wastewater streams concentrations and variability

Waste Gas Emissions

Waste gas samples of raw biogas are collected from the Gas to grid feed. They are collected by an independent consultancy approximately 2 monthly intervals and there are proposals in to increase the characteristic analysis. The biogas characteristics are detailed in Table 3 below. Flow was calculated from daily biogas production over the last 2 years, providing an average of 37,158 m3/day (Raw Biogas- waste stream F).

Raw Biogas- *Waste stream F*				
Parameter	Units	Average concentration	Average concentration in milligram/m3 (mg/m^3)	Average load per day *(x 37158m^3 flow)* (kg/day)
Hydrogen Sulphide	ppm	518.607	518,607	19270.39
Carbon Dioxide	%mol	38.213	699,402	25,988.39
Oxygen	%mol	0.086	572	21.27
Nitrogen	%mol	0.417	2,428	90.24
Hydrogen	%mol	<0.01	<4	<0.15

Methane	%mol	61.466	409,089	15,200.94
Ethane	%mol	0.5*	6,254	232.39
Ethene	%mol	0.5*	5,834	216.78
Propane	ppm	0.5*	500	18.58
Butanes	ppm	0.5*	500	18.58
Pentanes	ppm	0.5*	500	18.58
C6	ppm	0.5*	500	18.58
C7	ppm	0.5*	500	18.58
C8	ppm	0.5*	500	18.58
C9	ppm	0.5*	500	18.58
C10	ppm	0.5*	500	18.58
C11	ppm	0.5*	500	18.58
C12	ppm	0.5*	500	18.58
Total Siloxanes as Si	mg/m^3	95.76	95.76	3.56
Hexamethyldisiloxane	mg/m^3	3.10*	3.10	0.12
Hexamethylcylotrissiloxaine	mg/m^3	0.34*	0.34	0.01
Octamethyltrisiloxane	mg/m^3	37.53	37.53	1.39
Octamethylcyclotetrasiloxane	mg/m^3	14.04	14.04	0.52
Decamethyltetrasiloxane	mg/m^3	23.11	23.11	0.86
Decamethylcyclopentasiloxane	mg/m^3	141.17	141.17	5.25
Dodecamethylpentasiloxane	mg/m^3	11.78	11.78	0.44
Dodecamethylcyclohexasiloxane	mg/m^3	3.15	3.15	0.12
Terpenes	.mg/m3	276.98	276.98	10.29
3 Carene	.mg/m3	0.52*	0.52	0.02
Alpha Pinene	.mg/m3	5.72	5.72	0.21
Beta Pinene	.mg/m3	11.51	11.51	0.43
Para Cymene	.mg/m3	226.35	226.35	8.41
Limonene	.mg/m3	28.77	28.77	1.07
Terpinolene	.mg/m3	0.25*	0.25	0.01
Aldehydes	.mg/m3	0.25*	0.25	0.01
Ketones	.mg/m3	0.25*	0.25	0.01
Alcohols	.mg/m3	0.25*	0.25	0.01
2 Butyl Octanol	.mg/m3	0.25*	0.25	0.01
Isopulegol	.mg/m3	0.41*	0.41	0.02
Ammonia	.mg/m3	0.25*	0.25	0.01
Branched Cycloalkanes Circa C9	.mg/m3	1.27*	1.27	0.05
Branched Alkanes Circa C10	.mg/m3	0.5*	0.5	0.02
Branched Alkanes Circa C11	.mg/m3	0.5*	0.5	0.02
Branched Alkanes Circa C15	.mg/m3	0.5*	0.5	0.02
Branched Alkanes Circa C12	.mg/m3	0.5*	0.5	0.02
Benzene 1 methyl 3 (1 methylethyl)	.mg/m3	0.5*	0.5	0.02
1 Ethyl 3,5 Dimethyl Benzene	.mg/m3	0.5*	0.5	0.02

2,2,4,6,6 Penta Methyl Heptane	.mg/m3	0.5*	0.5	0.02
1,2,3 Trimethyl Benzene	.mg/m3	0.5*	0.5	0.02
1,2,4 Trimethyl Benzene	.mg/m3	0.5*	0.5	0.02
1,3,5 Trimethyl Benzene	.mg/m3	0.5*	0.5	0.02
Benzene	.mg/m3	0.5*	0.5	0.02
Toluene	.mg/m3	51.78	51.78	1.92
Xylene	.mg/m3	0.5*	0.5	0.02
Total Sulphur	.mg/m3	0.89	0.89	0.03
Dimethyl Sulphide	.mg/m3	0.40*	0.40	0.01
Carbon Disulphide	.mg/m3	0.34*	0.34	0.01
Dimethyl Trisulphide	.mg/m3	0.13*	0.13	0.00
Methyl propyl Trisulphide	.mg/m3	0.18*	0.18	0.01
Dipropyl trisulphide	.mg/m3	0.14*	0.14	0.01
Dimethyl Disulphide	.mg/m3	0.31*	0.31	0.01
2 methyl Thiophene		0.14*	0.14	0.01
3 methyl Thiophene	.mg/m3	0.04*	0.04	0.00
Propyl Mercaptan	.mg/m3	0.02*	0.02	0.00
Sulphur Dioxide	.mg/m3	0.01*	0.01	0.00
Methyl Mercaptan	.mg/m3	0.03*	0.03	0.00
Ethanediol	.mg/m3	0.06*	0.06	0.00
1 Pentathiol	.mg/m3	0.05*	0.05	0.00
Dipropyl Disulphide	.mg/m3	0.01*	0.01	0.00
Mercury	.µg/m3	0.50*	0.00	0.00
Arsenic	.mg/m3	0.01*	0.01	0.00
Particulates	.mg/m3	0.0005*	0.00	0.00
Micro Organisms	.cfu/ml	0	0	0.00
The calculation for %mol conversion to mg/m3 is ((ppm*mol Weight)/(24.04012). 24.04012 is a constant * Adjusted average value where a significant number of less than results were recorded. Less than results were halved in calculation of the average.				

Table 3: Biogas analysis summary, concentration and load

Proposal

Wastewater streams

Proposal for inventory development following the EA/WaSC workshop on the 28th September is a sampling programme over 12 months with monthly sampling followed by a risk assessment process as stipulated by Risk assessments for your environmental permit - GOV.UK (www.gov.uk). The streams will be assessed using "risks to surface water from sanitary and other pollutants" to determine impact, but also assess the impact on the onsite WRC and the Environmental Risk Assessment, Appendix 7 of this application will be updated. Then a proposal for ongoing wastewater analysis to meet BAT 6 and 7 can be developed.

Our current list of parameters, proposed parameters and sample frequencies are detailed in table 4 below.

Parameter	SAS filtrate	Raw GBT filtrate	Centrifuge Centrate	Gas lines Condensate	Consolidation Tank liquors
Waste Stream	**A**	**B**	**C**	**D**	**E**
BOD	Weekly	Weekly	Weekly	*Monthly*	*Monthly*
COD	Weekly	Weekly	Weekly	*Monthly*	*Monthly*
Suspended solids	Weekly	Weekly	Weekly	*Monthly*	*Monthly*
Ammonia	Weekly	Weekly	Weekly	*Monthly*	*Monthly*
Nitrate	Weekly	Weekly	Weekly	*Monthly*	*Monthly*
Nitrite	Weekly	Weekly	Weekly	*Monthly*	*Monthly*
Orthophosphate	Weekly	Weekly	Weekly	*Monthly*	*Monthly*
PH	Weekly	Weekly	Weekly	*Monthly*	*Monthly*
Chloride	Weekly	Weekly	Weekly	*Monthly*	*Monthly*
Total Nitrogen	Weekly	Weekly	Weekly	*Monthly*	*Monthly*
Orthophosphate	Weekly	Weekly	Weekly	*Monthly*	*Monthly*
Mercury	*Monthly*	*Monthly*	*Monthly*	*Monthly*	*Monthly*
Other metals: As, Cd, Cr, Cu, Ni, Pb, Zn	*Monthly*	*Monthly*	*Monthly*	*Monthly*	*Monthly*
PFOA	*not sampled*	*not sampled*	*not sampled*	*not sampled*	*not sampled*
PFOS	*not sampled*	*not sampled*	*not sampled*	*not sampled*	*not sampled*
Flow	No flowmeter	No flow meter	No flowmeter	No flowmeter	No flowmeter

Table 4: Current and proposed sampling programme for waste streams (Entries in italics are proposed)

Waste Gas stream

We propose to expand the gas sampling to include:

- Temperature
- Water Vapour

As specified by the Biological waste treatment: appropriate measures for permitted facilities published September 2022.

BAT 24 Digester Performance

Demonstrate how key process parameters are measured for the anaerobic digestion process and subsequent action that would be taken in the case that these process parameters are not met.

Actual tank volumes

Level monitoring on all tanks with high level alarms and inhibits. Acid Phase Digesters are batch fed (32 x 56m3 batches in 24 hours). The feed is controlled by PLC and critical control points of flow and temperature. The mesophilic digesters are then fed in sequence.

If the levels in the sludge storage tanks go high, the feed to the Acid Phase Digesters will automatically stop. In this case the operators will increase the dewatering of the digestate and free space in the sludge storage tanks. If the Acid Phase Digester primary digesters feed stops for any reason, the PLC is not able to will make up the missing volume and the total volume for the 24hr period will below the target.

Parameter	Method and key values	Mitigations
Actual tank volume	Level Monitors /high level and inhibits	Inhibits Process on high level. Missing volume will not be made up with in the 24hr period.
Hydraulic retention time	APD feed is a HACCP CCP Feed to APD is a setpoint in the PLC APD feed for the previous 24hrs is monitored daily Hydraulic Retention Time calculation for APD and MAD is automatically updated and displayed on real time monitoring tool Amulet. APD HRT >2.23 days MAD HRT >11.4 days	Modulate feed to digester in line with HACCP critical control points
Organic loading rate (OLR)	Organic loading rate calculation for MAD is automatically updated and displayed on real time monitoring tool Amulet. 3-4 kgVSm3/day typical	Increase or decrease feedstock in line with HACCP critical control points
Sludge feed	Daily samples are analysed on site for Dry Solids%	Increase or reduce thickness of digester feed

	4-6% feed to digester APD loading calculation TDS/d – 100TDS/d Samples submitted to offsite laboratory for Dry Solids and Volatile solids%	
Digestate ammonia	Individual digesters are sampled and submitted to offsite laboratory for ammonia analysis Typical expected 1500mg/l	Check PH, and alkalinity VFA within digester Modulate feed to digester Reduce OLR.
Alkalinity	Individual digesters are sampled and submitted to offsite laboratory Typical range 4000-5000mg/l	Modulate feed to digester in line with HACCP critical control points
Volatile fatty acids (VFAs)	Individual digesters are sampled and submitted to offsite laboratory Typical range 50-150mg/l	Modulate feed to digester in line with HACCP critical control points
VFAs: Alkalinity ratio	VFA ratio calculation for MAD is automatically updated and displayed in real time monitoring too Amulet Typical VFA:Alkalinity ratio 0.01 – 0.03	Modulate feed to digester in line with HACCP critical control points
pH	Individual digesters sampled daily and analysed for pH onsite Individual digesters sampled and analysed at off site laboratory Range between 7.0-8.5	Check VFA/Alkalinity ratio. Modulate feed to digester in line HACCP critical control points
Biogas methane (%)	Monitor daily using portable analyser Typically 65% methane 35% carbon dioxide	Check feed, loading and retention time Modulate feed to digester in line HACCP critical control points

Temperature	Inline temperature monitoring for APD vessel 1 (HACCP CCP) Inline temperature monitoring for individual MADs. Individual MADs sampled daily, temperature recorded using handheld probe.	Provide additional heat via CHP engines or hot water boiler. Feed to APD will be inhibited if temperature set point is not met. Missing set volume will not be made up in 24hr period.
Foaming	Foam level sensors and visual inspections. Foam levels recorded on operators tick sheets.	Check for inconstant feeds, high VFA levels, mixing, temperature variations. Modulate feed to digester in line HACCP critical control points Dose antifoam if required
Gas Production	Monitor gas production levels. 0.8 – 1.1m3/kg Volatile solids destroyed.	Check for toxicity (heavy metals, VFA, ammonia) Modulate feed to digester in line HACCP critical control points Reduce OLR
Volatile Solids Destroyed	Volatile Solids Destroyed calculation across digestion process is automatically updated and displayed in real time monitoring tool Amulet.	Check for toxicity (heavy metals, VFA, ammonia) Modulate feed to digester in line HACCP critical control points Reduce OLR