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3 February 2014

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Dear Rick

Results of Odour Extraction System December 2013 Inspection

This email summarises results from our inspection of the Rendering Plant air extraction system at the Imlay meat works on 12 December 2013.

Inspections are normally made in April or May. On this occasion fire had propagated through dry air ducting from the unground meal bin to the scrubber/humidifier and ID1 fan, exhausting to the uncovered biofilter. A further inspection was requested to check that the extraction system was still performing adequately.

1 Assessment of Extraction System Performance

1.1 Figures and Tables

Figure 1 in Appendix A provides a schematic of the Dry Side, Wet side and Drier air extraction system feeding the biofilters.

Table 1 in Appendix A summarises the measured data for the Drier to Covered Biofilter system in Fig 1.

Table 2A in Appendix A summarises the measured data in the morning of 12/12/13 for the Wet Side to Uncovered Biofilter in Fig 1.

Table 2B in Appendix A summarises the measured data in the afternoon of 12/12/13 for the Wet Side to Uncovered Biofilter in Fig 1. This is after an open hatch at the top of the humidifier/scrubber had been closed.

Table 3 in Appendix A provides an overview of measured data since 2008 for comparison.

1.2 System Description

With reference to Figure 1:

a) Dry Side gas passes through a spray tower (known as the Dry Process heat exchanger) to a common induced draught fan (ID1) which discharges into the uncovered biofilter. The primary function of the spray tower is the humidification of the Dry Side gas flow that might otherwise dehydrate the biofilter and reduce biological activity.

b) Wet Side gas and vapour is cooled in the Wet Process heat exchangers; i.e. Wet Process HX1, HX2 and HX3. After cooling and some water removal, the Wet Side gas passes to the common ID1 fan which discharges into the uncovered biofilter.

c) Drier gas and vapour passes through the Drier Trash Vessel which removes entrained water and then two heat exchangers (Gardiner HX and Potter HX) which cool the gas and vapour and remove condensed water from the gas stream. After cooling and water removal the Drier gas passes to induced draught fan ID2 which discharges to the covered biofilter.

d) Water in the Dry Process humidifier (previously called the Dry Process heat exchanger) is recirculated by a pump (P1) with water make up to balance that discharged to drain.

1.3 Process Measurements

The biofilter gas and vapour systems were characterised by:

Thermocouple readings and pitot tube gas velocity readings taken by removing plugs and inserting instruments at:

- The outlet from the Drier gas fan, ID2.
- The gas ductwork inlet to the Dry Process humidifier.
- The gas outlet ductwork from Wet Process Heat Exchangers HX1, HX2 and HX3, prior to the connection with ductwork from the Dry Process humidifier and prior to the ID1 fan.
- The gas duct outlet ductwork from the ID1 fan.

Static pressure measurements made at the covered biofilter distributor ducting inlet and end.

Indicative pH spot measurement of the biofilter media.

Infiltration airflow into the wet processing area measured when the roller door was open.

1.4 Comments on Flowrates, Pressure and Temperatures

Table 1 shows the results of covered biofilter flowrate and temperature measurements taken during the afternoon of 12 December 2013. This was a quick check as this part of the system had not been affected by the fire.

Table 2A shows the results of the uncovered biofilter flowrate and temperature measurements taken during the morning of 12 December 2013. During this testing it became apparent that airflow into the humidifier/scrubber was lower than expected yet the flow from the ID1 fan to the biofilter was higher than expected. Further investigation of the plant found an open manway hatch at the top of the humidifier tower. Apparently this had been opened by the Fire Service at the time of the fire and not subsequently closed. The hatch was closed and the results in Table 2B obtained.

From the data in Figure 1 and Tables 1, 2A and 2B:

1.4.1 Covered Biofilter Airflow

The air flow to the covered biofilter was 3,000 – 3,100 m3/h or 3.5 – 3.7 tonnes/hour (tph). This was based on measurements taken at the thermowell six metres downstream of the ID2 fan and was the only readily available access into the duct. The measured flow was greater than the flow measured in April 2013. It is understood that tillage of the biofilter bed together with lime addition had been carried out during winter following recommendations in the 27 June 2013 report hence the increased flow is likely due to improved bed permeability. The airflow is adequate but could be higher as is discussed in 1.4.3 Covered Biofilter Media below.

1.4.2 Uncovered Biofilter Airflow

In the first measurements made in the morning, the air flow to the uncovered biofilter was 45,300 – 47,100 m^3/h or 53.9 to 56.1 tph (Table 2A). Measurements were taken at a removable plug eight metres downstream of the ID1 fan. The measured flow was 7% up on what it had been in May 2013. On the upstream side of the fan the flow from the wet process heat exchangers was about the same yet the air flow into the humidifier was only 57% of what it had been. Further investigation of the system then found that a manway on top of the humidifier tower was open (see Fig 4 photo in Appendix A) providing a passage for ingress of around 15,500 m^3/h external ambient air. The manway was closed and subsequent measurement gave the results shown in Table 2B.

The air flow to the uncovered biofilter was 42,400 – 44,100 m^3/h or 47.8 – 50.7 tph in the afternoon after the hatch in the top of the humidifier tower had been closed (Table 2B). The measured flow is similar to what was measured in April 2013. As seen in Figure 1 an average total flow of around 49 tph was made up of 16 tph of Wet Side vapour and 32 tph of Dry Side Gas. The humidifier/scrubber vapour flow is 23% up on what it was in May 2013 with the Wet Side Gas flow being 80% of what it was. As the total flow to the biofilter is similar to what it was, the change is likely due to reduced resistance in the humidifier arising from the loss of the packing in the fire.

Action: If humidifier use is to continue without packing some damper adjustment should be made to increase the flow from the wet side and reduce the dry gas flow to the humidifier.

1.4.3 Humidifier/Scrubber Tower Packing

Following the fire and clean up there was no packing left in the humidifier tower. As seen in Fig 5 in Appendix A only the steel packing support grating and one working spray nozzle remains. It appears that the spray manifold was built for three spray nozzles. From external observation it appears that the most intense heat generation in the fire came from the burning tower packing (see Fig 2). Without having seen any installation records, indications are that the packing had been polypropylene Type 2R Tellerettes, manufactured by Armatec Environmental in New Plymouth. For these to ignite and burn it is believed that there could not have been any water spray discharge onto the packing at the time of the fire upstream.

It was noted that the connection flanges on the balancing dampers in the ID1 fan upstream ducting had been slightly distorted in the fire and need additional bolting and gasket material if necessary to prevent air leakage into the duct.

A thermocouple was able to be inserted through the narrow gap, after the manway hatch at the top of the tower had been closed. This indicated that the effect of the one working spray nozzle was reducing the temperature of the 32 tph airflow by 9.6°C on average, from 30.4°C to 20.8°C.

A question that arises is why does the humidifier tower need packing? The air temperature to the uncovered biofilter without the packing is much the same as it always has been with the packing. Wet side vapours from HX1 – HX3 are typically saturated and around 40°C. This combined with the spray tower 20°C moist air gives a combined stream at around 30°C which is good for going to the biofilter. Possible advantages of using packing may be that the same outlet temperature or less could be achieved with reduced spray water flow and that any residual meal dust in the air is more effectively scrubbed out.

It may also be that the presence of the packing enables the air to get closer to saturation as the moisture content of biofilter media tested averaged around 36% w/w wet basis moisture which is a bit

low. Perhaps hot air from the fire had dried the biofilter bed significantly and it is still returning to its normal equilibrium. Further monitoring of the bed moisture content should be done to check whether the bed is in fact still drying out.

We were asked to provide details of the packing for replacement: The volume to be filled is 2.4m diameter up to a height around 2m i.e. a packing volume of 9 m^3. Armatec currently have polypropylene Type 2R Tellerettes in stock at present and the cost would be $24,480 plus freight. A fibreglass packing support grating would cost $1690 plus freight if the existing grating has to be replaced. Armatec also have 4m^3 of polypropylene pall rings as an alternative which would cost $9792 but these would not be as effective as the Tellerettes. A further alternative would be to use a reduced height of Tellerettes say 1m, this would still give some improvement in gas–liquid contact at lower cost.

Action: Ducting damper flanges need bolt adjustment and gasketting to eliminate inward air leakage.

Manway hatch at the top of the humidifier spray tower needs a new gasket and bolting to eliminate inward air leakage

Non-working water nozzles in the humidifier should be replaced to achieve better water distribution. Reduced water flow can be achieved by selection of lower flow nozzles.

Give further consideration to the need for humidifier tower packing.

1.4.4 Covered Biofilter Media

The covered biofilter was not affected by the fire but as eight action points had been suggested in the June 2013 report, a quick inspection was made:

The media looked dry. Testing showed that bark at the surface had 20% w/w moisture wet basis. However this was only surface dryness and samples further down in the bed all averaged around 50% w/w moisture wet basis which was good. Compared to the media bed in April, the reduced moisture content, the tillage and lime addition has resulted in a much improved bed structure. The air loading on the biofilter of 33 m^3/h of air per m^3 of media is within the recommended range for the type of air[1] and there was no visible sign of smoking.

It is observed that the bed pressure drop is still high. It is understood that in carrying out the tillage there was concern to avoid getting too close to the gas distributor tubing. It seems likely that there is still a hard packed bed zone close to the distributor tubes which is where most of the bed pressure drop is occurring. This could be looked at more closely at the next inspection. In the meantime the bed pressure drop is significantly less than what it was.

It was noted that the broken mortar around the covered biofilter ducting manhole was still broken and a source of gas leakage.

1.4.5 Un-covered Biofilter Media

The moisture content measurements in the uncovered biofilter averaged 37% moisture w/w wet basis and although at the low end of the acceptable range is consistent with normal operation prior to the fire.

[1] Cudmore & Gostomski in “Biotechnology for Odor and Air Pollution Control” Ch.8, Springer, 2005, ISBN 3-540-23312-1

The biofilter loading at 62 m^3/h of air per m^3 of media is within the recommended range for the type of air.

The distributor and media pressure drop (as measured at the test point downstream of the fan) has again decreased slightly since the April 2013 inspection from 55 mm wg to 52 mm wg. The slightly reduced pressure drop may be due to higher porosity arising from drier summer conditions or perhaps heat from the fire removed some obstructions. Current air flow through the bed is good and evenly distributed with the pressure drop being much the same as what it was in 2010.

Action: The media is currently in satisfactory working condition. Tillage of the top part of the bed should be effective for some time yet if bed pressure drop increases.

1.4.6 Rendering Plant Wet Processing Area Ventilation

A check on the air flow into the Wet Processing Area from outside when the roller door was partially open during the morning gave an average air velocity across the doorway in of 2.2 m/s. This velocity was well above the 0.3 to 0.5 m/s minimum capture velocity needed to prevent escape of odour out through the open door.

We trust that the above information is of assistance.

Regards

John Vickerman
Mechanical Engineer.

Appendix A
Figures & Tables

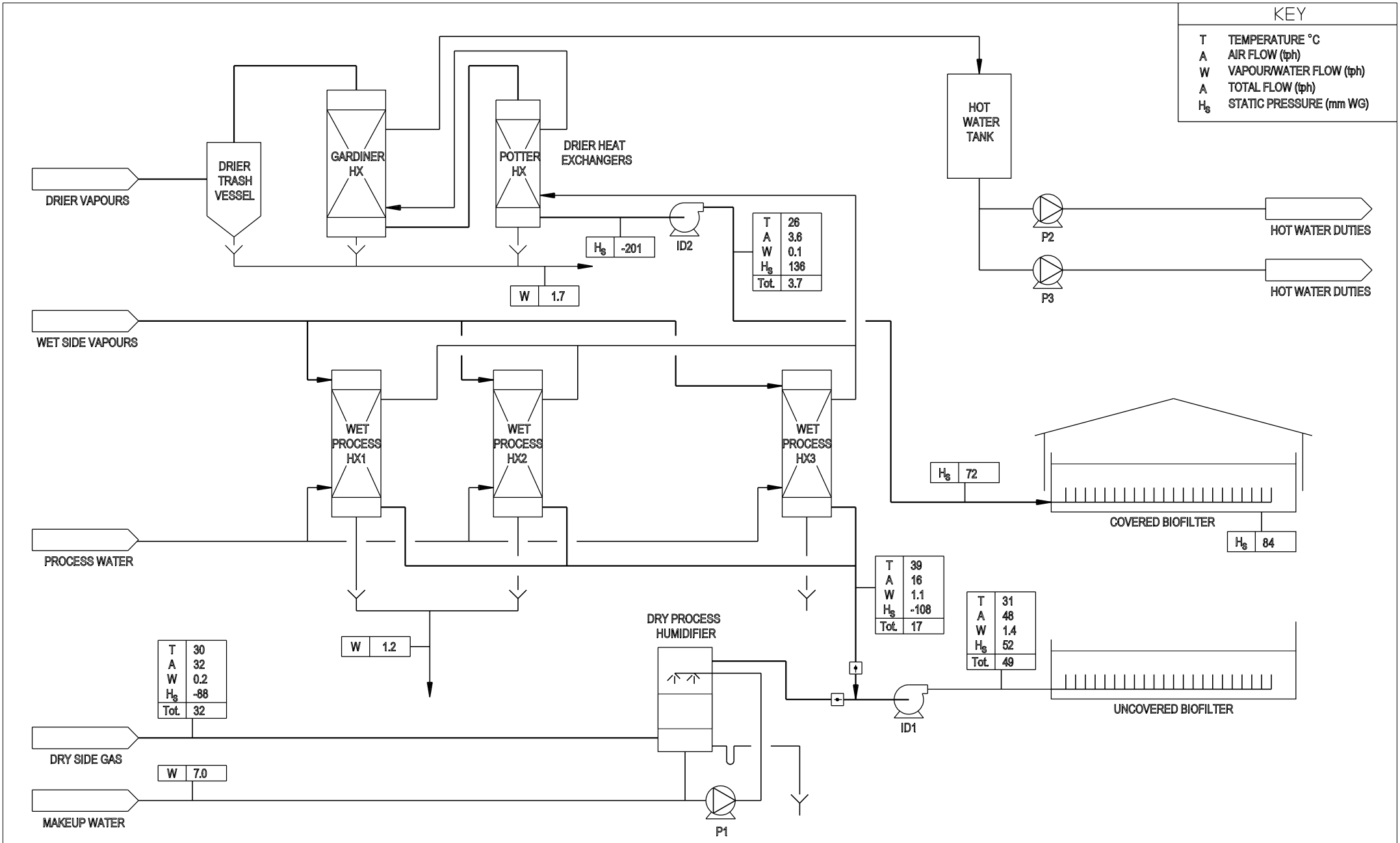


Figure 1. Biofilter Systems at AFFCO, Imlay Plant December 2013

Photographs

Fig 2: Humidifier/Scrubber Tower

Fig 3: ID1 Fan Inlet Plenum

Fig 4: Open Manway

Fig 5: Water Spray

Table 1: AFFCO Imlay - Covered Biofilter

Performance Assessment 12 December 2013
Data gathered between 1500h and 1700h 12/12/13

A Ambient Conditions

On site temperatures (open air)	23	to	29	°C
Humidity (site open air)	47	to	67	%RH
Atmospheric pressure	101.1	to	101.2	kPa
Wind - Light from SW to W, generally	1	to	4	m/s
Occasional wind gusts to maximum around 6 m/s				

B Measured Air Flow to Covered Biofilter

(at thermowell approx 6m downstream of ID2 fan)

	Duct Diameter mm	Static Head mm wg	Dynamic Head pitot mm wg	Air °C	Manometer Water °C	Barometric Pressure kPa	Pitot Coefficient	Duct Moist Air Density kg/m^3	Air Velocity m/s	Air Flow m^3/h	Air Flow kg/s	Air Flow tph
Max Air Flow	302	136	9	25.4	22	101.2	1.00	1.17	12.3	3,168	1.03	3.7
Min Air Flow	302	133	8	26.6	23	101.2	1.00	1.16	11.6	2,995	0.97	3.5

C Covered Biofilter Characteristics

Length	14.8	m
Width	13.0	m
Min media depth	0.5	m
Media bed area	192	m^2
Media volume	96	m^3

Media Moisture Analysis

%w/w (wet basis)

NW		NE
	50.8	
49.8		
SW	*River Side*	SE

Media pH

5.5 - 6.5

D Biofilter Loading

33 m^3/h air per m^3 media

E Duct Static Pressure

ID2 Fan Inlet static head	-201	mm wg
ID2 Fan Outlet static head	136	mm wg
Biofilter inlet static head	73	mm wg
Biofilter end manhole static head	84	mm wg

Table 2A: AFFCO Imlay - Uncovered Biofilter

Performance Assessment 12 December 2013
Data gathered between 0930h and 1300h 12/12/13

A Ambient Conditions

On site temperatures (open air)	20	to	27	°C	
Humidity (site open air)	50	to	63	%RH	(Temperature hotter and humidity lower on north side of rendering plant)
Atmospheric pressure	101.2	to	101.3	kPa	
Wind - Light SW	1	to	4	m/s	
Occasional wind gusts to maximum around 6 m/s					

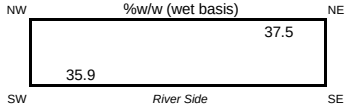
B Measured Air Flow to Uncovered Biofilter At removable plug 8m downstream of fan

	Duct Diameter mm	Static Head mm wg	Dynamic Head PDL pitot mm wg	Air °C	Manometer Water °C	Barometric Pressure kPa	Pitot Coefficient	Duct Moist Air Density kg/m^3	Air Velocity m/s	Air Flow m^3/h	Air Flow kg/s	Air Flow tph
Max Air Flow	898	58	26	19.8	24	101.2	1.00	1.19	20.7	47,141	15.58	56.1
Min Air Flow	898	56	24	20.7	24	101.2	1.00	1.19	19.9	45,292	14.97	53.9

C Uncovered Biofilter Characteristics

Length	36.0	m
Width	35.7	m
Min media depth	0.55	m
Media bed area	1285	m^2
Media volume	707	m^3

Media Moisture Analysis



Media pH 5.5 - 6.0

D Biofilter Loading 67 m^3/h air per m^3 media

E Measured Air flow from Wet Process Heat Exchangers

	Duct Size W x H mm		Static Head mm wg	Dynamic Head PDL pitot mm wg	Air °C	Manometer Water °C	Barometric Pressure kPa	Pitot Coefficient	Duct Moist Air Density kg/m^3	Air Velocity m/s	Air Flow m^3/h	Air Flow kg/s	Air Flow tph
Max Air Flow	645	790	-66	4	41.6	18	101.2	1.00	1.08	8.5	15,603	4.69	16.9
Min Air Flow	645	790	-66	3	39.9	17	101.2	1.00	1.09	7.3	13,458	4.08	14.7

F Measured Air Flow into Dry Gas Scrubber

	Duct Diameter mm	Static Head mm wg	Dynamic Head PDL pitot mm wg	Air °C	Manometer Water °C	Barometric Pressure kPa	Pitot Coefficient	Duct Moist Air Density kg/m^3	Air Velocity m/s	Air Flow m^3/h	Air Flow kg/s	Air Flow tph
Air Flow	702	-31	8	31.2	25	101.2	1.00	1.17	11.6	16,149	5.23	18.8
	702	-32	8	31.8	25	101.2	1.00	1.17	11.6	16,149	5.23	18.8

Table 2B: AFFCO Imlay - Uncovered Biofilter

Performance Assessment 12 December 2013
Data gathered between 1500h and 1700h 12/12/13

A Ambient Conditions

On site temperatures (open air)	23	to	29	°C	
Humidity (site open air)	47	to	67	%RH	(Temperature hotter and humidity lower on north side of rendering plant)
Atmospheric pressure	101.1	to	101.2	kPa	
Wind - Light from SW to W, generally	1	to	4	m/s	
Occasional wind gusts to maximum around 6 m/s					

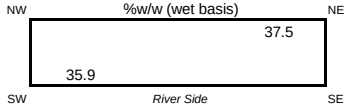
B Measured Air Flow to Uncovered Biofilter At removable plug 8m downstream of fan

	Duct Diameter mm	Static Head mm wg	Dynamic Head PDL pitot mm wg	Air °C	Manometer Water °C	Barometric Pressure kPa	Pitot Coefficient	Duct Moist Air Density kg/m^3	Air Velocity m/s	Air Flow m^3/h	Air Flow kg/s	Air Flow tph
Max Air Flow	898	53	22	29.4	24	101.2	1.00	1.15	19.3	44,111	14.09	50.7
Min Air Flow	898	50	20	32.9	24	101.2	1.00	1.13	18.6	42,360	13.27	47.8

C Uncovered Biofilter Characteristics

Length	36.0 m
Width	35.7 m
Min media depth	0.55 m
Media bed area	1285 m^2
Media volume	707 m^3

Media Moisture Analysis



Media pH 5.5 - 6.0

D Biofilter Loading 62 m^3/h air per m^3 media

E Measured Air flow from Wet Process Heat Exchangers

	Duct Size W x H mm		Static Head mm wg	Dynamic Head PDL pitot mm wg	Air °C	Manometer Water °C	Barometric Pressure kPa	Pitot Coefficient	Duct Moist Air Density kg/m^3	Air Velocity m/s	Air Flow m^3/h	Air Flow kg/s	Air Flow tph
Max Air Flow	645	790	-108	4	39.1	24	101.2	1.00	1.10	8.4	15,473	4.73	17.0
Min Air Flow	645	790	-107	3	39.3	24	101.2	1.00	1.10	7.3	13,400	4.09	14.7

F Measured Air Flow into Dry Gas Scrubber

	Duct Diameter mm	Static Head mm wg	Dynamic Head PDL pitot mm wg	Air °C	Manometer Water °C	Barometric Pressure kPa	Pitot Coefficient	Duct Moist Air Density kg/m^3	Air Velocity m/s	Air Flow m^3/h	Air Flow kg/s	Air Flow tph
Air Flow	702	-88	24	30.2	24	101.2	1.00	1.15	20.2	28,156	8.99	32.4
	702	-87	22	30.7	24	101.2	1.00	1.15	19.3	26,957	8.61	31.0

Table 3: AFFCO Imlay - Rendering Plant Historical Air Extraction Data

	2008	2010	2011	2012	May-13	Dec-13
Drier Vapours						
Fan ID2 inlet static pressure (mm wg)	-312	-302	-290	-285	-228	-201
Fan ID2 outlet static pressure (mm wg)	83	80	101	123	140	136
Fan ID2 outlet air temperature (°C)	27	28	29	22	26	26
Covered Biofilter inlet total pressure (mm wg)	4	13	37	59	97	84
Flow to Covered Biofilter (m^3/h)	3,600	3,700	3,500	3,800	3,000	3,100
Mass flow to Covered Biofilter (tonnes/h)	4.3	4.3	4.1	4.5	3.5	3.6
Biofilter Loading (m^3/h air per m^3 media)	47	42	40	40	35	33
Non-Drier Vapours						
Dry Side Air						
Humidifier Inlet Static Pressure	-83	-83	-77	-95	-98	-88
Humidifier Inlet Temperature (°C)	32	35.1	30.4	24.1	27	30
Inflow to Humidifier (m^3/h)	24,900	20,300	20,700	22,100	22,800	28,000
Mass flow to Humidifier (tonnes/h)	29.2	22.5	23.9	25.9	26.6	31.7
Wet Side Vapours from HX1 - HX3						
Static pressure (mm wg)	-123	-119	-93	-118	-131	-108
Temperature (°C)	35	46.1	43.7	37.5	41	39
Flow (m^3/h)	20,400	20,800	16,600	15,100	19,100	14,400
Mass flow (tonnes/h)	22.5	19.4	17.8	16.6	20.7	15.8
Uncovered Biofilter						
Fan ID1 outlet static pressure (mm wg)	40	56	138	68	58	52
Air temperature to Uncovered Biofilter (°C)	33	22.5	31.5	26.6	32.4	31.2
Flow to Uncovered Biofilter (m^3/h)	44,800	41,300	37,500	39,900	43,500	43,200
Mass flow to Uncovered Biofilter (tonnes/h)	51.7	44.3	43.5	46	49	49
Biofilter Loading (m^3/h air per m^3 media)	63	58	53	56	62	62