Schedule 5 Request for Further Information

Question 1 (d) A demonstration that the odour streams treated by thermal oxidation are suitable for this type of abatement plant based on their chemical speciation. *The combustion plant needs to be protected from incompatible contaminants such as vapour, acid gases and particulates, because contaminants from the process (cooker, non-condensable and other reduction streams) can foul the burner of the combustion plant. This will lead to incomplete combustion and damage the plant, providing ineffective odour abatement. In such cases a pre-treatment device might be needed to remove such pollutants prior to passing the gas through the combustion plant.*

Introduction

It is well documented that that the odour streams from processing animal by-products (ABP) can be treated in a thermal oxidiser designed for this purpose with effective levels of abatement. The gas oxidiser to be installed is the same design as those already in use (within the industry in addition to within the Omega Proteins Ltd business operations) and the technology is already proven. The Biomass Oxidiser has been built to a bespoke design, taking into account the knowledge from the rendering operations and the effective use of the design within other industries.

As described in the document "Summary of BAT Review – P137-R04A-F2" consideration has been given to the Guidance Document for Rendering – SG8 where it is clearly described as BAT to pass the strongest odours through a Thermal Oxidiser. The most relevant paragraphs from the SG8 document are set out below:

BAT 38 **All emissions of substances prescribed for air or offensive odours should be prevented or contained and ducted to suitable arrestment plant as approved by the regulator. Sources at rendering processes which must be dealt with include:**

- **a) odorous emissions arising from the cooker during the cooking process;**
- **b) the intermittent or continuous discharge from cookers;**
- **c) presses or centrifuges receiving hot processed material;**
- **d) driers;**
- **e) ducts and glands on the processing equipment or transfer pipelines;**
- **f) the transfer of processed or semi-processed material.**

BAT 45 **Emissions of differing odour intensity are likely to be produced within the process. In the case of rendering processes, the odour streams should normally be kept separate and treated by appropriate treatment plant which has been suitably designed to deal with specific types of odour. For example, high intensity process odours and those containing incondensable gases should be treated by incineration, either within the plant boilers or a dedicated thermal oxidiser, or by alternative means which can be demonstrated to be equally effective. Less intense odours, for example from storage areas, may be vented to chemical scrubbers, biological filters, or similar suitable arrestment plant.**

BAT 49 **Any new or substantially changed installation should be fitted with odour arrestment equipment at least as efficient as a dedicated thermal oxidiser. All contained high intensity odorous emissions should be directed through such arrestment equipment. Low intensity emissions should be dealt with in the same manner as BAT 54.**

Section 4.3.3.10 of the European BREF Document for Slaughterhouses and Animal By-Products (currently under review) also sets out thermal oxidation as BAT and notes under 'Achieved Environmental Benefits' the following statement:

"Reduced emissions of low volume/high intensity and high volume/low intensity odours to almost 100 % efficiency and the elimination of whole vapour, thus removing the need for it to be treated in the WWTP."

The effectiveness of thermal oxidation is also discussed in detail in the review document ER32 – 'Review of Odour Monitoring and Control Techniques at Rendering Plants', published by Ricardo-AEA in March 2013.

Odour Stream

The odour stream is typically made up of Volatile Organic Compounds (VOCs), ammonia, hydrogen sulphide and organic sulphides (such as amines and mercaptans). The temperature of the combustion chamber is set so that it is higher than the auto-ignition point of the volatile compounds. The auto-ignition temperature range for the majority of VOCs is 537 – 760 °C. Other compounds are in a similar range such as ammonia 651 °C, methylamine 430 °C , or lower such as hydrogen sulphide at 232 °C.
The normal operating range of the oxidisers is 850- 900 °C therefore ensuring destruction of a wide range of compounds.
Acid gases are of more significance with municipal waste incineration than odour abatement for animal by-products. A review of emissions testing results from within the business shows that levels of gases such as hydrogen chloride are very low. The levels of sulphur dioxide vary depending on the levels of sulphur compounds in the odour stream. A review of levels monitored within the rendering industry is shown in Figure 2.

Figure 1 *Example Category 1 ABP Emissions Results 2018 from Thermal Oxidiser*

where MU = Measurement Uncertainty associated with the Result

	Concentration				Mass Emission			
Parameter	Units	Result	MU +/-	Limit	Units	Result	MU +/-	Limit
Total Particulate Matter [1]	mg/m³	4.2	0.28	-	g/hr	178	18.9	-
Hydrogen Chloride [1]	mg/m³	0.41	0.03	-	g/hr	17.4	1.9	-
Hydrogen Sulphide [1]	mg/m³	< 1.1	0.22	-	g/hr	< 47.0	10.1	-
Ammonia [1]	mg/m³	1.0	0.16	-	g/hr	42.5	7.7	-
Sulphur Dioxide [1]	mg/m³	175	13.1	-	g/hr	7463	825	-
Total Amines [1]	mg/m³	< 0.75	0.15	-	g/hr	< 31.8	6.9	-
Diethylamine [1]	mg/m³	< 0.15	0.03	-	g/hr	< 6.36	1.37	-
Dimethylamine [1]	mg/m³	< 0.15	0.03	-	g/hr	< 6.36	1.37	-
Ethanolamine [1]	mg/m³	< 0.15	0.03	-	g/hr	< 6.36	1.37	-
Methylamine [1]	mg/m³	< 0.15	0.03	-	g/hr	< 6.36	1.37	-
Trimethylamine [1]	mg/m³	< 0.15	0.03	-	g/hr	< 6.36	1.37	-
Amides [1]	mg/m³	< 5.0	1.0	-	g/hr	< 214	46.1	-
Total Mercaptans [1]	mg/m³	< 0.0051	0.0010	-	g/hr	< 0.22	0.05	-
Ethyl Mercaptan [1]	mg/m³	< 0.0009	0.0002	-	g/hr	< 0.04	0.01	-
Methyl Mercaptan [1]	mg/m³	< 0.0034	0.0007	-	g/hr	< 0.15	0.03	-
N-Butyl Mercaptan [1]	mg/m³	< 0.0009	0.0002	-	g/hr	< 0.04	0.01	-
Total VOCs (as Carbon) [1]	mg/m³	2.2	0.30	-	g/hr	96.1	15.3	-
Oxides of Nitrogen (as NO_2) [1]	mg/m³	133	4.6	-	g/hr	5680	502	-
Oxygen % v/v Wet 6.7	% v/v	Dry 9.8	0.32					
Water Vapour	% v/v	31.6	1.5					
Stack Gas Temperature	°C	296						
Stack Gas Velocity	m/s	18.5	1.2					
Volumetric Flow Rate (ACTUAL)	m³/hr	88395	7172					
Volumetric Flow Rate (REF) [1]	m³/hr	42609	3457					

NOTE: VOLUMETRIC FLOW RATE & VELOCITY DATA TAKEN FROM AN AVERAGE OF ALL OF THE ISOKINETIC RUNS.

[1] Reference Conditions (REF) are: 273K, 101.3kPa, without correction for water vapour content.

Figure 2 *Review of Rendering Sites with Thermal Oxidisers Using Natural Gas as Fuel*

No of Sites Reviewed	ELV Set in Permit (mg/m^3)		Range of Results (mg/m^3)	
	NO_x	SO_x	NO_x	SO_x
12	4 sites 14/300/800/1100	3 sites 10/175/200	100 – 800	50-550

The key parts of the process are:

- Temperature of operation
- Role of the effluent fan (which is an integral part of the oxidiser)
- The collector vessel (and importantly the suction pressure to maintain a vacuum)
- The design of the combustion chamber to create a strong mixing effect
- The control of the combustion of the fuel to ensure the maintenance of combustion temperature, mixing and residence time (Time – temperature – turbulence are three key things for good oxidiser performance).

System controls (PLC controlled) modulate the flows to balance combustion, extraction from the cookers and the demand for fuel to regulate the thermal destruction of the odour stream.

Protection of Combustion Plant / Burner

To ensure that the combustion plant is protected, the oxidisers are designed so that the burner head itself does not come into direct contact with the effluent and that the temperature in the chamber is high enough to vaporise the odour stream and prevent condensation.

To prevent solids being carried over the following are part of the design:

- Drop out pots (acting as interceptors) on top of the cookers will take out larger particulates, fat particles.
- A collector vessel is in place before the effluent stream reaches the oxidiser, the effect of gravity also removes particles.
- Effluent is injected into the combustion chamber at a high velocity which aids dispersion and mixing.
- Provision for filtering the Combustion air / effluent stream if required (dependent on the composition of the effluent stream and not always required).
- Foul air is pre-heated to aid the combustion process and reduce the risk of condensation.
- All parts coming into contact with the effluent stream are made of stainless steel to prevent corrosion.

Regular preventative maintenance is carried out to ensure the burner units remain in good condition.

Details of the oxidiser design and control of emissions are detailed in the application document - OP-PV-R01Cv2.0 Installation Information MFO.

Monitoring Combustion and Effectiveness

The combustion chamber temperature cannot be maintained if combustion is incomplete, therefore this is continuously monitored. There are alarm systems in place (including automatic shutdown) if the combustion chamber temperature drops below 850^0C to ensure that the odour streams are not passed through for treatment unless the required temperature has been reached. The mechanism for this is covered in the Odour Management Plan.

Results from the monitoring of CO and O2 in the stack exhaust emissions can also be used to demonstrate fuel is burnt efficiently.

Results for Odour Removal

Annual odour testing is not a permit requirement, the most recent results for the site are from 2016 (tests carried out by Envirocare) and compare favourably with industry benchmark figures:

Outlet results in OU_E/Nm^3 for the existing oxidisers were 2,410 and 1,392.

As part of the commissioning for the new oxidisers the odour testing will be carried out to ensure the abatement continues to be effective and to confirm the modelling done to date.

References

- Sector Guidance Note IPPC SG8 – For the A2 Rendering Sector
- Integrated Pollution Prevention and Control Reference Document on Best Available Techniques in the Slaughterhouses and Animal By-products Industries May 2005
- ER32 Review of Odour Monitoring and Control Techniques at Rendering Plants - Ricardo-AEA (March 2013).
- Babcock Wanson Thermal Oxidisers DEO Type – Odour Abatement for Animal By-Product Plants Process Description