30 July 2012

Mr Brian Hanley
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Dear Brian,

ODOUR EMISSIONS FROM CONTINOUS AND BATCH FERMENATION

1 INTRODUCTION

A comparison is presented between the total odour emissions released during continuous and batch fermentation process.

When fermentation was operated as a continuous process, odour emissions were relatively constant, released from the tanks during the fermentation process. Emissions from tank filling would only occur intermittently, when fermentation tanks are drained for cleaning and subsequently refilled.

Fermentation is now run as a batch process which takes approximately 45 hours / batch. Emissions to air occur during tank filling (direct release to air) and during fermentation (released via the ethanol recovery scrubber vent). The fermentation tanks are batch filled (sequentially one by one) and filling takes approximately 9 hours. For the first 4.5 hours the discharge is released directly from the tank vent, after which time the discharge switches to the ethanol recovery scrubber. For the remaining 4.5 hours of tank filling, there is no direct venting to air, until such time as the next tank is filled at the end of the 9 hour period. The discharge from the ethanol recovery scrubber occurs continuously during the fermentation process. No emissions occur during tank emptying.

2 ODOUR MEASUREMENTS

To compare the difference in odour emissions from a continuous and batch process, Shoalhaven Starches have commissioned Stephenson Environmental Management Australia (SEMA) to take odour measurements from the fermentation process, as follows:

- **Tank Filling Emissions - Batch Process**: Odour samples taken for tank filling at various fill volumes (10%, 20%, 30%, 40% and 50%.
- **Fermentation Emissions – Batch Process**: Samples taken during fermentation at the ethanol recovery scrubber outlet (represent odour emissions during fermentation after passing through the scrubber).
- **Fermentation Emissions – Continuous Process**: Odour samples taken during fermentation at the ethanol recovery scrubber inlet (representative of odour emissions produced during fermentation prior to passing through the scrubber - released directly to air in continuous process).

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A summary of the odour monitoring results are provided in **Table 2.1** and **Table 2.2**. Odour measurements were taken at an ethanol production rate equivalent to 250 ML/annum.

Table 2.1: Odour Monitoring Results – Tank Filling

Sample Type	Odour Concentration (OU)
Fermenter 10% Fill	10,000
Fermenter 20% Fill	12,023
Fermenter 30% Fill	8,318
Fermenter 40% Fill	16,596
Fermenter 50% Fill	10,000
Average	**11,387**

Table 2.2: Odour Monitoring Results – Fermentation

Sample Type	Odour Concentration (OU)
CO_2 Scrubber Inlet	22,909
CO_2 Scrubber Inlet	16,596
Average	**19,753**
CO_2 Scrubber Outlet	9,886
CO_2 Scrubber Outlet	9,120
Average	**9,503**

3 ODOUR EMISSION RATES

Odour emission rates (OERs) have been calculated for both a batch and continuous process and presented for comparison in **Table 3.1**.

OERs were derived as follows:

- OERs for tank filling for the batch process have been calculated based on a volume of displaced air during the first 4.5 hours (i.e. to 60% fill) of 1,680 m^3. Note: after 4.5 hours filling emissions are directed to the scrubber.
- OERs for the ethanol scrubber have been estimated by SEMA based on the measured flow rate at the time of sampling.
- OERs for fermentation emissions (continuous process) have been calculated by SEMA based on the measured flow rate at the time of sampling.

Table 3.1: Derived Odour Emission Rates

Description	Odour Emission Rate (OER) (OU.m^3/s)
Batch Process	
Fermenter Tank Filling	1,181
Emissions from CO_2 /Ethanol Scrubber	16,153
Total OER for Batch Process	**17,334**
Continuous Process	
Total OER for Continuous Process	**29,732**

Note: we have not allowed for filling emissions for the continuous process. This would occur when tanks are drained for cleaning and subsequently refilled.

4 DISCUSSION / CONCLUSION

A comparison between total odour emission rates ($OU.m^3/s$) between a continuous and batch process indicates that odour emissions are reduced by moving to a batch process. Although the sequential tank filling required for the batch process results in additional odour emissions, the installation of an ethanol recovery scrubber reduces emissions generated during fermentation by over 50% and offsets the additional odour emissions produced during tank filling.

Recent odour dispersion modelling was performed to predict ground level concentrations (glcs) of odour for the 300 ML/annum ethanol production scenario, which included a representation of the batch fermentation process (**PAEHolmes, 2012**). For modelling purposes it was conservatively assumed that emissions during tank filling were continuous (there would be 4.5 hours for each tank filling event where no venting would occur). The results of these modelling predictions are shown in **Table 4.1** and indicate there is no measureable increase in odour for 300 ML/annum, incorporating a batch process.

Table 4.1: Predicted Odour Concentration (OU, 99th Percentile, nose response average)

Scenario Description	Bomaderry (R1)	North Nowra (R2)	Nowra (R3)	Terara (R4)
300 ML/annum				
All Sources	4.7	2.6	5.3	5.1
Factory Only	4.7	2.5	5.2	5.1
240 ML/annum				
All Sources	4.8	2.6	4.9	5.1
Factory Only	4.6	2.5	4.9	5.1
126 ML/annum				
All Sources	4.7	2.3	4.7	5.1
Factory Only	4.6	2.3	4.7	5.1

5 REFERENCES

PAEHolmes (2012) "Odour Audit for Operating at 300 ML/annum Ethanol Production", 4 April 2012.