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-Statement-

Odour Potential of Solid Digestate for composting activity – odour risk rating assessment

INTRODUCTION

When assessing the impact of an odour in a particular context, there are several factors which influence the extent to which communities may be adversely affected including frequency, intensity, duration, offensiveness and location of the odour events.

Composting in Queensland is an environmentally relevant activity (ERA) meaning that composting facilities are regulated by the state and require an Environmental Authority to operate. Composting falls under ERA 53(a) which previously focused on composting but has been recently updated to include anaerobic digestion under ERA 53(b) and is now entitled 'Organic material processing'. This is part of a broader suite of waste-related ERA reforms which are being implemented – the change to ERA 53 commenced in November 2018.

As part of the composting activity 53(a), KALFRESH is looking to utilise separated, solid digestate from the activity 53(b) as one of their feedstocks. Based on long-standing experience of WELTEC BIOPOWER GMBH biological specialist, the below assessment of odour risk rating of separated digestate has been determined. The biological specialists have utilised the Recognised Entity Reports and the risk score rating as per methodology in Section 6 of the Phase 2 report to determine the odour risk.

OVERVIEW

In general, anaerobic digestion is considered to be suitable to reduce the odour of feedstock by turning volatile organic compounds into biogas and therefore minimising the odour potential for the remaining digestate.

Biogas plants engineered by WELTEC BIOPOWER GmbH are designed with a **long hydraulic retention time** (HRT) to keep the organic feedstocks as long as possible inside the digester and the covered storage tank. Through this design aspect, almost all biological degradable compounds like carbohydrates (C) and proteins are converted into biogas. Hence, the residual gas potential of the digestate will be minimised and potential odour emission magnificently reduced.

Furthermore, odour intensive compounds like sulphur are removed through the anaerobic digestion process from the feedstocks and accumulated as hydrogen sulphide in the biogas. Therefore, the sulphur concentration in the remaining digestate will be significantly reduced.

ASSESSMENT OF SOLID DIGESTATE

Feedstock of the KALFRESH composting plant will be green waste, digestate solid fraction, vegetable food waste and mushroom substrate.

The following assessment will determine the odour risk rating of the solid digestate using the Recognised Entity Reports and the risk score rating as per methodology in Section 6 of the Phase 2 report. The methodology is using five different Factors (A-E) and the following formula to determine the overall score.

Factors

- Factor A: Putrescible content – the extent to which the material contains readily biodegradable solids or high concentrations of dissolved organics (e.g. sugars) which are likely to decompose rapidly, enhanced by the moisture content of the material (see Table 38)
- Factor B: Concentration – the extent to which the relevant odour contributing components are concentrated (or diluted) within the raw material, potentially compounding their impact (Table 39)
- Factor C: Nitrogen content of the feedstock (Table 40)
- Factor D: Sulphur content of the feedstock (Table 41)
- Factor E: Content of fats, oils and proteins within the feedstock (Table 42).

Formular

$$\text{Total odour contribution potential score} = A \times B \times (C + D + E) \quad (1)$$

Risk ranking score

Score	Odour Risk Category
0	none
1 to 7	Low
8 to 14	Medium
15 to 30	High
31 +	Very high

<table>
<tr><th>Factor</th><th>Category</th><th>Solid Digestate Rating</th><th>Explanation</th></tr>
<tr><td>A</td><td>Table 38: Putrescible content scores (Factor A)<table><tr><th>Score</th><th>Definition</th></tr><tr><td>0</td><td>Very low or zero carbon content overall (i.e. inert materials) and no other significant odour contributing compounds.</td></tr><tr><td>1</td><td>Low content of readily degradable solids with carbon present as slowly degradable or non-biodegradable organic matter, and usually with low moisture content and little or no dissolved organics.</td></tr><tr><td>2</td><td>Moderate content of degradable solids and moisture, and/or dilute dissolved organics if in liquid form.</td></tr><tr><td>3</td><td>High content of dissolved or readily degradable solids, likely to decompose and turn putrid rapidly, and likely to arrive at a composting facility in anaerobic state. Particularly where no pre-treatment or digestion has occurred.</td></tr></table></td><td>1</td><td>Readily biodegradable solids (carbohydrates, proteins) or dissolved solids (volatile organic compounds) will be significantly reduced through anaerobic digestion and converted into renewable biogas.

• Long hydraulic retention time inside the digester and storage tank
• Known feedstock source and mix
• Process monitoring of anaerobic digester for optimum conditions</td></tr>
<tr><td>B</td><td>Table 39: Concentration factor (Factor B)<table><tr><th>Score</th><th>Definition</th></tr><tr><td>1</td><td>Odour contributing components are already present in low concentrations or in diluted form in the unblended feedstock, such as weak effluent solutions.</td></tr><tr><td>2</td><td>Odour contributing components are present in moderate concentrations, mostly naturally occurring levels – not particularly diluted, nor concentrated.</td></tr><tr><td>3</td><td>Odour contributing components are present in very concentrated and readily available form.</td></tr></table></td><td>1</td><td>Feedstock mix for anaerobic digester plant with overall low odour potential.

Odour reduction through Anaerobic digestion process.</td></tr>
</table>

<table>
<tr>
<td>C</td>
<td>
Table 40: Nitrogen content scores (Factor C)
<table>
<tr><th>Score</th><th>Definition</th></tr>
<tr><td>1</td><td>Low or virtually zero content of nitrogen in any form.</td></tr>
<tr><td>2</td><td>Moderate content of nitrogen.</td></tr>
<tr><td>3</td><td>High content of nitrogen in concentrated solid / sludge form (e.g. dewatered sludges, animal manures) or in concentrated chemical form (e.g. chemical fertiliser residues), particularly if nitrogen is present as ammonia / ammonium.</td></tr>
</table>
</td>
<td>2</td>
<td>Optimised C to N ratio for optimised biological process reduces the production of odour intensive nitrogen compounds.

Reduced nitrogen concentration in separated digestate through liquid/solid separation. Note: Vast majority of N will stay in the liquid digestate in form of NH_4^+.</td>
</tr>
<tr>
<td>D</td>
<td>
Table 41: Sulphur content scores (Factor D)
<table>
<tr><th>Score</th><th>Definition</th></tr>
<tr><td>1</td><td>Low or virtually zero content of sulphur in any form.</td></tr>
<tr><td>2</td><td>Moderate content of sulphur.</td></tr>
<tr><td>3</td><td>High content of sulphur in concentrated solid / sludge form (e.g. dewatered sludges) or in concentrated chemical form (e.g. gypsum), particularly if already present in reduced form (sulphides).</td></tr>
</table>
</td>
<td>2</td>
<td>Moderate sulphur content as odour intensive compounds like sulphur are removed through the anaerobic digestion process from the feedstocks and accumulated as hydrogen sulphide in the biogas. Therefore, the sulphur concentration in the remaining digestate will be significantly reduced.</td>
</tr>
</table>

<table>
<tr>
<td>E</td>
<td>
Table 42: Fats, oils, protein content scores (Factor E)
<table>
<tr><th>Score</th><th>Definition</th></tr>
<tr><td>1</td><td>Low or virtually zero content of fats, oils or proteins.</td></tr>
<tr><td>2</td><td>Moderate content of fats, particularly if derived from vegetable sources or digested fats and proteins (e.g. biosolids, animal manures)</td></tr>
<tr><td>3</td><td>High content of fats and proteins derived from animals and animal products, high content of volatile oils and greases</td></tr>
</table>
</td>
<td>1</td>
<td>Fats, oils, or proteins can be categorised as readily available organic compounds. These substances are easily accessible for the anaerobic digestion bacteria and will be converted fully into biogas.</td>
</tr>
</table>

RESULT

Based on the above assessment of each individual category the following odour risk score for solid digestate can be calculated:

Total odour contribution potential score = A x B x (C + D + E) = 1 x 1 x (2+2+1) = **5 (LOW)** (2)

Risk Ranking Scores	Odour Risk Category	Description
1 to 7	Low	Feedstocks may contain slowly biodegrading organic matter with low nitrogen (high C:N ratio) and/or trace concentrations of chemicals which may contribute to odour. Considered to be generally uncontaminated, other than physical impurities or trace chemical contaminants. Low risk feedstocks can be used in composting with minimal controls. Solid biomass residues can be used as bulking agents and have a beneficial impact on odour management when blended with other odorous streams. Low potential odour contribution feedstocks include: • Agricultural or forestry biomass materials such as cane residue, straw, saw dust, mulch, bark, or wood chips • Carbon containing but dilute effluents and waste waters • Storm and washdown waters with trace hydrocarbon levels. Of the feedstocks assessed, 37 were scored as 'Low' potential odour contribution.

The solid fraction of the digestate can be compared to filter cake and presses, but with a reduced odour risk as available organic compounds have been reduced through anaerobic digestion. According to ACARDIS – critical evaluation of composting operations and feedstock suitability; Phase 2 – contamination (Queensland Department of Environment and Science, Contract DES18070; 2019) Chapter 6.1.4 table 46 filter cake and presses feedstock is classified as follows:

Type	Feedstock material	Assumed source / nature	Odour Factors	Odour Contribution Potential	Feedstock Classification	Controls
Industrial residues	Filter cake and presses	Concentrated waste streams from water treatment in a filter press. Source industry unknown.	- unknown composition / source - assume organic content	Medium	2 – Suitable in composting with standard controls	Composition analysis, appropriate blending rates

For solid digestate from the KALFRESH anaerobic digestion system, the following classification has been recommended:

Type	Feedstock material	Assumed source / nature	Odour Factors	Odour Contribution Potential	Feedstock Classification	Controls
	Solid Digestate	Separated solid digestate from an anaerobic digestion plant with known input material	- known composition/source - assume low volatile organic content	Low	2 – Suitable in composting with standard controls	standard composting best practice

The risk ranking exercise indicates that the solid digestate can be rated as a low odour contributing material. These material mediums should generally be manageable in terms of odour risk, provided standard operational controls are in place such as appropriate blending.