# NPT (RECYCLING) LTD

# CRYMLYN BURROWS SITE

# ASSESSMENT OF BIO-FILTER ODOUR CONTROL UNIT.

OCTOBER 2013









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## Findings

The findings and conclusions of this report are based on the experience and odour findings (if any) that are found on the day of the survey, at which time, as far as was possible to ascertain, the facility was operating normally. Any departure from normal operating conditions or variation in weather conditions and process flows could have an effect upon the composting process and associated odour control system and hence could alter the findings of this report.

## Document Revisions

| Ref | Details | Date |
|---|---|---|
| R001 | Original, DRAFT | 31/10/2013 |
| R002 | Original, FINAL | 05/11/2013 |

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**Report for:**

Neath Port Talbot (Recycling) Ltd
Material Recovery & Energy Centre,
Crymlyn Burrows,
Swansea
SA1 8PZ

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OCTOBER 2013


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# Executive Summary

## Introduction

### Description of the site and surrounding area

The NPT (Recycling) Ltd Materials Recycling and Energy Centre is located in Crymlyn Burrows to the East of Swansea, South Wales. The site is bordered to the south and west by commercial and industrial premises, to the north by a Nature Reserve (Crymlyn Bog) and to east by waste ground and further industrial premises. The nearest residential receptor in the vicinity of the facility are located on Elba Crescent and Baldwins Crescent, situated approximately 300 to 350m to the south of the site.

### Overview of site activities

The facility receives approximately 110,000 tonnes per annum of domestic refuse (primarily one-weekly collection black bin bag waste), as well as small quantities of recyclable materials and green waste.

In a dedicated waste reception building refuse is delivered by road vehicle and initially tipped onto the floor where it is piled up by loading shovel prior to being moved by crane grab into a hopper feeding a 300mm shredder. The shredded waste then passes along a short open conveyor (with metals removal belt) onto a separate area of the floor. The shredded materials are then moved by loading shovel into a hopper which transfers shredded waste into the processing building via open conveyor. Oversize materials are removed prior to shredding and stored in a dedicated area of the building.

Within the reception building 2 No. bays are used for the receipt and bulking up of biodegradable bagged kitchen waste, which is typically despatched by road vehicle within 24 hours.

In the processing building, shredded waste from the reception building arrives via an enclosed inclined section of conveyor to a hopper (enclosed and served by local extraction) and then passes along a short open conveyor to an enclosed rotary screen (served by local extraction).

Waste falls from 3 No. sections of the rotary screen through enclosed hoppers to 3 No. enclosed conveyors (sub 80mm, 80-150mm and >150mm) which run through the processing building.

Materials on the sub-80mm line pass through a ferrous metal removal belt and an eddy current separator which removes remaining metals etc. to a skip via an open conveyor which has an extraction point above. The remaining materials pass through an enclosed hopper (served by local extraction) to an open skip.

The 80-150 mm and >150mm lines pass through a sorting cabin (which is rarely in use) after which the 80-150mm materials conveyor passes through an eddy current separator and then combine with the >150mm conveyor (both open) to a short common conveyor. This common conveyor transfers waste through a metals removal belt and then into enclosed 100mm and 65mm shredders and finally through an eddy

current separator. Materials are then transferred along an open conveyor up to an elevated enclosed conveyor which directs materials either down onto an enclosed conveyor which transfers it (via enclosed densifiers) through a disused green waste processing room and into the RDF building for storage prior to incineration, or alternatively along an enclosed conveyor into the compost building.

5 No. waste storage bays within the processing building are used for the storage of waste materials from plant cleaning operations.

In the fuel preparation ("composting") building, waste from the processing building is delivered by open conveyor which runs along the top of 9 No. enclosed composting vessels, and is deposited onto the floor prior to loading into the tunnels by loading shovel.

The composting vessels are used to pass the waste materials through a drying cycle, and are served by forced aeration and air extraction systems. On days 1 to 5 or 6 the materials heat up naturally (to around 50 to 60°C) and air in the tunnel is predominantly recirculated (although a small proportion of "fresh" from within the composting building is also added). From days 6 to 11 a higher proportion of fresh air is introduced and the materials are cooled prior to emptying. Air extracted from each tunnel is conveyed along a common exhaust duct via 2 No. bio-filter fans and passed through a humidifier to a bio-filter odour control unit.

Internal building air from the composting building is extracted via ceiling mounted ductwork along an inlet air channel from which "fresh" air can be drawn into each tunnel. At the end of the inlet air channel a bypass valve allows the transfer of any unused "fresh" air into the bio-filter fans. Each tunnel also has an outlet valve to a common "exhaust channel" which is extracted by the 2 No. bio-filter fans.

Following completion of the composting cycle the dried materials are emptied from a tunnel by loading shovel, deposited into a hopper and short open conveyor to a 30 mm screen and further conveyor which deposits the materials onto the floor. Materials are then loaded into road trailers within the building for dispatch offsite.

## Purpose of this report

Neath Port Talbot (NPT) Recycling Ltd commissioned Odour Services International Ltd. to carry out an assessment of the current status and operation of the bio-filter odour control unit that provides the principal odour control function for the composting process at the facility.

The overall objectives of the assessment were as follows:

- To subject the wood-chip media currently installed in the bio-filter odour control unit physical and micro-biological testing to determine its current status.
- To estimate remaining working life for the bio-filter odour control unit wood-chip media.
- To review the operation of the bio-filter odour control unit and make recommendations to ensure the unit is operationally robust and able to reliably meet the required odour removal performance

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# Key Findings of this report

The key findings of this report are as follows:

- The overall process design for the wood-chip media bio-filter odour control unit is in line with accepted industry standards for such applications.
- There are problems with the design and implementation of the bio-filter irrigation system leading to unsatisfactory wetting of wood-chip media. This is impacting on airflow distribution through the bio-filter and odour removal efficiencies.
- Despite the irrigation problems, the wood-chip media is in relatively good physical condition given its age (approximately 3 years).
- Despite the irrigation problems, the wood-chip media is in relatively good microbiological condition although excessive amounts of fungal species were noted. The required microbial balance should be restored once correct irrigation is achieved.
- OSIL recommend that the existing irrigation system be replaced with a system of headers equipped with full cone pattern spiral spray nozzles located to provide overlapping spray areas across the entire bio-filter surface and to ensure that the entire media bed is correctly wetted. The irrigation duration and interval should then be optimised to ensure correct penetration into the bed and minimise drying out between irrigation phases.
- The performance of the wood-chip media bio-filter odour control unit is currently likely to be less than the original process design in terms of odour removal efficiency and this has been confirmed by recent Air Spectrum Environmental Ltd Odour Sampling and Assessment report issued 19/08/13, whereby the unit was reported to achieve a 73.7% reduction in incoming odour to give an outlet odour level of 2,366 $OU_e/m^3$.
- Subject to improvements to the irrigation system and subsequent operational optimisation OSIL estimate that the remaining media life is up to 3 years and that the bio-filter can then reliably achieve industry standard performance for wood-chip media bio-filter odour control units in such applications.

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# Contents

# 1. Scope of Assessment

The overall objectives of the assessment were as follows:

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- To estimate remaining working life for the bio-filter odour control unit wood-chip media.
- To review the operation of the bio-filter odour control unit and make recommendations to ensure the unit is operationally robust and able to reliably meet the required odour removal performance

# 2. Description of Existing System

**Odour Control Unit (bio-filter)**
The odour control unit serving the composting process is a wood-chip media bio-filter having overall surface dimensions of approximately 50 m x 13 m and an estimated current bed depth of 1.7 m.

The approximate media volume is calculated as 50 m x 13 m x 1.7 m = 1,105 $m^3$

The current media was installed approximately 3 years ago and total ordered volume = 1,350 $m^3$.

Odorous air from the composting process initially passes through a humidifier and then enters the bio-filter via a plenum floor void below the unit. It is then extracted through the bio-filter by ventilation fans prior to discharge to atmosphere via exhaust stack.

The bio-filter is divided into two approximately equal sections with separate irrigation systems for each half. Each section is irrigated separately on a timed interval with the irrigation of the second section following on immediately after the first

**System Ventilation Fans**
The installed fans are Orcon type SQR 36 with 15 kW motors which have a stated maximum capacity of 40,000 $m^3/h$ at 800 Pa pressure. Previous testing by OdourNet reported in May 2010 confirmed that the measured bio-filter outlet airflow varied between 13,680 $m^3/h$ and 76,572 $m^3/h$.

# 3. Methodology

**Site visit**

- Site visit by Dr Corby Lee on 17/09/13 to obtain samples of bio-filter odour control unit wood-chip media and carry out visual assessment of bio-filter and its operation.

**Qualitative analysis of wood-chip media samples**

- Visual and odour assessments of each sample were carried out by Mr Matt Wilkes and a qualitative assessment made for each sample based upon 20+ years of experience within the odour control industry.

**Laboratory analysis of wood-chip media samples**

- Moisture content and microbiological assessments of each sample were carried out by Dr Wan Li Low using OSIL standard methodologies.

# 4. Findings

## Site visit

*Structure*

The bio-filter is a concrete constructed unit segregated into two approximately equal area sections by a central diving wall. The bio-filter is fully enclosed with access to the surface of the bio-filter bed via a single doorway. The lack of lighting inside the bio-filter prevented any usable photos being taken.

*Media*

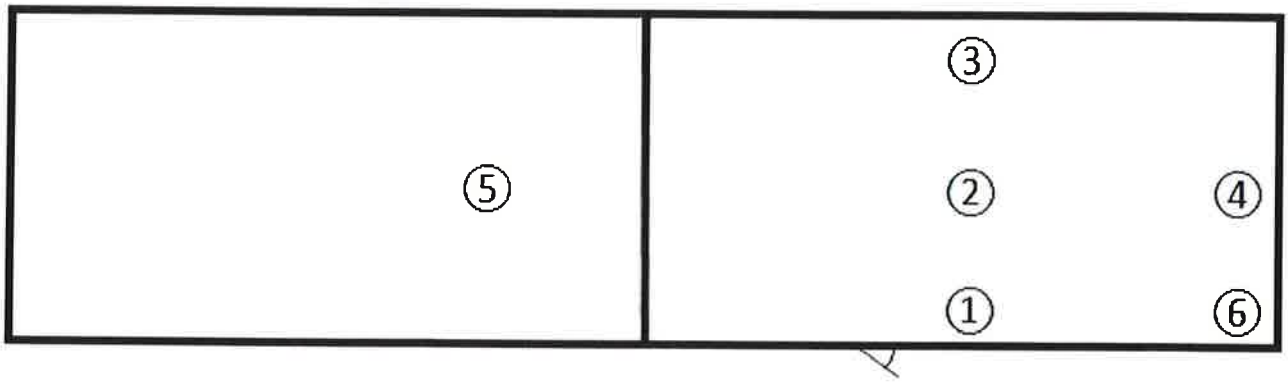
The media is a graded woodchip media installed on top of the plenum floor. The current media depth is estimated at 1.7 m based upon overall bio-filter depth of 2 m and an ullage depth at the top of the bio-filter of approximately 0.3 m.

Overall the media appeared to be evenly distributed with some evidence of minor "ponding" / local depression in level. These depressions coincided with areas of high moisture content

In all locations checked, the media appeared to be compacted suggesting that no media turning had been undertaken since its initial installation (believed to be late 2010).

Visual inspection of the bio-filter surface indicated that expansive patches of the media surface were extremely dry. In comparison, other areas of the bio-filter surface appeared relatively moist and in some cases the surface media was fully saturated to such a degree than on walking on these section the author would sink into the media to a depth of at least 100mm. These observations are indicative of non-heterogeneous flow distribution and moisture control within the bed. Bearing in mind that the air presented into the base of the bio-filter would preferentially pass through these dry areas this potentially limits the odour removal efficiency of the bio-filter

A total of 6 No. sub-surface samples of wood-chip media were taken from the following locations for subsequent analysis off-site (① etc. represents sample number):

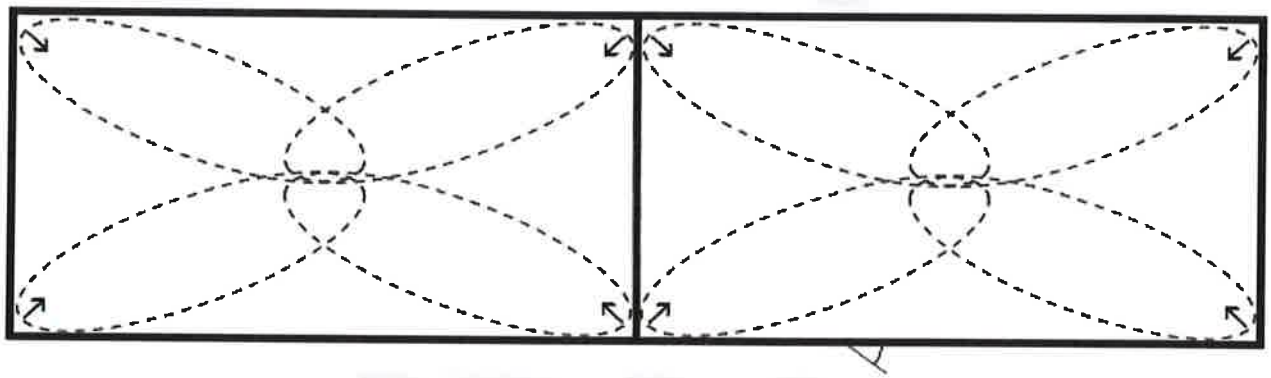


Initial on-site visual assessment of each samples moisture content was as follows:

- Sample 1 = Dry
- Sample 2 = Saturated
- Sample 3 = Moist
- Sample 4 = Very dry
- Sample 5 = Saturated
- Sample 6 = Wet

*Irrigation*

The bio-filter has an irrigation system consisting of a "ring main" of DN25 pipe and hose feeding to a total of 8 No. oscillating "golf course" type sprinklers, one located on each corner of the two sections of the bio-filter. Visual inspection of the media surface pattern of wet and dry areas suggests that the sprinkler spray pattern is approximately as follows (↗ etc. = sprinkler):



*Environmental conditions*

The following temperatures were determined on the day of site visit by use of an IR Thermometer:

- Ambient external temperature = 12 °C
- Ambient temperature in Fuel Preparation Building = 33 - 34 °C
- Ambient temperature in Bio-filter = 36 - 39 °C

Entry to the bio-filter was only possible once the irrigation sequence had been completed. Oppressive levels of humidity were then noted in to the bio-filter for the duration of access (approximately 2 hours in total).

*Process conditions*

Based upon estimated current bio-filter wood-chip media volume of 1,105 $m^3$, the calculated empty bed retention time (EBRT) based on the apparent design extraction rate of 40,000 $m^3/h$ is 99 s. At the minimum airflow previously reported by OdourNet, 13,680 $m^3/h$, calculated EBRT is 292 s and at the maximum airflow previously reported by OdourNet, 76,572 $m^3/h$, calculated EBRT is 52 s.

The accepted industry standard minimum EBRT for such wood-chip media bio-filters is 45s and hence under even the most extreme reported operational conditions this is exceeded. The lack of any observed in-filter composting also confirms that retention times are acceptable.

## Qualitative analysis of wood-chip media samples

The results of the qualitative analysis carried out by Matt Wilkes on 19/09/13 on the 6 No. wood-chip media samples are presented in the table below:

*Results for Qualitative analysis of wood-chip media samples*

| Sample No. | Moisture Content | Description | Odour | Mechanical Observation | Quality | Comment |
|---|---|---|---|---|---|---|
| 1 | Light damp | Wood that is seeing dry air and the moisture is being driven out | Damp forest floor | Strong in shear and compression | Good | This sample would not be seeing any microbial activity but has the capability of being a good media |
| 2 | Saturated | Media that is seeing a high irrigation rate | Wet wood | Spongy and weak in shear | Good | Sample would be capable of sustaining a good microbial growth |
| 3 | Damp | Wood that has been installed but with little moisture/irrigation | Damp forest floor | Fairly strong in shear and compression | Good | Media seeing some moisture but would suggest from entrained liquid rather than through irrigation system |
| 4 | Dry | Very dry, no moisture evident | Dry wood | Strong in shear and compression | Good | No irrigation at all. Has the possibility to be good media with sufficient irrigation. Suggest no irrigation for some considerable period. |
| 5 | Saturated | Media that is seeing a very high irrigation rate | Wet wood | Spongy and very weak in shear | Good | Sample would be capable of sustaining a good microbial growth. However, the sample is too wet suggesting over irrigation in this area of the system |
| 6 | Light Damp | Wood that is seeing dry air and the moisture is being driven out | Damp forest floor | Strong in shear and compression | Good | This sample would not be seeing any microbial activity but has the capability of being a good media |

*Conclusions from Qualitative analysis of wood-chip media samples*

- Distinct differences between samples suggest very irregular irrigation patterns and/or diffusion of irrigation liquors into the media bed.
- All the samples have the capability of sustaining good microbial growth and, if they are fully representative of the complete media bed, then we estimate up to 3 years life left in the media.
- Overall media condition in all samples is such that, given improved irritation along with some TLC and operational optimisation, there is no reason why the bio-filter should not achieve the expected odour removal performance for such a wood-chip media bio-filter in this type of application and hence reliably provide an outlet odour level of between 1,000 and 2,000 $OU_E/m^3$ with a 80 – 90% reduction from incoming odour level.

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**Laboratory analysis of wood-chip media samples**

*Images of collected samples:*

Sample 1

Sample 2

Sample 3

Sample 4

Sample 5

Sample 6

*Moisture content results:*

| | | |
|---|---|---|
| Sample 1 | - | 16.1 % of sample weight |
| Sample 2 | - | 71.8 % of sample weight |
| Sample 3 | - | 51.7 % of sample weight |
| Sample 4 | - | 15.4 % of sample weight |
| Sample 5 | - | 75.1 % of sample weight |
| Sample 6 | - | 49.4 % of sample weight |

*Total viability count results after overnight incubation at 37°C:*

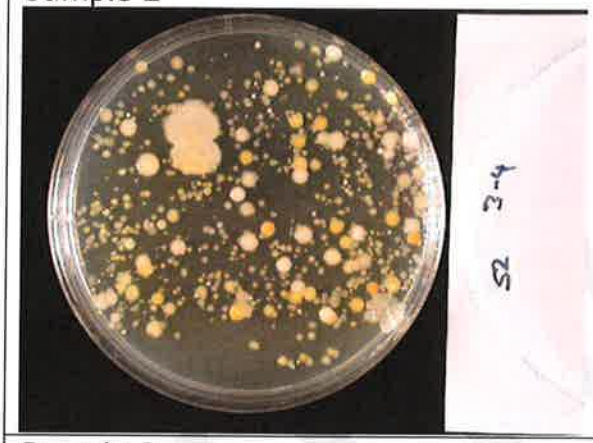
| Sample: | Bacterial agar | Fungus agar | Thermophilic fungal agar |
|---|---|---|---|
| 1 | $1.82 \times 10^6$ cfu/g | $1.31 \times 10^6$ cfu/g | $8.53 \times 10^5$ cfu/g |
| 2 | $2.34 \times 10^6$ cfu/g | $1.31 \times 10^6$ cfu/g | $1.40 \times 10^6$ cfu/g |
| 3 | $3.20 \times 10^6$ cfu/g | $2.02 \times 10^6$ cfu/g | $7.28 \times 10^5$ cfu/g |
| 4 | $8.65 \times 10^5$ cfu/g | $1.68 \times 10^5$ cfu/g | $8.25 \times 10^4$ cfu/g |
| 5 | $1.73 \times 10^4$ cfu/g | $1.27 \times 10^4$ cfu/g | $3.26 \times 10^4$ cfu/g |
| 6 | $2.39 \times 10^6$ cfu/g | $7.00 \times 10^5$ cfu/g | $8.00 \times 10^5$ cfu/g |

*Physical microbiological examination for the overall diversity of the populations:*

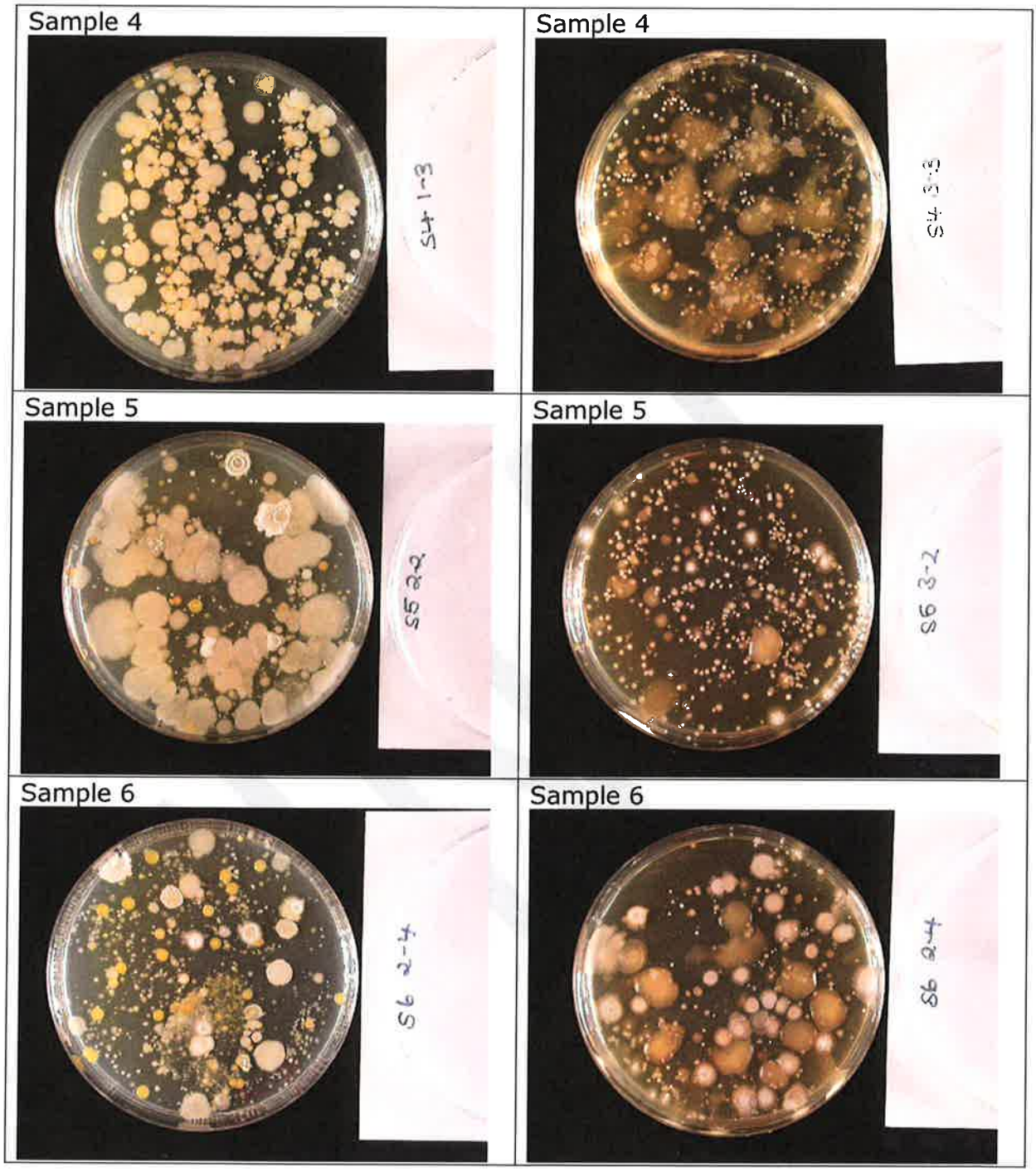
| Type of agar | Observation |
|---|---|
| Bacterial agar | At least 5 different types of bacterial strains were observed. Pre-dominantly *Bacillus* species observed. |
| Fungal agar | At least 4 different types, of which one (external slime producing species) has shown a higher degree of dominance in the population |
| Thermophilic fungal species | At least 3 different types, of which one (external slime producing species) has shown a higher degree of dominance in the population |

N.B. Thermophilic fungal species isolation methodology was carried out to determine the presence of harmful fungal *e.g. Aspergillus fumigatus*. Based on the reported observations, *Aspergillus fumigatus* were not found in the samples.

*Agar plate photos:*

| Bacterial agar | Fungal agar |
|---|---|
| Sample 1   | Sample 1   |
| Sample 2   | Sample 2   |
| Sample 3   | Sample 3   |

*Agar plate photos (continued):*




- Large populations of microorganisms were growing on the wood-chip media.
- Moisture content was found to be not consistent in the different samples.
- Total viability counts on both bacterial and fungal agar showed quite consistent results in sample 1, 2 and 3.
- Sample 5 had the lowest count (average of $10^4$ CFU/g) and it also had the highest moisture content (75.08 % moisture). Such high levels of water may be unsuitable for microorganism proliferation, hence affecting microorganism growth.
- Physical examination of the bacterial agar showed the presence of a variety of bacteria species. However, it has also been found that the population was pre-

dominated by a variety of *Bacillus* spp. (appears as large colonies with dry and/or wrinkled colony surface).

- Similarly, on the fungal agar, physical examination showed the pre-dominance of a "slime" producing fungal species which has also been found to be thermophilic (able to grow at temperatures higher than 37°C).

*Conclusions from Laboratory analysis of wood-chip media samples:*

- The wood-chip media samples showed relatively good counts of microorganisms. However, the high proportion of fungal cultures in the media may affect the population of bacteria when other parameters such as moisture, pH and temperature changes within the bio-filter; thereby affecting the function as well as the performance of the bio-filter.
- Based on the varying moisture content, it is suggested that the irrigation regime needs to be checked and re-configured to achieve a better distribution and gain better control of the system. Media collected from sections which were constantly wet had shown signs of accelerated degradation when compared to those collected from less irrigated area.

# 5. Recommendations

- Ensure that existing humidification system on inlet to bio-filters is operating correctly and that the associated instruments are correctly calibrated to ensure that air feed to the bio-filters is at design humidity level at all times to minimise drying effect of air-flow through the bio-filter.
- OSIL recommend that the existing irrigation system be replaced with a system of headers equipped with appropriate number of full cone pattern spiral spray nozzles (e.g. Bete type TF nozzles, see http://www.bete.co.uk/docs/default-source/spec-sheet-pdf's/tf-full-cone-data-sheet.pdf) located to provide overlapping spray areas across the entire bio-filter surface to ensure that the entire media bed is correctly wetted. The irrigation duration and interval should then be optimised to ensure correct penetration into the bed and minimise drying out between irrigation phases.
- Repeat testing of bio-filter wood-chip media at yearly intervals to monitor on-going performance and condition as an aid to predict when media replacement will be required.

# 6. Conclusions

- The overall process design for the wood-chip media bio-filter odour control unit is in line with accepted industry standards for such applications.
- There are problems with the design and implementation of the bio-filter irrigation system leading to unsatisfactory wetting of wood-chip media. This is impacting on airflow distribution through the bio-filter and odour removal efficiencies.
- Despite the irrigation problems, the wood-chip media is in relatively good physical condition given its age (approximately 3 years).
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