Odour Test Certificate

ODOUR MONITORING IRELAND LTD
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Client Organisation:	Greenstar
Contact:	Ms. Louise Demir
Address	Greenstar, Sarsfieldcourt Industrial Estate, Glanmire, Co. Cork
Telephone	louise.demir@panda.ie
Project:	Odour sample testing
Project number	130622GREENSTAR140622
Lead technician	Dr. Brian Sheridan

Investigated item:

Odour concentration Ou_E/m^3, determined by sensory measurement of odour concentration of an odour sample supplied in a sampling bag.

Identification:

The odour sample bags were labelled individually and supplied with a chain of custody. The label showed the identification of the bag. This identification is referenced within the results table.

Method

The odour concentration measurements were performed according to the European Standard EN13725:2003 '*Air quality – Determination of odour concentration by dynamic olfactometry*', and according to those parts as described in the internal procedure SOP2042: ' *Procedure for olfactometry based on EN13725:2003*'. The odour perception characteristic of the panel within the presentation series for the samples was analogous to that for the butanol calibration. The yes/no method of presentation was used and at least three rounds are presented to determine the panel threshold. Sample bags are manufactured from Nalophane and are not re-used.

Measuring range

The measuring range of the olfactometer is $2^4 \leq x \leq 2^{16}$ ou_E/m^3. When the sample concentration is outside the measuring range the odour sample may have been pre-diluted. If samples are pre-diluted in the laboratory, this is specified under the column *Pre-dilution factor Z* in Table 1.

Laboratory Environment

The measurements were performed in an air- and odour conditioned room, at a temperature of T ≤25 °C and with a fluctuation of less than ±3 °C. The CO_2 concentration is ≤0.1 %. The relative humidity is ≤55%. The laboratory is stationary and permanent.

Measurement dates and times

The measuring dates and times are specified together with the results in Table 1.

Results

The measurement results for odour threshold concentration as determined by dynamic dilution olfactometry in accordance with EN13725:2003 are presented in Table 1.

Uncertainty

The confidence limits for a value x for one measurement according to EN13725:2003, with a cover factor $k = 2$ are: $x \cdot 2.21^{-1} \leq x \leq x \cdot 2.21$. Based on repeated measurements of n-butanol reference gas the actual confidence limits at the OMI Lab are more favourable: for one measurement, including pre-dilution, the confidence limits are: $x \cdot 1.80^{-1} \leq x \leq x \cdot 1.80$ ($k = 2$). It is assumed that this uncertainty, based on verification with reference gases, is transferable to environmental samples. The most recent inter-laboratory comparison result is A = 0.14.

Traceability

The measurements have been performed using standards for which the traceability to (inter)national standards has been demonstrated. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits set. The results from the assessors are traceable to primary standards (PSM's) of n-butanol in nitrogen.

For and on behalf of Odour Monitoring Ireland Ltd,

Brian Sheridan Ph.D Eng.

Laboratory Director

CERTIFICATE OF ANALYSIS

Certificate number 130622GREENSTAR140622 Rev 1

Table 1:

Analysis file	Sample ID	Client reference	Analysis results (Ou_E/m^3)	Pre-dilution factor Z	Odour conc. (Ou_E/m^3)	Date and time of sampling	Date and time of analysis	Number of valid panel members	Number of valid ITE's	Remarks	Odour character in Laboratory
13062222GREENSTAR140622-1	Exhaust Carbon filter 1 S1	Odour sample	282	--	282	13/06/2022 – 10.01AM – 10.15AM	14/06/2022 – 10.24AM	4	9	Dynamic dilution olfactometry to EN13725:2003.	No distinct odour
13062222 GREENSTAR140622-2	Exhaust Carbon filter 1 S2	Odour sample	241	--	241	13/06/2022 – 10.20AM – 10.38AM	14/06/2022 – 11.06AM	4	9	Dynamic dilution olfactometry to EN13725:2003.	No distinct odour
13062222 GREENSTAR140622-3	Exhaust Carbon filter 2 S1	Odour sample	251	--	251	13/06/2022 – 10.48AM – 10.59AM	14/06/2022 – 11.44AM	4	9	Dynamic dilution olfactometry to EN13725:2003.	No distinct odour
13062222 GREENSTAR140622-4	Exhaust Carbon filter 2 S2	Odour sample	362	--	362	13/06/2022 – 11.04AM – 11.21AM	14/06/2022 – 12.19PM	4	9	Dynamic dilution olfactometry to EN13725:2003.	No distinct odour
13062222 GREENSTAR140622-5	Inlet to Carbon filters 1 and 2 S1	Odour sample	1,770	--	1,770	13/06/2022 – 10.05AM – 10.41AM	14/06/2022 – 12.56PM	4	9	Dynamic dilution olfactometry to EN13725:2003.	Waste, Vegetable, Celery
13062222 GREENSTAR140622-6	Inlet to Carbon filters 1 and 2 S1	Odour sample	2,252	--	2,252	13/06/2022 – 11.06AM – 11.26AM	14/06/2022 – 13.28PM	4	9	Dynamic dilution olfactometry to EN13725:2003.	Waste, Vegetable, Celery

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Client Organisation:	Greenstar
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Address	Greenstar, Sarsfieldcourt Industrial Estate, Glanmire, Co. Cork
Telephone	louise.demir@panda.ie
Project:	Odour sample testing
Project number	131022GREENSTAR141022
Lead technician	Dr. Brian Sheridan

Investigated item:

Odour concentration Ou_E/m^3, determined by sensory measurement of odour concentration of an odour sample supplied in a sampling bag.

Identification:

The odour sample bags were labelled individually and supplied with a chain of custody. The label showed the identification of the bag. This identification is referenced within the results table.

Method

The odour concentration measurements were performed according to the European Standard EN13725:2003 '*Air quality – Determination of odour concentration by dynamic olfactometry*', and according to those parts as described in the internal procedure SOP2042: ' *Procedure for olfactometry based on EN13725:2003*'. The odour perception characteristic of the panel within the presentation series for the samples was analogous to that for the butanol calibration. The yes/no method of presentation was used and at least three rounds are presented to determine the panel threshold. Sample bags are manufactured from Nalophane and are not re-used.

Measuring range

The measuring range of the olfactometer is $2^4 \leq x \leq 2^{16}$ ou_E/m^3. When the sample concentration is outside the measuring range the odour sample may have been pre-diluted. If samples are pre-diluted in the laboratory, this is specified under the column *Pre-dilution factor Z* in Table 1.

Laboratory Environment

The measurements were performed in an air- and odour conditioned room, at a temperature of T ≤25 °C and with a fluctuation of less than ±3 °C. The CO_2 concentration is ≤0.1 %. The relative humidity is ≤55%. The laboratory is stationary and permanent.

Measurement dates and times

The measuring dates and times are specified together with the results in Table 1.

Results

The measurement results for odour threshold concentration as determined by dynamic dilution olfactometry in accordance with EN13725:2003 are presented in Table 1.

Uncertainty

The confidence limits for a value x for one measurement according to EN13725:2003, with a cover factor $k = 2$ are: $x \cdot 2.21^{-1} \leq x \leq x \cdot 2.21$. Based on repeated measurements of n-butanol reference gas the actual confidence limits at the OMI Lab are more favourable: for one measurement, including pre-dilution, the confidence limits are: $x \cdot 1.80^{-1} \leq x \leq x \cdot 1.80$ ($k = 2$). It is assumed that this uncertainty, based on verification with reference gases, is transferable to environmental samples. The most recent inter-laboratory comparison result is A = 0.14.

Traceability

The measurements have been performed using standards for which the traceability to (inter)national standards has been demonstrated. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits set. The results from the assessors are traceable to primary standards (PSM's) of n-butanol in nitrogen.

For and on behalf of Odour Monitoring Ireland Ltd,

Brian Sheridan Ph.D Eng.

Laboratory Director

CERTIFICATE OF ANALYSIS

Certificate number 131022GREENSTAR141022 Rev 1

Table 1:

Analysis file	Sample ID	Client reference	Analysis results (Ou_E/m^3)	Pre-dilution factor Z	Odour conc. (Ou_E/m^3)	Date and time of sampling	Date and time of analysis	Number of valid panel members	Number of valid ITE's	Remarks	Odour character in Laboratory
13102222GREENSTAR141022-1	Exhaust Carbon filter 1 S1	Odour sample	724	--	724	13/10/2022 – 13.10PM – 13.25PM	14/10/2022 – 09.01AM	4	9	Dynamic dilution olfactometry to EN13725:2003.	Weak caramel, Weak waste
13102222 GREENSTAR141022-2	Exhaust Carbon filter 1 S2	Odour sample	644	--	644	13/10/2022 – 13.28PM – 13.46PM	14/10/2022 – 09.37AM	4	9	Dynamic dilution olfactometry to EN13725:2003.	Weak caramel, weak waste
13102222 GREENSTAR141022-3	Exhaust Carbon filter 2 S1	Odour sample	764	--	764	13/10/2022 – 13.49PM – 14.01PM	14/10/2022 – 10.18AM	4	9	Dynamic dilution olfactometry to EN13725:2003.	Weak caramel, weak waste
13102222 GREENSTAR141022-4	Exhaust Carbon filter 2 S2	Odour sample	845	--	845	13/10/2022 – 14.05PM – 14.22PM	14/10/2022 – 11.01PM	4	9	Dynamic dilution olfactometry to EN13725:2003.	Weak caramel, weak waste
13102222 GREENSTAR141022-5	Inlet to Carbon filters 1 and 2 S1	Odour sample	2,574	--	2,574	13/10/2022 – 13.12PM – 13.44PM	14/10/2022 – 11.46PM	4	9	Dynamic dilution olfactometry to EN13725:2003.	Waste, Musty, Dank
13102222 GREENSTAR141022-6	Inlet to Carbon filters 1 and 2 S1	Odour sample	2,896	--	2,896	13/10/2022 – 13.52PM – 14.26AM	14/10/2022 – 12.29PM	4	9	Dynamic dilution olfactometry to EN13725:2003.	Waste, Musty, Dank

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Client Organisation:	Greenstar
Contact:	Ms. Louise Demir
Address	Greenstar, Sarsfieldcourt Industrial Estate, Glanmire, Co. Cork
Telephone	louise.demir@panda.ie
Project:	Odour sample testing
Project number	150822GREENSTAR160822
Lead technician	Dr. Brian Sheridan

Investigated item:

Odour concentration Ou_E/m^3, determined by sensory measurement of odour concentration of an odour sample supplied in a sampling bag.

Identification:

The odour sample bags were labelled individually and supplied with a chain of custody. The label showed the identification of the bag. This identification is referenced within the results table.

Method

The odour concentration measurements were performed according to the European Standard EN13725:2003 '*Air quality – Determination of odour concentration by dynamic olfactometry*', and according to those parts as described in the internal procedure SOP2042: ' *Procedure for olfactometry based on EN13725:2003*'. The odour perception characteristic of the panel within the presentation series for the samples was analogous to that for the butanol calibration. The yes/no method of presentation was used and at least three rounds are presented to determine the panel threshold. Sample bags are manufactured from Nalophane and are not re-used.

Measuring range

The measuring range of the olfactometer is $2^4 \leq x \leq 2^{16}$ ou_E/m^3. When the sample concentration is outside the measuring range the odour sample may have been pre-diluted. If samples are pre-diluted in the laboratory, this is specified under the column *Pre-dilution factor Z* in Table 1.

Laboratory Environment

The measurements were performed in an air- and odour conditioned room, at a temperature of T ≤25 °C and with a fluctuation of less than ±3 °C. The CO_2 concentration is ≤0.1 %. The relative humidity is ≤55%. The laboratory is stationary and permanent.

Measurement dates and times

The measuring dates and times are specified together with the results in Table 1.

Results

The measurement results for odour threshold concentration as determined by dynamic dilution olfactometry in accordance with EN13725:2003 are presented in Table 1.

Uncertainty

The confidence limits for a value x for one measurement according to EN13725:2003, with a cover factor $k = 2$ are: $x \cdot 2.21^{-1} \leq x \leq x \cdot 2.21$. Based on repeated measurements of n-butanol reference gas the actual confidence limits at the OMI Lab are more favourable: for one measurement, including pre-dilution, the confidence limits are: $x \cdot 1.80^{-1} \leq x \leq x \cdot 1.80$ ($k = 2$). It is assumed that this uncertainty, based on verification with reference gases, is transferable to environmental samples. The most recent inter-laboratory comparison result is A = 0.14.

Traceability

The measurements have been performed using standards for which the traceability to (inter)national standards has been demonstrated. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits set. The results from the assessors are traceable to primary standards (PSM's) of n-butanol in nitrogen.

For and on behalf of Odour Monitoring Ireland Ltd,

Brian Sheridan Ph.D Eng.

Laboratory Director

CERTIFICATE OF ANALYSIS

Certificate number 150822GREENSTAR160822 Rev 1

Table 1:

Analysis file	Sample ID	Client reference	Analysis results (Ou_E/m^3)	Pre-dilution factor Z	Odour conc. (Ou_E/m^3)	Date and time of sampling	Date and time of analysis	Number of valid panel members	Number of valid ITE's	Remarks	Odour character in Laboratory
15082222GREENSTAR160822-1	Exhaust Carbon filter 1 S1	Odour sample	422	--	422	15/08/2022 – 10.10AM – 10.26AM	16/08/2022 – 09.21AM	4	9	Dynamic dilution olfactometry to EN13725:2003.	Weak caramel
15082222 GREENSTAR160822-2	Exhaust Carbon filter 1 S2	Odour sample	483	--	483	15/08/2022 – 10.29AM – 10.44AM	16/08/2022 – 09.49AM	4	9	Dynamic dilution olfactometry to EN13725:2003.	Weak caramel
15082222 GREENSTAR160822-3	Exhaust Carbon filter 2 S1	Odour sample	523	--	523	15/08/2022 – 10.50AM – 11.03AM	16/08/2022 – 10.32AM	4	9	Dynamic dilution olfactometry to EN13725:2003.	Weak caramel, Sour
15082222 GREENSTAR160822-4	Exhaust Carbon filter 2 S2	Odour sample	603	--	603	15/08/2022 – 11.09AM – 11.24AM	16/08/2022 – 11.04PM	4	9	Dynamic dilution olfactometry to EN13725:2003.	Weak caramel, Sour
15082222 GREENSTAR160822-5	Inlet to Carbon filters 1 and 2 S1	Odour sample	2,413	--	2,413	15/08/2022 – 10.06AM – 10.46AM	16/08/2022 – 11.39PM	4	9	Dynamic dilution olfactometry to EN13725:2003.	Waste, Musty, Dank
15082222 GREENSTAR160822-6	Inlet to Carbon filters 1 and 2 S1	Odour sample	2,735	--	2,735	15/08/2022 – 10.52AM – 11.28AM	16/08/2022 – 12.36PM	4	9	Dynamic dilution olfactometry to EN13725:2003.	Waste, Musty, Dank

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Client Organisation:	Greenstar (Munster)
Contact:	Ms. Louise Demir
Address	Greenstar Munster, Sarsfieldcourt Industrial Estate, Glanmire, Co. Cork
Telephone	louise.demir@panda.ie
Project:	Odour sample testing
Project number	170522GREENSTAR170522
Lead technician	Dr. Brian Sheridan

Investigated item:

Odour concentration Ou_E/m^3, determined by sensory measurement of odour concentration of an odour sample supplied in a sampling bag.

Identification:

The odour sample bags were labelled individually and supplied with a chain of custody. The label showed the identification of the bag. This identification is referenced within the results table.

Method

The odour concentration measurements were performed according to the European Standard EN13725:2003 '*Air quality – Determination of odour concentration by dynamic olfactometry*', and according to those parts as described in the internal procedure SOP2042: ' *Procedure for olfactometry based on EN13725:2003*'. The odour perception characteristic of the panel within the presentation series for the samples was analogous to that for the butanol calibration. The yes/no method of presentation was used and at least three rounds are presented to determine the panel threshold. Sample bags are manufactured from Nalophane and are not re-used.

Measuring range

The measuring range of the olfactometer is $2^4 \leq x \leq 2^{16}$ ou_E/m^3. When the sample concentration is outside the measuring range the odour sample may have been pre-diluted. If samples are pre-diluted in the laboratory, this is specified under the column *Pre-dilution factor Z* in Table 1.

Laboratory Environment

The measurements were performed in an air- and odour conditioned room, at a temperature of T ≤25 °C and with a fluctuation of less than ±3 °C. The CO_2 concentration is ≤0.1 %. The relative humidity is ≤55%. The laboratory is stationary and permanent.

Measurement dates and times

The measuring dates and times are specified together with the results in Table 1.

Results

The measurement results for odour threshold concentration as determined by dynamic dilution olfactometry in accordance with EN13725:2003 are presented in Table 1.

Uncertainty

The confidence limits for a value x for one measurement according to EN13725:2003, with a cover factor $k = 2$ are: $x \cdot 2.21^{-1} \leq x \leq x \cdot 2.21$. Based on repeated measurements of n-butanol reference gas the actual confidence limits at the OMI Lab are more favourable: for one measurement, including pre-dilution, the confidence limits are: $x \cdot 1.80^{-1} \leq x \leq x \cdot 1.80$ ($k = 2$). It is assumed that this uncertainty, based on verification with reference gases, is transferable to environmental samples. The most recent inter-laboratory comparison result is A = 0.14.

Traceability

The measurements have been performed using standards for which the traceability to (inter)national standards has been demonstrated. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits set. The results from the assessors are traceable to primary standards (PSM's) of n-butanol in nitrogen.

For and on behalf of Odour Monitoring Ireland Ltd,

Brian Sheridan Ph.D Eng.

Laboratory Director

CERTIFICATE OF ANALYSIS

Certificate number 170522GREENSTAR180522 Rev 1

Table 1:

Analysis file	Sample ID	Client reference	Analysis results (Ou_E/m^3)	Pre-dilution factor Z	Odour conc. (Ou_E/m^3)	Date and time of sampling	Date and time of analysis	Number of valid panel members	Number of valid ITE's	Remarks	Odour character in Laboratory
17052222DAWNFARMS180522-1	Exhaust Carbon filter 1 S1	Odour sample	242	--	242	17/05/2022 – 10.10AM – 10.21AM	18/05/2022 – 12.02PM	4	9	Dynamic dilution olfactometry to EN13725:2003.	No distinct odour
17052222DAWNFARMS180522-2	Exhaust Carbon filter 1 S2	Odour sample	201	--	201	17/05/2022 – 10.24AM – 10.36AM	18/05/2022 – 12.43PM	4	9	Dynamic dilution olfactometry to EN13725:2003.	No distinct odour
17052222DAWNFARMS180522-3	Exhaust Carbon filter 2 S1	Odour sample	221	--	221	17/05/2022 – 10.42AM – 10.53AM	18/05/2022 – 13.27PM	4	9	Dynamic dilution olfactometry to EN13725:2003.	No distinct odour
17052222DAWNFARMS180522-4	Exhaust Carbon filter 2 S2	Odour sample	322	--	322	17/05/2022 – 10.55AM – 11.06AM	18/05/2022 – 14.08PM	4	9	Dynamic dilution olfactometry to EN13725:2003.	No distinct odour
17052222DAWNFARMS180522-5	Inlet to Carbon filters 1 and 2 S1	Odour sample	1,689	--	1,689	17/05/2022 – 10.15AM – 10.40AM	18/05/2022 – 14.47PM	4	9	Dynamic dilution olfactometry to EN13725:2003.	Waste, Vegetable, Acrid, Celery
17052222DAWNFARMS180522-6	Inlet to Carbon filters 1 and 2 S1	Odour sample	1,931	--	1,931	17/05/2022 – 10.44AM – 11.15AM	18/05/2022 – 15.33PM	4	9	Dynamic dilution olfactometry to EN13725:2003.	Waste, Vegetable, Acrid, Celery

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QTR 2 2022 - ASSESSMENT OF ODOUR EMISSIONS FROM ODOUR CONTROL SYSTEM LOCATED IN GREENSTAR RECYCLING LTD, SARSFIELDCOURT, GLANMIRE, CO. CORK

REFERENCE NUMBER:	2022890(1)
ATTENTION:	Ms. Louise Demir
PREPARED BY:	Dr. Brian Sheridan
REPORTING DATE:	20th June 2022
TESTING DATE:	13th June 2022
DOCUMENT VERSION:	Document Ver.001
WASTE LICENCE NO:	WO136-02
REVIEWERS:	

TABLE OF CONTENTS

This document is submitted as part of odour monitoring carried out by Odour Monitoring Ireland Ltd on the 13th June 2022 on behalf of Greenstar Recycling Ltd. The results reported are representative of measurements carried out on the day, only.

Respectively submitted,

Brian Sheridan B.Sc. M.Sc. (Agr) Ph.D (Eng).

For and on behalf of Odour Monitoring Ireland™

Document Amendment Record

Client: ***Greenstar Recycling Ltd***

Project: Qtr 2 2022 - Assessment of odour emissions from odour control system located in Greenstar Recycling Ltd, Sarsfieldcourt, Glanmire, Co. Cork

Project Number: 2022890(1)			**Document Reference:** Qtr 2 2022 - ASSESSMENT OF ODOUR EMISSIONS FROM ODOUR CONTROL SYSTEM LOCATED IN GREENSTAR RECYCLING LTD, SARSFIELDCOURT, GLANMIRE, CO. CORK.		
2022890(1)	Document for review	B.A.S.	JMC	B.A.S	20/06/2022
Revision	**Purpose/Description**	**Originated**	**Checked**	**Authorised**	**Date**

1. Introduction and scope

1. Introduction

Odour Monitoring Ireland Ltd was commissioned by Greenstar Recycling Ltd to perform an odour assessment of the odour filtration system located in Greenstar Recycling Ltd. The assessment was carried out using standard volume flow and odour measurement techniques. Samples were taken on the inlet and exhaust of the odour control system and values are reported in *Section 3* of this report.

This report will outline the materials and methods, Results and Discussion and Conclusions of the sampling.

1.2 Scope of the work

This report will provide the relevant authorities with the following information:

1. The proposed physical and operational parameters of the odour control system;
2. The proposed odour emission rate of the odour control system;

2. Materials and methods

This section will describe the materials and methods used throughout the study period.

2.1 Odour sampling and analysis

2.1.1 Odour sampling techniques

In order to obtain air samples for odour assessment, a static sampling method was used where air samples were collected in 40 to 60 litre pre-conditioned Nalophan^{NA} bags using a vacuum sampling device over a 5 to 10 minute period. The sampler operates on the 'lung principle', whereby the air is removed from a rigid container around the bag by a battery powered SKC vacuum pump at a rate of 5 to 9 $l\ min^{-1}$. This caused the bag to fill through a stainless steel and PTFE tube whose inlet is placed in ambient air, with the volume of sample equal to the volume of air evacuated from the rigid container. Samples were taken on the inlet and exhaust of the carbon filter system.

2.1.2 Olfactometry

Olfactometry using the human sense of smell is the most valid means of measuring odour (Dravniek et al, 1986) and at present is the most commonly used method to measure the concentration of odour in air (Hobbs et al, 1996). Olfactometry is carried out using an instrument called an olfactometer. Three different types of dynamic dilution olfactometers exist:

- Yes/No Olfactometer
- Forced Choice Olfactometer
- Triangular Forced Choice Olfactometer.

In the dynamic dilution olfactometer, the odour is first diluted and is then presented to a panel of screened panellists of no less than four (CEN, 2003) Panellists are previously screened to ensure that they have a normal sense of smell (Casey et al., 2003). According to the CEN standard this screening must be performed using a certified reference gas *n*-butanol. This screening is applied to eliminate anosmia (low sensitivity) and super-noses (high sensitivity). The odour analysis has to be undertaken in a low odour environment such as an air-conditioned odour free laboratory. Analysis was performed 24 hours of sampling.

2.1.3 Odour measurement in accordance with the EN13725:2003

An ECOMA TO8 dynamic yes/no olfactometer was used throughout the measurement period to determine the odour threshold concentration of the sample air. The odour threshold concentration is defined as the dilution factor at which 50% of the panel can just detect the odour. Only those panel members who pass screening tests with n-butanol (certified reference gas, CAS 72-36-3) and who adhered to the code of behaviour were selected as panellists for olfactometry measurements (CEN, 2003). Odour measurement was carried out in an odour free laboratory in accordance with EN13725:2003. The analyses were carried out in the laboratory of Odour Monitoring Ireland in Trim Co. Meath.

2.1.4 What is an odour unit?

The odour concentration of a gaseous sample of odourant is determined by presenting a panel of selected screened human panellists with a sample of odourous air and varying the concentration by diluting with odourless gas, in order to determine the dilution factor at the 50% detection threshold. The Z_{50} value (threshold concentration) is expressed in odour units ($Ou_E\ m^{-3}$).

The European odour unit is that amount of odourant(s) that, when evaporated into one cubic metre of neutral gas (nitrogen), at standard conditions elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one European Reference Odour Mass (EROM) evaporated in one cubic meter of neutral gas at standard conditions. One EROM is that mass of a substance (n-butanol) that will elicit the Z_{50} physiological response assessed by an odour panel in accordance with this standard. *n*-Butanol is one such reference standard and is equivalent to 123µg of n-butanol evaporated in one cubic meter of neutral gas at standard conditions (CEN, 2003).

2.2 Volume flow rate and static pressure measurements

The volumetric flow rate of the odour control system was determined in accordance with EN16911-1, where possible. Measurements were performed on the exhaust of each of the carbon filtration systems in operation.

Static pressure measurements were taken using a calibrated static pressure measurement device while temperature measurements were taken with a PT100 probe.

2.3 Odour emission rate calculations.

The measurement of the strength of a sample of odourous air is, however, only part of the problem of quantifying odour. Just as pollution from a stack is best quantified by a mass emission rate, the rate of production of an odour is best quantified by the odour emission rate. For a chimney or ventilation stack, this is equal to the odour threshold concentration ($Ou_E\ m^{-3}$) of the discharge air multiplied by its flow-rate ($m^3\ s^{-1}$). It is equal to the volume of air contaminated every second to the threshold odour limit ($Ou_E\ s^{-1}$). The odour emission rate can be used in conjunction with dispersion modelling in order to estimate the approximate radius of impact or complaint (Hobson et al, 1995).

3. Results

3.1 Volume flow rate, Odour threshold concentration and static pressure results

Table 3.1 illustrates the overall odour control system exhaust stream characteristics gather throughout the study including results of the testing.

Table 3.1. Overall exhaust stream characteristics of odour filtration system located in Greenstar.

Identity		**Inlet to Carbon filter 1 & 2**	**Exhaust stack Carbon filter 1**	**Exhaust stack Carbon filter 2**
Odour threshold concentration (Ou_E/m^3) (ref 293.15K, 101.3KPa, wet gas)	Sample 1	1,770	282	251
	Sample 2	2,252	241	362
Average odour threshold conc. (Ou_E/m^3)		**2,011**	**261**	**307**
Volumetric airflow rate (Am^3/s) ((ref 293.15K, 101.3KPa, wet gas))		23.49 (calc.)	11.81	11.68
Odour loading / emission rate (Ou_E/s)		**47,241**	**3,088**	**3,583**
Exhaust air stream temperature (K)		287.35	287.35	287.35
Odour removal eff (%)		-	87	85
Total odour emission rate (Ou_E/s)		47,241	6,670	
Extract pressure from building / inlet to RJP (Pa)		228		
After RJP before fan (Pa)		694		
After fan before carbon vessel 1 (Pa)		1,211		
After fan before carbon vessel 2 (Pa)		1,168		
Exhaust stack carbon vessel 1 (Pa)		34		
Exhaust stack carbon vessel 2 (Pa)		35		
Pressure loss across operating fan 1		1,905 (limit value 3000 Pa)		
Pressure loss across operating fan 2		1,862 (limit value 3000 Pa)		
Pressure loss across RJP dust filter		466 (Limit value typically 1000 Pa)		
Pressure loss across Carbon vessel 1		1,177 (Typical value >500 Pa)		
Pressure loss across Carbon vessel 2		1,133 (Typical value >500 Pa)		

4. Discussion of results

With regards to the test results gathered throughout the study, the following data was collected and calculated. This includes:

1. The overall treatment volume of the odour control system on the day of monitoring was 84,564 Am^3/hr ref 293.15K, 101.3 KPa, wet gas.
2. The measured odour threshold concentration on carbon vessel 1 and 2 was 261 and 307 Ou_E/m^3, respectively.
3. The overall odour removal efficiency of carbon vessel 1 and 2 was 87% and 85%, respectively.
4. The mass odour emission rate form the overall odour abatement system was 6,670 Ou_E/s.
5. The total head loss across the RJP dust filter was 466 Pa which is well within the typical range for such a system (typical limit value of 1000 Pa).
6. The total head loss across carbon filter fan 1 and fan 2 was 1,905 and 1,862 Pa, respectively and this is well within the typical limit value for these fans (typical limit value of 3000 Pa).

5. Conclusions

The following conclusions were drawn from the study:

1. The overall treatment volume of the odour control system on the day of monitoring was 84,564 Am^3/hr ref 293.15K, 101.3 KPa, wet gas.
2. The measured odour threshold concentration on carbon vessel 1 and 2 was 261 and 307 Ou_E/m^3, respectively.
3. The overall odour removal efficiency of carbon vessel 1 and 2 was 87% and 85%, respectively.
4. The mass odour emission rate form the overall odour abatement system was 6,670 Ou_E/s.
5. The total head loss across the RJP dust filter was 466 Pa which is well within the typical range for such a system (typical limit value of 1000 Pa).
6. The total head loss across carbon filter fan 1 and fan 2 was 1,905 and 1,862 Pa, respectively and this is well within the typical limit value for these fans (typical limit value of 3000 Pa).

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QTR 4 2022 - ASSESSMENT OF ODOUR EMISSIONS FROM ODOUR CONTROL SYSTEM LOCATED IN GREENSTAR RECYCLING LTD, SARSFIELDCOURT, GLANMIRE, CO. CORK

REFERENCE NUMBER:	20221346(1)
ATTENTION:	Ms. Louise Demir
PREPARED BY:	Dr. Brian Sheridan
REPORTING DATE:	02nd Nov 2022
TESTING DATE:	13th Oct 2022
DOCUMENT VERSION:	Document Ver.001
WASTE LICENCE NO:	WO136-02
REVIEWERS:	

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This document is submitted as part of odour monitoring carried out by Odour Monitoring Ireland Ltd on the 13th Oct 2022 on behalf of Greenstar Recycling Ltd. The results reported are representative of measurements carried out on the day, only.

Respectively submitted,

Brian Sheridan B.Sc. M.Sc. (Agr) Ph.D (Eng).

For and on behalf of Odour Monitoring Ireland™

Document Amendment Record

Client: ***Greenstar Recycling Ltd***

Project: Qtr 4 2022 - Assessment of odour emissions from odour control system located in Greenstar Recycling Ltd, Sarsfieldcourt, Glanmire, Co. Cork

Project Number: 20221346(1)			**Document Reference:** Qtr 4 2022 - ASSESSMENT OF ODOUR EMISSIONS FROM ODOUR CONTROL SYSTEM LOCATED IN GREENSTAR RECYCLING LTD, SARSFIELDCOURT, GLANMIRE, CO. CORK.		
20221346(1)	Document for review	B.A.S.	JMC	B.A.S	02/11/2022
Revision	**Purpose/Description**	**Originated**	**Checked**	**Authorised**	**Date**

1. Introduction and scope

1. Introduction

Odour Monitoring Ireland Ltd was commissioned by Greenstar Recycling Ltd to perform an odour assessment of the odour filtration system located in Greenstar Recycling Ltd. The assessment was carried out using standard volume flow and odour measurement techniques. Samples were taken on the inlet and exhaust of the odour control system and values are reported in *Section 3* of this report.

This report will outline the materials and methods, Results and Discussion and Conclusions of the sampling.

1.2 Scope of the work

This report will provide the relevant authorities with the following information:

1. The proposed physical and operational parameters of the odour control system;
2. The proposed odour emission rate of the odour control system;

2. Materials and methods

This section will describe the materials and methods used throughout the study period.

2.1 Odour sampling and analysis

2.1.1 Odour sampling techniques

In order to obtain air samples for odour assessment, a static sampling method was used where air samples were collected in 40 to 60 litre pre-conditioned Nalophan^{NA} bags using a vacuum sampling device over a 5 to 10 minute period. The sampler operates on the 'lung principle', whereby the air is removed from a rigid container around the bag by a battery powered SKC vacuum pump at a rate of 5 to 9 $l\ min^{-1}$. This caused the bag to fill through a stainless steel and PTFE tube whose inlet is placed in ambient air, with the volume of sample equal to the volume of air evacuated from the rigid container. Samples were taken on the inlet and exhaust of the carbon filter system.

2.1.2 Olfactometry

Olfactometry using the human sense of smell is the most valid means of measuring odour (Dravniek et al, 1986) and at present is the most commonly used method to measure the concentration of odour in air (Hobbs et al, 1996). Olfactometry is carried out using an instrument called an olfactometer. Three different types of dynamic dilution olfactometers exist:

- Yes/No Olfactometer
- Forced Choice Olfactometer
- Triangular Forced Choice Olfactometer.

In the dynamic dilution olfactometer, the odour is first diluted and is then presented to a panel of screened panellists of no less than four (CEN, 2003) Panellists are previously screened to ensure that they have a normal sense of smell (Casey et al., 2003). According to the CEN standard this screening must be performed using a certified reference gas *n*-butanol. This screening is applied to eliminate anosmia (low sensitivity) and super-noses (high sensitivity). The odour analysis has to be undertaken in a low odour environment such as an air-conditioned odour free laboratory. Analysis was performed 24 hours of sampling.

2.1.3 Odour measurement in accordance with the EN13725:2003

An ECOMA TO8 dynamic yes/no olfactometer was used throughout the measurement period to determine the odour threshold concentration of the sample air. The odour threshold concentration is defined as the dilution factor at which 50% of the panel can just detect the odour. Only those panel members who pass screening tests with n-butanol (certified reference gas, CAS 72-36-3) and who adhered to the code of behaviour were selected as panellists for olfactometry measurements (CEN, 2003). Odour measurement was carried out in an odour free laboratory in accordance with EN13725:2003. The analyses were carried out in the laboratory of Odour Monitoring Ireland in Trim Co. Meath.

2.1.4 What is an odour unit?

The odour concentration of a gaseous sample of odourant is determined by presenting a panel of selected screened human panellists with a sample of odourous air and varying the concentration by diluting with odourless gas, in order to determine the dilution factor at the 50% detection threshold. The Z_{50} value (threshold concentration) is expressed in odour units ($Ou_E\ m^{-3}$).

The European odour unit is that amount of odourant(s) that, when evaporated into one cubic metre of neutral gas (nitrogen), at standard conditions elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one European Reference Odour Mass (EROM) evaporated in one cubic meter of neutral gas at standard conditions. One EROM is that mass of a substance (n-butanol) that will elicit the Z_{50} physiological response assessed by an odour panel in accordance with this standard. *n*-Butanol is one such reference standard and is equivalent to 123µg of n-butanol evaporated in one cubic meter of neutral gas at standard conditions (CEN, 2003).

2.2 Volume flow rate and static pressure measurements

The volumetric flow rate of the odour control system was determined in accordance with EN16911-1, where possible. Measurements were performed on the exhaust of each of the carbon filtration systems in operation.

Static pressure measurements were taken using a calibrated static pressure measurement device while temperature measurements were taken with a PT100 probe.

2.3 Odour emission rate calculations.

The measurement of the strength of a sample of odourous air is, however, only part of the problem of quantifying odour. Just as pollution from a stack is best quantified by a mass emission rate, the rate of production of an odour is best quantified by the odour emission rate. For a chimney or ventilation stack, this is equal to the odour threshold concentration ($Ou_E\ m^{-3}$) of the discharge air multiplied by its flow-rate ($m^3\ s^{-1}$). It is equal to the volume of air contaminated every second to the threshold odour limit ($Ou_E\ s^{-1}$). The odour emission rate can be used in conjunction with dispersion modelling in order to estimate the approximate radius of impact or complaint (Hobson et al, 1995).

3. Results

3.1 Volume flow rate, Odour threshold concentration and static pressure results

Table 3.1 illustrates the overall odour control system exhaust stream characteristics gather throughout the study including results of the testing.

Table 3.1. Overall exhaust stream characteristics of odour filtration system located in Greenstar.

Identity		**Inlet to Carbon filter 1 & 2**	**Exhaust stack Carbon filter 1**	**Exhaust stack Carbon filter 2**
Odour threshold concentration (Ou_E/m^3) (ref 293.15K, 101.3KPa, wet gas)	Sample 1	2,574	724	764
	Sample 2	2,896	644	845
Average odour threshold conc. (Ou_E/m^3)		**2,735**	**684**	**804**
Volumetric airflow rate (Am^3/s) ((ref 293.15K, 101.3KPa, wet gas))		7.20 (calc.)	6.72	0.48
Odour loading / emission rate (Ou_E/s)		**19,693**	**4,595**	**386**
Exhaust air stream temperature (K)		290.15	290.15	290.15
Odour removal eff (%)		-	75	71
Total odour emission rate (Ou_E/s)		19,693	4,981	
Extract pressure from building / inlet to RJP (Pa)		303		
After RJP before fan (Pa)		682		
After fan before carbon vessel 1 (Pa)		717		
After fan before carbon vessel 2 (Pa)		79		
Exhaust stack carbon vessel 1 (Pa)		3		
Exhaust stack carbon vessel 2 (Pa)		1		
Pressure loss across operating fan 1		1,399 (limit value 3000 Pa)		
Pressure loss across operating fan 2		761 (limit value 3000 Pa)		
Pressure loss across RJP dust filter		379 (Limit value typically 1000 Pa)		
Pressure loss across Carbon vessel 1		714 (Typical value >500 Pa)		
Pressure loss across Carbon vessel 2		78 (Typical value >500 Pa)		

4. Discussion of results

With regards to the test results gathered throughout the study, the following data was collected and calculated. This includes:

1. The overall treatment volume of the odour control system on the day of monitoring was 25,920 Am^3/hr ref 293.15K, 101.3 KPa, wet gas.
2. The measured odour threshold concentration on carbon vessel 1 and 2 was 684 and 804 Ou_E/m^3, respectively.
3. The overall odour removal efficiency of carbon vessel 1 and 2 was 75% and 71%, respectively.
4. The mass odour emission rate form the overall odour abatement system was 4,981 Ou_E/s.
5. The total head loss across the RJP dust filter was 379 Pa which is well within the typical range for such a system (typical limit value of 1000 Pa).
6. The total head loss across carbon filter fan 1 and fan 2 was 714 and 78 Pa, respectively and this is well within the typical limit value for these fans (typical limit value of 3000 Pa).

5. Conclusions

The following conclusions were drawn from the study:

1. The overall treatment volume of the odour control system on the day of monitoring was 25,920 Am^3/hr ref 293.15K, 101.3 KPa, wet gas.
2. The measured odour threshold concentration on carbon vessel 1 and 2 was 684 and 804 Ou_E/m^3, respectively.
3. The overall odour removal efficiency of carbon vessel 1 and 2 was 75% and 71%, respectively.
4. The mass odour emission rate form the overall odour abatement system was 4,981 Ou_E/s.
5. The total head loss across the RJP dust filter was 379 Pa which is well within the typical range for such a system (typical limit value of 1000 Pa).
6. The total head loss across carbon filter fan 1 and fan 2 was 714 and 78 Pa, respectively and this is well within the typical limit value for these fans (typical limit value of 3000 Pa).

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ASSESSMENT OF ODOUR EMISSIONS FROM ODOUR CONTROL SYSTEM LOCATED IN GREENSTAR RECYCLING (MUNSTER) LTD, SARSFIELDCOURT, GLANMIRE, CO. CORK

REFERENCE NUMBER:	202735(1)
ATTENTION:	Ms. Louise Demir
PREPARED BY:	Dr. Brian Sheridan
REPORTING DATE:	23rd May 2022
TESTING DATE:	17th May 2022
DOCUMENT VERSION:	Document Ver.001
WASTE LICENCE NO:	WO136-02
REVIEWERS:	

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This document is submitted as part of odour monitoring carried out by Odour Monitoring Ireland Ltd on the 17th May 2022 on behalf of Greenstar Recycling (Munster) Ltd. The results reported are representative of measurements carried out on the day, only.

Respectively submitted,

Brian Sheridan B.Sc. M.Sc. (Agr) Ph.D (Eng).

For and on behalf of Odour Monitoring Ireland™

Document Amendment Record

Client: ***Greenstar Recycling (Munster) Ltd***

Project: Assessment of odour emissions from odour control system located in Greenstar Recycling (Munster) Ltd, Sarsfieldcourt, Glanmire, Co. Cork

Project Number: 2022735(1)			**Document Reference:** ASSESSMENT OF ODOUR EMISSIONS FROM ODOUR CONTROL SYSTEM LOCATED IN GREENSTAR RECYCLING (MUNSTER) LTD, SARSFIELDCOURT, GLANMIRE, CO. CORK.		
2022735(1)	Document for review	B.A.S.	JMC	B.A.S	23/05/2022
Revision	**Purpose/Description**	**Originated**	**Checked**	**Authorised**	**Date**

1. Introduction and scope

1. Introduction

Odour Monitoring Ireland Ltd was commissioned by Greenstar Recycling (Munster) Ltd to perform an odour assessment of the odour filtration system located in Greenstar Recycling (Munster) Ltd. The assessment was carried out using standard volume flow and odour measurement techniques. Samples were taken on the inlet and exhaust of the odour control system and values are reported in *Section 3* of this report.

This report will outline the materials and methods, Results and Discussion and Conclusions of the sampling.

1.2 Scope of the work

This report will provide the relevant authorities with the following information:

1. The proposed physical and operational parameters of the odour control system;
2. The proposed odour emission rate of the odour control system;

2. Materials and methods

This section will describe the materials and methods used throughout the study period.

2.1 Odour sampling and analysis

2.1.1 Odour sampling techniques

In order to obtain air samples for odour assessment, a static sampling method was used where air samples were collected in 40 to 60 litre pre-conditioned Nalophan^{NA} bags using a vacuum sampling device over a 5 to 10 minute period. The sampler operates on the 'lung principle', whereby the air is removed from a rigid container around the bag by a battery powered SKC vacuum pump at a rate of 5 to 9 $l\ min^{-1}$. This caused the bag to fill through a stainless steel and PTFE tube whose inlet is placed in ambient air, with the volume of sample equal to the volume of air evacuated from the rigid container. Samples were taken on the inlet and exhaust of the carbon filter system.

2.1.2 Olfactometry

Olfactometry using the human sense of smell is the most valid means of measuring odour (Dravniek et al, 1986) and at present is the most commonly used method to measure the concentration of odour in air (Hobbs et al, 1996). Olfactometry is carried out using an instrument called an olfactometer. Three different types of dynamic dilution olfactometers exist:

- Yes/No Olfactometer
- Forced Choice Olfactometer
- Triangular Forced Choice Olfactometer.

In the dynamic dilution olfactometer, the odour is first diluted and is then presented to a panel of screened panellists of no less than four (CEN, 2003) Panellists are previously screened to ensure that they have a normal sense of smell (Casey et al., 2003). According to the CEN standard this screening must be performed using a certified reference gas *n*-butanol. This screening is applied to eliminate anosmia (low sensitivity) and super-noses (high sensitivity). The odour analysis has to be undertaken in a low odour environment such as an air-conditioned odour free laboratory. Analysis was performed 24 hours of sampling.

2.1.3 Odour measurement in accordance with the EN13725:2003

An ECOMA TO8 dynamic yes/no olfactometer was used throughout the measurement period to determine the odour threshold concentration of the sample air. The odour threshold concentration is defined as the dilution factor at which 50% of the panel can just detect the odour. Only those panel members who pass screening tests with n-butanol (certified reference gas, CAS 72-36-3) and who adhered to the code of behaviour were selected as panellists for olfactometry measurements (CEN, 2003). Odour measurement was carried out in an odour free laboratory in accordance with EN13725:2003. The analyses were carried out in the laboratory of Odour Monitoring Ireland in Trim Co. Meath.

2.1.4 What is an odour unit?

The odour concentration of a gaseous sample of odourant is determined by presenting a panel of selected screened human panellists with a sample of odourous air and varying the concentration by diluting with odourless gas, in order to determine the dilution factor at the 50% detection threshold. The Z_{50} value (threshold concentration) is expressed in odour units ($Ou_E\ m^{-3}$).

The European odour unit is that amount of odourant(s) that, when evaporated into one cubic metre of neutral gas (nitrogen), at standard conditions elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one European Reference Odour Mass (EROM) evaporated in one cubic meter of neutral gas at standard conditions. One EROM is that mass of a substance (n-butanol) that will elicit the Z_{50} physiological response assessed by an odour panel in accordance with this standard. *n*-Butanol is one such reference standard and is equivalent to 123µg of n-butanol evaporated in one cubic meter of neutral gas at standard conditions (CEN, 2003).

2.2 Volume flow rate and static pressure measurements

The volumetric flow rate of the odour control system was determined in accordance with EN16911-1, where possible. Measurements were performed on the exhaust of each of the carbon filtration systems in operation.

Static pressure measurements were taken using a calibrated static pressure measurement device while temperature measurements were taken with a PT100 probe.

2.3 Odour emission rate calculations.

The measurement of the strength of a sample of odourous air is, however, only part of the problem of quantifying odour. Just as pollution from a stack is best quantified by a mass emission rate, the rate of production of an odour is best quantified by the odour emission rate. For a chimney or ventilation stack, this is equal to the odour threshold concentration ($Ou_E\ m^{-3}$) of the discharge air multiplied by its flow-rate ($m^3\ s^{-1}$). It is equal to the volume of air contaminated every second to the threshold odour limit ($Ou_E\ s^{-1}$). The odour emission rate can be used in conjunction with dispersion modelling in order to estimate the approximate radius of impact or complaint (Hobson et al, 1995).

3. Results

3.1 Volume flow rate, Odour threshold concentration and static pressure results

Table 3.1 illustrates the overall odour control system exhaust stream characteristics gather throughout the study including results of the testing.

Table 3.1. Overall exhaust stream characteristics of odour filtration system located in Greenstar (Munster).

Identity		Inlet to Carbon filter 1 & 2	Exhaust stack Carbon filter 1	Exhaust stack Carbon filter 2
Odour threshold concentration (Ou_E/m^3) (ref 293.15K, 101.3KPa, wet gas)	Sample 1	1,689	242	221
	Sample 2	1,931	201	322
Average odour threshold conc. (Ou_E/m^3)		1,810	222	272
Volumetric airflow rate (Am^3/s) ((ref 293.15K, 101.3KPa, wet gas))		23.24 (calc.)	11.82	11.42
Odour loading / emission rate (Ou_E/s)		42,064	2,621	3,101
Exhaust air stream temperature (K)		286.75	286.75	286.75
Odour removal eff (%)		-	88	85
Total odour emission rate (Ou_E/s)		42,064	5,723	
Extract pressure from building / inlet to RJP (Pa)		220		
After RJP before fan (Pa)		680		
After fan before carbon vessel 1 (Pa)		1,146		
After fan before carbon vessel 2 (Pa)		1,048		
Exhaust stack carbon vessel 1 (Pa)		33		
Exhaust stack carbon vessel 2 (Pa)		36		
Pressure loss across operating fan 1		1,826 (limit value 3000 Pa)		
Pressure loss across operating fan 2		1,728 (limit value 3000 Pa)		
Pressure loss across RJP dust filter		460 (Limit value typically 1000 Pa)		
Pressure loss across Carbon vessel 1		1,113 (Typical value >500 Pa)		
Pressure loss across Carbon vessel 2		1,012 (Typical value >500 Pa)		

4. Discussion of results

With regards to the test results gathered throughout the study, the following data was collected and calculated. This includes:

1. The overall treatment volume of the odour control system on the day of monitoring was 83,664 Am^3/hr ref 293.15K, 101.3 KPa, wet gas.
2. The measured odour threshold concentration on carbon vessel 1 and 2 was 222 and 272 Ou_E/m^3, respectively.
3. The overall odour removal efficiency of carbon vessel 1 and 2 was 88 and 85%, respectively.
4. The mass odour emission rate form the overall odour abatement system was 5,723 Ou_E/s.
5. The total head loss across the RJP dust filter was 460 Pa which is well within the typical range for such a system (typical limit value of 1000 Pa).
6. The total head loss across carbon filter fan 1 and fan 2 was 1,826 and 1,728 Pa, respectively and this is well within the typical limit value for these fans (typical limit value of 3000 Pa).

5. Conclusions

The following conclusions were drawn from the study:

1. The overall treatment volume of the odour control system on the day of monitoring was 83,664 Am^3/hr ref 293.15K, 101.3 KPa, wet gas.
2. The measured odour threshold concentration on carbon vessel 1 and 2 was 222 and 272 Ou_E/m^3, respectively.
3. The overall odour removal efficiency of carbon vessel 1 and 2 was 88 and 85%, respectively.
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QTR 3 2022 - ASSESSMENT OF ODOUR EMISSIONS FROM ODOUR CONTROL SYSTEM LOCATED IN GREENSTAR RECYCLING LTD, SARSFIELDCOURT, GLANMIRE, CO. CORK

REFERENCE NUMBER:	20221125(1)
ATTENTION:	Ms. Louise Demir
PREPARED BY:	Dr. Brian Sheridan
REPORTING DATE:	30th Aug 2022
TESTING DATE:	15th August 2022
DOCUMENT VERSION:	Document Ver.001
WASTE LICENCE NO:	WO136-02
REVIEWERS:	

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This document is submitted as part of odour monitoring carried out by Odour Monitoring Ireland Ltd on the 15th August 2022 on behalf of Greenstar Recycling Ltd. The results reported are representative of measurements carried out on the day, only.

Respectively submitted,

Brian Sheridan B.Sc. M.Sc. (Agr) Ph.D (Eng).

For and on behalf of Odour Monitoring Ireland™

Document Amendment Record

Client: ***Greenstar Recycling Ltd***

Project: Qtr 3 2022 - Assessment of odour emissions from odour control system located in Greenstar Recycling Ltd, Sarsfieldcourt, Glanmire, Co. Cork

Project Number: 20221125(1)			**Document Reference:** Qtr 3 2022 - ASSESSMENT OF ODOUR EMISSIONS FROM ODOUR CONTROL SYSTEM LOCATED IN GREENSTAR RECYCLING LTD, SARSFIELDCOURT, GLANMIRE, CO. CORK.		
20221125(1)	Document for review	B.A.S.	JMC	B.A.S	30/08/2022
Revision	**Purpose/Description**	**Originated**	**Checked**	**Authorised**	**Date**

1. Introduction and scope

1. Introduction

Odour Monitoring Ireland Ltd was commissioned by Greenstar Recycling Ltd to perform an odour assessment of the odour filtration system located in Greenstar Recycling Ltd. The assessment was carried out using standard volume flow and odour measurement techniques. Samples were taken on the inlet and exhaust of the odour control system and values are reported in *Section 3* of this report.

This report will outline the materials and methods, Results and Discussion and Conclusions of the sampling.

1.2 Scope of the work

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2. The proposed odour emission rate of the odour control system;

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This section will describe the materials and methods used throughout the study period.

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2.1.2 Olfactometry

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2.1.3 Odour measurement in accordance with the EN13725:2003

An ECOMA TO8 dynamic yes/no olfactometer was used throughout the measurement period to determine the odour threshold concentration of the sample air. The odour threshold concentration is defined as the dilution factor at which 50% of the panel can just detect the odour. Only those panel members who pass screening tests with n-butanol (certified reference gas, CAS 72-36-3) and who adhered to the code of behaviour were selected as panellists for olfactometry measurements (CEN, 2003). Odour measurement was carried out in an odour free laboratory in accordance with EN13725:2003. The analyses were carried out in the laboratory of Odour Monitoring Ireland in Trim Co. Meath.

2.1.4 What is an odour unit?

The odour concentration of a gaseous sample of odourant is determined by presenting a panel of selected screened human panellists with a sample of odourous air and varying the concentration by diluting with odourless gas, in order to determine the dilution factor at the 50% detection threshold. The Z_{50} value (threshold concentration) is expressed in odour units ($Ou_E\ m^{-3}$).

The European odour unit is that amount of odourant(s) that, when evaporated into one cubic metre of neutral gas (nitrogen), at standard conditions elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one European Reference Odour Mass (EROM) evaporated in one cubic meter of neutral gas at standard conditions. One EROM is that mass of a substance (n-butanol) that will elicit the Z_{50} physiological response assessed by an odour panel in accordance with this standard. *n*-Butanol is one such reference standard and is equivalent to 123µg of n-butanol evaporated in one cubic meter of neutral gas at standard conditions (CEN, 2003).

2.2 Volume flow rate and static pressure measurements

The volumetric flow rate of the odour control system was determined in accordance with EN16911-1, where possible. Measurements were performed on the exhaust of each of the carbon filtration systems in operation.

Static pressure measurements were taken using a calibrated static pressure measurement device while temperature measurements were taken with a PT100 probe.

2.3 Odour emission rate calculations.

The measurement of the strength of a sample of odourous air is, however, only part of the problem of quantifying odour. Just as pollution from a stack is best quantified by a mass emission rate, the rate of production of an odour is best quantified by the odour emission rate. For a chimney or ventilation stack, this is equal to the odour threshold concentration ($Ou_E\ m^{-3}$) of the discharge air multiplied by its flow-rate ($m^3\ s^{-1}$). It is equal to the volume of air contaminated every second to the threshold odour limit ($Ou_E\ s^{-1}$). The odour emission rate can be used in conjunction with dispersion modelling in order to estimate the approximate radius of impact or complaint (Hobson et al, 1995).

3. Results

3.1 Volume flow rate, Odour threshold concentration and static pressure results

Table 3.1 illustrates the overall odour control system exhaust stream characteristics gather throughout the study including results of the testing.

Table 3.1. Overall exhaust stream characteristics of odour filtration system located in Greenstar.

Identity		**Inlet to Carbon filter 1 & 2**	**Exhaust stack Carbon filter 1**	**Exhaust stack Carbon filter 2**
Odour threshold concentration (Ou_E/m^3) (ref 293.15K, 101.3KPa, wet gas)	Sample 1	2,413	422	523
	Sample 2	2,735	483	603
Average odour threshold conc. (Ou_E/m^3)		**2,574**	**453**	**563**
Volumetric airflow rate (Am^3/s) ((ref 293.15K, 101.3KPa, wet gas))		12.94 (calc.)	6.82	6.12
Odour loading / emission rate (Ou_E/s)		**33,310**	**3,086**	**3,446**
Exhaust air stream temperature (K)		291.15	291.15	291.15
Odour removal eff (%)		-	82	78
Total odour emission rate (Ou_E/s)		33,310	6,532	
Extract pressure from building / inlet to RJP (Pa)		333		
After RJP before fan (Pa)		724		
After fan before carbon vessel 1 (Pa)		728		
After fan before carbon vessel 2 (Pa)		622		
Exhaust stack carbon vessel 1 (Pa)		6		
Exhaust stack carbon vessel 2 (Pa)		4		
Pressure loss across operating fan 1		1,452 (limit value 3000 Pa)		
Pressure loss across operating fan 2		1,346 (limit value 3000 Pa)		
Pressure loss across RJP dust filter		391 (Limit value typically 1000 Pa)		
Pressure loss across Carbon vessel 1		718 (Typical value >500 Pa)		
Pressure loss across Carbon vessel 2		618 (Typical value >500 Pa)		

4. Discussion of results

With regards to the test results gathered throughout the study, the following data was collected and calculated. This includes:

1. The overall treatment volume of the odour control system on the day of monitoring was 46,584 Am^3/hr ref 293.15K, 101.3 KPa, wet gas.
2. The measured odour threshold concentration on carbon vessel 1 and 2 was 453 and 563 Ou_E/m^3, respectively.
3. The overall odour removal efficiency of carbon vessel 1 and 2 was 82% and 78%, respectively.
4. The mass odour emission rate form the overall odour abatement system was 6,532 Ou_E/s.
5. The total head loss across the RJP dust filter was 391 Pa which is well within the typical range for such a system (typical limit value of 1000 Pa).
6. The total head loss across carbon filter fan 1 and fan 2 was 1,452 and 1,346 Pa, respectively and this is well within the typical limit value for these fans (typical limit value of 3000 Pa).

5. Conclusions

The following conclusions were drawn from the study:

1. The overall treatment volume of the odour control system on the day of monitoring was 46,584 Am^3/hr ref 293.15K, 101.3 KPa, wet gas.
2. The measured odour threshold concentration on carbon vessel 1 and 2 was 453 and 563 Ou_E/m^3, respectively.
3. The overall odour removal efficiency of carbon vessel 1 and 2 was 82% and 78%, respectively.
4. The mass odour emission rate form the overall odour abatement system was 6,532 Ou_E/s.
5. The total head loss across the RJP dust filter was 391 Pa which is well within the typical range for such a system (typical limit value of 1000 Pa).
6. The total head loss across carbon filter fan 1 and fan 2 was 1,452 and 1,346 Pa, respectively and this is well within the typical limit value for these fans (typical limit value of 3000 Pa).