REPORT

Regenerative Thermal Oxidizer Stack Testing - Odour VOC and Neopentyl Glycol

AkzoNobel Sunshine North

Submitted to:

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Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian / national standards

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1.0 INTRODUCTION

Golder Associates Pty Ltd (Golder) was commissioned by AkzoNobel Pty Ltd (AkzoNobel) to conduct a stack emission monitoring programme at the AkzoNobel site located at 51 McIntyre, Sunshine North (the site). The purpose of the emissions monitoring programme was to assess odour, neopentyl glycol and volatile organic compounds (VOCs) emissions to air from the regenerative thermal oxidiser (RTO) recently commissioned to service the resin plant.

The assessment has been conducted in response to a Clean Up Notice (CUN No. 90011933) and Pollution Abatement Notice (PAN No. 90011934) issued to AkzoNobel by the Environment Protection Authority (EPA VIC) issued on 23 April 2021.

The sampling of the RTO was conducted on 19 May 2022 with duplicate odour, neopentyl glycol and VOC samples taken from the inlet and outlet of the RTO system. Golder was informed by AkzoNobel that sampling occurred during worst case operating conditions (i.e. maximum capacity). The following parameters were measured for each source:

- Exhaust gas velocity, flowrate and moisture content
- Odour concentration and rate of emission.
- Neopentyl glycol concentration and rate of emission.
- VOC concentration and rate of emission.

Odour analysis was conducted at the Air Quality and Noise Laboratory at Golder Associates, Richmond (NATA accreditation No. 1910).

Neopentyl glycol and VOC analysis was conducted by SGS, Notting Hill (NATA Laboratory Accreditation No. 2562).

The following report describes the test methods used and the results obtained from the monitoring programme.

2.0 TEST METHODS

2.1 Exhaust gas velocity

For stack emissions, velocity profiles were obtained across the flue utilizing an L-type pitot static tube and a TSI DP-Calc micromanometer.

Positions for velocity pressure measurement were determined to be at the centre of equal areas over the cross section of the sampling plane.

The micromanometer was calibrated against reference manometer 7970 (NATA Calibration Report No. A35450PA – 01/03/2020). Manometer readings were corrected in accordance with the test results.

The test methods used were in accordance with Golder Source Test Method V2, *"Velocity and Volume Flowrate: For Source Emissions"*.

When sampling plane conditions comply with the requirements of Australian Standard AS 4323.1 – 1995, "*Stationary Source Emissions: Method 1: Selection of Sampling Positions*", a conservative estimate of the measurement uncertainty involved in the determination of exhaust gas average velocity with a pitot tube and micromanometer is ± 5% (for velocities greater than 5 m/sec). At lower velocities the uncertainty is substantially increased.

2.2 Exhaust gas temperature

Exhaust gas temperature was determined using an electronic thermometer equipped with a chromel/alumel thermocouple. The thermometer was calibrated against AMA mercury in glass thermometer 526.10938 (NATA Calibration Report No. NT200434.02 – 18/08/2020).

2.3 Exhaust gas moisture content

Moisture content was determined by wet and dry bulb psychometry, in accordance with Golder Source Test Method M5, *"Moisture Content"*. This Golder Source Test Method has a basis in the following U.S. Environmental Protection Agency Method; 4, *"Determination of Moisture Content in Stack Gases."*

2.4 Odour/Dynamic Olfactometry

Samples were taken in accordance with Golder Source Test Method B1, *"Bag Sampling in Ambient Air and Source Emissions"*.

Samples were obtained by creating a vacuum within a rigid plastic drum, which draws in the sample gas at a through a polytetrafluoroethylene (PTFE) tube and into a Nalophan sample bag, sealed with a stainless-steel plug. The analysis conducted was in accordance with the following standards, methodology and guidelines:

- Australian Standard AS/NZS 4323.3 *"Determination of Odour Concentration by Dynamic Olfactometry"*
- Golder Associates Source Test Method No. O4, *"Odour (Dynamic Olfactometry) In Ambient Air and Source Emissions"*
- EPA VIC Publication 1666.1 *"Determination of Odour Concentration by Dynamic Olfactometry".*

Using a series of calibrated mass flow controllers, the Nalophan bag of sample was dynamically diluted to various concentrations with dry odour free air and passed through a mixing chamber.

The diluted sample was then presented to a panel of up to six people where their individual odour threshold was recorded. The odour level is determined from the geometric mean of the individual panellist odour threshold estimates, multiplied by the sample pre dilution factor.

All items of equipment in contact with the sample, or diluted sample, were constructed from PTFE, stainless steel or glass to prevent contamination.

The accepted range for a known reference material (n-butanol) of panel detection threshold concentration is between 20 – 80 parts per billion by volume (ppb).

2.5 Neopentyl Glycol

A sample of stack gas was drawn through a XAD-7 OVS sorbent cartridge. The inlet of the sampling cartridge was located at approximately a quarter of the flue diameter from the wall.

Sample volume was determined by placing a calibrated critical orifice in the sample train. The critical orifice was calibrated using a transfer standard flowmeter. Sorbent tubes consist of sample and control section. Sections were analysed individually to determine if there had been significant break-through from the sample section.

The sorbent cartridge was analysed using Gas Chromatography (GC) and conducted by SGS (not covered by NATA accreditation).

Samples were taken in accordance with Golder Source Test A13 *"Adsorbent Tube Sampling: Volatile Organic compounds in source emissions"*. The test method used was based on the National Institute for Occupational Safety and Health (NIOSH) Method 5523 "Glycols".

2.6 VOCs

A sample of stack gas was drawn through an activated carbon tube. The inlet of the sampling line was located at approximately a quarter of the flue diameter from the wall.

Sample volume was determined by placing a calibrated critical orifice in the sample train. The critical orifice was calibrated using a transfer standard flowmeter. Sorbent tubes consist of sample and control section. Sections were analysed individually to determine if there had been significant break-through from the sample section.

The sorbent cartridge was analysed using Gas Chromatography (GC) and conducted by SGS, NATA Laboratory Accreditation No. 2562.

Samples were taken in accordance with Golder Source Test A13 *"Adsorbent Tube Sampling: Volatile Organic compounds in source emissions"*.

3.0 RESULTS

Results of the stack emission monitoring programme are presented in Table 1 and Table 2. A summary of results is presented in Table 3.

Table 1: Emission Results – RTO Inlet

Sampling Details	
Company	AkzoNobel, 51 McIntyre, Sunshine North, 3020 VIC
Sample Date	19 May 2022
Location	Resin Plant – RTO Inlet
Process Conditions	Worst case operating conditions
Sampling Plane Description	One access port, >10 diameters downstream from a bend and <1 diameter upstream from a bend.
Sampling Plane Compliance	Not compliant with the dimensional requirements of Australian Standard AS 4323.1 *"Method 1: Selection of Sampling Positions"*. Additional sampling points were conducted, and the velocity/temperature traverse results indicate compliance with exhaust gas requirements a – e. Therefore, the sampling plane is classified as non-ideal.
Testing Officers	Florence Damour.
Test Conditions	
Stack dimensions (mm)	550 (diam)
Av. stack gas temperature (°C)	15
Barometric pressure (kPa)	102.9
Duct static pressure (kPag)	-0.49
Average velocity (m/s) ^{A}	6.9
Actual gas flowrate (m^3/min) ^{A}	98
Gas flowrate at S.T.P. (Nm^3/min)	94
Dry gas flowrate at S.T.P. (Nm^3/min)	93
% H_2O v/v	1.1

AS 4323.1 Compliance

Requirements	Criteria	Sampling Plane	Status
Distance from downstream disturbance	2 D min.	< 1 D	X
Distance from upstream disturbance	6 D min.	> 6 D	✓
Flow direction at all points	Same direction	Same direction	✓
Velocity at all points	> 3 m/s at all points	> 3 m/s at all points	✓
Cyclonic component	< 15°	< 15°	✓
Difference between points	< 10% absolute temperature	< 10% absolute temperature	✓
Difference between mean and points	< 10% absolute temperature	< 10% absolute temperature	✓
Highest to lowest pitot pressure	< 9 : 1	< 9 : 1	✓
Highest to lowest gas velocity	< 3 : 1	< 3 : 1	✓
Gas temperature	> dew point	> dew point	✓
Overall Classification			Non-Ideal

Test Results – RTO Inlet

Odour

Sample number	22-895	22-896
Sample period (hours)	11:18-11:28	11:36-11:46
Analysis date	19/05/22	19/05/22
Odour laboratory temperature (°C)	20	20
n-butanol panel threshold (ppb) [B]	100	100
Pre-dilution factor	1	1
Sample holding time	5 hours	5 hours
Odour character	Sickly sweet	Sickly sweet
Concentration (ou) [C]	2 600	1 700
Mass rate (ou.m^3/min)	250 000	160 000
Average mass rate (ou.m^3/min)	200 000	
Neopentyl Glycol		
Sample number	22-897	22-898
Sample period (hours)	12:24-12:44	23:49-13:09
Analysis date	30/05/22	30/05/22
Concentration (mg/m^3) [D]	<0.2	<0.2
Mass rate (g/min)	<0.020	<0.02
Average mass rate (g/min)	<0.02	

VOCs				
Sample number	22-899		22-900	
Sample period (hours)	12:24-12:44		12:49-13:09	
Analysis date	2/06/2022		2/06/2022	
Compound	**Concentration (mg/m^3)**	**Mass rate (g/min)**	**Concentration (mg/m^3)**	**Mass rate (g/min)**
1,2,4 Trimethylbenzene [E]	19	1.8	49	4.6
1,3,5 Trimethylbenzene [E]	8.7	0.81	26	2.4
Benzene [E]	0.38	0.035	0.38	0.035
Ethylbenzene [E]	2.5	0.23	7.0	0.65
Isopropyl benzene [E]	3.1	0.29	10	0.97
n-Butylbenzene [E]	0.19	0.018	0.38	0.035
n-Propylbenzene [E]	8.5	0.79	27	2.6
s-Butylbenzene	0.28	0.026	0.85	0.079
Toluene [E]	3.0	0.28	4.4	0.41
m, p-Xylene [E]	16	1.5	45	4.1
o-Xylene [E]	22	2.0	60	5.6

Notes
A - Actual gas flowrate and velocity at stack gas temperature and pressure
B - Panel n-butanol detection threshold concentration in parts per billion by volume (ppb). Certified reference material n-butanol 61.6 ppm (Cylinder No. 438266; certificate date: 17/08/2021)
C - Wet gas basis.
D - Sample analyses conducted by SGS Australia Pty Ltd. Not covered by NATA accreditation. Report No. ME326898
E - Sample analyses conducted by SGS Australia Pty Ltd. NATA accreditation No.2562. Report No. ME326898

Deviations from AS/NZS 4323.3: 2001 *"Stationary Source Emissions – Part 3: Determination of Odour Concentration by Dynamic Olfactometry"*: Nil.

Table 2: Emission Results – RTO Outlet

Sampling Details	
Company	AkzoNobel, 51 McIntyre, Sunshine North, 3020 VIC
Sample Date	19 May 2022
Location	Resin Plant – RTO Outlet
Process Conditions	Worst case operating conditions
Sampling Plane Description	Two access ports, > 6 diameters downstream from a fan and > 2 diameters upstream from an exit point.
Sampling Plane Compliance	Not compliant with the dimensional requirements of Australian Standard AS 4323.1 “Method 1: Selection of Sampling Positions”. Additional sampling points were conducted, the velocity profile indicates the temperature difference between points is > 10% absolute temperature and the temperature difference between points and mean is > 10% absolute temperature Therefore, the sampling plane is classified as non-compliant.
Testing Officers	Laurent Campbell
Test Conditions	
Stack dimensions (mm)	430 (diam)
Av. stack gas temperature (°C)	77
Barometric pressure (kPa)	102.9
Duct static pressure (kPag)	-0.081
Average velocity (m/s) [A]	14
Actual gas flowrate (m^3/min) [A]	125
Gas flowrate at S.T.P. (Nm^3/min)	99
Dry gas flowrate at S.T.P. (Nm^3/min)	97
% H_2O v/v	2.0
O_2 (%v/v)	21

AS 4323.1 Compliance			
Requirements	**Criteria**	**Sampling Plane**	**Status**
Distance from downstream disturbance	2 D min.	> 2 D	✓
Distance from upstream disturbance	6 D min.	> 6 D	✓
Flow direction at all points	Same direction	Same direction	✓
Velocity at all points	> 3 m/s at all points	> 3 m/s at all points	✓
Cyclonic component	< 15°	< 15°	✓
Difference between points	< 10% absolute temperature	< 10% absolute temperature	**X**
Difference between mean and points	< 10% absolute temperature	< 10% absolute temperature	**X**
Highest to lowest pitot pressure	< 9 : 1	< 9 : 1	✓
Highest to lowest gas velocity	< 3 : 1	< 3 : 1	✓

Gas temperature	> dew point	> dew point	✓
Overall Classification			Non-Ideal

Test Results – RTO Outlet				
Odour				
Sample number	22-901		22-902	
Sample period (hours)	11:19-11:29		11:35-11:45	
Analysis date	19/05/22		19/05/22	
Odour laboratory temperature (°C)	20		20	
n-butanol panel threshold (ppb) [B]	100		100	
Pre-dilution factor	1		1	
Sample holding time	5 hours		4.5 hours	
Odour character	Sickly sweet		Sickly sweet	
Concentration (ou) [C]	250		140	
Mass rate (ou.m^3/min)	25 000		14 000	
Average mass rate (ou.m^3/min)	20 000			
Neopentyl Glycol				
Sample number	22-903		22-904	
Sample period (hours)	12:24-12:44		12:49-13:09	
Analysis date	30/05/22		30/05/22	
Concentration (mg/m^3) [D]	<0.02		<0.02	
Mass rate (g/min)	<0.002		<0.002	
Average mass rate (g/min)	<0.002			
VOCs				
Sample number	22-905		22-906	
Sample period (hours)	12:24-12:44		12:49-13:09	
Analysis date	2/06/2022		2/06/2022	
Compound	**Concentration (mg/m^3)**	**Mass rate (g/min)**	**Concentration (mg/m^3)**	**Mass rate (g/min)**
1,2,4 Trimethylbenzene [E]	0.037	0.0036	0.084	0.0081
1,3,5 Trimethylbenzene [E]	0.019	0.0018	0.046	0.0045
Benzene [E]	<0.01	<0.001	<0.01	<0.001
Ethylbenzene [E]	<0.01	<0.001	0.0093	0.00090
Isopropyl benzene [E]	<0.01	<0.001	0.019	0.0018
n-Butylbenzene [E]	<0.01	<0.001	<0.01	<0.001
n-Propylbenzene [E]	0.019	0.0018	0.046	0.0045

s-Butylbenzene [E]	<0.01	<0.001	<0.01	<0.001
Toluene [E]	0.0093	0.00090	0.019	0.0018
m, p-Xylene [E]	0.037	0.0036	0.074	0.0072
o-Xylene [E]	0.046	0.0045	0.11	0.011

Notes
A - Actual gas flowrate and velocity at stack gas temperature and pressure
B - Panel n-butanol detection threshold concentration in parts per billion by volume (ppb). Certified reference material n-butanol 61.6 ppm (Cylinder No. 438266; certificate date: 17/08/2021)
C - Wet gas basis.
D - Sample analyses conducted by SGS Australia Pty Ltd. Not covered by NATA accreditation. Report No. ME326898
E - Sample analyses conducted by SGS Australia Pty Ltd. NATA accreditation No.2562. Report No. ME326898

Deviations from AS/NZS 4323.3: 2001 *"Stationary Source Emissions – Part 3: Determination of Odour Concentration by Dynamic Olfactometry"*: Nil.

4.0 DISCUSSION

A summary of the results of the odour and neopentyl glycol emission results for the monitoring conducted at the RTO on the 18 March 2022 is presented in Table 3.

Table 3: Stack emission monitoring - Summary of results

Contaminant	Average result	Inlet	Outlet
Odour	Concentration (ou)	2100	196
	Mass rate (ou.m^3/min)	200 000	19 000
Neopentyl glycol	Concentration (mg/m^3)	<0.2	<0.02
	Mass rate (g/min)	<0.02	<0.002
1,2,4 Trimethylbenzene	Concentration (mg/m^3)	34	0.060
	Mass rate (g/min)	3.2	0.0059
0.1,3,5 Trimethylbenzene	Concentration (mg/m^3)	17	0.032
	Mass rate (g/min)	1.6	0.0032
Benzene	Concentration (mg/m^3)	0.38	<0.01
	Mass rate (g/min)	0.04	<0.0009
Ethylbenzene	Concentration (mg/m^3)	4.7	≤0.007
	Mass rate (g/min)	0.44	≤0.007
Isopropyl benzene	Concentration (mg/m^3)	6.8	0.0046
	Mass rate (g/min)	0.63	0.00045
n-Butylbenzene	Concentration (mg/m^3)	0.28	<0.01
	Mass rate (g/min)	0.026	<0.0009

Contaminant	Average result	Inlet	Outlet
n-Propylbenzene	Concentration (mg/m^3)	18	0.032
	Mass rate (g/min)	1.7	0.0032
s-Butylbenzene	Concentration (mg/m^3)	0.57	<0.01
	Mass rate (g/min)	0.053	<0.0009
Toluene	Concentration (mg/m^3)	3.7	0.014
	Mass rate (g/min)	0.34	0.0014
m,p-Xylene	Concentration (mg/m^3)	30	0.056
	Mass rate (g/min)	2.8	0.0054
o-Xylene	Concentration (mg/m^3)	41	0.079
	Mass rate (g/min)	3.8	0.0077

The measured inlet and outlet mass emission rates for the RTO are used to calculate the RTO's removal efficiency. The calculated average odour removal efficiency of the RTO is 90%., therefore, no removal efficiency has been calculated. The calculated average removal for VOCs is between 98% and 100%. Neopentyl glycol was not detected above the LOR, therefore, removal efficiency has not been calculated.

5.0 IMPORTANT INFORMATION

Your attention is drawn to the document titled - "Important Information Relating to this Report", which is included in Appendix A of this report. The statements presented in that document are intended to inform a reader of the report about its proper use. There are important limitations as to who can use the report and how it can be used. It is important that a reader of the report understands and has realistic expectations about those matters. The Important Information document does not alter the obligations Golder Associates has under the contract between it and its client.

Signature Page

If you have any questions, please don't hesitate to contact us.

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https://golderassociates.sharepoint.com/sites/115853/project files/6 deliverables/058-r - rto stack testing - odour-npg-voc - may 2022/19130795-058-r-rev0 - rto stack testing_odour npg voc_mdt.docx

APPENDIX A

Important information relating to this report

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