



Environmental Project Management

A Cost-Effective Solution to VOC Abatement

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For the attention of Mr. Ian Turner

ProAmpac Ltd
Pegasus Way
Europarc
Grimsby
DN37 9TS

14th March 2022

PROG/0122/R/GS

Re: Donau Carbon RTO, Emissions Monitoring

Dear Sirs,

Please find attached a copy of our report of the emissions monitoring, as your instructions.

I trust that it meets with your satisfaction, should you have any queries please do not hesitate to contact me on the above number or mobile 07763 049 121.

Yours Faithfully,

Ghazali Syed

Ghazali Syed,
Environmental Project Management.



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Emissions Monitoring – Donau Carbon RTO

ProAmpac Packaging Limited, Grimsby

Prepared by Ghazali Syed, MSc Process Engineering, Environmental Project Management

PROG/0122/R/G

14th March 2022

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1. GENERAL

1.1. INTRODUCTION

ProAmpac Packaging Limited operate a flexible packaging process at their site in Europarc, Grimsby

This process involves using solvent-based inks that contain Volatile Organic Compounds (TOC's). TOC's are considered to be atmospheric pollutants and therefore their release to atmosphere from stationary industrial sources is controlled under the Environmental Protection Act (1990).

The Permit includes a condition that the captured emissions of TOC's must be abated prior to discharge to atmosphere in accordance with the Secretary of State's Guidance for Printing of Flexible Packaging Process Guidance Note PG6/17 (2011). As a result, ProAmpac, Grimsby have installed a Donau Carbon Regenerative Thermal Oxidiser.

The purpose of the Thermal Oxidiser is to abate the captured TOC's prior to emission to atmosphere. The Oxidiser abates the TOC's from the following flexographic presses

- | | |
|----------|----------|
| a. F&K 3 | b. F&K 4 |
| c. F&K 5 | d. F&K 6 |
| e. W&H | f. Soma |
| g. F& K | |

There are two RTO's installed – Donau Carbon and Siri. However, the Siri has been decommissioned. Therefore, this report covers the emissions from the Donau Carbon RTO only.

The process involves using solvent-based inks that contain volatile organic compounds (VOC's). VOC's are an atmospheric pollutant which contribute to ozone depletion, and as a result, are controlled under the Environmental Protection Act (1990).

The emission limits stipulated within the Permit as derived from the Solvent Emissions Directive (1999/13/EC) is:

	Chemical Species	Emission Limit	Condition
1	VOC	50 mg/m ³	of carbon, when taken as 15-minute average (from captured sources) over a period of 5 hours minimum
2	CO	100 mg/m ³	
3	NOx	100 mg/m ³	expressed as nitrogen dioxide

1.2. PURPOSE

The purpose of the emissions monitoring was to determine a provisional correlation of oxidization temperature in relation to the VOC emissions. In this way, the ongoing emissions are proven by surrogate monitoring of temperature. A final correlation will be carried out when the full production capacity is available.

This report does not cover other aspects of the Permit including the following

- Solvent Management Plan
- Olfactory checks, etc. by the Operator
- Fugitive emissions.

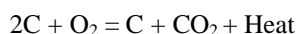
1.3. ABATEMENT PLANT

The Donau Carbon abatement plant is a 3-tower regenerative thermal oxidiser (RTO) rated at 35,000Nm³/h airflow capacity and operates in the following way.

The process exhaust is passed through the oxidiser via a hot ceramic bed where it absorbs stored heat raising the temperature to near combustion temperature. The hot gases pass through the bed where they are oxidised at around 800-820°C. The solvents from the presses in the airstream add thermal energy to the oxidization process enabling an exothermic reaction. If there is sufficient combined energy from the internal heat recovery and solvent, then the burner will switch off. This is known as an autothermal or self-sustaining condition where the combustion chamber temperature is maintained without the burner.

The air is held at the controlled temperature in the bed for the required residence time usually around 1-2 seconds (depending on the airflow loading at the time). The air path cycles up or down through a bed of ceramic media where it is heated then gives up its heat for recovery during the next cycle, leaving the oxidiser around 40-50°C hotter than it entered. At the end of this cycle the outlet bed is hot, and the inlet bed is now cooler. The cycle is therefore reversed periodically (around 2 – 2½ minutes) in order to maintain equilibrium and to keep the regenerated heat within the oxidiser plant.

The chemical reaction involved during the process is as follows



The RTO fan speed varies depending on the loading from the printing presses. With low loading, the energy efficiency and oxidization efficiency increase accordingly.

1.4. STANDARDS

The monitoring procedures were carried out (where applicable) in accordance with the following guidance documents and standards

Environment Agency Technical Guidance Note (Monitoring) M1
Sample requirements for stack emissions monitoring. (January 2010)

Environment Agency Technical Guidance Note (Monitoring) M2
Monitoring of stack emissions to air (July 2011)

Environment Agency Technical Guidance Note (Monitoring) M16
The measurement and monitoring of volatile organic compounds to air from industrial installations (June 2012)

Environment Agency Technical Guidance Note (Monitoring) M20
Quality assurance of continuous emission monitoring systems – application of BS EN 14181 and BS EN 13284-2 (September 2008)

Environment Agency Performance Standards for Portable Systems for Emissions Monitoring (March 2005)

DEFRA Secretary of State's Guidance for Printing of Flexible Packaging Guidance Note PG 6/17 (2011)

BS EN 13526:2002 Stationary source emissions. Determination of the mass concentration of total gaseous organic carbon in flue gases from solvent using processes. Continuous flame ionisation detector method

BS EN 12619:2013 Stationary source emissions. Determination of the mass concentration of total gaseous organic carbon in flue gases from solvent using processes. Continuous flame ionisation detector method

BS ISO 14164:1999. Stationary source emissions – Determination of volume flowrate of gas streams in ducts.

BS EN 13284-2:2002 Stationary source emissions. Determination of low range mass concentration of dust. Automated measuring systems

BS ISO 12039:2001 Stationary source emissions -- Determination of carbon monoxide, carbon dioxide and oxygen -- Performance characteristics and calibration of automated measuring systems

BS ISO 10849:1996 Stationary source emissions -- Determination of the mass concentration of nitrogen oxides -- Performance characteristics of automated measuring systems

STA (Source Testing Association) Risk Assessment Guide: Industrial emission monitoring (2008)

1.5. MONITORING AND CALCULATION METHODOLOGY

The testing was carried out in the following ways:

1.5.1. Analysing VOC's

The VOC's were analysed in accordance with EN13526 for Volatile Organic Compound by using a Bernath model 3006K portable flame ionisation detector (FID) total hydrocarbon analyser (serial number 4938). The instrument is an MCERT-certified instrument for the measurement of Volatile Organic Compound emission measurements (Project Number 674/00113G, SIRA Certificate Number MC 040036/01). The analyser was last serviced by Alkali Environmental December 2021.

The FID analyser works on the principle of a hydrogen flame being used to break down the hydrocarbon (VOC) vapours in the sample gas and to create ions, which are captured and measured. The output is proportional to the number of carbon atoms present in the sample and is expressed as total carbon.

The analyser operates on 110V is supplied by a 240V transformer. The analyser was situated at ground level adjacent to the stack and be protected against possible rain showers by a portable cover. The sampling line was run vertically and be secured to the sampling platform with a stainless probe in the stack sampling point provided.

Prior to sampling, the analyser was heated up and stabilised to full operating temperature of 200°C and pressure of 200mbar. The samples were continuously drawn from a 100mm dia sample port in the main exhaust stack through a 5m long heated sampling line which operated at a minimum temperature of 20°C above the stack gas temperature to avoid condensation of the gases.

The FID was calibrated against ambient air to set the zero and calibration gas to set the span at 20 ppm of propane in air %vol/vol. The instrument was set to monitor on the 0 to 1000 ppm range.

The VOC readings were recorded as ppm at intervals of 20 seconds using an Easylog EL12 datalogger hard wired to 0-10V signal output from the FID. The results being downloaded and later imported into an Excel spreadsheet where the results were converted to mgC/Nm³ and averaged over a rolling 15-minute period for the period of the sampling.

The calibration procedure was repeated at the beginning of the logging and again at the end with the results. At the end of the sampling period, the sampling line was tested for leaks by introducing the span calibration gas at the end of the sample line at atmospheric pressure to confirm the correct calibration without any dilution leakage.

The results were calculated as follows, in accordance with EN 13526:

$$\begin{aligned}\text{VOC (mgC/m}^3\text{)} &= \text{Instrument reading (ppm) x carbon content at STP} \\ &= \text{ppm x } 36/22.4\end{aligned}$$

With a span calibration of 80 ppm, the graphical value can be calculated as being:

$$= 20 \text{ ppm x } 36/22.4 = \underline{\underline{32.14 \text{ mgC/m}^3}}$$

The results are expressed as total hydrocarbon at temperature 273K, pressure 101.3kPa and no correction for water vapour.

1.6. CO & NOx Emissions

The CO and NOx were measured using a Testo 335 combustion gas analyser (serial number 01485310/801) calibrated by Alkali Environmental in January 2022.

The analyser is a portable battery-powered instrument uses electro-chemical technology and is TUV approved. A calibration check will be carried out prior to sampling using a certified calibration gas of 80ppm CO in air (equivalent to 69 mg/m³) and 80 mg/m³ NOx in air.

The analyser was set for natural gas flue gases with a controlled flow rate of 6.0 l/min with sampling taken from the stack test point via a 400mm long probe. The analyser was connected directly to a laptop using Testo EasyHeat software and set to automatically record samples both of CO and NOx simultaneously as ppm at 20 second intervals over a minimum 5-hour sampling period. The data was later exported to an Excel spreadsheet where the results were converted from ppm to mg/m³, as follows

$$\text{CO (as ppm)} \times 1.25 = \text{CO mg/m}^3$$

$$\text{NOx (as ppm)} \times 2.054 = \text{NOx mg/m}^3$$

The results of Carbon Monoxide (CO) and Nitrogen Oxide (NOx) are expressed at temperature 273K, pressure 101.3kPa, dry.

1.7. SURVEY

All presses were running intermittently during the period of monitoring.

During the period of monitoring, were running a range of jobs with medium-high coverage print which were regarded as typical of the production loading.

During the period of testing, the RTO was principally operating under 'autothermal' conditions (i.e. using the energy from solvent without the gas injection) with combustion temperatures typically around 800-820°C and varying airflow depending on the number of presses running at the time.

The survey was carried out on 04th February 2022 was carried out by Ghazali Syed, BSc Chemical Engineer, Msc Advance Process Engineering, AMIChemE of Environmental Project Management.

The monitoring report was prepared by Mr. Ghazali Syed.

2. COMPLIANCE MONITORING

2.1 EMISSION LIMIT MONITORING RESULTS

The results are shown graphically on the following appendices:

Appendix I VOC emissions (mgC/Nm³) with 15-minute averages

Appendix II CO & NO_x emissions (mgC/Nm³)

The results are summarised:

Target Chemical	Sampling Time				Number of Records	Emission limit mg/m ³	Maximum recorded mg/m ³ (15 min average)	Result
	From	To	Duration hh:mm	Intervals (s)				
VOC	11:23	16:39	5:15	5	3783	50	28.61	Pass
CO	11:50	16:32	5:00	5	3608	100	0.163	Pass
NO _x	16:51	16:32	5:00	5	3608	100	0.00	Pass

** All presses were running intermittently during the period.

3. CONCLUSIONS

The Donau Carbon RTO has been proven to be compliant during the period of monitoring of VOC's for the 50 mgC/m³ 15-minute average PEL (Permitted Emission Limit) with a maximum of 28.61 mgC/m³.

The Donau Carbon RTO has also been proven to be compliant during the period of monitoring of CO and NOx for the 100 mgC/m³ 15-minute average PEL (Permitted Emission Limit) with maximum values of 0.163mg/m³ and 0 mg/m³ respectively.

3.1. MAINTAINING EMISSION RECORDS

Your permit requires that the emission records should be maintained and updated at least every 12 months for submission to the Local Authority.

However, if any significant changes take place during that period to the production loadings to the RTO (such as the installation of a new press) or oxidiser efficiency, then the monitoring should be carried again out at that time and re-submitted.

3.2. INFLUENCING FACTORS

The RTO has various influencing factors that may change the VOC emissions, as follows:

	Factor	Details
1	<i>VOC loading</i>	lower concentrations at the inlet means the RTO is more efficient which reduces the VOC's at the outlet.
2	<i>Airflow loading</i>	lower airflow increases the thermal efficiency and retention time in the combustion chamber and therefore reduces the VOC's
3	<i>Solvent types</i>	different solvent types have different thermal energy values and carbon content that will affect oxidisation efficiency
4	<i>RTO performance</i>	higher temperatures improve oxidisation efficiency and therefore reduce the VOC's at the outlet.
5	<i>Damper seals</i>	any leakage through the dampers will enable by-pass to take place and increase VOC's at the outlet
6	<i>Valve timing</i>	depending on the speed of the valve changeover and the timing between cycles will vary the solvent releases without oxidisation.
7	<i>Media condition</i>	any damage, blockage or 'hole' in the media will affect the thermal efficiency and increase the VOC's at the outlet.
8	<i>RTO temperature</i>	maybe new technology or settings, such as software changes, etc may be available that could improve efficiency.

4. APPENDICES

4.1. Appendix 1 - Graph of VOC emissions against time

4.2. Appendix 2 - Graph of CO & NOx emissions against time

