EPM
Environmental Project Management
A Cost-Effective Solution to VOC Abatement
32 Cornmill Lane, Bardsey, Leeds, LS17 9EQ, UK. Tel (+44)1937 573468 Fax (+44)1937 572432

For the attention of Mr. Ian Turner

Ultimate Packaging Ltd
Pegasus Way
Europarc
Grimsby
DN37 9TS

21st August 2016

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 07976 428971.

Yours Faithfully,

Stephen Askew

Stephen Askew,
Environmental Project Management.

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RTO Emissions Monitoring

Ultimate Packaging Ltd, Grimsby

Prepared by Stephen Askew, Environmental Project Management
21st August 2016

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1.00 General

1.01 INTRODUCTION

Ultimate Packaging Ltd (Ultimate) operate a flexible packaging process at their site in Europarc, Grimsby.

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

Ultimate have applied for a Permit to the Grimsby Council to operate the process.

The Permit will include 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, Ultimate 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

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 pollutants which contribute to ozone depletion, and as a result, are controlled under the Environmental Protection Act (1990).

The emission limits from the Thermal Oxidisers are stipulated within PGN 6/17 as derived from the Solvent Emissions Directive (1999/13/EC) is:

Captured TOC's	50 mgC/m^3
- when taken as an 15 minute average (from captured sources)	
- over a period of 5 hours minimum	
CO	100 mg/m^3
NOx (expressed as nitrogen dioxide)	100 mg/m^3

1.02 MONITORING OBJECTIVES

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

1.03 ABATEMENT PLANT

The Donau Carbon abatement plant is a 3-tower regenerative thermal oxidiser (RTO) rated at 35,000 Nm^3/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 volatile gases pass through the combustion chamber where they are oxidised at around 800-820ºC. The solvents from the presses in the airstream add thermal energy to the oxidisation 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 combustion chamber for the required resonance time usually around 1-2 seconds (depending on the airflow loading at the time). The cleaned air exits from the combustion chamber through a second bed of ceramic media where it gives up its heat for recovery during the next cycle, leaving the oxidiser around $40\text{-}50^0$C hotter than it entered. At the end of this cycle the oxidiser outlet bed is hot and the inlet bed is now cooler. The cycle is therefore reversed periodically (around 2 minutes) in order to maintain equilibrium and to keep the regenerated heat within the oxidiser plant.

During continuous operation, the RTO is very efficient at reducing TOC emissions to very low levels. However, the reverse action of the airflow gives a brief emission or ‘spike’ of untreated air which is treated by the third tower.

The chemical reaction involved during the process is as follows:-

$$C + O_2 = C + CO_2 + \text{Heat}$$

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

1.04 STANDARDS

The monitoring procedures were carried out (where relevant) 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)

1.05 MONITORING METHODOLOGY

The testing was carried out in the following ways:

.01 Analysing VOC’s

The VOC’s were be analysed in accordance with EN13526 for VOC’s 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 Total Organic Compound emission measurements (Project Number 674/00113G, SIRA Certificate Number MC 040036/01). The analyser was last serviced/calibrated by Quantitech August 2015.

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 be heated up and stabilized to full operating temperature of 200ºC and pressure of 200mbar. The samples were continuously drawn from the sample port in the main exhaust stack (see position in picture below) through a 5m long heated sampling line which operated at a minimum temperature of 20ºC above the stack gas temperature to avoid condensation of the gases.

A preliminary test was made to determine the required range scale. The FID will then be calibrated and checked against ambient air to set the zero and calibration gas to set the span using a certified mixture of propane in air %vol/vol using a concentration approximately 60% of the range scale.

The calibration and check followed the procedure, with the values being continuously recorded on a datalogger:-

1. Set zero against ambient air through the heated sampling line
2. Calibrate the span against propane in air through the heated sampling line

3. Check the zero through the heated sampling line
4. Check the span through the heated sampling line
5. Check the zero through the heated sampling line
6. Start sampling
7. At the end of the sampling period, calibration checks of zero and span will be made through the heated sampling line

The sampling period was completed over a period of 3 days during which time normal production process was taking place with the press exhausts being diverted to the RTO automatically when the presses were operating.

The VOC readings were recorded as ppm at intervals of 60 seconds directly onto an Easylog EL12 datalogger using the 0-10V signal output from the FID. The results were later downloaded onto a laptop computer and then later imported into an Excel spreadsheet where the results have been converted to mgC/Nm^3. The individual results were averaged over a rolling 15 minute period for the period of the sampling to determine if the average exceeds the PEL for VOC.

.02 Analysing CO and NOx Combustion Gases

The CO and NOx were measured using a Testo 335 combustion gas analyser (serial number 01485310/801) purchased from and calibrated by Testo in 18th July 2016 (Testo ref. J4408319).

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/m^3) and 80 mg/m^3 NO in air.

The analyser was set for natural gas flue gases with a controlled flow rate of 0.6 l/min with sampling taken from the stack test point via a 400mm long probe. The analyser was programmed to automatically record samples both of CO and NOx simultaneously as ppm at 30 second intervals over a 3 day sampling period. The internal data being recorded directly onto a laptop PC using Testo EasyHeat software and then exported to an Excel spreadsheet where the results were converted from ppm to mg/m^3.

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

Additional data was recorded for information of flue gas temperatures and oxygen using the Testo analyser during the same sampling period.

1.06 CALCULATIONS OF RESULTS

.01 VOC's

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

VOC (mgC/m^3) = Instrument reading (ppm) x carbon content at STP

$= \text{ppm} \times {}^{36}/_{22.41}$

The results will be expressed as total hydrocarbon at temperature 273K, pressure 101.3kPa and without correction for water vapour.

.02 CO

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

CO (mgC/m^3) = Instrument reading (ppm) x carbon content at STP

$= \text{ppm} \times {}^{(12+16)}/_{22.41}$

$= \text{ppm} \times 1.25$

The results will be expressed as total hydrocarbon at temperature 273K, pressure 101.3kPa and without correction for water vapour.

.03 NOx

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

NOx (mgC/m^3) = Instrument reading (ppm) x carbon content at STP

= ppm x $^{(14+(16*2))}/_{22.41}$

= ppm x 2.05

The results will be expressed as total hydrocarbon at temperature 273K, pressure 101.3kPa and without correction for water vapour.

1.07 SURVEY

The monitoring was carried out on 17th to 19th August 2016 by Stephen Askew IEng MIPlantE MSOE ACIBSE of Environmental Project Management as a MCERTS Level 1 (SIRA Registration Number MM 08 909).

General view of RTO's and exhaust stacks – the Donau Carbon RTO is on the right

2.00 Compliance Monitoring

2.01 OPERATING CONDITIONS

The RTO’s were operating automatically with a temperature setpoint 800ºC.

2.02 EMISSION MONITORING RESULTS – DONAU CARBON

The results are shown graphically on the following appendices:

Appendix III	VOC emissions (mgC/m^3) with 15 minute averages
Appendix IV	CO & NOx emissions (mg/m^3)

The results are summarised:

Target	**Sampling Time**	**Records**	**Sample**	**Permitted (mg/m^3)**	**Result Emission Limit (mg/m3)**
VOC	14:48 17th Aug – 11:14 19th Aug (44 hrs 24 mins)	8,000	5.37 (max 15 min average)	50	Pass
CO	12:26 17th Aug – 12:40 19th Aug (46 hrs 17 mins)	8,230	10.22 (max 15 min average)	100	Pass
NOx	12:26 17th Aug – 12:40 19th Aug (46 hrs 17 mins)	8,230	14./74 (max 15 min average)	100	Pass

3.00 Conclusions

3.01 CONCLUSIONS

The Donau Carbon RTO had a maximum 15min VOC average of 5.37 mgC/m3 over the length of the monitoring period which is within the 50 mg/m^3 permitted emission limit. The monitoring of combustion gases recorded a maximum 15min average of 10.22 mg/m^3 CO and 14.74 mgC/m^3 of NOx over the length of the monitoring period both of which were within the 100 mg/m^3 permitted emission limit.

The degree of uncertainty has been determined as being 5%

The Donau Carbon RTO’s was therefore performing within the Permitted Emission Limits during the period of the test.

3.02 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 temperature correlation monitoring should be carried again out at that time and re-submitted.

3.03 INFLUENCING FACTORS

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

.01 VOC loading - lower concentrations at the inlet means the RTO is more efficient which reduces the VOC’s at the outlet.

.02 Airflow loading – lower airflow increases the thermal efficiency and retention time in the combustion chamber and therefore reduces the VOC’s.

.03 Solvent types – different solvent types have different thermal energy values and carbon content that will affect oxidisation efficiency.

.04 Combustion temperature – higher temperatures improves oxidisation efficiency and therefore reduce the VOC’s at the outlet.

.05 Damper seals – any leakage through the dampers will enable by-pass to take place and increase VOC’s at the outlet

.06 Valve timing – depending on the speed of the valve changeover and the timing between cycles will vary the solvent releases without oxidisation.

.06 Media condition – any damage or blockage in the media will affect the thermal efficiency and increase the VOC’s at the outlet.

.07 RTO performance – maybe new technology or settings, such as software changes, etc may be available that could improve efficiency.