

Appendix 17 – Explanation of Analysis Methodology

Result Sheet

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DEFINITION OF ANALYTICAL TERMINOLOGIES AND METHODOLOGIES

1. BACKGROUND

Recovered Energy Australia (REA) submitted a draft Works Approval Application (WAA 2003297) to the Victorian EPA on the 5th September 2018 for their waste to energy project. The EPA conducted a review of the review of the draft WAA and responded with several comments and requests for additional supporting information.

One specific comment that was made within the EPA's response, comment #37 reads as follows:

"Inconsistences in the HRL sample analysis and analytical reporting requires justification clearly explaining the rationale for the determination for example Ash Yield, loss on ignition (LOI) and leachability on waste samples. No relevant data has been made available for the concentrations of Dioxin/Furans and Total Organic Carbon in this waste"

Signed:.....

Jarryd Cutting
Analytical Chemist - LATS

Approved:.....

Nicholas Miller
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In response to these comments, Recovered Energy Australia (REA) has engaged HRL Technology Group (HRL) to produce a short report describing, in non-scientific language, the terminologies of some of the analytical methods that have previously been implemented for analysing REA submitted samples and to further define the rationale beyond these determinations .

2. DEFINITIONS AND EXPLANATION OF TESTING METHODOLOGY

2.1 Ash Yield:

The ash yield is defined as the percentage of material remaining after a sample of fuel is combusted under standardised heating conditions, specific to the sample matrix, to a constant mass, i.e.: all combustible material has been removed and the mass of the remaining material does not change with subsequent weighing. The ash yield of recovered waste material (RWM) is performed at the standardised temperature of 550°C according to internationally recognised standard method: I.S. EN15403.

An operating temperature of 550°C is used to ensure the collected ash retains any major elemental components. If the operating temperature is higher than 550°C this may cause some major and trace elements of the RWM to be lost during the ashing process, therefore, introducing a bias to any subsequent analysis of the ash, i.e.: In accordance with international standard method: I.S. EN15140, major elemental analysis of RMW requires fusion of the RWM ash and dissolution of the fused ash in hot water to generate a sample for major elemental analysis.

This process would only be used for the determination of % Ash Yield of a RWM and not of ash that has been collected from a commercial combustion system/plant.

Ash that has been collected from a combustion system or commercial plant may be characterised for % Ash Yield using alternative temperatures similar to LOI as explained below. The methodology described above using 550°C is not applicable in this case, as the collected ash has already undergone combustion at significantly higher temperatures, e.g. >800°C. In this case, the limitations previously dictated by potential further analysis of the ash does not apply in determining the % Ash Yield.

2.2 Loss on Ignition (LOI):

LOI is a calculated value comprising 100 percent of the initial sample mass minus the percentage ash yield of the sample (i.e.: $LOI \% = 100\% - \text{ash yield}\%$). LOI is conducted to provide information regarding the percentage of weight that will be combusted or lost following high temperature combustion.

The temperatures used for a LOI determination should be greater than 450°C because at this temperature and above the removal of volatile components such as moisture, waters of hydration or Carbon that may have been deposited into the ash as result of emissions management processes will be facilitated. Typically, LOI could be conducted at 450°C, 600°C, 650°C, 815°C or 950°C depending on the analysis methodologies that may be applied following the LOI determination. The temperature used for LOI determination is not critical as long as the process continues long enough to remove all volatile components.

2.3 Leachability:

The methodology that was employed to classify the ash samples for waste categorisation was ASLP 4439.2 as directed by the Victorian EPA document: IWRG 631, "SOLID INDUSTRIAL WASTE HAZARD CATEGORISATION AND MANAGEMENT". This methodology requires the use of two leachate solutions, one at either a pH of 2.9 or 5.0, acidic conditions, as determined during the execution of the procedure, and the other at pH 9.2, alkaline conditions. Potential contaminants in the solid ash material are extracted using these two solutions over a defined period of time. This is followed by the analysis of the collected leaching solutions using techniques that can accurately determine the specific parameter(s) under investigation. In the case relating to REA's WAA, the resulting solutions were analysed for trace elements and Anions as defined in Table 2 "Solid industrial waste hazard categorisation thresholds" found in IWRG 631.

The action of the leaching solution is to demonstrate the leachability of the potentially harmful metals or anions from the solid ash substance by the action of a percolating liquid, i.e.: acids in groundwater that leach calcium out of the bedrock.

In the case of ash generated from RWM, the leachability is the potential for harmful trace and major elemental constituents to be drawn from the solid material into the surrounding environment where it would be disposed of e.g a landfill, and determination of factors in the disposal environment may have a direct impact on the leachability of elements such as: soil pH, environment reduction/oxidation potentials, and groundwater chemistry.

2.4 Carbon, Hydrogen, Nitrogen & Oxygen (CHNO):

Analysis is conducted according to international standard method I.S. EN15407. The sample is combusted at 950°C with the carbon and hydrogen are analysed using infra-red detection and the nitrogen is analysed using thermal conductivity detection. The instrument used to perform this test is a LECO CHN analyser.

Oxygen content is a calculated value using the equation:

$$\% \text{ Oxygen} = 100 \% - (\text{Ash} + \text{C} + \text{H} + \text{N} + \text{S} + \text{Cl})$$

2.4.1 Total Organic Carbon

The determination of Total Organic Carbon can be conducted by the means of a two staged process. The first step is to determine Total Carbon on the ash sample using the method outlined in section 2.4. The second step is to react a sample of the ash with acid to remove the carbonate species within the ash and re-analyse the treated ash for carbon again. This second step will determine the Organic Carbon level. Subtracting the total carbon from the Organic carbon will also provide a Total Inorganic Carbon level by difference.

The other industry accepted practice is to use the LOI as an approximate level for Total Organic Carbon (TOC) . It can be seen that for most of the samples presented in the draft WAA , the LOI is low at reported levels of ~1-2%. Some of this LOI could also be residual moisture that can be absorbed into the ash during storage and thus it is suggested that the TOC could be lower than this observed ~1-2% LOI.

2.5 Calorific Value (Heating Value)

Calorific value (CV) is the determination of energy output of a sample under constant volume conditions. It is the energy contained within a sample, which is determined by measuring the heat produced by the complete combustion of a specified quantity of sample. The sample is combusted in a vessel known as a bomb calorimeter. Calorific values are typically expressed in megajoules per kilogram of sample (MJ/kg) as both gross and net CV.

Gross CV: Accounts for water in the exhaust leaving as vapour and includes liquid water in the sample prior to combustion.

Net CV: Accounts for the energy required to convert liquid water in the sample to vapour, which therefore lowers the energy released as heat during combustion.

2.6 Total Sulphur & Chlorine

The determination of Total Sulphur and Chlorine is conducted according to international standard method: I.S. EN15408. The sample is combusted in a bomb calorimeter, and the resulting gaseous species are collected in a capturing solution. The capture solution is collected as well as the washings following the rinsing of the inside of the bomb calorimeter. These collected solutions are made to a known volume (50ml). Chlorine and Sulphur are determined on the collected washings using Inductively Coupled Plasma Organic Emission Spectroscopy (ICP-OES) analysis and subsequently calculated as a percentage of the total mass of sample used in this determination.