Energy recovery of waste using incineration technology

Charalampos Georgios Litinas

hlitinas@outlook.com

Introduction

In light of the ambitious goals set by the National Waste Management Plan promoting the development of Energy Recovery Facilities (ERF), combustion seems the most viable solution for the treatment of residual waste albeit public objections. An opportunity has arisen given the circumstances; including the introduction of the Landfill tax which could make energy recovery cheaper than Landfill disposal, as well as the energy and fuel crisis seeking for renewable energy and the goals set by the government minimising coal usage.

An example of a quite large state of the art ERF would be operating in 2 processing Lines with a capacity to deal on average 25 tonnes/hr each for approximately 7.800 hours annually with circ. 90% availability processing 400.000 tonnes annually. The good operational record will be ensured by having an Outage period for maintenance activities scheduled, usually taking place twice per annum with a duration of 2 weeks. The operator would charge the authorities for the gate fee, for the electricity that would be exported to the grid, as well as for the Intermediate Pressure steam extracted in a CHP facility and sent to nearby facilities or the steam distributed at a lower range to district heating networks. Given the arrangements in place ie the use of vibrating tables, overband magnets or drums the operator could make additional profit secondarily from the metals that could be recovered from the bottom ash fraction.

Discussion

The purpose of an ERF following the waste hierarchy is to recover the non recyclable waste which would otherwise been driven to Landfill for subsequent disposal. Although incentives are given for the use of recyclates as a raw material to convert into new materials thereby reducing virgin raw materials including plastics, there can be challenges. In a highly adaptive and constantly changing market with many drivers affecting the supply chain ie prices, purity protocols, incidents with a global scale impact like the China Ban effect etc. sometimes it is highly improbable the recyclates to be absorbed by the Producers and would therefore be disposed to Landfills. The use of ERFs can be used complimentary for the waste fraction that cannot be recycled.

Primarily non-hazardous Municipal Solid Waste (MSW) and similar waste may be fed to the incinerator. The grate type that has predominantly been used, is the moving grate technology one. It's widespread application relies on the robust design and it's technological advanced features. The untreated waste offers in theory several benefits including the avoidance of treatment costs and the processing of a wider range of feedstock. By doing so, it seems as if the operator is provided with benefits and flexibility however, there are several limitations that shall be considered. By the diverse nature of the treating waste and the incineration practice, combustion could create several issues to mechanical equipment, frequent blockages, unstable operation due to inhomogeneous calorific value, non combustible materials coming of the bottom ash, while pollution problems could be caused. Even the type of waste that by it's state could be seen as being non hazardous ie plastics a common type of waste within the refuge which might offer a good heating value, however during the burning process it releases pollutants such as high Cl, S emissions.

The recovered biodried RDF or certified SRF gives more confidence to the operator as it follows a standard regime which requires routine sampling procedures and monitoring laboratory analysis. By doing so the feedstock is certified for it's performance on low moisture, ash percentages, suitable calorific value, low impurities ie Cl etc. To avoid operational issues, the Environmental Permit sets among other things, a list of accepted materials under the European Waste Catalogue (EWC) which can be treated and request from the operator to provide means of compliance assessment including; protocols for dealing with non-conforming waste and carrying out regular sampling and monitoring analysis to assess compliance with their outputs including ash and emissions.

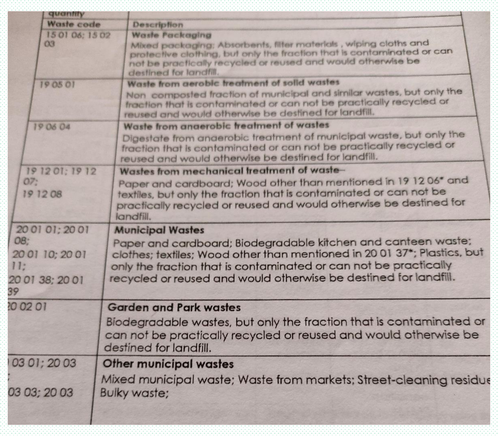

Figure 1 List of acceptable waste indicated by the Environmental Permit including RDF and other waste fractions ie digestate. Additional measures shall apply ie for the fractions contained in the mixed MSW under Chapter 20 of the EWC which might pose operational hazards. An example might be the bulkies which would require additional treatment such as shredding.

As part of the planned maintenance activities and the annual maintenance plan, by law there are requirements for periodic inspection and testing of Pressure Equipment by the competent authorities, checks of the steam boiler, expansion valves and so on. Additionally, preventative maintenance shall cover calibration of measuring equipment, regular periodic inspections, e.g. Non Destructive Tests (NDT) and inspections of the heat exchangers part for wear ie measuring the thickness of heat tube exchangers, replacement of refractory materials, regular cleaning of parts ie the boiler, tensioning belts, lubrication of moving parts, filters change and parts of the auxiliary equipment ie lifting beams to be inspected by competent authorities and so on. Outage covers the Worker Orders that can be conducted as appropriately. The primary objective is to run the plant at it's highest availability and offset any downtime costs.

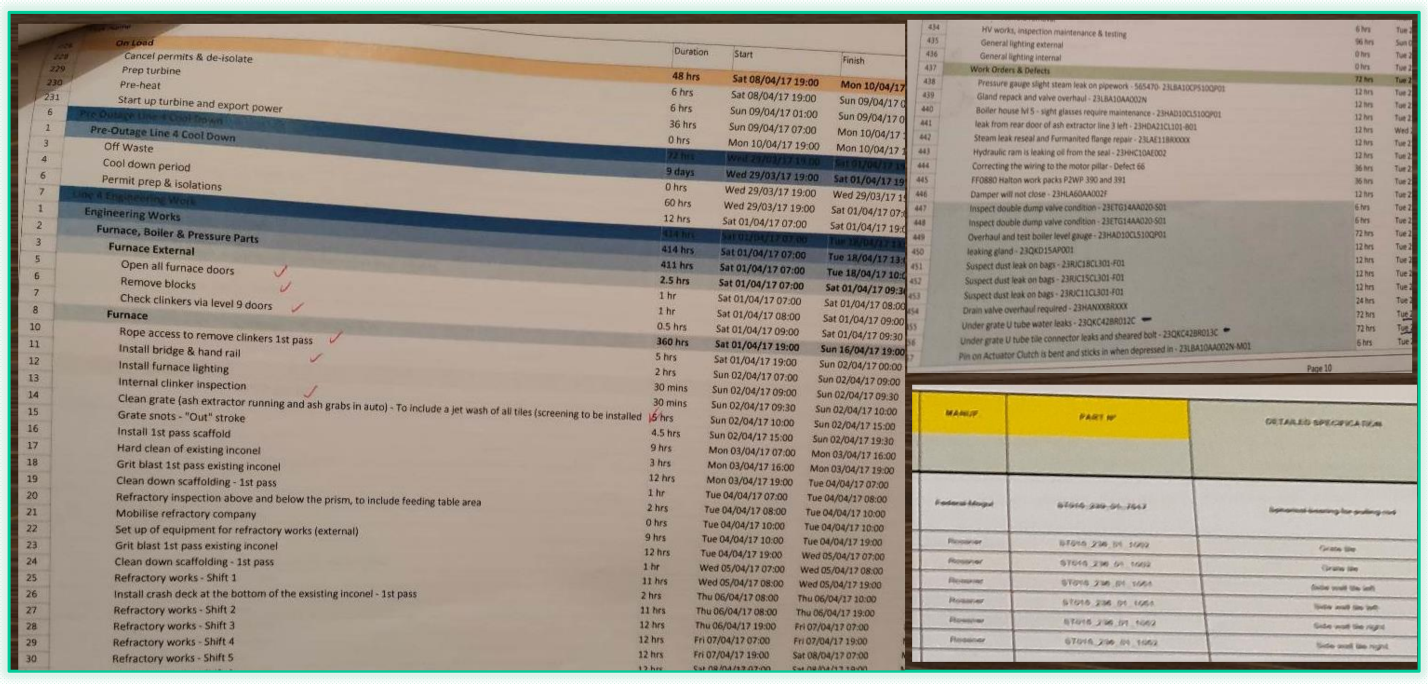

Figure 2 *Typical Outage breakdown* (on the left and side). *Work Orders are executed, defects are rectified, changes are implemented during the Outage as a window of opportunity arises* (at the bottom right section). *Part of the critical spares list inventory supplied by the EPC which is monitored by the operator considering the spares consumption and lead time* (At the top right side)

In addition to preventive maintenance requirements, there are ongoing issues that require continuous monitoring and regular attention ie treatment of blockages. Although training and supervision has been provided by the EPC, these issues could not always be claimed under contracts, as the EPC might prove that these failures are attributed to operational misuse. Although the contractor has provided the necessary warranties e.g. 40.000 guaranteed hours of operation for a type of heating tubes and the number of critical spare parts required, many times wear resulting from omissions or failures by the operator, e.g. not properly monitoring the demineralised water, ineffective cleaning of soot deposits and so on can halve lifespan of tubes. Lifetime of tubes at elevated temperatures is reduced exponentially and relatively to the Temperature drifting, resulting in thinning of tubes which in turn has a knock on effect to the steam boiler and therefore to the operation of the plant. The formation of soot driven mainly by the high operating Temperatures from combustion and the acidic environment by the acid gases formed inside the boiler leads to heating tube failures.

Figure 3 *Root causes of boiler tubes failures including scale inside the heat exchanger and deposits formation around the heat exchanger tube (at the top). Effects on* Boiler tubes thinning, scabbing, pitting, Flow Accelerated Corrosion and cracking (at the bottom)

Frequent breakdowns in the feeding system ie failure of the cranes can hinder the grate supply. The level of water in the Boiler Drum could cause operational issues. The non-calibration of measuring equipment could lead to operational parameters drifting and major operational control issues. The damage of the cooling system in a water-cooled grate could cause the fast reduction of the grate tiles lifespan. The ineffectiveness of boiler cleaning e.g. insufficient Pressure on rapping gear system, operating in the heat exchangers section, or the interruption of cleaning flow on the shower cleaning system operating in the 2nd/3rd pass section, would lead to fouling, transfer heat inefficiencies, thinning and wear to the heat exchanger tubes. The deficient monitoring of water quality would cause scale and failures to the tubes and other parts of the boiler by the steam carry over. Auxiliary Burners failure, the noncalibration of the Continuous Emissions Monitoring System (CEMS), the incorrect supply of chemicals or failure of equipment ie SNCR supply, may result in abnormal operation and could result in environmental fines.

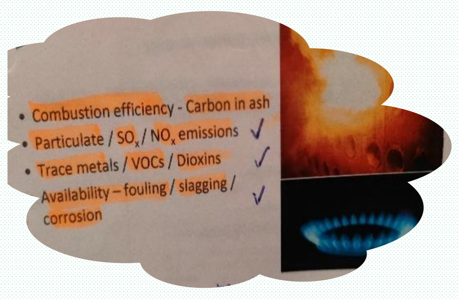

Figure 4 *Indicative key operational parameters which must be monitored*

Figure 7 *The boiler rapping system*

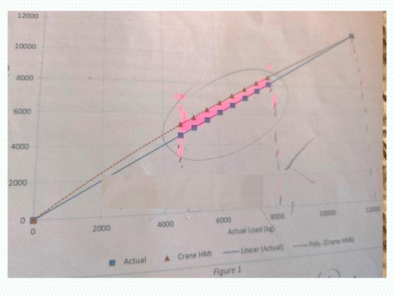

Figure 5 *Waste Cranes load cells quarter calibration regime against calibrated weighbridge carried out with the use of load tests. Calibration results to be plotted to monitor inconsistencies of drifting between the DCS values and the actual operating envelope*

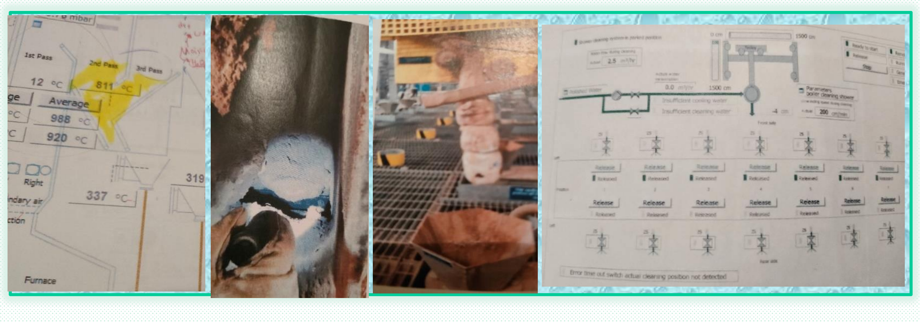

Figure 6 2nd/3rd pass blockages and the *Boiler shower cleaning system*

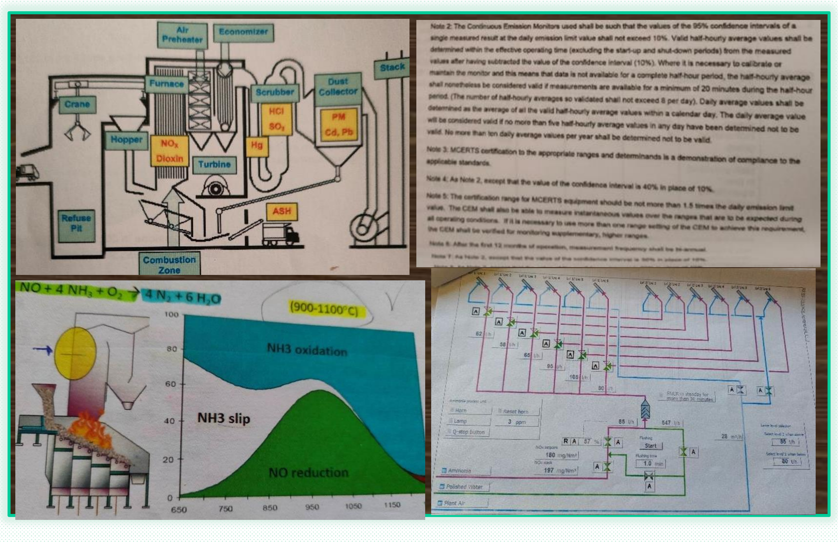

Figure 8 Indicative *hazardous pollutants generated at different stages of the plant and treatment technologies, Any dioxins reformed as part of cooling within the economiser zone are treated with the addition of activated carbon* (At the top left corner). *Continuous Emissions Monitoring System (CEMS) requirements according to EN 14181* (At the top right corner) . *SNCR dosing system (at the bottom side)*