Waste Incineration

Introduction

The energy recovery of waste is an important lever of the energy transition involving the mobilisation of all alternative sources of energy. Most of this is done in household waste incinerators.

Incineration is a process of heat treatment of waste with excess air. This process consists of burning household refuse and ordinary industrial waste in furnaces adapted to their characteristics (composition, moisture content). For instance, France has 113 installations with an incineration capacity of 17 million of tonnes per year (authorised capacity).

Waste Incineration Process

Incineration with energy recovery

Incineration involves recovering the heat emitted by the burning of combustible elements contained in waste. This heat, recovered initially in the form of steam under pressure, will then be:

- used to supply an urban district heating system or neighbouring industrial premises
- introduced into a turbo-generator to generate electricity

The energy produced is estimated at about 1.3 million tonnes of oil equivalent (TEP), including 5.23 GWh of electricity and 10.5 GWh of heat. More than 98% of the tonnages of waste entering incineration are subject to energy recovery, although at varying levels.

Incineration with an efficient energy recovery is a waste management tool enabling the energy potential present in the waste to be valorised. This limits the use of other imported resources of fossil combustibles, in the respect of the hierarchy of management methods: prevention, reuse, recycling, including organic recovery, and then energy recovery. It is an alternative to landfilling in storage facilities.

Storage and preparation of waste – feeding the oven

Collection vehicles unload waste into a pit. A grapple ensures the homogeneous distribution of the waste and feeds the furnace. The waste is dumped into the feed hopper and then into the combustion chamber by gravity or by means of a pusher.

Incineration plant, France

Combustion

The combustion cycle lasts about one hour and is broken down into three phases:

- drying
- combustion
- extinction / evacuation of solid residues (ashes, metals, clinker)

The combustion chamber generally comprises a grid which ensures the advancement and the mixing of the waste. The furnace gases are completely burned in the post-combustion chamber. There are different types of incineration furnaces: grid, roller, oscillating, fixed or fluidized bed.

Recovery of heat

The temperature of the flue gases is lowered from 1,000 °C at the exit of the furnace to 400 °C by passage through a boiler. The steam produced at the boiler can then be subjected to:

- thermal recovery, by supplying district heating or distribution to enterprises and / or public institutions (yield up to 90%)
- thermal and electrical valorisation (cogeneration) (yield up to 80%)
- electrical valorisation by electricity production with a turbo generator (yield up to 35%)

Water treatment

Of course, during the process of making steam, chemical control of the water quality is essential to avoid corrosion or scaling of the equipment. Otherwise if the chemical water parameters are not respected the turbine or boiler could be damaged and this will lead to a costly production stop and replacement of expensive parts.

To produce steam at high pressure up to 570 bar, raw water can't be used. It needs to be treated, usually by removing all the salt content through demineralisation.

This process is common in all thermal industries and can be done by sending the raw water into tanks containing ion exchange resins (anionic, cationic, sometimes mixed bed) where the metallic salts are exchanged to hydronium and hydroxyl ions, removing also the silica and the carbonic acid. There are also other ways of removing salt content which can be found in the power plants, like the reverse osmosis, ion exchange membranes... sometimes several techniques of demineralisation are combined.

At that stage the water is pure and contains only traces of metallic salt, such as NaCl, Na_2SO_4, low loads of K+ and CO32- ions and dissolved CO_2. The water doesn't have buffering capacity anymore, so the CO_2 present will lower the pH, and the water will become very aggressive.

To avoid the corrosion of the boiler, turbine, and other equipment, alkalinising agent is added, usually ammonia (NH3) or much less frequently NaOH, rising the pH over 8.5.

The water should contain only traces of Silica which could deposit on the turbine.

In the same way, the dissolved oxygen, inducing pitting corrosion, should also be eliminated by thermal treatment, adding scavenger, or by stripping.

Grapnel for refuse

Monitoring water and steam quality

The water quality must be monitored either by laboratory measurement or by in line analysers, or both. Laboratory measurements only provide a snapshot of the water chemistry at certain times, not prejudging what it will be few hours later.

The best way to ensure that the water chemistry is compliant with the standards of conduct of the boiler and turbine given by the manufacturer is to measure the parameters continuously.

The basic and most common parameters to be measured are the pH, cationic degassed conductivity, and silica. For a more accurate view, you can add the specific and cationic conductivities, dissolved oxygen, and sodium.

Lower the temperature and pressure of the steam

The first step before taking samples from the line, or using in line analysers is to reduce heat and pressure of the steam. This is achieved by a water heat exchanger, coupled with a pressure reducer and important safety devices to protect the user.

All those devices are regrouped on a single panel, the first step of the monitoring system. The water from the demineralisation plant doesn't need this physical treatment because it is cold with low pressure.

Cooling Water

The temperature and pressure reducer will need cooling water to lower the temperature down to an acceptable level for the analysers, between 20 to 40 °C.

To avoid corrosion and scaling of the heat exchanger, it will be better to get filtered and decarbonised water, with the requirements:

- pressure; 3 to 6 bar
- temperature: below 40 °C
- turbidity: under 50 NTU
- pH: 7 to 12
- chlorides concentration:
  - below 250 ppm for a sample temperature of 25 – 180 °C
  - below 100 ppm for a sample temperature of 180 – 290 °C
  - below 25 ppm for a sample temperature of 290 – 550 °C

In case of higher concentration of chlorides, an Inconel cooler should be used instead of Stainless Steel.

The cooling water flow will depend on the cooling heat exchanger, and the volume of the water sample required to supply all the analysers.

It is also possible to use other kinds of water, less treated, depending on the origin of water (ground, river, municipal...)

If there is no cooling water available, a closed water loop skid with a chiller could be used.

Hach Solutions

In some incinerating plants, the manpower and knowledge regarding online water analysis may be limited. Our goal is to simplify the process of choosing equipment by offering turn-key systems that are easy to install and ready to use.

Hach® is partnering with Technopomiar, a Polish company specialising in power applications. They are a leading manufacturer in the European Fossil Power market. In this partnership, we intend to integrate Hach instruments on Technopomiar stands and panels.

We offer several options to our customers:

1. Standard Panels

Three (3) standard panels are available that are standalone, stainless steel, and ready to be set up and used.

Standard panel 1: Temperature and pressure reducer + cationic degassed conductivity + silica analysers 2 channels:

Sampling and analysis panel

This panel allows the user to detect traces of metallic ions, without the influence of corrosive chemicals: NH_3 and CO_2, and the content of silica from the condensed steam and the water at the output of the demineralisation plant.

Standard panel 2: Includes the features of standard panel 1, and a two-channel sodium analyser:

The purpose of the sodium analyser is to analyse the exhaustion of cationic resin at the output of the demineralisation plant, and some eventual leakages from the condenser, or from the priming of the boiler. Priming is a carry over or contamination of the steam by water droplets and solids from the boiler.

Standard panel 3: Consists of only the temperature and pressure reduction devices:

The water coming from this unit, can be used to feed other analysers which the power plant can be fitted with or will acquire later.

2. Customised Panels – Easysam

In some other cases, a different solution is required over the capabilities of standard panels. Hach offers a customised solution in the Easysam configurator.

Step one: identify the elements to be used for the customised temperature and pressure reduction panel based on the pressure and temperature of the steam/water sample and quality of the cooling water. For each water or steam sample, there should be a separate panel.

Step two: Each parameter has a dedicated panel. If using a 2-channel controller, one panel will suffice for two parameters, e.g. pH and conductivity.

Available in-line analysers include:

- pH
- Calculated pH through conductivity
- Conductivity (specific, cationic, and degassed)
- Silica (up to 6 channels)
- Dissolved oxygen, electrochemical or optical (LDO)
- Sodium (up to 4 channels)
- Hydrazine
- Phosphate (up to 6 channels)
- Turbidity

Step three: decide between wall-mounted panels (to hang on the wall or on an already existing stand) or a stand-alone support.

The size of the stand-alone support will depend on the number of samples and elements to be measured. Options for the stand alone: roof, light, various electrical cabinets, and outputs are in the configurator.

3. Fully Customised Systems

It is also possible for the customers to have a completely customised system with their requirements.

For that we need a tender document with all necessary specifications, then our partner Technopomiar will propose a customised solution.

Steam turbine in an incineration plant

Summary

Hach, already a major player in the Power market by fulfilling 98% of the needs of a power plant in water analysis, goes a step further.

Now we are filling the gap, offering not only instruments to measure the water quality parameters but also a solution to install and use them in a very industrial way.

Doing so, we meet the need of our customers to have a monitoring system which is simple, easy to install, and ready to use. All this done with one supplier, reducing cost, work load of the employees of the power plant and with the warranty of a very well-known name: Hach.

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