About the EPOS Technology Focus

Within the scope of the EPOS project, extensive literature and market research reviews were performed in order to identify different technological, organisational, service and management solutions that could be applied to different industrial sites and clusters. The collected information will aid in establishing on-site and/or cross-sectorial industrial symbiosis opportunities; additionally, to enhance overall sustainability, performance and resource efficiency of different process industry sectors. Through the cooperation of project partners, a longlist of different technological options was created. Resource material for this list included: scientific articles, project reports, manufacturer’s documentation and datasheets.

SOLIDS

In addition to liquids and gases, solid waste and other by-products can be utilised in many ways in order to achieve RE and IS. Two of the most common options for utilisation of solid wastes are re-use and recycling, and is often used in waste streams of plastics and metals. General techniques for pre-treatment and the recycling of plastics, metal and other wastes are addressed.

Re-use and recycling of the solid waste is in some cases not feasible, e.g. due to highly contaminated waste. In such cases, the solid waste can be used for energy production through incineration, producing heat, steam or electricity. Energy valorisation of the solid wastes is especially practical, as it can have caloric content. In addition to basic waste incineration, other options for energy valorisation of solids are considered, namely pyrolysis and gasification. Using these two approaches, new resources can be obtained from the waste (gas and liquid fuels, etc.).

In addition to the energy valorisation, some emergent approaches for the recovery of minerals, metals and rare earths from cement kiln dust and fly ash are added, together with options for combustion improvement.

INCINERATORS

- Grate incinerator
- Fixed hearth unit
- Rotary kiln
- Oscillating kiln
- Fluidised bed
- Bubbling fluidised bed
- Circulating fluidised bed
- Rotating fluidised bed
- Pulverised fuel unit
INCINERATORS
Grate incinerators are usually comprised of the following components: waste feeder, incineration grate, bottom ash discharger, incineration air duct system, incineration chamber and auxiliary burners. Combustion takes place over a mobile platform, usually a grate. First, primary air passes through the grate in which drying, gasification and charcoal combustion take place. Flue gases are extracted from the upper part of the chamber to a post combustion unit, where secondary air is added to burn the combustible gases produced during the first stage.

**Technology 1: Grate incinerator**

For the incineration of mixed municipal waste and the incineration of industrial non-hazardous waste, sewage sludge and certain clinical waste.

**Applicability**

**Maturity**

Commercial.

**Project/product reference**

Igniss Energy’s moving grate incinerator.
In a fixed hearth unit waste is introduced onto a platform (i.e. hearth) in the bottom of the combustion chamber. The air flow is controllably introduced through the hearth and may also be provided from the front wall over the waste bed.
Rotary kilns are combustion chambers in the form of a slowly rotating (<2rpm) cylinder, mounted at a slight incline (1° to 4°) to aid gravity feed and mixing of the waste. This waste can be either solid, liquid or gaseous. There are two main types of rotary kilns:

- Co-current, where the flue gases flow in the same direction as the waste
- Counter-current, where the flue gases flow in the opposite direction of the waste.

Typical rotary kiln operation temperatures are between 500°C and 1450°C. The temperature is normally above 850°C for conventional combustion, and for hazardous wastes, between 900°C and 1200°C. The amount of time that a material will spend in the kiln will change based on the rotation speed of the kiln and the angle; 30-90 minutes is usually enough.

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**Technology 3: Rotary-kiln**

**Applicability**
For the incineration of hazardous and other waste. Due to a robust design, almost any type of waste can be incinerated.

**Maturity**
Commercial.

**Project/product reference**
Waterleau’s rotary kiln incinerator.
The combustion chamber of consists of an oscillating inclined cylinder. Air enters the combustion chamber through nozzles and the exhaust gases are extracted from the middle of the hearth or at the discharge of the bottom ash.

Technology 4: Oscillating kiln

Applicability
For the incineration of hazardous and other waste.

Maturity
Commercial.

Project/product reference
Tiru commercial brochure.
Fluidised beds are vertical cylinders that house lined combustion chambers. Air is injected at the lowest point in the combustion chamber. This air passes through openings in a grate or distribution plate and is fluidised with the inert material found there (sand or ash). Using a pump, the waste is continuously fed into the fluidised sand bed. The temperature of the bed can be 650°C or higher. Depending on the fluidisation velocity, there are two types of fluidised beds, namely bubbling fluidised beds and circulating fluidised beds.

**Technology 5: Fluidised bed**

**Applicability**
For the incineration of finely divided waste.

**Maturity**
Commercial.

**Project/product reference**
Waterleau’s fluidised bed incinerator.
The bubbling fluidised bed is a type of fluidised bed incinerator, where the fluidisation velocity is approximately 1 to 3 m/s. It can be used to treat more than 5 tons of waste per hour. The upper limit of the bed is well defined and the temperature of the bed is uniform.

**Technology 6: Bubbling fluidised bed**

**Applicability**
For the incineration of finely divided waste.

**Maturity**
Commercial.

**Project/product reference**
Mitsubishi Hitachi Power Systems.

![Figure 6 Bubbling fluidised bed](image)
Circulating fluidised beds are a type of fluidised bed using high gas speeds in a combustion chamber to remove the fuel. The fluidisation velocity can be approximately 4 to 8 m/s. It can be used to treat more than 12 tons of waste per hour. Unlike the bubbling bed, the upper limit is ambiguous, and the types of wastes treated is broader. Waste below the bed must be properly treated (drawback), using a cyclone for the recovery of particles outside the area of fluidisation. This process can be advantageous as it requires a lower reaction volume to create more uniform temperatures.

**Technology 7: Circulating fluidised bed**

**Applicability**
For the incineration of finely divided waste.

**Maturity**
Commercial.

**Project/product reference**
Application of circulating fluidised bed to sewage sludge incinerator.
The rotating fluidised bed is a type of fluidised bed consisting of a porous cylindrical air distributor, where different fluidisation velocities are created in the bed section. The capacity of rotating fluidised beds ranges from 2 to 12 tons per hour.

Figure 8 Rotating fluidised bed

Applicability
For the incineration of finely divided waste.

Maturity
Emergent.

Project/product reference
TU Delft experiment.
Pulverised fuel units are incinerators in which both fuel and primary air are injected into a combustion chamber in order for the combustion of the suspended fuel to take place. Combustion in this process usually occurs between 1300 – 1700 °C. To be used, the fuel must be ground into powder. Gas burnout is achieved after the secondary air addition.

**Technology 9: Pulverised fuel unit**

**Applicability**
For the incineration of small particle fuels.

**Maturity**
Commercial.

**Project/product reference**
GE’s pulverised coal tower type boiler.

2. “Synthetic elements about WtE thermochemical and biological technologies," VEOLIA Recherche & Innovation SNC – Centre de Recherche de Limay.


7. “Mitsubishi circulating fluidized bed incineration system”, [Online].

