Ports Energy and Carbon Savings

Deliverable: Output 13

INDACHLOR - Heat Recovery and Chlorine Recovery

Project No. 2S03-009

With the financial support of

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1	31/08/2022			Final progress report - INDACHLOR - Heat Recovery and Chlorine Recovery

REPORT

INDACHLOR
Heat Recovery and Chlorine Recovery

To

IndaChlor:
Jan Geeroms

cc

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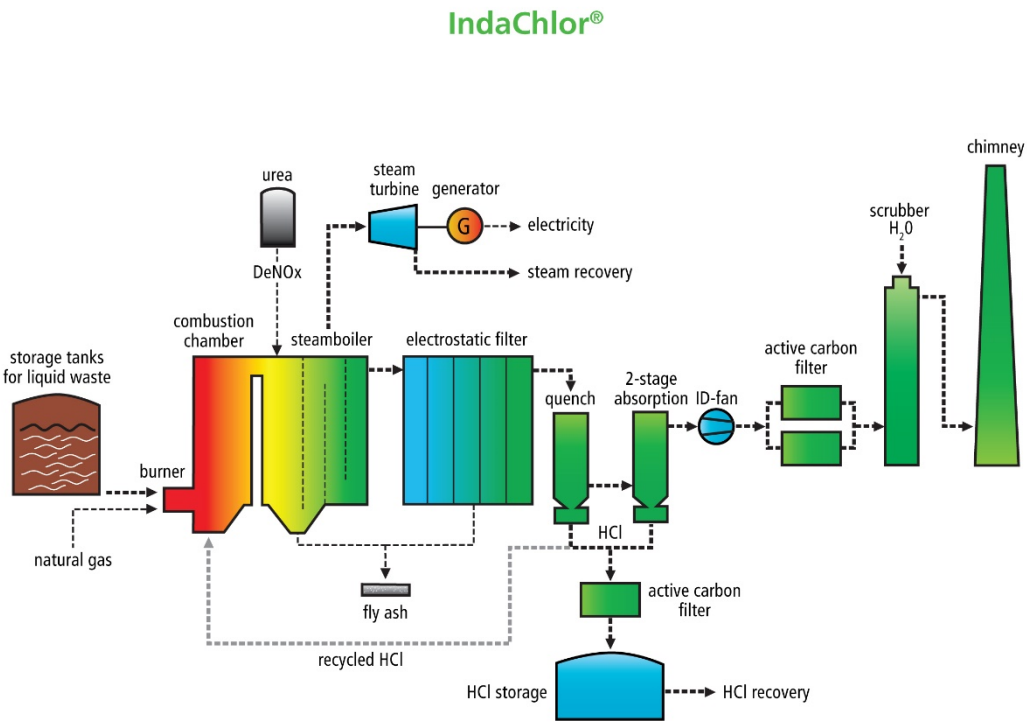
1 Description of the facility

1.1 Thermal treatment

The IndaChlor unit for thermal treatment of hazardous waste will be fed with polluted chlorinated solvents. Chlorinated solvents, considered as hazardous waste, are generated by industrial processes such as vinyl chloride monomer (VCM) production, used as a precursor in PVC production, chlorinated hydrocarbon production and pharmaceuticals.



Liquid chlorinated solvent waste is transferred via the tank farm, where it is pumped to the static incinerator via a pipe rack. This incinerator is fed with chlorinated solvents as fuel and consists of the following equipment:

- A burner of 20 MW thermal power
- A post-combustion chamber
- A steam boiler
- A superheater
- An evaporator
- An economiser.

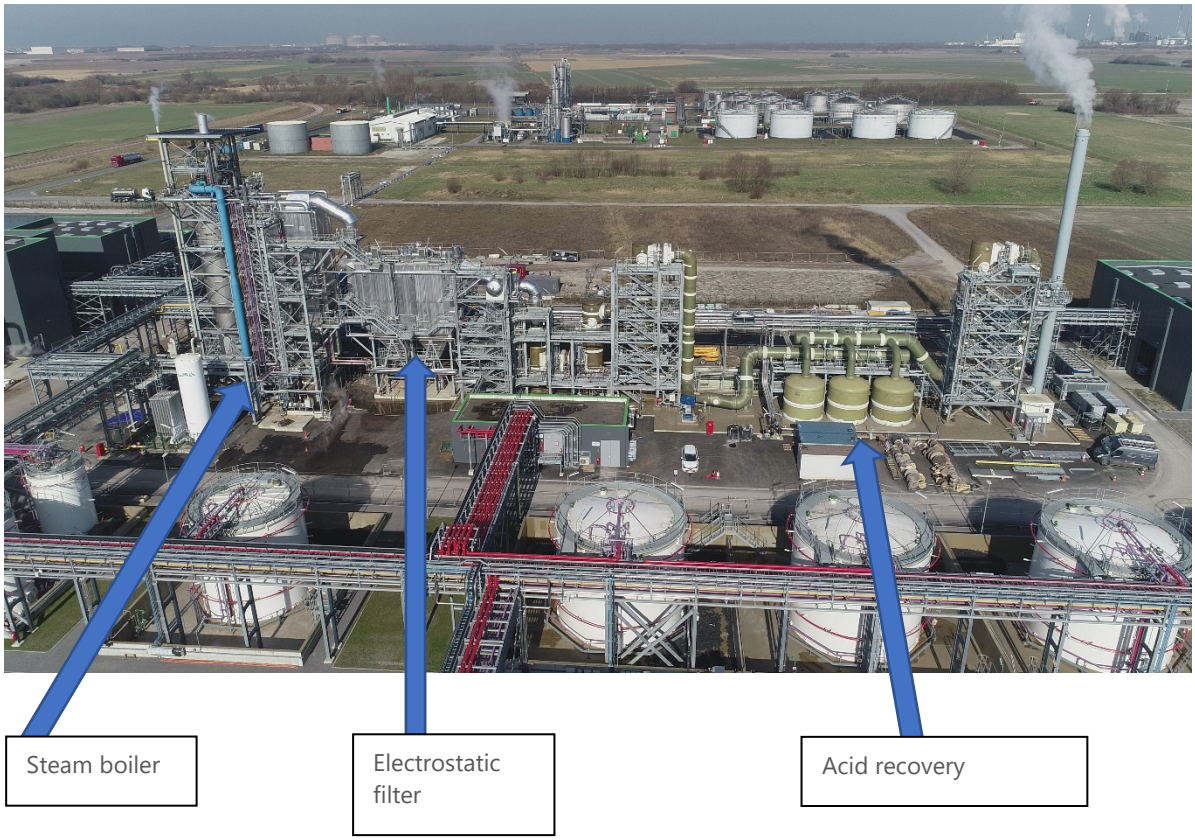
The chlorinated solvents are thermally treated in the static incinerator at a temperature of 1,200°C. The liquid chlorinated waste is injected into a static combustion chamber. These self-combusting liquids result in a very high temperature in the combustion chamber, at least 1,200°C, ensuring complete disintegration of all molecules. This temperature is controlled by injecting small quantities of water and/or recycled hydrochloric acid into the combustion chamber. It should be noted that

temperatures above 1,100°C guarantee the destruction of dioxins and polychlorinated biphenyls (PCBs).

The IndaChlor unit allows that the heat produced by the thermal treatment of chlorinated solvent waste with an average LHV of 14 MJ/kg is utilised in the form of electricity and high pressure steam. The heat contained in the hot gas flows is then recovered by a boiler, producing steam which is mainly used in the steam process at the neighbouring RYSSEN distillation plant, but also partly converted into electricity by a steam turbine coupled to a generator. The turbine is supplied by M+M Turbinen-Technik GmbH, type GET-5-410.

This is the combined heat and power principle, which consists of generating electrical energy and thermal energy in the form of steam from a single fuel source. In the case of IndaChlor, the fuel is hazardous waste from which energy is generated due to its LCV. As part of this project, the thermal energy produced by the static incinerator is recovered mechanically and thermally in a steam turbine coupled to an alternator and equipped with a bleed system. The superheated and pressurised steam expands in the turbine, which drives an alternator that converts the mechanical energy into electricity.

The incinerator generates steam at a rate of 20 tonnes/hour, of which 15 tonnes are used directly by the RYSSEN plant located 300 metres away (providing 80% of its needs). The remaining 5 tonnes will generate electricity for the site. This represents 90,000 MWh of heat usefully recovered per annum which equates to over 7,700 toe. This steam is therefore utilised in the industrial ethanol production process at RYSSEN ALCOOLS. In addition, 5,700 MWh of electricity are generated for the site's needs.



1.2 Useful application of hydrochloric acid and flue gas scrubbing

Before entering the flue gas treatment area, an electrostatic precipitator first removes dust particles from the flue gases. The flue gases leave the steam boiler and electrostatic precipitator at about

200°C where they are scrubbed at 70°C and conducted to 2 absorption columns. The main purpose of the scrubbing process and the absorption columns is to absorb the gaseous hydrochloric acid in the flue gas.

The IndaChlor unit enables hydrochloric acid (HCl) to be recovered at a concentration of 20 - 24% (increased to 24% in order to find more outlets) from the thermal treatment flue gas thanks to a recovery system installed in the flue gas treatment section (absorption columns).

In the original scenario, this hydrochloric acid was sent directly to the neighbouring ALIPHOS ROTTERDAM BV (ECOPHOS Group) industrial site at a rate of 128,000 tonnes per annum (20%) - 110,000 tonnes per annum (24%), at 100% capacity, via an underground pipeline, where it would be utilised in phosphate production for the extraction of phosphates contained in rock or in ash from sewage sludge incineration. Unfortunately, IndaChlor had to abandon this route due to the bankruptcy of the ALIPHOS company.

Immediately after the ALIPHOS bankruptcy, IndaChlor started to look for other partners who might utilise HCl as a raw material in their production process. Since December 2021, structural deliveries are made to 2 customers, at a rate equivalent to 29,000 T HCl 24% per annum. In addition, IndaChlor expects a gradual increase in the annual shipments. IndaChlor expects to achieve full utilisation in 2025, based on 4 - 5 additional customers. Test deliveries for one of them are scheduled for the end of 2021.

The flue gas treatment system consists of the following equipment:

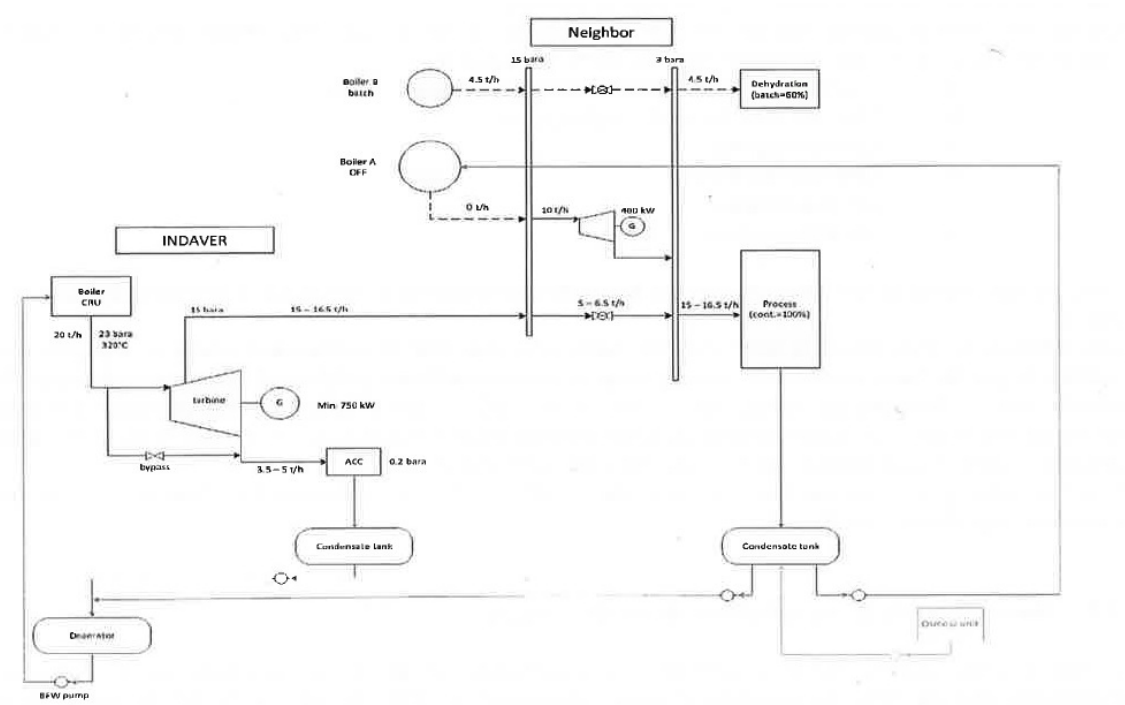
- a ducting system for flue gases coming from thermal treatment unit, with associated fans and extractors
- an acid scrubbing system
- two absorption columns
- an ESP electrostatic precipitator dedusting system
- an activated carbon filter for removing dioxins
- a water scrubber system
- a stack for atmospheric dispersion.

These facilities are located near the static incinerator line.

2 Summary of technical data

2.1 Technical summary of the energy recovery and utilisation system

Type of energy recovery	Waste heat: steam
Recovered thermal power	16 MW
Boiler outlet temperature	180°C
Quantity of waste heat recovered	90,000 Mwh per annum
Thermodynamic heat engine Turbine	
Creating or extending a heat network	Yes - single customer
Network length	300 m
RE coverage rate	100%
Tonnes of CO_2 equivalent avoided:	7,800 teqCO_2 per annum



2.2 Technical summary of the waste utilisation system

Plant treatment capacity	60,000 tonnes per annum
Type of waste	chlorinated solvent residues with more than 50% Cl Hydrochloric acid, containing 35% of acid
type of acid recovered	128,000 t per annum HCl with a concentration of 20% - 110,000 tonnes per annum (24%), at 100% plant capacity
Hydrochloric acid recovery facility	Quench and 2 acid absorption columns
Creating a distribution network	2,000 m underground pipeline to single customer ECOPHOS.
Uses	acid for phosphate extraction
Benefit	HCl used as a substitute for HCl transported currently to site by truck See page 4/6 above in the section on HCl sales.
Transport avoided	6 to 12 trucks per day
HCl waste utilisation rate	100%

3 Acceptance reports

Annex 1: Actemium acceptance report, steam and condensate network.
Annex 2: SPAC acceptance report, underground network from Indachlor to Aliphos.
Annex 3: M+M commissioning report

As of the end of March 2021, IndaChlor sasu has initiated legal proceedings against its contractor Stein Energy, the supplier of the incinerator-steam boiler-flue gas scrubbing section. IndaChlor has requested the court to appoint a legal expert to determine whether Stein Energy has failed to fulfil its contractual obligations and the consequences of this in terms of damages relating to it.
In parallel, IndaChlor has replaced Stein Energy - out of court - to carry out the hot testing phase of the facility and to render the facility capable of acceptance.

Consequently, a provisional acceptance certificate from Stein Energy is not available.

4 Final ground plan

Annex 4 General plot plan.

5 Start date for heat delivery

Due to delays caused by the contractor Stein Energy's default (see above), the first steam supplies to RYSSEN ALCOOLS did not start until 19/07/2021. This marked the start of the test phases, with the final adjustments of the flow and pressure regulators on both the Indachlor and RYSSEN ALCOOLS sides.

The start date for heat delivery is 04/08/2021 (end of test phases). For technical reasons at the waste treatment plant, steam deliveries were carried out at rates of between approx. 6 and 10 tph (the target being 16 tph) and with numerous interruptions. See Annex 6 - RYSSEN steam delivery chart 04/08/21 → 20/12/21. To date, the total energy delivered to RYSSEN ALCOOLS amounts to 8,127 MWh.

At the moment steam production is not stable enough to start recording the metering specified in the finance agreement with ADEME. The start of recording is scheduled for 2023.

Annex 6 - Ryssen Steam Delivery Chart 04-08-21 20-12-21

6 Photographic report

Annex 5 Photographic report

ANNEXES:

ANNEX 1: ACTEMIUM ACCEPTANCE REPORT, STEAM AND CONDENSATE NETWORK.
ANNEX 2: SPAC ACCEPTANCE REPORT, UNDERGROUND NETWORK FROM INDACHLOR TO ALIPHOS.
ANNEX 3: M+M COMMISSIONING REPORT
ANNEX 4: GENERAL PLOT PLAN.
ANNEX 5: PHOTOGRAPHIC REPORT
ANNEX 6: RYSSEN STEAM DELIVERY CHART 04-08-21 20-12-21

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