



EVALUATION OF ÖKO-ENERGIE UMWELTFONDS 1 SYNTROL® THERMOLYSIS PLANT ACCORDING TO *CRADLE TO CRADLE*® DESIGN

Executive Summary

The Öko-Energie Umweltfonds 1 Syntrol® thermolysis plant, as a technology for breaking down plastic packaging materials composed primarily of PE, PP, PB and PS into basic chemical building blocks, may be used as a part of a Cradle to Cradle® system of materials management.

Introduction

Pyrolysis technologies are well-researched, and becoming ever more established around the world, especially in areas with little previously existing recycling infrastructure. Current developments include mobile thermolysis reactors, and gasification plants to produce combined gaseous fuels, heat and generate electricity.

Pyrolysis technology can be used to recover valuable materials from mixed waste or from separated fractions, such as plastics. This use is particularly interesting, given the extensive plastic pollution existing worldwide, on land and in the seas. 'Specific pyrolysis' may also be used to produce industrially relevant monomers from separated plastic fractions, usually in the presence of a catalyst, where the required volume of pure materials can be collected.

The Syntrol® pyrolysis technology is referred to as thermolysis, in order to differentiate it as a new, low temperature, plant technology.

In developing countries, the existence of a Syntrol® thermolysis plant transforming plastic pollution into valuable products such as fuel oil for powering machinery would provide an incentive for the collection of the plastic strewn across the land, and currently leading to innumerable deaths of animals. Equally, the technology may be an incentive, in some developing economies, for fishermen to bring in the plastic floating in the seas.

Discussion

The main considerations indicating the suitability of the Öko-Energie Umweltfonds 1 thermolysis plant for a Cradle to Cradle® materials management system are summarized below:

- a. The incineration currently of 56% of the plastic waste produced in Germany indicates the lack of an alternative recycling possibility for this material, due to various factors. This means that over half the plastic waste is available for thermolysis.
- b. The analysis of the expected main oil product, as well as the expected coke by-product shows a product quality that is satisfactory for the purpose for which it is intended, i.e.



combustion.

- c. No toxic emissions are expected from the thermolysis plant: the only gases emitted to the air are the results of complete combustion of hydrocarbons, and therefore only CO₂ and H₂O.
- d. Extended use of thermolysis to produce heating oil may lead to a reduction in the demand for this fraction from petroleum cracking. However, as petroleum combustion currently accounts for more than 90% of mined petroleum, and plastics production around 5%, this is not expected to make much difference to the overall demand for petroleum or for virgin plastics, nor therefore on the mining activities worldwide.
- e. A significant reduction in the amount of plastic going to incineration would have an effect on the demand for these facilities, as plastic is a high caloric value input for incineration. This is in contrast to biomass which is incinerated together with plastic in the household waste fraction.
- f. From the point of view of creating a Cradle to Cradle® materials management system, this would be a positive step, as less incineration demand, leading to fewer facilities would also mean that alternative facilities for the recycling of biomass waste may be promoted.
- g. The by-products coke and aluminium have a good market. The coke produced is low-sulfur, so it can be used preferably wherever facilities for coal or coke burning exist. However, as with coal-ash, the ashes produced from combustion would need to be disposed of carefully, and, as there is significant heavy metal content in the coke, filters would be needed on the coke-burning facility. If there is a significant increase in the price of primary ores, the feasibility of extraction of heavy metals from the ashes from coke-burning may be evaluated in future.

The future potential for aluminium recovery is good. If a higher percentage of aluminium-coated PE, for example from the relevant layers of Tetra-Pak drinks cartons, can be included in the allowable input to the thermolysis plant, and selectively recovered in a pure aluminium fraction. The current price of primary aluminium is twice that of heating oil.

- h. From the point of view of a Cradle to Cradle® materials management system, it would be desirable for the oil fraction which is produced to be useable as a chemical feedstock and not just as a heating oil, intended for combustion. This would ensure a reduced reliance on petroleum for the chemicals industry, which currently uses approximately 8% of the total petroleum that is drilled, and ensure security of supply of materials, especially but not only, plastics, for the future.

Summary of Analytical Results

Elemental analysis of oil fraction

element	symbol	content
carbon	C	86,00%
hydrogen	H	14,00%
oxygen	O	< 0,1%
nitrogen	N	0,14%
sulfur	S	400 ppm
fluorine	F	< 20 ppm
chlorine	Cl	200 ppm
bromine	Br	< 20 ppm
iodine	I	< 30 ppm
antimony	Sb	< 1 ppm
arsenic	As	< 1 ppm
lead	Pb	< 1 ppm
cadmium	Cd	< 0,1 ppm
chromium	Cr	< 1 ppm
cobalt	Co	< 1 ppm
nickel	Ni	< 1 ppm
mercury	Hg	< 0,1 ppm
thallium	Tl	< 1 ppm
vanadium	V	< 1 ppm
tin	Sn	< 1 ppm

("<" means "below detection limit")

- The main fraction from the Syntrol[®] process is a liquid with properties similar to heating oil (Heizoel EL), with a calorific value of around 44 MJ/kg.
- It consists only of hydrocarbons. Content of aromatic hydrocarbons is 24%.
- It does not contain oxygen.
- It has low sulfur content (400 ppm) and meets the sulfur requirements for Heizoel EL (< 1000 ppm sulfur).
- It has low chlorine content (200 ppm). No other halogens were detected.
- Content of any toxic heavy metal is below the detection limit (1 ppm).

Elemental analysis of solid fraction

- The solid fraction is similar to lignite (brown coal) but with a much lower sulfur content (190 ppm).
- There is significant toxic heavy metal content, so that filter systems have to be applied if it is to be combusted for heat production in industrial processes.