



Evaluation of system costs for the use of plastics with regard to disposal costs

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1. Introduction

1. Clean Biomass, polluted Plastics?

EcoEnergy has been operating the demonstration plant for the SCHUBIO®-Process for wet mechanical separation of waste since 2005. In the process, biogenic, organic matter is separated from the fossil organics, the plastics.

Chemical analysis of these fractions shows decreased pollution in the native organics fraction and increased pollution in the fractions, containing plastics.

2. RDF for Coal-Fired-Power-Plant is Biomass?

Another clue for the pollution of plastics came up, when we investigated possible RDF fuels for co-combustion in a coal fired power plant. We established suitable input criteria not only for plant emissions but also for the quality of gypsum and fly ash.

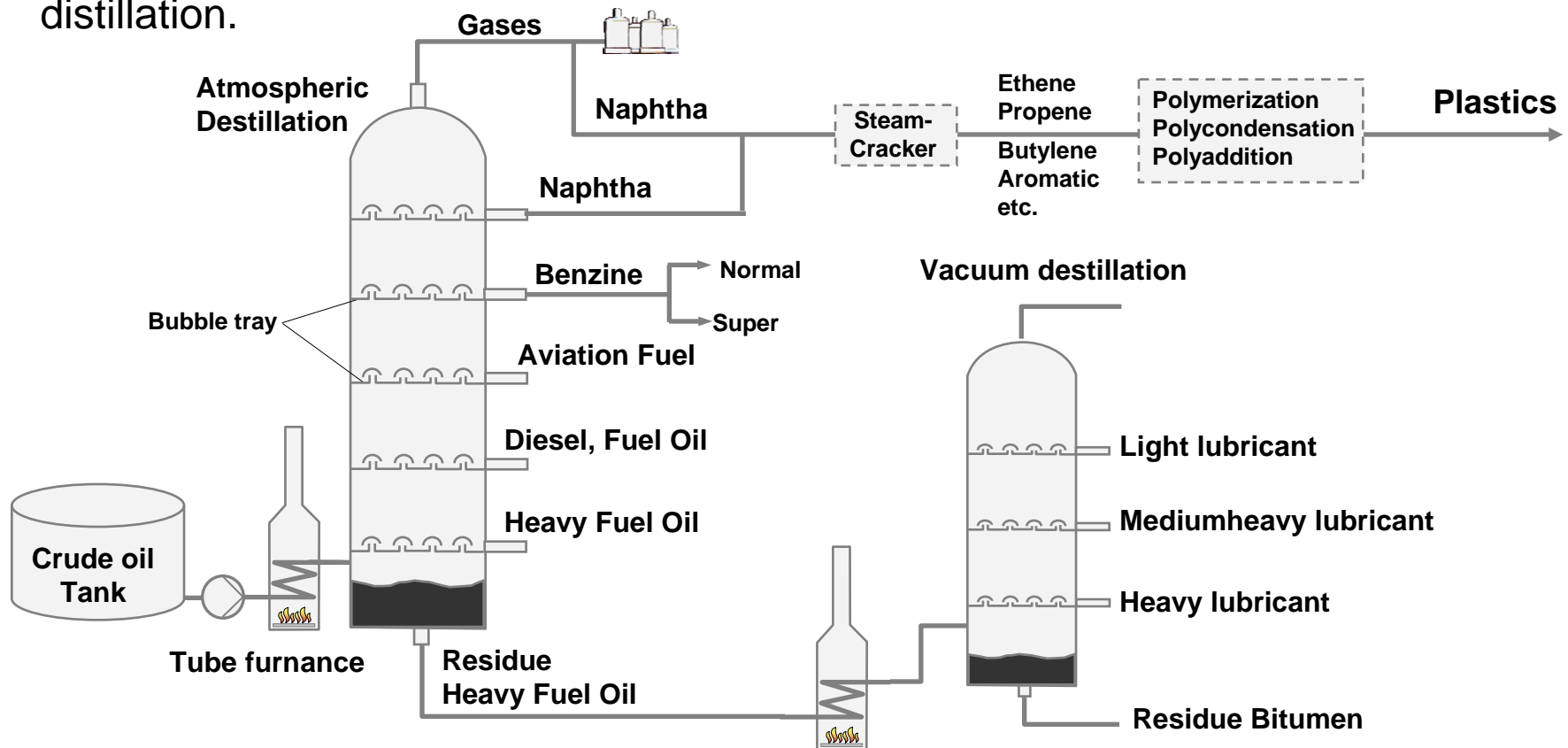
In the end, only material blends with little or no plastics could meet the input criteria.

These findings let us to investigate further and analyze the system costs for the use of plastics with regard to disposal costs.

2. Production of Plastics

Naphtha is produced from crude oil and is the raw material for production of plastics.

Until the Fifties, naphtha was used directly as fuel. The development of higher compression for combustion engines caused the need for more knock-proof fuel with higher octane number. Naphtha became a by-product from crude oil distillation.



Production for Users - or Use for Production

The percentage distribution of fractions from crude oil depends on the oil properties. Precursors for plastics production are therefore not being produced on demand from the market for plastics, but depending on crude oil quality and on the technical conditions of the refinery.

Consequently, refineries can only run when the produced naphtha is processed further to plastics.

Demand for plastics dropped recently by 20 % to 70 %, depending on the sort. Logistics of the by-products are important for operating a refinery, since these, like f. ex. naphtha, are generated in huge amounts. For this reason, the steamcracker of BASF in Ludwigshafen, Germany, was shut down in March 2009.

To ensure the demand for the produced plastics, the price can be adapted until they are cheaper than the corresponding natural material.

Polyvinylchloride – Residue from Soda Production

Another example is PVC, already much discussed in waste industry. PVC contains 57 % chlorine and is produced from chlorine gas and hydrochloric acid (HCl).

Formerly, there has been a surplus of chlorine gas from sodium electrolysis in the chemical industry because sodium hydroxide was needed for production processes.

PVC production needs chlorine gas as well as naphtha and provided a way out of a disposal problem.

Today, the situation is reversed because of the increased demand and acceptance for PVC.

Costs of raw plastics production

Many refineries worldwide are still burning off naphtha without using it.

Naphtha is difficult to combust, because it is a very heterogeneous material. Gas turbines for naphtha need external combustion chambers and have to be equipped with explosion protection. In addition, they have a short lifetime and need to be replaced after 3 to 5 years. Naphtha is easily inflammable and transportation is a logistic challenge. Consequently, plastics production plants are often installed near a refinery.

The use of naphtha for plastics production is more profitable than using naphtha for power generation. During the last few years naphtha prices have been between 150 €/t and 400 €/t.

The naphtha price is lower than benzene, diesel and light fuel. For processing naphtha to plastics precursors, the energy content of naphtha is needed once again.

Replacement of renewable resources by plastics

Cotton fights against Plastics

The material use of renewables, for example cotton, is not supported by the government in any way. Textile sellers like IKEA, OTTO, C&A and H&M have taken the initiative and support cotton farmers in Africa, whose survival on the market is threatened by cheap synthetic textiles, partly produced from PET-recycling material.

EEG supports Plastics

The German Renewable Energy Sources Act benefits energy recovery from wood as a renewable energy source. Consequently, the wood price is rising, also for material use of wood, which is not supported in any way. Therefore, plastics have a good chance to replace wood in many applications, for example thick-walled products like garden benches, fences or terrace paving.

Disposal of plastic waste

Today, plastic waste is mostly seen as recyclables, even though about 50% of plastic waste is burned in waste incineration plants and recycling of mixed industrial waste is questionable too. The separate collection of plastic waste from households is seen critically.

Energy Recovery from Plastic Waste

Pure polyethylene and polypropylene production waste with a low pollution level can be used for energy recovery in coal fired power plants and cement kilns.

In general however, plastics contain several critical pollutants such as chloride, bromide and especially heavy metals like mercury, lead, cadmium and antimony. Besides emission control, the product cement and the residues from the power plant should also be watched closely.

Cadmium pollution

Cadmium is a waste product from tin smelting and has been used as pigment in plastics and especially as stabilizer in PVC.

Our evaluation of pollutant distribution in a coal firing power plant with co-combustion up to 25 % of thermal capacity shows, that the limit value for cadmium is approximately 0.4 mg/kg fuel. Only then, the quality of gypsum is still adequate. Biogenic waste material without plastics can meet this requirement.

The current limit value for cadmium of the “Bundesgütegemeinschaft Sekundär-brennstoffe e.V.”, an association of RDF producers, is 4 mg/kg RDF and is only meant for lower co-combustion rates.

Waste with plastics can barely keep this new, low limit. According to the EU Directive 76/769/EWG, the limit value for plastics is 100 mg/kg Cadmium.

Antimony pollution

The corrosion effects of antimony in combustion are still unknown and have also not been investigated yet.

Antimony concentration in plastics is 1'000 to 2'000 times higher than in coal. In natural products antimony concentration is less than 0.01 mg/kg. PET contains 300 mg/kg and Polyester 150 mg/kg. Migration of toxic antimony from PET bottles into the liquid has been verified in 2006. Doctors are warning against wearing PET textiles because of sweat releasing antimony.

The limit value for Antimony in waste for combustion in cement kilns in Switzerland, was originally at 5 mg/kg and has since been adjusted to 300 mg/kg for „plastic waste“ and to 800 mg/kg especially for PET-waste. Until today there has been no long term study on the migration of antimony from concrete containing antimony polluted cement.

So far, there are no binding declarations by the plastics industry for reducing the use of antimony. Technically there is no alternative for antimony, neither as a stabilizer in PET and polyester nor as a synergist in bromide containing plastics.

Lead Pollution

Lead is used as stabilizer for the PVC production and as pigment. PVC in today's waste contains about 2'000 mg/kg lead, the limit value for co-combustion is at 70 mg/kg. According to a voluntary declaration of PVC producers (Vinyl 2010), the use of lead in PVC production shall be reduced from 2015 on.

Mercury pollution

Hydrochloric acid is used for PVC production.

Two thirds of hydrochloric acid is produced with chlorine-alkali-electrolysis and the amalgam process. In this process, contamination of the hydrochloric acid with mercury is unavoidable. In consequence the mercury is also incorporated into the PVC.

Around 1973, 58 mg mercury per kg chlorine was used in PVC production. PVC products have a lifetime of 2 to 50 years.

The limit value for co-combustion is 0.6 mg/kg.

Chlorine pollution

The chlorine content of waste containing plastics stems to 60 % to 95 % from the plastics. Best known example is crude PVC with a chlorine content of 57 %.

The final PVC products contain about 30 % to 80 % of crude PVC; resulting in 15 % to 45 % chlorine content in the PVC based plastics.

Separation by automatic sorting is therefore difficult. The reject material is not recyclable as PVC and the operators of waste-to-energy plants do not accept this mixed PVC waste, containing > 10 % of chlorine.

Chlorine is further used in many other plastics as flame retardant.

No energy recovery of PVC - PVC for disposal

Chlorine, together with chloride-forming heavy metals and alkaline, is responsible for high temperature corrosion in the boiler. Many waste-to-energy plants have a permit for burning material with maximum of only 1 % chlorine.

Not all flue gas cleaning systems of currently operating waste incineration plants or waste-to-energy plants allow for chlorine content higher than 2.5 %. On top of the costs caused by boiler corrosion, f. ex. higher maintenance costs, less availability and shorter run time, chlorine causes also higher utilities consumption for chlorine binding and higher costs for disposal of residues.

The total extra costs because of the chlorine load are

400 to 700 €/t PVC (only chlorine),

basic costs for waste incineration (300 – 400 €/t) not included.

It is evident, that the presence of PVC in a mixed waste, declared for energy recovery, is not any indication for the suitability of PVC for energy recovery.

PVC incineration is not energy recovery!

Raw material recycling of Plastics – Theory meets Reality

Raw material recycling of plastics is irrelevant at present, since

- the coal-oil-plant in Bottrop, Germany, was closed in 1999
- the gasification plant for methanol synthesis SVZ shut down in 2005
- the steelworks do not use DSD plastic waste as reduction material since 2005

Antimony content is important for steel production because antimony causes grain boundary segregation and, even more so, surface segregation of steel and iron based alloys. This causes higher corrosion risk of the steel. Commercial steel contains about 10 mg/kg antimony. Due to the increasing use of low quality scrap metal from car recycling, electronics scrap metal and ferrous scrap metal from waste incineration slag, it is likely that the antimony content of steel will increase.

We do not expect a “revival” of the use of plastic waste in the steel industry.

Material recycling

We also investigated material recycling of waste, containing plastics. The term “recycling” of plastics implies that the same product can be produced again from the recycle granulates. Until now, this is regrettably not the case!

The term „bottle-to-bottle“ in PET- bottle recycling does only mean a 15% addition of recycling PET to the raw material for production of new bottles. The highest recycling quality to date is reached by blending regranulates from production waste with new raw material.

This application for high quality products however, is not possible from post consumer waste without an inappropriate sorting effort and by mixing more than 10 % into the product.

Not enough thermal capacity for plastics waste?

Material recycling of plastics usually means production of thick-walled products. These can not be recycled after use and have to be disposed of by thermal treatment. So the incineration of the original plastic material is delayed, but ecologically and economically it is still the better alternative compared to land filling.

In any case, there is not enough waste incineration capacity in Germany today for disposal of all plastics waste.

Until 2020, we have to double the existing waste incineration capacity, if only because of reduced plastic recycling and better monitoring of illegal disposal.

“Society Landfill” – not hidden – not seen

The term “society landfill” suggests the intermediate storage of polluted plastics in society in the form of thick-walled plastic recycling products, such as garden benches, fences or even bicycle stands, prior to their final disposal. The society landfill secures the plastic waste for a subsequent controlled disposal.



Thermal Disposal by Plastics Waste Incineration – BAT?

The most accepted and best way for the disposal of plastic waste is waste incineration.

Plastics are responsible for 50% to 80% of incineration costs even though their proportion in the waste is only 15% to 40%.

Because of their high heating value they account for 50% to 90% of the thermal input of the waste incineration plant.

Costs depend mainly on the waste volume, determining logistics, bunker and feeding costs as well as on pollution of the waste and on the thermal output of the plant.

The mass throughput is only a minor factor for the costs of waste incineration.

Costs for thermal treatment largely depend on heating value

One ton industrial waste with a high plastics content and 16'000 kJ/kg heating value is displacing two tons household waste with 8'000 kJ/kg heating value.

Consequently, the plant operator earns only half when processing this industrial waste.

Average costs for waste incineration have been about 150 €/t in Germany during the last 3 years relating to an average heating value of 10'000 kJ/kg.

One ton of plastic waste with 40'000 kJ/kg heating value consequently displaces four tons of household waste.

The theoretical costs for disposal of plastic waste are therefore about **600 €/t plastics.**

Landfill

Plastic waste from car recycling and plastics in the MBT landfill fraction are still dumped legally in Germany. In other countries, with few exceptions, disposal of plastic waste on landfills is still the main disposal method.

Export for pseudo recycling

Officially, German plastic waste goes mainly into material recycling in foreign countries.

In 2008 the “Bundeskriminalamt” (Federal Criminal Police Office) has published a report about „Waste management cross-border crime in connection with the EU enlargement to the East“.

Quotation: „On the European waste market there is a large dark field of illegal transport, especially of so-called pseudo recycling. The 2002 ecological report of the German Council of Environmental advisors states, that this is usual practice and calls this development a perversion of waste management. Compulsory use of the public disposal system for recycling was abolished and consequently the national and international waste transport increased...“

Uncontrolled plastics disposal and CO₂-Emissions

In our opinion, plastic waste has to be regarded as hazardous waste, but the danger to the environment is only perceivable in the long term. The point is not an acute toxic effect but the extremely high persistence of plastics in the environment.

In 2004 it has been discovered, that several million tons of plastic waste are drifting in the Pacific Ocean between California and Hawaii. These plastic are slowly crushed mechanically and raise the plastic content of the plankton. Degradation and therefore release of the toxic pollutants however, is estimated to take more than 500 years.

The most obvious problem with using oil is carbon dioxide emission. This problem applies to 90% of the oil application and can – at least in theory – be solved in a time frame of fifty to hundred years by switching to renewable resources.

The other 10 % are used for production of plastics. The consequences from their disposal are not reversible during the next millennium.

Conclusion

Post consumer plastics waste is not recyclable sustainably.

The real system costs of plastics production are fundamentally higher than those of basic material like glass, paper, wood, natural fibres, stone, metal etc. for the same application.

The system costs of oil based plastic production will increase along with the increasing shortage of crude oil.

Less plastics production is consequently leading to fewer applications for the material recycling of plastics.

The pressure for pseudo recycling can only be reduced if the compulsory use of **public disposal systems is re-established** for waste with plastics.

Anschluss- und Benutzungszwang für kunststoffhaltige Abfälle



**Thank you very much
for your
Attention!**

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