Case Study 3

Cynar Plastics to Diesel

Report for ZWSA

Ricardo-AEA/R/ED58135
Issue Number 1
Date 02/07/2013

Disclaimer:

This case study has been prepared by Ricardo-AEA Ltd for the exclusive use of Zero Waste SA and the Government of South Australia. The views expressed do not necessarily reflect those of the Government of South Australia. Zero Waste SA and Ricardo-AEA Ltd accept no liability or responsibility whatsoever for any third party for any loss or damage arising from any interpretation or use of the information contained in this report, or reliance on any views expressed therein.

Case Study 3: Cynar Plastics to Fuel

Overview

Cynar Plc. utilises a pyrolysis technology to convert non-recyclable waste plastics into liquid hydrocarbon fuels. In 2011, SITA UK, one of the resource management companies signed an exclusive agreement with Cynar to build the UKôs first fully operational plants to. The plant is to be located on a óresource re operational in July 2013.

Outcomes

¶ When operational, the facility will have the capacity to process 6,000 tpa of waste plastic with an estimated output of 5.7 million litres of fuel per year.
¶ The plant will be able to process plastics wastes which are not easily recyclable, including shrink wraps, agricultural plastics and residual plastics from materials recycling facilities.

Benefits

¶ The facility will result in the diversion of waste plastics from landfill while producing a fuel with the performance and quality of conventional diesel, but with a lower carbon footprint
¶ The fuel produced can be used directly as vehicle fuel without the need for further processing or adaptations to the engine
¶ SITA will benefit from lower internal transport costs to fuel their waste collection fleet

Success Factors

¶ Cynar have received financial backing by SITA, to both fund design and development of the technology and to develop 10 facilities across the UK
¶ SITA assessed a number of different potential vendors before choosing to work with Cynar plc. SITA cited Cynarôs employmen attitude and synergy with SITA gave the best probability of success
¶ SITA and Cynar have worked constructively over a period of 3 years to develop a good working relationship and trust.
¶ Part of the first plant investment by SITA was to fund re-design of the plant to improve the output and reliability
¶ In addition to being a strong industrial partner expertise in materials handling and in securing feedstock contracts

Background

Cynar Plc. ("Cynar") is a UK company established to commercialise its specialised pyrolysis and distillation technology to convert non-recyclable waste plastics into liquid hydrocarbon fuels.

Cynar has been developing its pyrolysis technology since 2004 and installed its first full scale plant in County Laois, Ireland in 2008. In 2011, SITA UK, one of the recycling and resource management companies and a subsidiary of French firm Suez Environment, signed an exclusive agreement with Cynar to build the UKô s first fully operational plants to convert ñend of life plasticò (ELP) into diesel fuel in a contract valued at £70m. SITA is planning to construct up to 10 plants, each with an annual throughput of 6,000 tonnes of plastic waste, producing approximately 5.7 million litres of synthetic fuel.

The first facility is currently being constructed at Avonmouth Resource Recovery Park, which will also include a gasification facility capable of treating 100,000 tonnes per annum (tpa) of residual waste and an 80,000 tpa materials recycling facility (MRF).

The Cynar Technology produces a synthetic fuel that is clean, low in sulphur and has a higher cetane number than generic diesel fuel. SITA UKô s agreement with Cynar UK as it attempts to deal with mixed waste plastic with a solution that is both environmentally efficient and energy productive.

Feedstock

The Plastics to Fuel facility will process 6,000 tpa of ELP. A MRF is co-located on the Resource Recovery Park and it is estimated that up to 10% of residue from the MRF (600 tpa) will be used as fuel for the Cynar plant.

As a rule of thumb, approximately 950ml of oil can be recovered from 1kg of plastics such as Polyethylene (PE), polypropylene (PP) and polystyrene (PS).

The facility can process commingled and miscellaneous waste plastics such as:

- **plastic packaging scrap from material recovery/sorting facilities**
- **oil and detergent bottles**
- **off-cuts/trimming from nappy production**
- **mulch film and silage wrap**
- **mixed post-consumer plastics**
- **caps/labels/rejected bottles from bottle recycling operations**
- **commercial stretch and shrink wrap**

Plastics recovered from the household kerbside collection are generally an ideal feedstock for the Cynar plant. Agriculture plastic waste is suitable, such as silage film, which is mainly polyethylene-based. Pallet wrap and stretch wrap form the commercial waste stream is typically based on low and linear-low density polyethylene and makes ideal feedstock.

Feedstock challenges

The pyrolysis process is more suited to certain feedstock than others and this was a challenge during the development of the technology. For example, some plastics such as polyvinyl chloride (PVC), polyethylene terephthalate (PET), nylon, polyurethanes and rubbers may cause difficulties. PET contains oxygen atoms, which take part in the oxidation reactions that can turn the plastic waste into a sludge-like substance. PVC contains chloride ions than produce unwanted chemicals such as hydrochloric acid and a range of dioxins.

Fortunately, PVC and PET are not commonly found within mixed plastics. PET is mainly found in the form of plastic bottles and tends to be removed in the recycling, while PVC is more common to objects such as window frames, pipes and electrical insulations.

Nonetheless these products can emerge within the mixed plastic waste stream. In the UK, PET constitutes 15% and PVC 3% of the mixed plastic waste stream. The system has been designed to manage low levels of these materials, up to 10%, by carefully controlling the pyrolysis temperature, driving off the oxygen and chlorine to break down the plastic waste.

Additionally, pyrolysis of PVC and PET produces a poor yield of fuel when compared with other plastic such as polystyrene and low density polyethylene (LDPE). The pyrolysis process can convert approximately 90% of polystyrene and 70% of LDPE into fuels, while converting just 30% of PET and PVC into fuels.

The plastic feedstock is usually cleaned and shredded into small pellets before the pyrolysis process, to remove non-plastic contaminants. This is important if the source of the plastic is not known. Contaminants in the feedstock will be in the form of paper and dirt, or could be blood, oils and grease in plastics from the meat processing industry. Some of the additives and other unwanted compounds in the plastics are driven off during the pyrolysis process in the same way as the oxygen and chlorine. Contaminants in the liquid fuel are removed by filtration or a centrifuge.

Technology

The facility effectively reverses the plastics production process, where hydrocarbons are used to create plastics. Instead, the process cracks the hydrocarbon chains within the plastics, to produce distilled fuels.

The feedstock is chipped to approximately 15mm, producing a plastic flake material. This material is washed (to remove impurities) and dried (to remove moisture). The flakes are fed through a melt-infeed system into the chamber, so almost any shape or size of waste plastics can be handled. The system consists of a stock in-feed system, pyrolysis chambers, contactors, distillation, oil recovery line and syngas.

During start up, the furnaces are supplemented with either natural gas or LPG, depending on availability. Control of the furnace heat output is modulating, rather than on/off, to maximise the consistency of the product and also as the syngas fuel is produced continuously.

The pyrolysis chamber operates on a 24 hour cycle, during which plastic melt is continually fed and pyrolysed.

The pyrolysis process is performed within a heated sealed chamber that has been purged of oxygen. The chamber is fed molten plastic by an extruder, and the plastic is stirred in the vessel by an agitator. Plastics in the chamber continue to be heated and pyrolysed in the absence of oxygen, producing hydrocarbon vapours. The plastic is pyrolysed at 370-420ºC, and the pyrolysis gases are condensed in a two-stage condenser to produce a low-sulphur distillate. The vapour is converted into various fractions, including raw diesel, in the distillation column and the distillates then pass into the recovery tanks. Non-plastic materials fall to the bottom of the chamber.

The raw diesel is further refined in another distillation column, where it is distilled into the main three products, road diesel, kerosene and light oil. A synthetic gas is produced as a by-product. This is manipulated and then cleaned prior to use in the furnaces that heat the

pyrolysis chambers, making the system a closed loop process, improving the efficiency of the process.

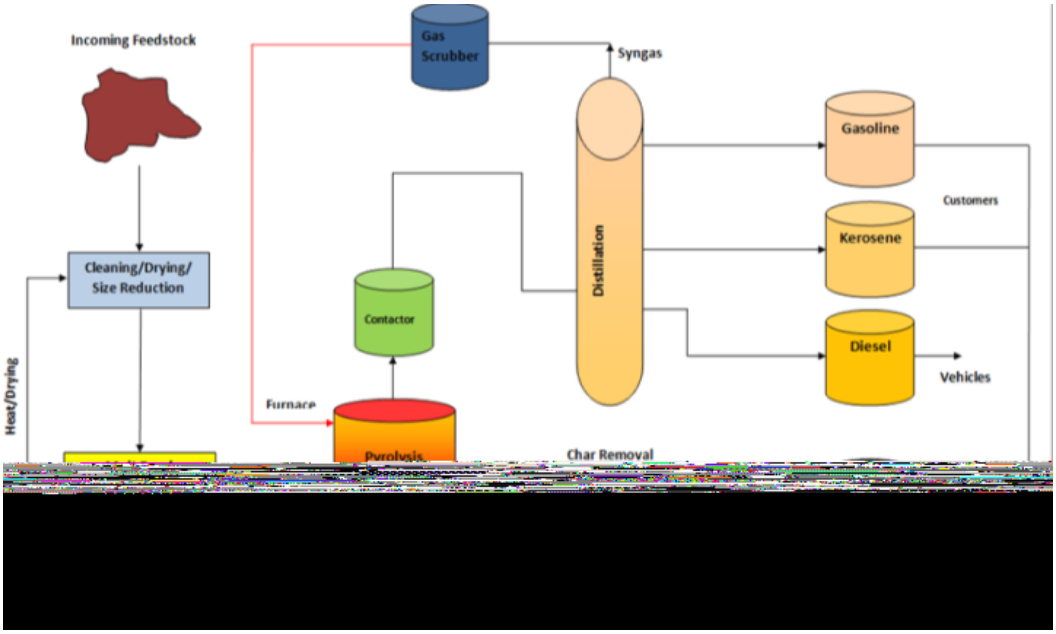

Figure 1: Cynar Plastics to Diesel conversion process. www.cynarplc.com

Outputs

The facility has an input capacity of 6,000 tpa of waste plastic and an output fuel capacity of about 5.7 million litres per year (yielding a conversion rate of approximately 96 %.) To give some context of the scale of recovered fuel production, the fuel used by the city of Canbe rentire waste collection fleet in one year would use less than one sixth of the fuel produced by this facility.

The plant converts mixed waste plastics into diesel, kerosene, light oil and a cleaned synthetic gas. The exact recovery ratio and characteristics of the product distillate differs depending on the types of plastics received and the decomposing temperature.

The outputs can be directly used as fuels, e.g. the diesel can be mixed with pump diesel (at a ratio of 70% to 30%), to be put directly into vehicles, such as those vehicles that collect the waste in the first place.

Each tonne of plastic produces approximately:

- 700 litres of EN590[1] diesel
- 200 litres of light oil
- 100 litres of kerosene
- Residual char (approximately 5% of outputs)

The diesel fuel produced can be directly used within SITAôs waste collection v allowing them better control over their internal transport costs. The light oil fraction can be used as a raw material in the chemicals industry, including as a raw material in the manufacture of new plastic products. The kerosene can be blended with conventional fuels or used in amended engines.

The char produced arises from any contamination of the feedstock. The char is classified as a non-hazardous waste. Cynar are currently investigating further uses for the char, such as for use in the manufacture of tiles or as a pigment for colouring concrete.

[1] EN590 describes the physical properties that all automotive diesel fuel must meet if it is to be sold in the European Union, Croatia, Iceland, Norway and Switzerland.