LABORATORY FOR CHEMICAL TECHNOLOGY
Technologiepark 125, 9052 Gent, Belgium

Coach	**Supervisor(s)**	**Funding**
dr. Maja Kuzmanović	Prof. dr. ir. Kevin Van Geem	

Valorisation of the mixed plastic waste stream by using a new concept based on the twin-screw extruder and reactor

Aim

The goal of this master thesis is to develop a new system for mixed plastic waste (MPW) valorisation consisting of a twin-screw extruder and reactor, as well as to optimise the conditions used during the processing for reaction kinetics and reactor hydrodynamics.

Justification

Polymer products became an integral part of our modern life, leading to a tremendous increase in the consumption of plastics, which ends up as a plastic waste. This brought along major challenges for the researchers how to solve issues concerning plastic waste disposal, and lowering its total impact on the environment. It is well known that recycling of plastic waste can reduce the necessary virgin resources, reducing the energy in production, and by that minimise the overall impact on the environment over the life cycle of the product. Therefore, recycling as an expanding field has captured the attention of the industry. There are several methods of plastic waste valorisation: energy recovery (incineration), mechanical recycling, chemical (de-polymerisation) and feedstock recycling (including pyrolysis, hydrogenation, gasification).

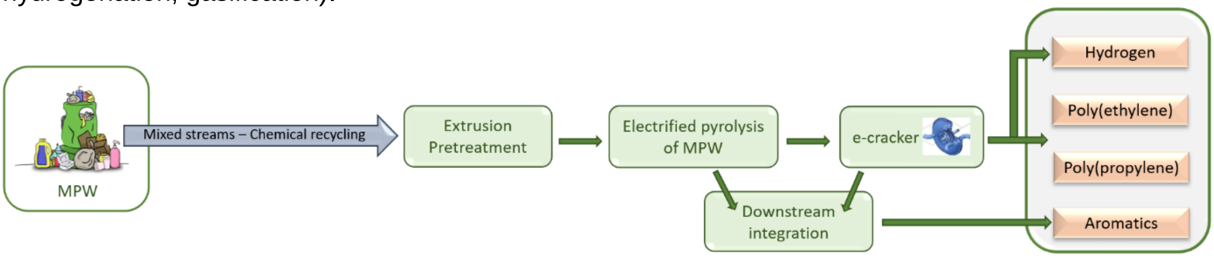

Figure 1. Process of chemical recycling of mixed plastic waste.

Chemical recycling is promissing technology, as the plastic waste can be converted to useful chemical building blocks. Selective catalytic de-polymerisation is possible in which a waste stream is broken down into its monomers with selectivity higher than 65%, and then these can be reprocessed into polymers that are indistinguishable from virgin polymers. However, this is only possible for very pure waste streams making it an infeasible technology for post-consumer unsorted plastic. Processes such as hydrocracking, gasification or catalytic cracking might be better for mixed waste streams becuase they can deal with the complexity of the feed; but they require a high amount of energy and an expensive infrastructure. While **pyrolysis** done on a MPW feed, has the advantage in combination with steam cracking because high value olefins are produced at mild conditions and low pressures. Pyrolysis of plastic waste takes place between 300 to 700 °C in the absence of oxygen, and produces gas, char and liquid oil. The most desired product from the process is the oil due to its relatively high calorific value and its many potential applications such as petroleum blends. Pyrolysis is considered to be relatively easy and cheap process. When the reactor is suitably designed it may enable a fast and controlled conversion of the plastic waste, producing primarily a product that is liquid at room temperature. However, to achieve a high degree of conversion, a high temperature (>550 °C) is needed, implying an energy intensive process. In this master thesis, pyrolysis will be selected as it is sufficiently robust to deal with the large variation in plastic waste, resulting in a less complex and expensive process, and it yields a liquid oil that can be used for the production of a large range of products.

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Program

Literature study will focus on the listed topics:

- Extrusion processes and its combination with pyrolysis of plastic waste.
- Thermodynamics and kinetics in the liquid phase.
- Catalysts and their reactivity, selectivity and stability against coking and contaminants in the upgrading of plastic waste pyrolysis oils.
- Experimental study on influence of the processing conditions during the extrusion pre-treatment.
- Characterisation by different techniques such as FT-IR and DSC of plastic waste, GPC to define the molecular weight distribution in products; GC-MS & HPLC will be applied to study the identification of additives. The elemental analysis for CHONS and Ion Chromatography for halogens, as well as, ICP-OES for metal and halogen quantification.