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Large-scale Pyrolysis—Plastic Chemical Recycling

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Abstract

Plastic has become one of the most ubiquitous materials in our lifestyle. However, the proliferation of plastics that contaminate rivers, oceans, and landfills has also brought adverse environmental consequences. This is a major global challenge and has sparked a strong interest in the more efficient production, use, and disposal of plastics, in line with the principles of the circular economy. There is also increasing regulatory pressure regarding recycling quota and recyclability along with strong commitments from global chemical industries toward increasing the share of recycled material in their offerings. As the chemical makers are under pressure to solve the plastic waste problem, firms are increasingly exploring chemical recycling as a complement to traditional mechanical techniques, which reform the plastic into a usable pellet only. However, the capacity of plastic chemical recycling via pyrolysis is limited because the technology solution is at only 10–50 tpd of plant capacity. Large-scale pyrolysis is being investigated as an option so that a large volume of plastic waste can be handled.

This report is focused on chemical recycling of plastics, mainly polyolefins from mixed waste plastics, using large-scale pyrolysis in plants with capacity ranging from 300 to 2,000 tpd. The objective of this report is to evaluate the process economics of such large-sized plants. IHS Markit presents a comprehensive description of the technology aspects, shows the current worldwide industry status, and discusses the major risk factors related to technology implementation. We also explore the factors that will eventually decide the large scale and various options for upgrading pyrolysis oil for different scales of pyrolysis plants. The following cases are covered in this report:

- Case I: Brightmark's 317 tpd of plastic pyrolysis plant in Ashley, Indiana, United States
- Case II: A 1,000 tpd large-scale pyrolysis under various scenarios
- Case III: A 2,000 tpd large-scale pyrolysis under various scenarios, including the use of different specific feedstocks and associated yields

We have used the IHS Markit internal tools to work out a process design and its economics. We have addressed the issue of pyrolysis oil quality by implementing downstream hydrotreating and dewaxing units, as applicable, to develop capital investment estimates for the various process cases. The main challenges associated with the economics of large-scale plastic pyrolysis processes are ensuring feedstock quality, supply and price over the long term, choice of products and by-products, reactor size and catalyst, and tipping fee. Targeting high-market price products provides benefits where the economics can be met at medium-to-high-range pyrolysis plants with a tpd greater than 1,000. Feedstock quality plays a critical role and high feedstock price may need to be considered. On the other hand, large-scale pyrolysis plants with a 2,000 tpd capacity can potentially be economically viable, depending upon the conditions of the product market prices. It is difficult to predict if the industry will be going directly toward the implementation of a 2,000 tpd plant for chemical recycling because the technology is not yet mature. Most of the current pyrolysis players now use a modular approach of 10–

50 tpd. To bring it to an industrial scale, chemical recycling needs to strike a balance between economic viability, regulatory compliance, and environmental impact.

Contents

Tables

Figures

Appendix C Figures

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