Feedstock recycling situation in Japan and its future view

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Abstract

The situation of feedstock recycling in Japan is changing dramatically. New possibilities in mechanical recycling make it difficult for chemical methods to obtain waste plastic materials from official sources. Acknowlegding this fact, mainly liquefaction plants had to shut down because of the shortage of input material. The largest converter of waste plastic is still the steel industry: both coking processes and the direct feed into blast furnaces is used. Hydrogen derived from the gasification of plastic is used for ammonia synthesis. PET is depolymerized by several processes aiming for the production of new PET for bottles and fibers.

Keywords:

1. Introduction

Large scaled feedstock recycling facilities related with the C&P recycling Law (the Containers and Packaging Recycling Law) in Japan. The total number is 16 facilities, and their capacity reaches 500 Kt/y. Japan is one of the most innovative nations related to recycling technologies. Most waste streams are collected, separated, and utilized. Mechanical recycling, chemical recycling, energetic conversion complement one another and play an important part in a balanced concept of plastic recycling. Waste is divided between interested parties using a bidding system in which mechanical recycling is granted priority before chemical recycling and energetic conversion. In the last years, the demand for plastics treated by mechanical recycling increased drastically. As a result, several chemical recycling facilities shut down caused by the shortage of waste materials. Based on the Containers and Packaging Law, there are today 16 large scale feedstock recycling facilities with a total capacity of about 500 ktons per year spread over the whole country (Figure 1). Most of the plastic waste is used in coke ovens, blast furnaces, gasification plants [1]. Only a small fraction is converted into fuels and lubricants by liquefaction.

2. Steel Industries

The Japanese steel industry is the largest consumer for waste plastic. Nippon Steel Corporation used in 2012 about 180,000 tons of waste plastic in their coke ovens. About 1 wt% plastic waste can be added to coal during coking without a reduction in the coke strength. At about 1000 °C gas (36 wt%), liquid (36 wt%), and coke (18 wt%) are obtained as products [2]. Gases are used at the spot for electricity production. Tar and light oil are used

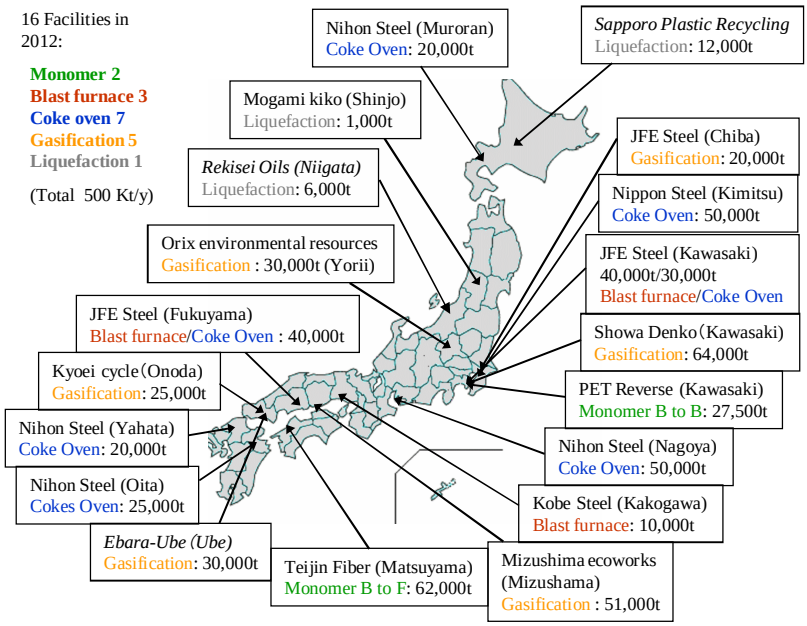

Figure 1. Feedstock recycling facilities with a capacity of more than 500 tons per year in Japan. Facilities in given in italic characters were shut down between 2007 and 2012 [Provided by the Plastic Waste Management Institute].

as feedstocks for petrochemical processes after desulfurization [3].

JEF Steel Corporation utilized about 24,000 tons of waste plastic in their blast fumaces in 2012. By using the raceway, plastic waste is directly fed into the bottom of the blast furnace and burnt together with coal and gas in the presence of oxygen. The slow combustion of plastic makes the modification of the raceway necessary. The high content of SiO_2 and Al_2O_3 in the plastic waste causes the formation of high melting slag which has to be overcome with the addition of $CaCO_3$ [4].

3. Gasfication

The Ebara-Ube-Process (EUP) is the most important gasification process in Japan [5]. A first plant was established outsider of Ube city in 2000 and reached after several extensions a capacity of 30,000 tons per year. The process relies on two in line gasifiers. The first one is used for the slow pyrolysis of the waste between 600 and 800 °C. Pyrolysis gases are gasified in the second stage at temperatures up to 1500 °C and then rapidly cooled down using ammonia water for the removal of chlorine and the preventions of dioxin formation. Hydrogen derived from the synthesis gas is used for the synthesis of ammonia. CO_2 is used as liquefied CO_2 in soft drinks and as dry ice. Showa Denko Corperation uses the same technology since 2003. The KBR process became fully operational with a capacity of about 60,000 tons in 2012.

4. Liquefaction

At this time, only one liquefaction plant with a capacity of 1250 tons in 2010 is in operation. Between 2002 and 2009 about 4000 to 7000 tons of waste plastic were converted into fuel each year. The largest liquefaction plant with a capacity of 14,000 tons per year shut down in Sapporo in 2011 [6]. The Sapporo Waste Liquefaction Plant (SPR) was able to process chlorine containing plastics. After a dechlorination step, the plastic melt was slowly pyrolyzed between 400 and 450 °C. The product oil was destilled and three fractions at 120 °C, 200 °C and 280 °C were obtained. Low boiling products (pyrolysis gas) were used as fuel for the operation of the plant. The solid residue and the different oil fractions were sold and used as fuels. It was claimed that in 2006 about 96% of the material processed in the plant was recycled and reused.

5. Monomer Recycling

Poly(ethylene terephthalate) (PET) from bottles is collected separately allowing the processing of high quality waste PET by various solvolytic methods. Teijin developed one methanolysis process via bis(hydroyethyl)terephthalate for the synthesis of fibers (bottle-to-fiber) and a hydrolysis process via dimethylterephthalate for the synthesis of bottles (bottle-to-bottle) [7]. Glycolysis is used for the AIES “bottle-to-bottle” process in the PET Reverse Co. Ltd. Waste bottle PET is cleaned and glycolyzed. The resulting BHET is purified by molecular distillation and directly polycondensed. In this way, 27,500 tons per year (2003) of bottle PET is obtained. This company, however, has been closed in 2008 [8]. At the present, this process was taken over by the PET Refinery Techology Co.Ldt of the Toyo Seikan Groupe at a capacity of 20,000 tons.

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