

Waste Plastics Liquefaction Technology of Niigata Plastic-to-oil Conversion Center

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A liquefaction plant to convert waste plastics into fuel oil was installed at Niigata Plastics-to-oil Conversion Center in Rekisei Kouyu K. K. in 1996. It is the first commercial plant for the thermal liquefaction process of waste plastics in Japan. The plant, which has a capacity of 6,000 metric tons of waste plastics per year, treats the waste plastics collected after being sorted from all households in Niigata City with a population of approximately 500,000, and a part of product oil is supplied as fuel to the public facilities in the city.

Introduction

The amount of waste plastics in Japan was about 9 million tons in 1995 and has been increasing every year. The treatment of such a huge amount of waste plastics is a serious social problem, and Japanese government instituted a program to make it a duty to reutilize some specified waste plastics derived from municipal waste after 2000.

In such a situation, Niigata City started a sorted collection of waste plastics from households in 1996. A liquefaction process was introduced in Niigata Plastics-to-oil Conversion Center in Rekisei Kouyu K. K. to produce fuel oil from waste plastics under a contract with Niigata City.

CHIYODA has been taking part in the development of the liquefaction technology as well as the construction of the plant.

Process Description

A simplified block flow diagram of the liquefaction plant is shown in Fig.1. The plant consists of pretreatment section and liquefaction section.

Pretreatment Section Sorted waste plastics from all households in Niigata City are filled in polyethylene bags and are brought to the plant site by trucks every day except Sundays and national holidays. They are thrown into a receiving hopper after measuring their weight.

The pretreatment section is operated in the daytime. The feed capacity of the section is 2.8 ton/h. The waste plastics in the hopper are transported by a conveyer and are treated

successively by a magnetic separator, manual separation of PET bottles, a crusher, a sorter and a volume reducer.

By these treatments, most of unsuitable materials to liquefaction such as metals, papers, wood tips and PET bottles are removed, and fluffy plastics are prepared as feedstock to liquefaction section.

Liquefaction Section

In the liquefaction section, 800 kg/h of plastic fluffs are treated continuously.

The fluffs are fed to a pair of dehydrochlorinators in which polyvinyl chloride (PVC) and some portion of other plastics are decomposed at around 300 deg. C. producing hydrogen chloride (HCl) gas and light hydrocarbon gas. The hydrocarbon gas is burnt in an incinerator at over 1,000 deg. C. to be innocuous. The HCl gas is absorbed into water in an absorber and recovered as 10wt% HCl aqueous solution.

Molten plastics discharged from dehydrochlorinators are fed to a pyrolysis reactor, which is equipped with a scraper to avoid coke deposition onto the inner wall. The reaction temperature in pyrolysis reactor is kept around 400 deg. C. by injecting high temperature vaporized recycle oil directly. The coke generated in pyrolysis reactor and other solid matters contained in the feed fluffs are periodically discharged from the bottom of the reactor.

The product vapor is quenched and sent to a fractionator, where the vapor is fractionated into off gas, light oil, medium oil and heavy oil. The off gas is burnt in the incinerator. The light oil, which is slightly lighter than kerosene, is used as fuel for the recycle heater and other facilities in the plant. The medium oil is shipped out as fuel oil equivalent to 'Fuel oil A'. The heavy oil is utilized as fuel for the facilities in the plant as well as the light oil.

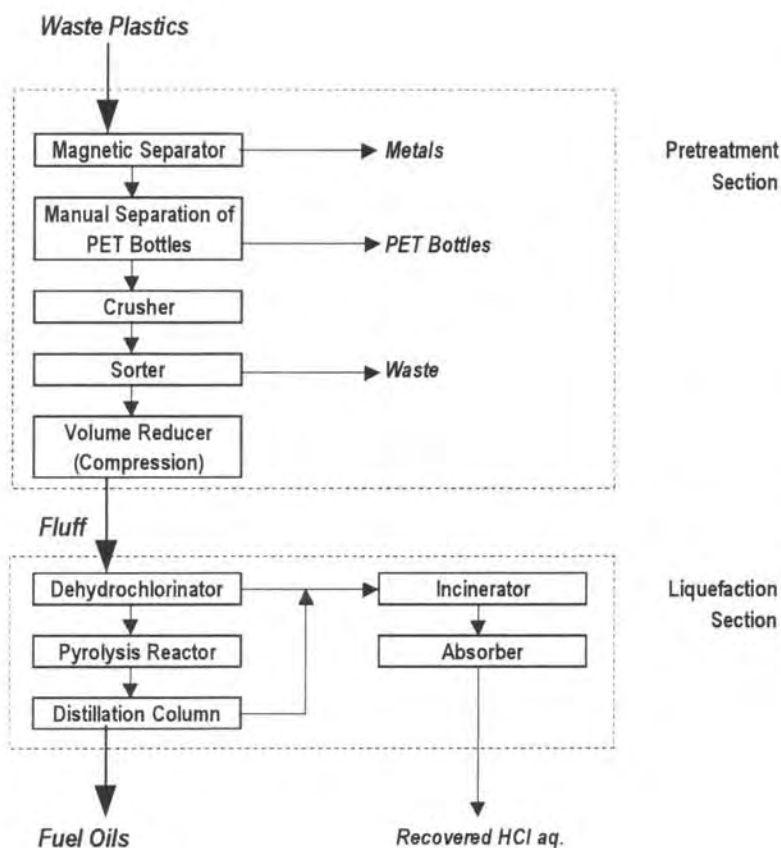


Figure 1 Block Flow of Liquefaction Plant

Results of Commercial Trial Run

The commercial trial operation of the plant started on October 1, 1996.

The pretreatment section of the plant has been operated smoothly for the last two and a half years. The operation of liquefaction section was once suspended due to a fire on December 19, 1996. After the modifications of plant facilities and the improvement of operation management system, the trial operation restarted on December 2, 1997.

Composition of Waste Plastics Table 1 shows the typical composition of waste plastics brought in the plant. The waste plastics collected from the households in Niigata City contain 11% of foreign substances that cause some troubles in the operation of the liquefaction plant as follows:

- Large metal blocks may cause a breakdown of the crusher.
- Non-magnetic metal pieces and wires may cause a blockage in the liquefaction section.
- Garbage may cause a malodor.

Composition of Fluff Table 2 shows the typical composition of fluffs to be fed to the liquefaction section. The major components of the waste plastics are polypropylene (PP), polyethylene (PE) and polystyrene (PS). These polyolefins, so called 3Ps occupy about 80% of the total volume.

Material Balance The typical material balances at pretreatment section and at liquefaction section are shown in Table 3. The yields of cracked oils are less than expected. The following actions are now studied to increase the oil recovery.

- Reduction of the unsuitable substances to liquefaction section.
- Improvement of the sorting method at pretreatment section.
- Optimization of the pyrolysis conditions to reduce the off gas yields.
- Improvement of the efficiency of plant facilities to reduce the consumption of product * oil.

Table 1 Composition of Waste Plastics

Items	wt%
Plastics	78.3
PET Bottles	10.7
Metals	1.3
Paper and Cloth	3.3
Garbage	3.0
others	3.4

Table 2 Composition of Fluff

Items	wt%
Polyethylene +Polypropylene +Polystyrene	81.3~86.7
PVC	4.3~9.4
PET	0.5~3.9
ABS, others	2.1~3.6
Ash	3.7~6.8

Properties of Product Oil The chloride contents in the medium oil and in the heavy oil are 45 wtppm and 43 wtppm, respectively. These values are low enough compared with the target value (100wtppm). The cetane index of medium oil is 46.0, which meets the requirement for the usage as diesel fuel.

Table 3 Material Balance

Items	wt% on Waste plastics	wt% on Fluff
Pretreatment Section		
Waste Plastics	100.0	-
Fluff	75.0	100.0
PET Bottles	5.2	-
Combustible residue	13.5	-
Incombustible residue	5.2	-
balance(water, etc)	1.1	-
Liquefaction Section		
Light Oil	25.3	33.8
Medium oil+Heavy Oil	12.7	16.9
Oil total	38.0	50.7
HCl	3.9	5.2
Residue	21.2	28.2
Off gas	11.9	15.9

Concluding Remarks

The performance of the first commercial plant of waste plastics liquefaction has been demonstrated through the commercial trial run. The plant can produce quality fuel oils from the waste plastics.

The new technology is expected to give a solution to the problems on the treatment of increasing waste plastics not only at Niigata City but also in any other area in Japan.

Acknowledgement

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