Advanced Steam Gasification Technology for Plastic Wastes using High Temperature Steam

Susumu Mochida[1], Takeshi Abe[1] and Ashwani Gupta[2]

[1]Nippon Furnace Co. Ltd., Yokohama, Japan
[2]University of Maryland, U.S.A.

Abstract

High Temperature Steam (HiTS) Gasification technology offers new innovative opportunities for highly successful and efficient energy conversion from waste plastics to clean synthetic gaseous fuel. Thermal energy required to produce the desired high temperature steam is available by combusting part of the synthetic gases. Nippon Furnace Co., Ltd. has been developing the technology to improve the yield of high quality synthetic gases which have higher calorific value than that obtained from the gases with ordinary method(s) of gasification. The demonstration test data for plastic gasification with 0.5 Tons/day scale plant in Ibaraki prefecture, Japan has proven the advantages of High Temperature Steam (HiTS) Gasification technology. The size of plant is suitable for not only pilot scale tests but also as a decentralized demonstration plant unit. The synthetic gases produced will be utilized as an energy source at the waste production site. In this paper we present results obtained from the demonstration plant that clearly shows distinct benefits of this technology.

1. Introduction

Nippon Furnace Co.,Ltd. (called NFK) and University of Maryland have demonstrated the effectiveness of advanced gasification technology using high temperature steam with specific application to thermal recycling for different kinds of organic wastes [1]. We call this "HiTS-Gasification". Special attention on the results obtained by other researchers has also been given on the performance characteristic results obtained from super high temperature steam. A. K. Gupta et.al.[2-4], C. Lucas et.al.[5] reported some results on gasification using pure high temperature steam as the gasifying agent. On the other hand, the practical development of the gasification facility has been progressed at NFK by comparing the test data through the pilot scale facility at its company and the basic experimental data obtained at University of Maryland. Based on the accumulated results from this basic study, the demonstration facility for HiTS-Gasification was installed in Ibaragi prefecture Japan with close cooperation of TANIZAWA company that deals with instruments for safety, such as helmets made from resins.

2. Features of HiTS-Gasification Technology

The advantages of HiTS gasification are summarized below:

i) Much higher calorific value of the syngas produced from HiTS gasification than that obtained from conventional gasification
ii) HiTS gasification reforms tar produced during ordinary gasification to gaseous components with the use of super high temperature steam
iii) The reformer and gasifier can be fabricated in the same chamber, so that the system will be very compact and of low cost.

Conventional gasification processes employ ambient air to partially oxidize the raw waste materials such as wastes. In such a process, the thermal energy produced is primary evolved from partial pyrolysis of the raw materials during the main gasification process. Therefore, these processes contain finite amounts of N_2 (contained in air) and CO_2, so that the diluted syngas produced is of lower calorific value. However, with HiTS gasification technology, the surplus steam is easy to separate by condensing it in the downstream section of the cooling process, so that high calorific value syngas is obtained, see Figure 1.

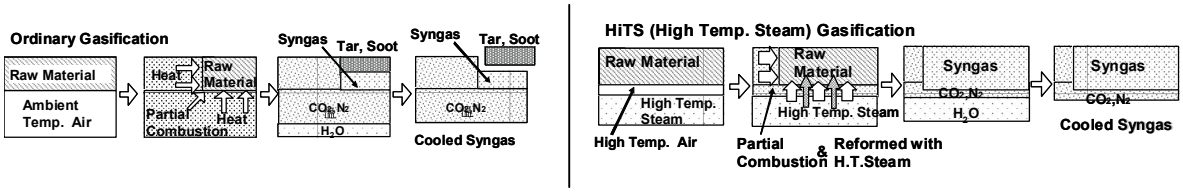

Figure 1. Distinction in results from High Temperature Steam Gasification and ordinary gasification.

3. Test Results

The composition of the syngas and lower heating value obtained from the gasification of PE at 15 kg/h material feed are shown in Figure 2. The syngas had as main components hydrogen (H2), methane (CH4), carbon monoxide (CO) and ethylene (C2H4) as shown in Figure 2. The temperature conditions of the high temperature steam and gasifier were in the range of 1,023 - 1, 086°C and 805 - 836°C respectively, and the pressure in the gasifier was in the range of 1.3 - 2.2k Pa. There was not a large difference in the concentration of the selected component in above test matrix range. It included 7 - 9%, methane 5.5 - 6.5%, carbon monoxide 9 - 11%, and about 11 to 12% of ethylene. The averaged lower calorific value was 15.0 MJ/m^{3}N.

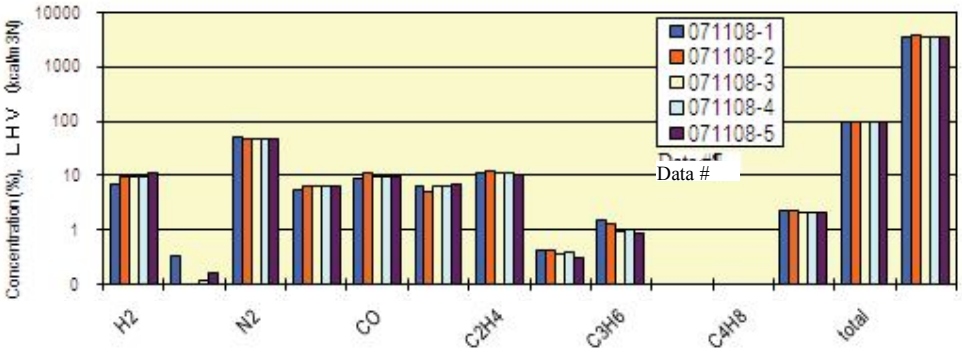

Figure 2. Syngas composition and heating value for PE gasification tests.

4. Conclusions

i) When polyethylene (PE) was used as feedstock, the results demonstrated that a continuous stabilized gasification occurs with the output being clean syngas, having a lower heating value of 3,500-4,000 kcal/m^{3}N.

ii) The cold gas efficiency was 73%, the carbon conversion ratio was 86%, and thermal efficiency of the gasification facility 75% using PE as the feedstock material. This high performance allows us to use this information for actual plant design for its operation as a decentralize unit.

iii) The results showed that independent operation is possible by using the syngas as a fuel for SI and boiler, which feature main components of this demonstration plant, through 48 hr of continuous operation and beyond.

5. References

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Author Biographies

Susumu Mochida is Director and General Manager of Technology and Engineering Division at Nippon Furnace Co., Ltd. He received the ASME George Westinghouse Silver Medal Award in 2001.

Ashwani Gupta is Distinguished University Professor at the University of Maryland, College Park, MD, U.S.A.