A New Exergy Regeneration Method of Waste Heat through Biomass Pyrolysis for CO_2 Reduction in Chemical Factory

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1. Background and Purpose

It is essential to reduce waste heat in chemical factory in order to suppress CO_2 emission. However, the waste heat exhausted from the present factory cannot reuse by heat utilization because of its low exergy. To overcome it, we proposed a new method to fix waste heat as high exergy products through endothermic reaction of biomass. The proposed concept is thermodynamically reasonable, but the efficient biomass conversion process with reducing the energy consumption of drying and grinding should be developed.

From this viewpoint, we selected the kiln pyrolyzer, and examined the validity of the proposed method by the following items: 1) the advantages to use big-size biomass, and 2) the comparisons of the exergy yields and CO_2 suppression between the proposed method and other conventional processes.

2. Adavntage of Pyrolysis of Big-size Biomass

Since biomass pyrolysis is almost finished at 400 ºC, the pyrolysis yield at 400 ºC was compared with between big-size biomass and powder one. As shown in Table 1, the solid (char) yield with high exergy increased, on the contrary, the liquid yield with serious handling problem decreased for the big-size biomass. From this result, it was clarified that the pyrolysis of big- size biomass had advantages to increase exergy of waste heat in addition to reduce grinding energy by two orders.

Table1 Product yields

diameter	yield [%]		
	solid	liquid	gass
30mm	41.90	49.35	8.749
<149 μm	26.76	63.82	9.423

3. Evaluation of Exergy Regeneration by Proposed Method

Since the kiln pyrolysis of big-size biomass is effective to save energy, we evaluated the exergy yields of the proposed method. The calculation was done on the assumption of 1.365PJ/year of waste heat utilize at 400 ºC, and compared with other conventional processes, pyrolysis with partial combustion and direct combustion. As listed in table 2, the exergy yields by the proposed method, abbreviated to External, was highest since the exergy of waste heat was boosted up to pyrolysis products. On the other hand, the amount of CO_2 reduction by utilizing the pyrolysis products in place of fossil energy was shown in Fig.1. The proposed method, abbreviated to External, was most effective at various operation conditions.

Table2 Exergy yields

	diameter	exergy [PJ·year^{-1}]
External	30mm	11.51
Partial	30mm	9.845
combustion	30mm	9.610

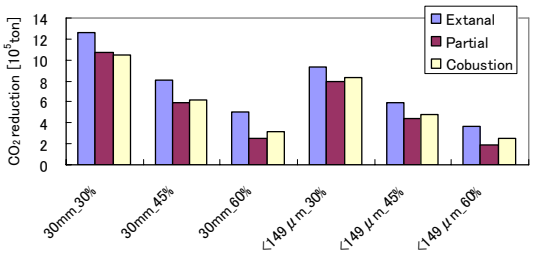

Fig.1 Reduction of CO_2 emission

4. Conclusion

A new method to regenerate waste heat in chemical factory by biomass pyrolysis was proposed. It was shown that the proposed method has a potential to reduce CO_2 emission by 11% in maximum as compared with those by the conventional processes.