Technical-economic analysis of waste pyrolysis/ gasification in rural area of China

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With the rapid economic development andindustrialization, the generation and collection amount of MSW in China has been increasing. The MSW collection amount was increasing from 150 million to 178.6 million tons per year from 2004 to 2014, with an annual increasing rate of 1.9 % (NBS, 2004 – 2014).By 2015, China's total population is 1.37 billion among which 600 million people are still living in the countryside. The rural waste collection amount is up to 80-120 million tons per year.Therefore, the research and development of waste processing equipment for rural area is very urgent.

The commonly disposal ways in China are: landfill, composting and incineration, etc(Cheng *et al*, 2010). With the increase concern of environment and the limited land resources, thermal treatment has gradually replaced the landfill treatment and becomes the main method of waste disposal. At present, 188 waste incineration power plants(≥1000 t/d) have been builtand over 60 are under construction in the large and medium-sized cities. However, rural waste processing is still often open dumping without further treatment and utilization.

Compared with the traditional direct combustion, pyrolysis and gasification technology has many advantages, for example flexible capacity suitable for small scale, less investment, high resource utilization, less secondary pollution, etc. Hence, it is quite suitable for rural area at this stage. This paper has investigated the technical-economic analysis in waste pyrolysis and gasification technology in order to provide some new ideas for rural waste treatment.

In general, pyrolysis represents a process of thermal degradation of the waste in the total absence of air that produces recyclable products, including char, oil/wax and combustible gases(Velghe *et al*, 2011). Gasification refers to the reactants react with gasification agent under the reducing atmosphere, which is mainly combustible gas generated conversion process. Gasification agent mainly includes air, rich oxygen, water vapor, carbon dioxide, etc. (Fang *et al*, 2011).Waste disposal technology in the small and medium-sized towns, urban and rural area is relatively backward. The wastes there has low concentration, low calorific value,high moisture content and ash content(Yuan *et al*,2012), so the waste pyrolysis and gasification technology is more applicable for it.

Gasifier is the core equipment in waste pyrolysis and gasification system, with the type of fixed bed, fluidized bed, rotary kiln, and other types(Chen *et al*,2015). The comparison of gasifier types are shown in Table 1. Fixed bed has the advantages of simple manufacture, low cost and simple operation, so it is suitable for the small-processing capacity waste pyrolysis and gasification project (1-10t/d). Rotary kiln has been used very popularly in the cement industry, but has not applied to the waste pyrolysis and gasification.Its feed adaptability is very relaxed and the operation parameters are flexible, so it is a good choice for pyrolysis and gasification device(50-150t/d). Fluidized bed is sensitive to changes in the size of the feedstocks and has a large processing capability. Tubular furnace is only used in the laboratory.

Table 1.Comparisonsof gasifier types.

Types	Pretreatment of raw materials	Processing capability	Maintenance cost	Flexibility to wastes
Fixed bed	Common	Small	Low	Very flexible
Rotary kiln	Not strict	Large	Medium	Flexible
Fluidized bed	Very strict	Large	High	Be sensitive to changes in the size of the material
Tubular furnace	Strict	Medium	Medium	Be sensitive to changes in the size and temperature of the material

Economic profit of waste pyrolytic gasification projects include two aspects:government subsidies and the end-product electricity or heating income(Zeng, 2014).The cost of waste pyrolysis gasification project is divided into capitalized cost, operating cost, depreciation cost and tax revenue.

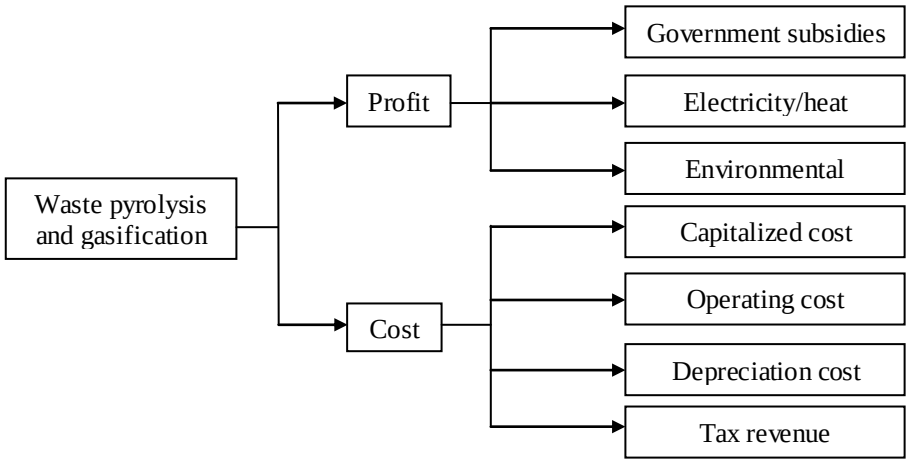

Figure 1.Economic analysis of waste pyrolytic gasification project

This paper takes three case studies of economic feasibility analysis. The comparison of economic feasibility is shown in theTable 2.

Table 2.Comparison of economic feasibility.

Types	Daily capacity(t/d)	Gasifier	Product	Total investment (million yuan)	Governmentsubsidies(yuan/t)	Payback period (year)
Village	1	Fixed bed	Heat	0.35	100	9.8
Town	10	Fixed bed	Heat	3	70	4.2
County	100	Rotary kiln	Electricity	59	70	4.8

Compared with the municipal solid waste, villages and towns waste disposal is faced with many problems, for example large and scattered range, incomplete collection and transportation system, small processing capacity, the highcost, etc.Hence, waste pyrolysis and gasification technology is more suitable for rural waste treatment in technology and economy.

The waste subsidy of the government is very important, the smaller scale project, the higher needs of government subsidies, otherwise difficult to maintain profitability.The operation mode of the project adopted is very critical, too. "BOT" and "PPP"are more and more used in the projects. In general, the development of waste disposal in rural areais closely linked with the government's support and technical advances.

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