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Cost Economics of Biomass Gasification

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ABSTRACT: *Biomass is a very important source of energy in many parts of the world, especially for remote areas. India produces a huge quantity of biomass from its agricultural, agro-industrial and forestry operations. The end use of briquettes is mainly for replacing coal substitution in industrial process heat applications (steam generation, melting metals, space heating, brick kilns, tea curing, etc) and power generation through gasification of biomass briquettes. Biomass gasification is thermo chemical process and it converts solid biomass into a combustible gas mixture (producer gas) which can be used as a fuel in the place of diesel in suitably designed/adopted internal combustion engines coupled with generators for electricity generation. Present study gives the cost economic analysis of biomass gasification, in which biomass briquettes are used as the fuel and air is used as the gasifying agent. Net cost of briquettes production including loading and transport charges is Rs. 2822/t. The cost of briquettes in the market is around Rs.3500/t. Hence Rs. 678/t profit can be gain during the biomass briquetting. The cost of gasification of 1 kg of briquette is Rs. 3.865. The cost of production of 1 m^3 of producer gas is Rs. 3.25.*

Keywords : *biomass gasification, Cost economics, economic analysis.*

INTRODUCTION

Biomass is a non-fossilized and biodegradable organic material originating from plants, animals and micro-organisms. This shall also include products, by-products, residues and waste from agriculture, forestry and related industries, as well as the non-fossilized and biodegradable organic fractions of industrial and municipal wastes. Biomass has high but varied moisture content and is made up of elements such as carbon, hydrogen, oxygen, nitrogen and sulphur. Thus biomass is a very important source of energy in many parts of the world, especially for remote areas.

India produces a huge quantity of biomass from its agricultural, agro-industrial and forestry operations. In order of, over 500 million tonnes per year of agricultural and agro-industrial residue is generated. However, studies have indicated that at least 150-200 million tonnes of this biomass do not find much productive use, and can be made available for alternative uses at an economical cost. This quantity of biomass is sufficient to generate 18,000-20,000 MW of electrical power at the existing plant load factors.

The conversion efficiencies of biomass are as low as 40% with particulate emissions in the flue gases in excess of 3000 mg/ Nm^2. In addition, a large percentage of un-burnt carbonaceous ash has to be disposed of. The briquetting of biomass could mitigate these pollution problems while at the same time making use of this important industrial/domestic energy resource. The briquettes can be used for domestic purposes (cooking, heating, barbequing) and industrial purposes (agro-industries, food processing) in both rural and urban areas (Singh,1996). The potential of biomass briquetting in India was estimated at 61,000 MW, while the estimated employment generation by the industry is about 15.52 million. The end use of briquettes is mainly for replacing coal substitution in industrial process heat applications (steam generation, melting metals, space heating, brick kilns, tea curing, etc) and power generation through gasification of biomass briquettes (Tripathi *et al*., 2000).

Biomass gasification is thermo-chemical process and it converts solid biomass into a combustible gas mixture (producer gas) through a partial combustion route with air supply restricted to less than that

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theoretically required for full combustion. Producer gas can be used as a fuel in the place of diesel in suitably designed/adopted internal combustion engines coupled with generators for electricity generation. Producer gas can replace conventional forms of energy such as oil in many heating applications in heating industry. The gasification of biomass is a relatively clean process. Large monetary savings can occur through even partial substitution of diesel in the existing diesel generator (DG) sets. The thermal efficiency of direct combustion is 20-30 percent only, whereas the thermal efficiency of gasification process is 50-70 percent.

Present study gives the cost economic analysis of biomass gasification, in which biomass briquettes are used as the fuel and air is used as the gasifying agent.

MATERIAL AND METHODS

Biomass briquetting

The following figure shows the overall biomass briquetting process which includes collection of biomass material from the field, drying of biomass in the solar tunnel dryer, powdering biomass with the help of shredding machine and briquetting by piston press type briquetting machine of capacity 500 kg/h. biomass briquettes are prepared without addition of binders, lignin in the biomass composition itself uself acted as a natural binder.

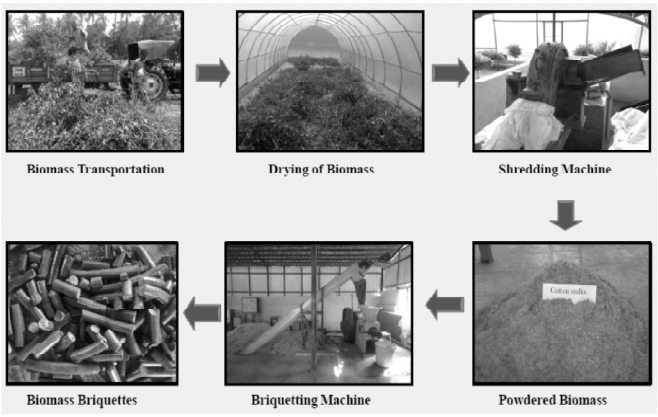

Figure 1: Overall briquetting process

The required considerations were taken into account for biomass briquetting and biomass gasification separately as follows,

A) Cost analysis was carried out to check economic acceptability of briquetting plant by considering following assumptions:

1. Life period of shredding machine is assumed 10 years
2. Fixed cost particulars are assumed as follows,
   a) Depreciation/ year = 10%
   b) Repair charges = 5%
   c) Maintenance charges = 5%
   d) Interest = 16%
3. Fixed cost particulars are assumed as follows,
   a) Labour wages = Rs 150/man/day, Rs 120/woman/day
   b) Electricity per unit = Rs 4.5/unit
4. Labor required for shredding machine operation is one man and for briquetting machine are 3 man and one woman
5. Operating days per year = 200 days
6. Operating hours per day = 8 hours

Biomass briquette gasification

The gasification of biomass briquettes was carried out in the 10 kg/h capacity downdraft gasifier. The downdraft gasifier was connected to the cooling and cleaning system for the purification of producer gas. Purified producer gas was used in the 6 hp diesel engine as a fuel replacement to the diesel on dual fuel mode.

Figure 2: Downdraft gasifier – diesel engine set up in operating condition

B) Cost analysis was carried out to check economic acceptability of biomass gasification by considering following assumptions:

1. Life period of downdraft gasifier is assumed 10 years
2. Fixed cost particulars are assumed as follows,
   e) Depreciation/ year = 10%
   f) Repair charges = 5%

g) Maintenance charges = 5%
h) Interest = 16%

3. variable cost particulars are assumed as follows,
c) Labour wages = Rs 150/man/day
d) Electricity per unit = Rs 4.5/unit
4. Only one labor required for gasifier operation
5. Operating days per year = 300 days
6. Operating hours per day = 8 hours

Following formulae were used for the calculations,

1) Total cost of gasifier - cleaning system = (Cost of downdraft gasifier + Cost of cleaning system + cost of pipe accessories)

2) Fixed cost = (Depreciation cost + Repair charges + Maintenance charges + Rate of interest)

3) Variable cost = (Labor cost + Electricity cost + Cost of power consumed by blower)

4) Total cost = (Fixed cost + Variable cost)

RESULTS AND DISCUSSION

Economic analysis of biomass briquetting

Capacity of the briquetting machine	=	500 kg/h
Operating days/year	=	200 days
Average cost of biomass raw material	=	Rs.1000/t
Total cost of producing 1 tonne of briquettes	=	Rs. 2372/ t

Net cost of briquettes production including loading and transport charges = Rs. 2822/t

Cost of briquettes	=	Rs. 3500/t
Profit	=	Rs. 678/t
Profit per day	=	Rs. 2712

Economic analysis of biomass gasification

Cost of downdraft gasifier	=	Rs. 75,000
Cost of cleaning system and pipe accessories	=	Rs. 15,000
Total cost of gasifier with cleaning system	=	Rs. 90,000

Fixed cost:

Life period of the gasification system	=	10 yrs.
Depreciation cost per year (10%)	=	Rs. 9,000
Repair charges (5%)	=	Rs. 4,500
Maintenance charges (5%)	=	Rs. 4,500
Rate of interest (12%)	=	Rs. 10,800
Total fixed cost per year	=	Rs. 28,800
Total operating hours of gasifier in a year	=	300 days
No. of working hours in a day	=	8 h
Fixed cost per hour	=	Rs. 12

Variable cost:

Labor cost per hour	=	Rs. 25

Electricity for running the blower @ Rs. 4.5

Cost of power consumed by the blower per hour	=	Rs. 1.65
Total variable cost per hour	=	Rs. 26.65
Total cost per hour	=	Rs. 38.65
Cost of gasification of 1 kg of briquette	=	Rs. 3.865
Cost of production of 1 m^3 of producer gas	=	Rs. 3.25

CONCLUSION

From the above study of economic analysis following conclusions can be made,

- The total estimated cost of gasifier with cleaning system and pipe accessories was Rs. 90,000.
- Total working days of gasifier in a year were 300 days and number of working hours in a day were 8h.
- The estimated total fixed cost per year was Rs. 28,800.
- Fixed cost per hour was Rs. 12.
- Total variable cost per hour was estimated as Rs. 26.65.
- Total cost per hour was Rs. 38.65.
- The cost of gasification of 1 kg of briquette was Rs. 3.865.
- The cost of production of 1 m^3 of producer gas was Rs. 3.25.

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