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RESEARCH ARTICLE

ABSORPTION OF CO_2 FROM COTTON STALK INCINERATOR

Gasmelseed, G.A., Ali, Z.S. and Alhussein, A.A.M.

Assistant Professor, Karary University, College of Engineering, Department of Chemical Engineering, Sudan

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Corresponding Author:
Gasmelseed

ABSTRACT

Renewable energy has obtained considerable interest as the fossil fuel reserve is getting shorter with a remarkable effect on the environment and global warming. Those resources are inexhaustible and cheaper than the fossil fuels. In Gezera of Sudan, cotton stalk is very huge in quantity and quality as cotton is one of the national crops planted and its fiber is used in textile industry and for export. However, there are worms that attack the roots of cotton and affect the quality and quantity of the product, therefore the cotton stalk must be derooted and burnt. The burnt is made in open areas of the field with evolution of CO_2 which affects the nearby residential areas with simultaneous effect on the environment. The aim of this paper is to collect the cotton stalk in bundles, and introduce it into a well-designed and controlled incinerator provided with a boiler for steam production and electricity generation, which can be supplied to the residential area and villages. It must be recognized that one kilogram of cotton stalk gives 17.1MJ, in addition of utilizing the ash residue as a fertilizer. The absorber dimensions are: out inside diameter 0.52m, thickness 7.5mm, outside diameter 0.5275m, overall height of 2.6m.

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INTRODUCTION

In Gezera state cotton is the main product mainly for export and local textile industry. The farmers and management authorities prepare the land with water supply and cleaning. The harvesting process last only for 3 to 4 months, after the elapse of this period, the farmers have again to prepare the land by derooting the cotton stalk and firing it. (1). Beside the risk of firing all over the area, CO_2 and fly ash affect the people and polluted the environment. Cotton stalk has other uses such as fermentation and production of ethanol and methanol which can be used as biofuels (2). In thiscase a feasibility study can be made whichever is economically feasible.

Application of biomass:

- Substitution of some parts of the fossil fuel.
- Enhancementof biomass as industrial and domestic fuels.
- Improve uses of biomass for lightening and domestic uses in the nearby areas.
- Use of biomass for thermal application.

The following table shows the contribution of biomass in converting the necessary primary resources: (3)

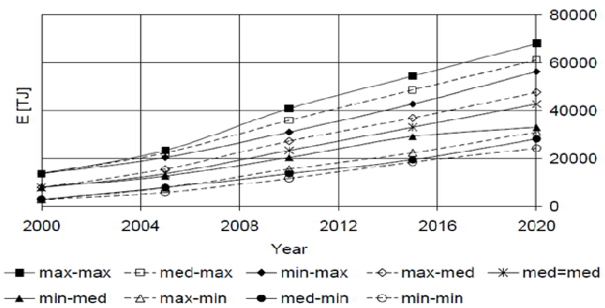
Energy Source	10^6 MJ
Energy from sun	1.5
Biomass hydro	3.5
Wood energy	1
Fossil oils (oil and coal)	9

Biomass can be grouped into the following main items: (4)

- Substitution of part of the fossil fuel in existing direct heating schemes (wood chips)
- Enhanced use of biomass as industrial fuel (wood chips and logs as industrial fuel for steam or hot water boilers) instead of fossil oil.
- Improve uses of biomass for heating schemes for small towns and villages near the resources, in the countryside, where the population has no access to central co-generation or gas supply
- Use of straw and other agricultural by-products in appropriate biomass boilers for heat supply of farms and small villages in the near future
- The top priority is the use of biomass for thermal applications, substituting fossil fuel.
- The most promising regions for the agricultural waste utilization are Aljunaid and Alrahad where agricultural is expected to be high.
- The expected development of the wood industries will encourage the rehabilitation of the existing boilers in thermal plants which account forabout 550 steam boilers, or construction of new ones.

In fig 1 and 2presentation of biomass potential: (4)

From wood



From agricultural waste

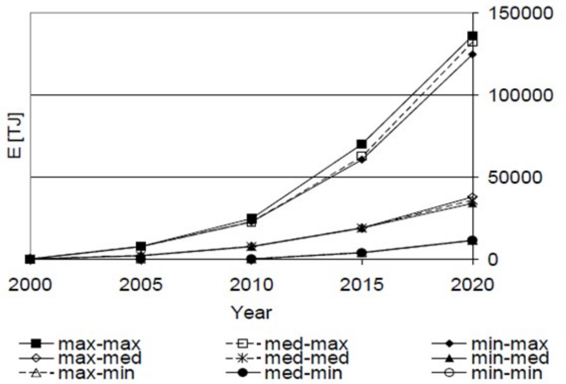


Table 3: The general characteristics of the biomass residues (sawdust). (5)

Country	Contribution of biomass	
	10^6MJ/year	%
Romania	49.290	2,3
Belgium	14.278	0,7
Danemark	33.371	4,5
Germany	144.417	1,3
Greece	24.446	2,7
Spain	90.133	2,5
France	404.619	4,4
Italy	124.395	1,9
Irland	3.554	0,9
Luxemburg	641	0,5
Netherlands	18.280	0,6
Portugal	47.746	7,3
United Kingdom	19.335	0,2
Austria	128.843	11,8

METHODOLOGY

As CO_2 is produced in the incinerator, it has to be removed so that it will not affect the environment. An absorption column, with an absorbing liquid (water) has to be designed to absorb the CO_2 emitted, the following fig, shows the schematic diagram of the process of absorption.

The procedure is as follows:

- Determination of the flow rate of the gas, G and Liquid, L
- Density of the absorbent, ρ_v
- Density of the solvent, ρ_L
- Calculation the flow factor F_{Lv}

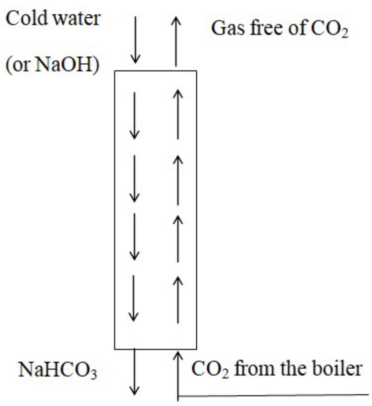


Fig 3. Process of gas absorption

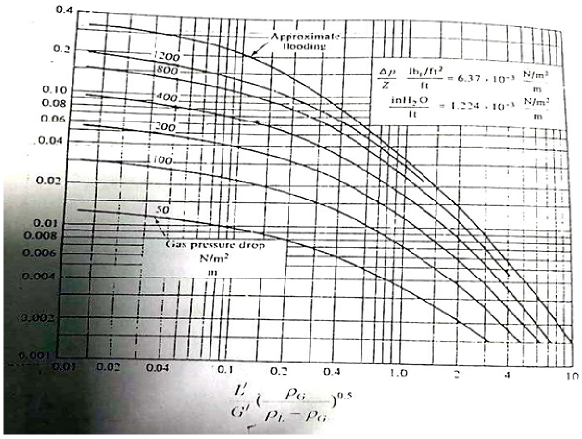


Fig. 4. Correlation of flooding velocities of a packed Column (6)

$F_{LV} = \frac{L}{G}\sqrt{\frac{\rho v}{\rho L}}$…………………………………………..①

Use fig (4) attached to determine:

$\frac{G\,a}{g\in}2 \left(\frac{\rho v}{\rho L}\right)_2 \left(\frac{\mu}{\mu}\right)^{0.2}$ …………………………..②

Take a,μ_w and put them into eq②

Where:
μ_w= viscosity of water.
∈= Percentage of the void volume.

Percentage flooding in the range of 70% - 80% of flooding velocity.
The area of cylindrical tower

$A=\frac{\pi D}{4}$…2………………..③

$D=\sqrt{\frac{4A}{\pi}}$…………………④

RESULTS AND DISCUSSION

Data given:

- Use rashing ring of 25mm saddles
- G= 1000 m^3/h
- Ratio of gas rate to the liquid rate should be of 2:1
- Let the tower working at 75% of flooding rate

- The density of the absorbent, ρ_L = 1000 Kg/m^3
- Viscosity of the liquid, μ_w = 0.001 pa.s
- Density of the gas mixture, ρ_G= 1.6 Kg/m^3
- Packing factor, Fp for ceramic ring of 25mm = 525 per meter
- $\frac{L}{G} = \sqrt{\frac{\rho G}{\rho L}} = 2\sqrt{\frac{1}{1000}} = 0.063$ ………………………..⑤

From fig4:

At 0.063 at flooding:

$G^2 F_p \mu_l^{0.2} = 0.04$ …………………………..⑥

$G = \sqrt{\frac{0.04\times1000\times1\times9.8}{525\times(0.001)^{0.2}}} = 1.724$ (Kg/s) $/m^2$

The rate of the gas at flooding = 75%

G = 1.724 × 0.75 = 1.3 (kg/s) $/m^2$

The flow rate of gas entering the tower:-

$G = \frac{1000}{3600} \times 1$ kg/s

$A = \frac{\pi D^2}{4}$

$D = \sqrt{\frac{1000\times1\times4}{3600\times1.3\times\pi}} = 0.52$m

$\frac{H}{D} = 5$

H = 5×0.52 = 2.60m

Let the packing height = 90% of the total height: Packing height= 2.6 × 0.9=2.34m The free space above and below the packing:

$\frac{0.10}{2}\times2.6 = \frac{0.26}{2} = 0.13$m

- Thickness = 7.5mm = 0.0075m
- The inside diameter = 0.52m
- The outside diameter.
- 0.52+0.007×2 = 0.5275m

= 5.275cm

Table 2. Summary of the design

Parameter	Value
Inside diameter	0.52m
Thickness	0.0075m
Outside diameter	0.5275m
Ratio of height to the inside diameter	1:5
Percentage flooding	75
Type of packing	Ceramic rahing ring
Packing height	saddles
Overall height	2.43m
Void volume	2.6m
Material of construction	90%
	Stainless steels

Discussion of the results

The aim of the design is to install an absorption column, with the packing of Rashing ringe of 25mm ceramic saddle which is made of crushed and minced cotton stalk. Pure water is heated, boiled and converted to steam which is partially passed to the turbine to produce electricity. The remainder of the steam from the turbine is condensed in a condenser, topped with pure water and passed to the boiler to complete the cycle it must be known that the make-up water has to be provided with anticorrosive or corrosion inhibiters to avoid any corrosion of the equipment. The agricultural wastes are always sustainable everywhere in the country, but care must be taken not to cut trees and bushes that contributed in reducing desertification. It is re commended that domestic and industrial solid waste must not be incinerated in open areas, instead they must be organized and prepared to be incinerated in a clean manner with elimination of green gases.

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