TECHNOLOGY FACTSHEET

FLUE GAS BASED FUEL DRYER FOR BIOMASS COMBUSTORS[1]

1. **Sector:** Energy Supply

2. **Introduction**:

Most of the industrial and electricity generation facilities at present use biomass fuels with moisture content in the range of 30% to 50% (wet basis). Such high moisture in the fuel reduces the overall efficiency of energy generation thus increases the fuel consumption rate and auxiliary energy inputs such as more fan power. This in turn adversely affects the economic merit of using biomass fuel based energy generation. The high moisture level in the fuel also limits the maximum desired energy output rate from the facilities. All these result in discourage the use of biomass fuel based energy generation and encourage the use of fossil fuel based energy generation.

A technology of reducing the moisture content of biomass fuels with minimal incremental cost would resolve the above mentioned issues.

3. **Technology Name**: Flue Gas Based Fuel Dryer For Biomass Combustors

4. **Technology Characteristics: (Feasibility of technology and operational necessities)**

Feasibility of Technology:

In a typical biomass combustion system, around 25% to 30% of the energy content in the fuel is carried away in the flue gas. Due to the very low sulphur content in biomass fuels, it is technically feasible to extract a part of energy available in the flue gas. To extract such energy from the flue gas and pass it to the intended medium steam, hot water or thermic fluid, the surface area of the heat exchanger required would be very large. Hence for economic reasons, such energy recovery process is not implemented.

Biomass fuel could be dried without the need of a heat exchanger, by simply blowing the flue gas directly into the wet biomass. The question of contaminating the fuel with undesirable constituents in the flue gas does not arise, as the fuel is meant to be completely combusted. However, it is necessary to mix the flue gas with ambient air before using it as the drying medium for the following two reasons: (a) To lower the temperature from around 200 oC to around 100 oC. (b) To lower the moisture level in the drying medium.

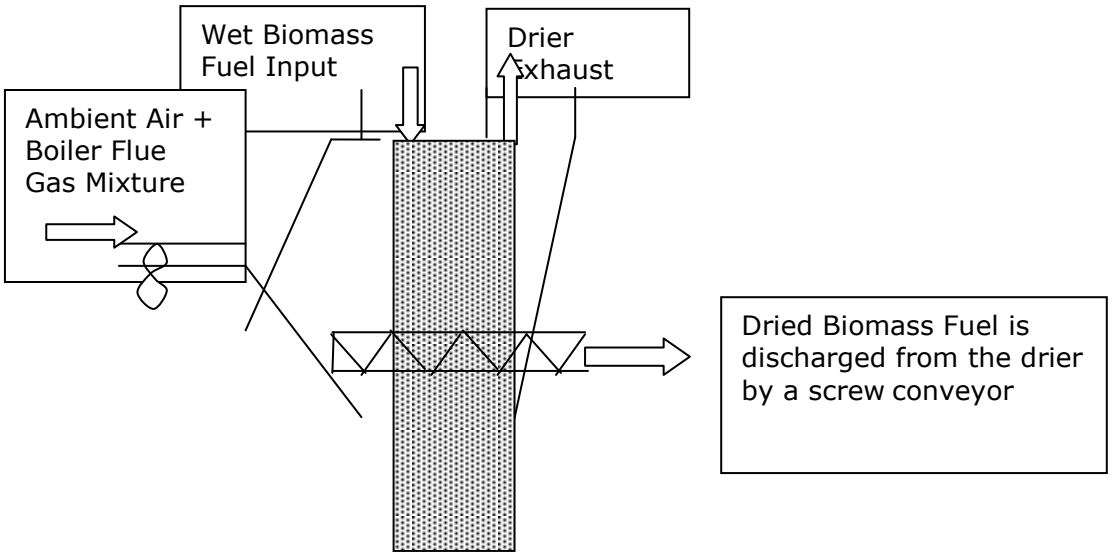
[1] **This fact sheet has been extracted from TNA Report – Mitigation for Sri Lanka. You can access the complete report from the TNA project website** http://tech-action.org/

Lowering the temperature is essential to prevent the biomass fuel from igniting itself. The reason for lowering the moisture level in the drying medium is to prevent condensation of water as the temperature is lowered from around 200ºC to around 50ºC when exiting from the drier.

The equipment required for this process is shown in figure 1. It consists of a vertical rectangular column. Into this column wet biomass in the form of chips is introduced at the top until the entire column is filled with biomass. At the bottom of the column, a screw conveyor discharges the dried biomass into a hopper. A bucket elevator is used for this purpose. Flue gas at around 200ºC is mixed with ambient air at 30ºC to obtain a mixed gas at a temperature of around 100ºC. This mixed gas is blown across the biomass column. As biomass is discharged from the bottom of the column by a screw conveyor, the biomass within the column moves downwards under gravity. The rate of discharge of biomass and the rate of flow of flue gas – air mixture across the column of biomass are regulated to ensure that the moisture content of biomass discharged from the drier is around 20% (wet basis). The exhaust gas from the dryer is vented into the atmosphere through a separate chimney.

The heat energy input to the dryer is provided entirely by the flue gas. Electrical energy is used to drive the fans for flue gas and ambient air and for driving the bucket elevator to feed the biomass into the vertical column and the screw discharge conveyor at the bottom of the column.

Figure 1: Sketch of Biomass Fuel Dryer



Operational Necessity

Most of the biomass fuels available locally have a moisture content of 30% to 60%. The Net Calorific Value (NCV) of 1 kg of a typical wood fuel at a moisture content of 60% (wet basis) is 14,757 kJ. If this 1 kg of wood is dried to 20% moisture, the NCV increases to 17,970 kJ. Hence by reducing the moisture of wood from 60% to 20% by drying it would reduce the fuel requirement to generate a specified amount of energy by 22 %. Hence the fuel cost of generating

energy is also reduced by 22 %. Such a reduction in fuel cost would encourage industrialists and power plant operators to switch from fossil fuels to biomass fuels thus helping the world to reduce GHG emissions.

In addition to reducing the cost of fuel, reducing the moisture content also enables the combustion system to deliver the desired energy output level. With high moisture in the fuel, many combustion systems are unable to generate the desired level of energy output simply because the combustion grate area, the combustion volume, the amount of adequate combustion air, the temperature desirable for good combustion and the turbulence required to achieve good combustion are simply could not be met. (Time-Temperature-Turbulence principle). In an attempt to reach the desired level of heat output, operating staff of biomass combustions systems increase the volume of combustion air supply well beyond the optimum level. This in turn results in an increase in the heat losses due to heat carried away by the flue gas. This higher loss further increases the amount of fuel requirement. Thus further increases the cost of fuel.
Apart from increasing the cost of fuel requirement, higher moisture in fuel results in lower production output due to failure to generate the desired energy output level.

5. Country Specific Applicability:

Electrical Energy Supply Sector

The data provided by the Sri Lanka Sustainable Energy Authority (SEA) in their web: www.energy.gov.lk show that the present the national peak electricity demand is 2033 MW (28th September 2011) and the corresponding daily electrical energy consumption is 33.35 GWh/ day. The same data published during this year (2011) also show that the annual electricity peak demand growth is growing at about 400 MW per year and the daily electrical energy demand is growing at around 8 GWh/day/year.

In order to meet the above mentioned growth, the Ceylon Electricity Board (CEB), the sole utility responsible for the generation and distributing most of the electricity generated to the final consumers have been annually preparing and releasing their Long Term Generation Plan (LTGP). According to the last published LTGP, most of the future generation of electricity would be generated from coal based power plants as shown in figure 2.

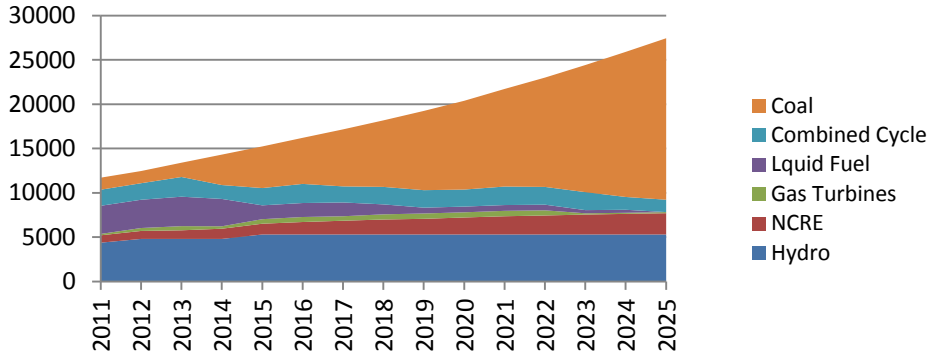


Figure 2: Annual Energy Generation (GWh/y)

In fact as per the above plan, EB has already commissioned and operating a 300 MW coal based power plant. The second phase of coal based power plant with a capacity of 2x300MW is under construction. Action has been initiated to construct another 2 x 500 MW coal based power plant in the country.

While the state owned utility CEB is planning to commission as many coal based power plants as necessary to meet the growing demand for electricity, the Ministry of Power and Energy, through the SEA is encouraging the private investors to develop renewable energy based power plants. In an attempt to generate at least 10% of the electrical energy requirements by the 2015, the SEA has offered an incentive scheme for the private sector to harness renewable energy resources and generate electrical energy and feed the national grid. A concessionary tariff based on the estimated cost of generation has been offered for each of the following technologies:

- Small Hydro: Rs. 13.04 / kWh
- Wind: Rs. 19.43 / kWh
- Biomass: Rs. 20.77 / kWh
- Agro/Industrial Waste: Rs. 14.60 / kWh
- Municipal Waste: Rs. 19.73 / kWh

In spite of the attractive tariff offered for biomass based electricity generation, only one power plant with a capacity of 0.5 MW has been commissioned a month ago. On the other hand by the end of 2010, a total of 86 small hydro power plants with a total capacity o 175.8 MW and 4 wind power plants with a total capacity of 30.15 MW and 2 agro residue based power plants with a total capacity of 11 MW have been commissioned.

A number of reasons have been attributed to the reluctance of investors to engage in biomass based energy generation. One important reason is that the difficulty in getting the desired energy output levels due to the high moisture levels prevailing in the biomass fuels. The development of

this technology to dry the biomass fuels using waste energy available in the flue gas would resolve this issue.

Industrial Heat Sector

The latest Energy Balance 2007 published by the SEA reveals that the industrial sector in Sri Lanka uses biomass fuels to generate 82% of the heat energy required by this sector. The balance 18% is generated using petroleum fuels. On the prevailing market values and on a useful energy output equivalent basis, the cost of petroleum fuels is at least four times the cost of biomass fuels. Due to this significantly higher fuel costs, in the recent past there had been an attempt by the industrialists using petroleum fuels to switch to biomass fuels. In fact, despite a heavy subsidy given to furnace oil used by the industries, a handful of industrialists have switched from petroleum fuels to biomass fuels.

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6. Status of the technology in the country and its future market potential:

Status of Technology in Sri Lanka

The technology of using flue gas from a combustion system to dry the biomass fuel has been implemented in Sri Lanka in one facility constructed by a private sector institution (Recogen Pvt. Ltd.). At this facility, Coconut shells are pyrolysed to charcoal. During pyrolysis of coconut shells, a part of the matter in the shells is volatized and liberated as gases and vapours. These gases and vapours are extracted from the reactor and combusted (by admitting combustion air) in a boiler to generate high pressure steam. The high pressure steam generated is used to drive a turbo-generator, charcoal produced in the process are used to manufacture activated carbon.

In this process of pyrolysis, the initial level of moisture in the biomass stock (coconut shell) plays an important role in the composition of the volatiles liberated. High moisture would result in a higher proportion of liquid tars and lesser amount of gaseous components. Moreover, a higher moisture level in the feed stock also lowers the quality of the charcoal produced. Hence the need to reduce the moisture in the feed stock is an important step in this process. The developers of this project were more or less compelled to develop a technology to dry the feed stock prior to admitting it into the reactor. Accordingly, a drying technology to dry the feed stock using the flue gas from the boiler has been developed and successfully deployed at this facility.

Future Market Potential

Electricity Generation Sector

At present a 10 MW biomass (agro-residue) based electricity generation facility has been commissioned a few years ago. Another 0.5 MW facility based on Gliricidia wood based power plant was commissioned about a month ago. Around 70 MW of power plants are in the pipeline. These 70 MW of biomass based power plants are expected to be commissioned within the next four years to meet the 5% of total generation target by the year 2015. An additional 70 MW of biomass power plants are expected to be commissioned before 2020 to reach the 20% target. All these plants will benefit from the proposed technology.

According to the study done by the Ministry of Science and Technology and European Union, the potential for biomass based power generation in Sri Lanka is over 4000 MW. Hence the long term potential of this technology is very large indeed.

Industrial Heat Generation Sector

At present over 82% of the industrial heat energy is generated from biomass. Most of this biomass is in the form of chunks. In these old furnaces biomass chunks are fed manually. The proposed technology does not match these old furnaces. Only around 12% of the existing biomass combustion systems could adopt the proposed technology. The amount of biomass coming under this category would be around 800,000 tonnes of biomass.

However, almost all the fossil fuel consuming combustion facilities are likely to switch to biomass once the present government subsidy granted to industrialists is removed. The total amount of biomass fuel required for such switch over would be 800,000 tonnes of biomass.

Hence the potential for this technology in this sector would be 1,600,000 tonnes of biomass per year.

7. Barriers: This section will be covered later.

8. Benefits: (How the technology could contribute to socio-economic development and environmental protection)

Social Benefits

The implementation of this technology will remove a serious barrier encountered in the sustainable production and use of biomass (Gliricidia Coppice Wood) as the fuel for the generation of electricity and industrial heat energy. This will result in many thousands of people from the rural farming communities engaging in the growing, harvesting (coppice cutting), transporting and deliver the harvested wood to the energy conversion facilities. In addition to the

wood, these farmers will be in possession of Gliricidia leaves. This could be used to enhance the rural dairy industry and increase the production of organic fertilizer. All these mean that the introduction of this technology will provide productive employment to the under-employed poverty driven rural farming communities.

The introduction of this technology will also provide employment opportunities to the skilled workforce in the engineering sector. The fabrication, installation, commissioning and operation of the dryers would require many skilled, semi-skilled and unskilled staff. Hence the social problem of urban poverty will also be resolved.

Economic Benefits

Electricity Generation Sector

As Sri Lanka does not possess any proven fossil fuel reserves and as the LTGP of the CEB is heavily depending on imported fossil fuels to meet the growing demand for electricity (see figure 2), the Ministry of Power Energy have formulated a policy to ensure that at least 10% of our electrical energy is generated from indigenous renewable energy resources by the year 2015. This share is to be increased to 20% by 2020. It is very unfortunate that those responsible for implementing this policy are promoting wind and solar PV. Wind and Solar PV do not contribute directly to any national economic benefits. Wind and Solar PV technologies depend entirely on foreign inputs for the import of necessary equipment and installation and commissioning staff.

On the other hand Sustainable Biomass based electricity generation results in significant local national input in the generation of electricity. All the fuel required for biomass based electricity generation is generated locally within the national boundary.

Moreover, on a level playing field, and if all costs including environmental, agricultural, health aspects are internalized, it can be proved that biomass based electricity generation is in fact the cheapest way of generating electricity.

Based on a net calorific value of 26,000 kJ/kg for coal and a landed cost of US$150/tone of coal and 15,000 kJ/kg for wood and a local price of Rs. 3.50 per kg, on an energy equivalent basis energy from coal is 2.77 times as expensive as the energy from locally available wood.

For the proposed 140 MW of biomass power plants, the savings in fuel cost would amount Rs. 3.2 billion per year.

Industrial Heat Generation Sector

As mentioned earlier, the introduction of the drying of biomass fuel technology would have two impacts: (a) It will reduce the fuel consumption in the existing wood chip using furnaces and (b)

It will encourage all the industrial sector petroleum fuel consumers to switch to biomass fuels. At present furnace oil is marketed at a subsidized price of Rs. 50 per litre. It is very likely that the subsidy will be removed soon and it will be marketed at Rs. 90/litre.

An estimated 800,000 tonnes of wood is presently used annually by the wood-chip consuming sector. Once the drying technology is introduced, the fuel consumption would be reduced by 22%. The impact to this subsector, presently using wood chips as fuel would be 33% of Rs. 3,500 x 800,000 tonnes amounting to Rs. 933 million per year.

When all the industries presently using petroleum fuels amounting to 200,000 tonnes per year switch to biomass fuel, the impact would be Rs. 200,000 x 90,000 – 800,000 x 3,500 = Rs.15.2 billion per year.

Environmental Benefits

The increase in the use of biomass as an alternative to fossil fuels for industrial heat and electricity generation would result in the following environmental benefits:

- Less SOX and NOX emissions.
- Less GHG emissions
- Additional Gliricidia plantations increasing the green cover in the country.

9. Operations

10. Costs

Discussions held with local engineering companies who handle this type of equipment have indicated that to construct and commission a dryer to match a 6MWth heater/ boiler that requiring 2 t of wood per hour would be Rs. 2 .0 million.

11. References

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