

Introduction

1.1 Background

Annual sugar consumption in Sri Lanka is around 670,000 MT. Pelwatte Sugar Industries Limited and Sevanagala Sugar Industries Limited together are producing nearly 66,000 MT annually. This is above 10% of total consumption. Earlier Hingurana sugar factory produced around 20,000 MT of sugar annually. But this sugar factory was closed down in 1993 and now it is going to start its production in the year of 2011. At present only Pelwatte Sugar Industries and Sevanagala Sugar Industries are being operated. These factories were installed in 1985 and 1986 respectively. Therefore the technology used by both Pelwatte and Sevanagala are older compared to the modern technology used in other sugar producing factories in the world. It is very difficult for our factories to compete with these countries, because they are using modern technology [5].

In sugar industry, research and development is a very important factor, as there are various sugar varieties frequently introduced. Therefore yield per hectare should be increased while getting more sucrose from the sugar cane. Similarly there are different types of diseases spreading out over the sugar cane and solutions should be given immediately. In case of reducing cost of production, the modern technologies can be used. These activities are used in sugar producing countries. But in Sri Lanka, considerable attention has not been given to this field. Sri Lanka is an agricultural based developing country. There are lots of bare lands in dry zone, which can not be used for other agricultural cultivations other than sugar cane. These sugar factories are located far away from the capital city, Colombo. Therefore large number of jobs has been provided by this industry. Otherwise people who live in these areas would have to come to main cities for job opportunities. There are thousands of people living in this area who have direct relationships with sugar industry.

Reduction of cost of production is a difficult task in Sri Lankan sugar industry. Lots of heavy machinery and their spares along with sensitive instruments are imported. Due to the depreciation of Rupee, cost of these imported items has been increased. In other countries, research and development in sugar industry plays a big role for reducing cost of production. Electricity which is in excess from the utilized amount in the manufacturing process is a

common by-product in sugar industry today. This is a very common practice in India. But in Sri Lanka, this is not practiced, as it requires very high pressure boilers and auxiliaries to be used. Implementation of this is not possible in Sri Lankan sugar industry, because existing system is not capable enough to withstand this pressure. The other major reason is the capital cost. For the replacement of existing machineries with new ones and to produce sugar and electricity, capital cost will be very high. Investment on 1kW of electricity generation and distributing it to national grid is approximately 45 million LKR. The potential of generating electricity from Pelwatta Sugar Industries is 20 MW. For that, the capital cost will be very high and pay back period is also around eight years. IRR value is not significant; therefore nobody is interested in this replacement, other than getting maximum output from the existing plant. Nowadays, electricity generation is more profitable than sugar manufacturing. The grid connection is the main problem faced by the Pelwatta Sugar Industries as it is far away from the national grid.

Fuel price is fluctuating, with the price changes of a crude oil barrel in world market. Therefore, industries that are directly related with energy are highly affected by these price variations. To sustain with these changes, fuel usage must be minimized. In Pelwatta sugar manufacturing process, whenever the released amount of bagasse is not sufficient, furnace oil is basically used to supplement the fuel requirement. Diesel generators are used during the off season for the power supply. The annual fuel consumption is therefore at a high level. Average annual furnace oil consumption is 600MT [5]. For the existence with the changing world, cost of production must be minimized. Otherwise the Sugar Industry in Sri Lanka will not survive long.

Optimum usage of bagasse is the most important factor, in minimizing the fuel consumption in sugar industry. For the optimum usage of bagasse, boiler efficiency should be increased. When the boiler efficiency is increased, bagasse consumption will be reduced. This causes to serve surplus bagasse. There are various methods of increasing boiler efficiency such as introduction of air pre-heater, introduction of feed water heater, minimizing blow down frequency, minimizing surface loss, etc. First two methods can be achieved from the waste heat of the flue gas. For other two methods, proper boiler water treatment and complete insulation of boilers are very important. Similarly mixing commonly available bio-mass (such as Giniseria) with bagasse is also possible for saving surplus bagasse. There are lots of bare lands of the sugar cane field, especially near the river banks, which can be used for the cultivation of these bio-mass [3].

1.2 Motivation

I have been employed about ten years in the Pelwatte Sugar Industries Ltd. Pelwatte Sugar Industries is the largest sugar manufacturing company in Sri Lanka. It produces 6.5% of the total sugar consumption in Sri Lanka. Pelwatte Sugar Company is located at Buttala in Monragala district which is nearly 235km away from the capital city Colombo. This subject area which is more familiar to me and opportunity to offer a significant benefit to the organization and also to the country motivated me for undertaking this project.

1.3 Process Description

Pelwatte Sugar Industry owns sugar cane cultivation in 12,000 hectares. Both company owned and private owned lands are used to cultivate sugar cane. Sugar cane is a large grass that has a bamboo – like stalk, grows 2.5 to 4.5 meters (8 to 15 feet) high, and contains a large amount of sucrose in the stalk. Different varieties occur throughout the tropical and semi tropical regions of the world, they are the results of the diverse soil conditions, climates and mode of cultivation. Two major seasons are in area, named “Yala” and “Maha” seasons. Generally these two seasons divided by considering rain fall. During rainy seasons cane harvesting is stopped and cultivation is started. Sugar production is a continuous and 24 hour operation, therefore regular cane supply from the field to factory is essential; but during the rainy seasons vehicles cannot enter in to the field due to wet ground condition. Basically 60-80 MT per hectare is the yield of sugar cane of these agricultural lands [6].

1.4 Literature review

Scientific findings strongly suggest that there is a stronger evidence for a human influence on climate change than at the time of adopting the United Nations Framework Convention on Climate Change (UNFCCC). It is likely that increasing concentrations of green house gasses have contributed substantially to the observed global warming over the Past 50 Years. The Intergovernmental Panel on Climate Change (IPCC) has now revised its earlier estimates to temperature of 1.3 - 6⁰ C to an increase 1.5 - 6⁰ due to the expected reduction of Sulfur Oxide emission. The IPCC report notes that the concentration of atmospheric Carbon Dioxide has now risen to over 360 parts per million (PPM) from the industrial level of about 270 PPM. Carbon Dioxide has an effective life time in the atmosphere of about 100 years, so that its global mean concentration responds to changes in emissions very slowly. Emission reductions of 60%-70% from current levels would be needed to prevent carbon concentrations from rising

further. Mean sea level has risen by between 10 to 25cm. If any CO₂ emission reductions are not implemented, sea floods also can be expected in future [3].

Bio-mass can be considered to cause zero Carbon Dioxide emissions, because when the biomass is burnt it releases carbon dioxide, which was absorbed by bio-mass during its growing phase. Therefore when total cycle is considered, net emission of Carbon Dioxide is zero. Energy sources, like wind energy, tidal energy, solar, biogas can also be considered as zero emission of Carbon Dioxide. That is why developing countries are always trying to use these types of energy. Uncultivated lands owned by Pelwatte Sugar Industries Limited (especially near the river banks), can be selected as agricultural lands for "Giniseria" which can be mixed with bagasse. Then huge quantity of bagasse can be saved, minimizing petroleum consumption at the same time input energy also can be increased, as Giniseria is having more heating value than bagasse. Finally by carefully studying the rules and regulations of UNFCCC, this project can be considered as a CDM (Clean Development Mechanism) project. Therefore, possibility is there to get some benefit for this project, under the concept of "Carbon Trading" [3].

1.5 Goals



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In Pelwatte sugar plant, only air pre- heaters are available for increasing boiler efficiency. Therefore efficiencies of boilers are estimated to be in the range 65-67%. If it is possible to install a feed water heater (through which an increment of 25^o C temperature will be possible), then the boiler efficiency can be increased up to 70%. Bagasse saving can be expected as a result of boiler efficiency increase. But for this, wide and sufficient research must be carried out. Design parameters of the boilers should not be changed. Similarly temperature of flue gas releasing to the atmosphere cannot be reduced below 175^o C. If we do so, sulfur content of the fuel will be on the chimney, air duct and structure. This is the main reason for corrosion of the effective parts. Capacities of the existing Induced Draft (ID) and Forced Draft (FD) fans should be considered. Turbulence of flue gas inside the feed water heater and pattern of the stream lines are also critical issues. Method of harvesting and emission are also effective factors for this project. Particulate matter (PM) is a common emission, and must be removed from the flue gas to reduce atmospheric pollution.

Ash and PM (particulate matter) will deposit on feed water heater tubes. Therefore before introducing a feed water heater, adequate space must be provided to avoid friction for the flue

gas flow. Arrangement should be made to remove deposited ash and particulate matters on the tubes. Otherwise, due to the obstruction for the flue gas flow, back pressure will be created inside the boiler. On the other hand this deposited ash will act as an insulation layer on the tubes reducing heat transfer rate of the feed water heater.



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