RENEWABLE SOURCES OF ENERGY FOR THE TEA INDUSTRY

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Energy is the subject of many a discussion today and the reason for this is that the world has finally come to recognise that oil, the most widely used fuel due to its convenience, will disappear in the foreseeable future. Even before this happens the rising oil prices will make it beyond the reach of most of the developing countries that are not so fortunate enough to have their own oil fields. Sri Lanka is one of the unfortunate countries in this respect and she has to look for alternative sources of energy for her industries and others.

Tea industry is the largest industry of this country and its export revenue in 1980 amounted to six billion rupees, about 40% of the countries foreign exchange earnings. The cost of production of tea has been rising steadily over the years and today the cost of fuel and electricity account for about 55% of the cost of processing. Use of cheaper sources of energy would therefore have a greater impact on controlling the cost of production, and would to a greater extent become the determining factor for the viability of the tea industry in the context of increasing competition from the other tea producing countries of the world.

The major requirement of the tea industry besides land, manpower, fertilizer, etc, is the energy required for processing of tea. This energy requirement can be broadly classified into three categories:—

(i)) heat energy for withering and drying;

(ii) electrical energy to drive motors of factory machinery; and,

(iii) electrical energy for lighting.

The gross energy requirement of a factory producing about half a million kg made tea per annum, that is an average of 1600 kg made tea per day is as follows:

(i) heat energy of one million KCal/day (5800 KWH/day);

(ii) electrical energy of 1100 KWH/day; and,

(iii) electrical power of 150-200 KVA.

Several new and renewable sources of energy are being considered to solve the energy crisis of the world today. These sources are not universal and only in some parts of the world can they be efficiently exploited. They are: Hydroelectricity, wind, waves, tides, geothermal, ocean thermal energy conversion (OTEC), biogas, fuelwood, charcoal, solar, etc. Only those sources of energy that could be exploited by the tea industry will be discussed in this paper.

Hydroelectricity

Sri Lanka is one of the countries that obtains most of her electrical power requirements from hydroelectricity. The National Grid supplies this power throughout the country and most of the factories are connected to this grid. The factories require electricity primarily to drive the motors of the machinery and also for lighting. In addition, electricity could also be used for obtaining hot air for withering and drying but it is considered not feasible in todays context of shortage of electrical power in the country. Electricity, if used would be the most efficient form of energy to provide heat for tea processing, as direct air heaters could be used. To obtain hot air alone on an average each factory would require one or more of 300-500 KW air heaters and if the entire tea industry which has about 800 factories were to use electricity the additional power requirement would be about 400 MW Such a quantum of power will not be available to the industry in the foreseeable future. Even if some factories were to use electricity for heating air, heavy capital expenditure for the following will be required:

(i) additional transformers of capacity 300-500 KVA;

(ii) additional or new transmission lines to carry these loads;

(iii) augmentation of existing substations; and,

(iv) electrical heaters themselves.

Electricity that is available at the factory must therefore be used for driving the motors of the machinery. As the demand for electricity from the other industries and the domestic users is also high, the tea industry must consider whether it could generate its own electricity. One possibility of doing so is by reviving or starting mini-hydroelectric schemes on the estates. The other possibility is to use generators coupled to oil fired engines. The second alternative is out in view of the rising price of oil and its non-availability in the future.

Mini-hydroelectric Schemes

Most of the estates in the upcountry have the potential for mini-hydro electric schemes and in the case of many of the estates, this has either been not tapped or only partially tapped. In the past large number of factories used hydro power, not necessarily hydroelectricity, to run the machinery by means of the overhead shaft drive. With the availability of cheap electricity from the national grid the estates quickly changed over to this power source and installed trough witherers replacing the bulking chamber arrangement. Individual motors were also fixed to all the machinery. The power requirement of a present day factory is therefore verymuch higher than that when the machinery was operated by means of the overhead shaft. Most of the mini-hydroelectricity schemes on the estates, except a very few, could generate only about 50-75 KVA, which is not sufficient to meet the electrical demand of most of the factories today. In such instances this power could be used only for a section of the factory, say the grading room and also for lighting in the factory as well as that in the staff quarters. However, still there are some problems, one of which is the non-availability of water usually for about three months of the year. This calls for alternative arrangements, such as the national grid or stand-by generators during this period of drought. The other problem is that most of these hydroelectric generators on estates do not have governors which control the flow of water to keep the frequency and voltage of the electricity generated constant. In such cases either a governor must be installed which is quite expensive today or, if the Government permits, these turbines should be used to pump energy into the national grid by coupling to induction generators. The second alternative should be encouraged by the Government as it is a step towards harnessing all the available hydro power in this country. Starting new mini-hydroelectric schemes has been considered very expensive upto now but recent developments in this country indicate that if turbines of a particular design are fabricated locally, the cost would be very much lower. The tea industry should therefore look into the hydroelectricity potential on the estates both in the untapped as well as tapped sources.

Fuel wood

Fuel wood has been the traditional full used in the tea industry but had been replaced by oil due to its cheapness at that time. The infrastructure for transport and storage of oil being well organised on the estates as well as the ease of operation and better temperature control have been the added attraction towards oil.

When fuel wood was used as the fuel most of the estates were self-sufficient in their requirements of fuel wood. Their requirements were met both from the trees grown for the purpose as well as from shade trees. These practices were given up for various reasons and now when the estates switch-over to fuel wood suddenly, they find that there is not enough fuel wood to meet their demand. No doubt certain amount of rubber wood from rubber replanting programmes and jungle fire wood was available to the tea industry in the past, but with the demand from other sectors and particularly the domestic users too increasing, there is less and less fuel wood available to the tea industry at a reasonable price.

It is estimated that for an estate with an average yield of 7000 kg per ha per annum, if fuel trees are grown on 10% of the tea area on a ten year rotation, the estate would be self-sufficient in its requirements of fuel wood. This area for fuel wood may be found in the ravines and lands unsuitable for tea. In many instances the estates may not find this area unless tea is pulled out from good land; under such circumstances, a solution could be found on a regional basis rather than as individual estates. On this regional concept sometimes the entire area of an unsuitable tea estate may have to be diversified into fuel-wood plantation in order to supply fuel wood needs of estates which are more suited for tea in the same region. Under the regional concept production of tea would be kept at its highest and transport of fuel-wood would be kept at its lowest.

One other method of obtaining fuel-wood is by growing shade trees. These being grown within the tea itself will not require additional land unlike fuel-wood trees grown for the purpose. It can be shown that, if shade trees are grown at 40'x40' spacing on a ten year rotation, the fuel wood available from these trees is adequate to meet 60% of the requirement of an estate with an average yield of 1000 kg per ha per annum. Therefore it is evident that either from shade trees alone when grown at a closer spacing than that mentioned above or by a combination of shade trees and fuel-wood trees the entire heat energy requirement of the estate could be met. This will be possible only through a planned tree planting programme and that too it should be remembered that the fuel wood will be available only after ten years from now, if we embark on this programme today. This is a definite source of energy for the tea industry when compared to the other sources of energy that will be discussed in this paper. Working according to a pre-planned programme is not something new to the tea industry and with the years of experience on planting, achieving self-sufficiency in fuel-wood requirements is not an impossible task at all.

Charcoal

Charcoal is obtained by the slow burning of wood with a very restricted supply of air. Compared to wood the efficiency of burning is better, stores better and produces less pollution. The other advantage is the ease of transportation as the bulk is reduced. However, the total energy obtained from a given weight of charcoal is about 50% less than that obtainable from the quantity of wood that produced the charcoal. Therefore when fuel wood is grown on the estate itself or within the region where transport is minimal, it is economical to use fuel wood direct rather than charcoal after conversion.

Wind

Though there are wind swept areas in many estates, still winds are intermittent and this fact limits the use of wind for the generation of electricity. According to theoretical calculations it is possible to obtain 1000 Watts of power from a windmill intercepting a square meter of the current of air, when the wind speed is 20 mph, this power drops to a mere 35 watts when the wind speed becomes 6.5 mph. This basic law that power varies as the cube of the wind speed is one of the major factors that limits the use of wind power to generate electricity, as there will be wide fluctuations in the electricity that will be generated. However, research is being carried out on the use of wind generators to feed electricity into the national grid. At present the most common application of wind energy is for pumping water.

Solar

Solar energy is the primary source of energy and its undoubted availability at zero running cost makes it the most attractive source for any application. On a clear day, solar radiation falls on the earth at an intensity of about 1 KW/m^2. Although this is a substantial intensity, the problem lies in converting this to other more suitable forms such as electrical or heat energy.

The energy of light from the sun can be converted directly to electric voltage by photo-voltaic effect of "Solar Cells". The capital costs involved in large installations as those required by industry are however prohibitive.

Conversion of solar energy to heat energy can be done either by "passive" collectors where heat is just trapped or in "active" collectors where, in addition, sun is tracked and radiation concentrated. "Passive" collectors such as a flat-plate collector has a black surface which absorb the radiation and any fluid such as air or water can be warmed up by contact with the warm black plate. Normally a plate of glass or some other suitable transparent cover is used to trap the warmness of the black plate and reduce heat losses. Such a collector can be made without too much capital investment and is suitable for any low-temperature application such as generation of hot air for withering. The temperature of warm air from the collector will depend on the flow rate of air through the collector, lower the flow rate the temperature being higher and vice versa.

A collector of area three times that of a trough will be required to heat up usual requirements of air flow in the trough by about 6°C. Although a simple collector alone cannot be used to generate air temperatures as that required by tea driers it can be used as a pre-heater for air to be coupled to conventional heat exchangers.

"Active" collectors are relatively more expensive and less cost effective than "passive" collectors and are more suitable for high temperature applications such as electricity generation via steam.

Actual use of solar heated air for tea processing has many practical difficulties. Among those are the unavailability of solar heat during wet days when warm withering air is really needed and the usual practice is processing tea (rolling, drying, etc.) during nights. This means that storing of heat energy is essential if solar energy were to be utilised in tea processing. This can be done by using materials such as rock for heat storing and investigations are under way.

Biogas

The term biogas is used for mixtures of methane and carbon dioxide (at a ratio of about 60/40) produced by the digestion of biological matter such as cattle dung, pig dung, plant leaves, weeds, etc. Biogas is produced by bacteria, feeding on this organic matter and these bacteria thrive only in anaerobic conditions. Therefore, essentially, biogas is generated in leak proof vessels where warmness too can be maintained at the optimum of about 30° - 35° C.

Biogas burns with a soot-less blue flame and it has a calorific value of about 5000-5500 Kcal/m^3 (compared with about 9000 Kcal/litre of diesel). A digestor of 10 m volume producing 1-3m^3 of biogas per day requires about 25 kg of cow-dung per day *ie* from about 3-5 heads of cattle. Such a volume would be sufficient for energy needs for cooking and lighting for a medium-size family, a promising solution to the energy needs of the plantation community.

Process energy needs of the tea industry are too large to be catered by biogas, for example at similar conversion efficiencies, a factory needing 250 1 of heavy diesel per day would alternatively require about 400 m^3 of biogas per day. Corresponding input requirements are dung from at least 400 heads of cattle and 400 acres (at least 200 acres under intensive cultivation practices) of land under pasture. Tea industry does not possess such vast lands at we its disposal.

Steam

Steam is not a primary source of energy, since to obtain steam water will have to be boiled by burning a fuel such as oil or fuel wood. The advantage of steam is that hot air could be obtained by passing air over banks of steam radiators which are much smaller in size than fuel wood or oil furnaces. There will be a better control of temperature and individual steam radiators could be fixed to the troughs bringing in savings on the cost of hot air ductings and cutting down on heat wastage. However, the capital cost of steam boilers, radiators and pipes is high. Further the overall efficiency of energy utilization is lower than that obtained by using fuel wood or oil in furnaces. The use of stem is found to be economical in certain other tea producing countries where primarily steam is produced to generate electricity and the waste steam is then used for tea processing. For such a system to be in operation the size of the factories have to be very much larger than that of ours. In any case this too would require high capital cost.