Experience on use of biomass gasifiers in Crumb rubber industries.

H.V.Sridhar, G.Sridhar, S.Dasappa, N.K.S.Rajan, P.J.Paul, H.S.Mukunda

Advanced Bioresidue Energy Technologies Society
Combustion Gasification and Propulsion Laboratory
Indian Institute of Science
Bangalore

Abstract

India is the fourth largest producer of natural rubber in the world. The natural rubber is processed from Latex secreted by rubber trees. The natural rubber is graded based on the quality of latex and conversion procedure. Technically specified rubber or Crumb rubber is a second grade rubber processed from plantation leftovers and other sources. In South India there are over 55 industries producing more than 60000 tons per annum of crumb rubber. Tire manufacturing industry is the major consumer of crumb rubber. The process of producing crumb rubber includes stages of soaking in water, squeezing and shredding, drying and pressing into final form. The entire operation is energy intensive both in terms of electrical and thermal energy requirement. The crumb rubber is dried in continuous driers which conventionally use diesel as fuel. The average fuel requirement is 40 litres per metric ton of dried crumb rubber. Currently, a couple of industries have done away with diesel for drying and are completely dependent on IISc open top gasifiers for their thermal energy requirement and a few are adopting wait and watch policy before making a switch over. The present paper discuses case study of two industries using IISc open top biomass gasifier for drying of crumb rubber. The system configuration, performance and economics of operations are elaborated.

Keywords: Biomass gasifier, crumb rubber, drying

1. INTRODUCTION

Fossil fuels especially diesel has been widely used as fuel for low temperature as well as high temperature thermal requirement. This is due to compactness of the combustion system and easy availability of fuel. The design package of the dryers also got evolved over the years both using electrical heating and diesel combustion systems. The latter package gained more momentum due to decentralized availability of fuel and opportunities for round the clock operation of the factory. The poor quality and non availability of continuous grid supply also forced industries to look into backup power supply in form of a DG set.

In recent times, with the changes in cost of petroleum fuels, the overall economics utilizing these fuels are being affected. Economics along with the environmental considerations has resulted in looking at alternate sources of energy. Amongst all other alternate sources biomass gasification qualifies for continuous operation irrespective of seasonal changes and least expensive option compared to any other renewables. The changes on the dryer are also minimal with provision for a gas combustor and retaining the existing diesel combustor. This gives a backup option in case of any unforeseen shut down of the gasifier. The reliability of the operations of IISc open top biomass gasifier for high temperature and low temperature thermal application is discussed by Dasappa et. al. [1].

India stands fourth in the world in production of natural rubber [2]. The production in 2001-02 was 6,31,400 tons from a total planted area of 5,58,592 ha. The plantation area is confined to Southern and North Eastern India. The natural rubber is formed out of latex collected from rubber trees in plantation.

Rubber collected from the field has to be processed for end use. One of the energy intensive activities is drying of the rubber which is being done using fossil. The scrap rubber obtained is soaked in soak pit for few days and it is taken though squeeze rollers and hammer mills with soaking in each stage. This ensures the rubber is clean. The rubber upon arrival to dryer has 32 – 35% moisture and has to be dried to 0.5 – 1% moisture level before taking it to a hydraulic press which gives final form to crumb rubber. This industry has continuous trolley type tunnel dryer, accommodating trolleys. Combustion of fossil fuel in the burner and diluting it to meet the hot air temperature of about 105 ± 5 ^{0}C meets the drier requirements. Typical consumption of fossil fuel consumption is about 37 litres per ton of processed rubber.

The present paper discusses the experiences in using gasifier for rubber drying application in two industries namely M/S Ideal crumb rubbers in Pallakad district of Kerala and M/S Comorin polymers at Nagarcoil district of Tamilnadu.

2. DRYING OF CRUMB RUBBER

Conventional drying of crumb rubbers

M/S Ideal crumb rubber is a partnership company set up to produce Technically Specified rubber, mainly ISNR-20 for tyre industries. The production predominantly is of the Tyre Grade, and is supplied to almost all the tyre giants in the country. The company produces 12 MT/day of crumb rubber and uses on an average 22 liters/hour for their drying needs.

M/S Comorin polymers and plantations (P) ltd are also in the field of crumb rubber manufacturing with a similar process. The industry has a dryer with 10 MT/day throughput and uses on an average about 18 l/hr for their drying needs.

These industries on analysis has found that the major cost components being raw material, drying costs, electricity costs and manpower operations cost of which drying costs could be easily optimized. This has encouraged them to replace fossil fuel by producer gas from IISc open top down draft solid bio-residue gasifier.

Gasifier based drying of crumb rubber

Based on the thermal energy requirements, suitable gasifier was installed to replace the diesel in the dryer. The temperature to be maintained in the dryer is 105 ± 5 ^{0}C. The schematic of the gasification system is shown in figure 1. While implementing this package, care was taken to ensure the existing operations are not affected.

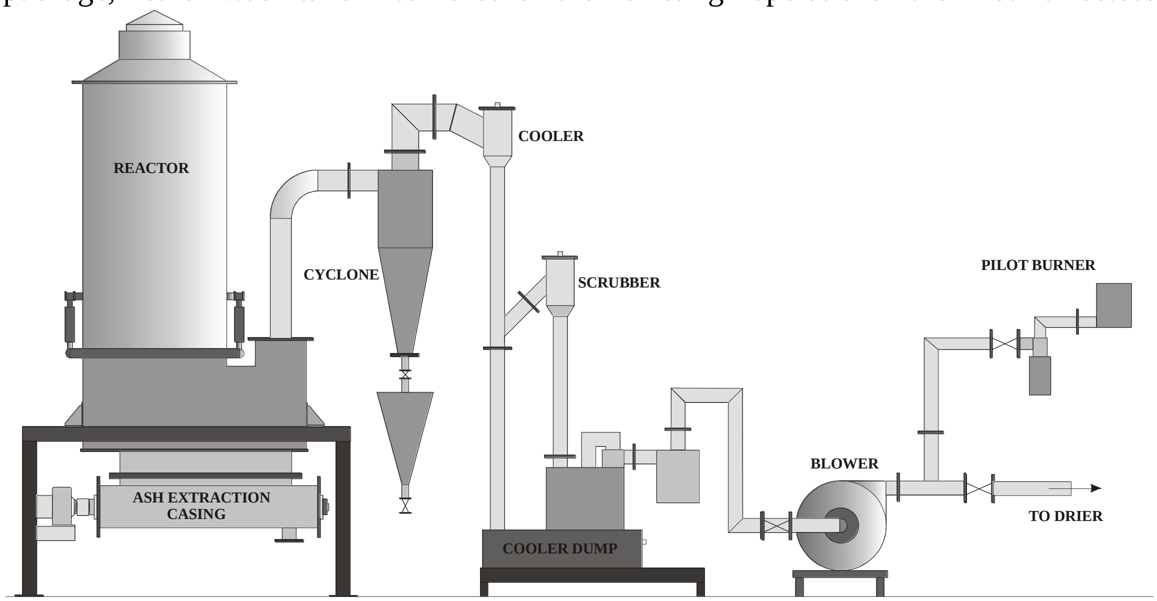

Figure 1: Schematic of the thermal gasification system for Crumb rubber drying

The elements of the system are:

Reactor

The system is open top down draft type. The reactor is essentially rolled from mild steel, and has an inner lining of ceramic, composed of high temperature insulation bricks and high alumina tiles. There are air nozzles provided around the combustion zone, which are kept open during the running of the system. A water seal forms the top of the reactor with a removable cover. This cover is kept open during the entire operation of the system, to facilitate loading of wood chips and movement of air inside. The reactor at the bottom has a screw based ash extraction system with facility to extract at a preset rate on an hourly basis. The extracted char/ash goes to water seal below.

Gas processing system

The gas has to be cooled and cleaned before being combusted. This requirement arises from the fact that gases have to be ducted a long distance in few cases, which could cause safety issues. Further handling cold gas was found attractive if system maintenance is to be addressed. The sensible energy lost in the cooling system is less than 5 % of the input energy. The gas processing train consists of a hot cyclone, cooler and scrubbing system with mist separator. The gas after passing though this will be at ambient temperature and clean to be handled by the down stream elements.

Blower

This device provides the required suction effect to draw out the gas produced in the reactor and through gas processing system. The rate at which the producer gas is drawn is controlled by means of a gas control valve provided at the inlet of the blower.

Burner

A specially designed burner for combusting producer gas is fitted near the liquid fuel burner. The provision in made in such a way that the liquid fuel burner co-exists with the producer gas burner.

Instrumentation

The system is provided with water tube manometers at strategic locations for monitoring the health of the gasifier. An oxygen indicator is provided to detect any leakage of air into the system.

Water recirculation system

The operation requires gas to be cooled and cleaned before combustion. Water is used as cooling and cleaning medium. The contaminated water is taken through the cooling tower to cool the water and a sand bed filter to remove the particulate.

3. PERFORMANCE OF THE SYSTEMS

Gasifier at M/S Ideal Crumb Rubbers:

The system was commissioned in March 2002 and initial trials were performed in the month of April 2003. The industry was able to mobilize coconut shells initially and later on had options to use saw dust briquettes, cashew kernels and wood chips depending upon the availability and major attraction is the cost of biomass. The industry typically operates for about 16 – 18 hours a day and 6 days a week; amounting to about 375 to 500 hours a month. The following table gives the performance of the system:

Commissioned On	25-3-2002
Designed capacity	90 kg/hr
Biomass used	Coconut shells, Saw dust briquettes, Cashew Kernels etc.
Average Biomass Consumption	65 kg/ hr
Diesel Saving / Hr.	22 ltrs/hr
Average Working Of The System	500 hrs/month
Total duration of system operations till Sep	6550

2003	
Total biomass used	460 Tons
Total fossil fuel saved	144 KL
Biomass used per liter fossil fuel saved	3.2 kg
Working Temperature (Drier)	96-105 ^{0}C

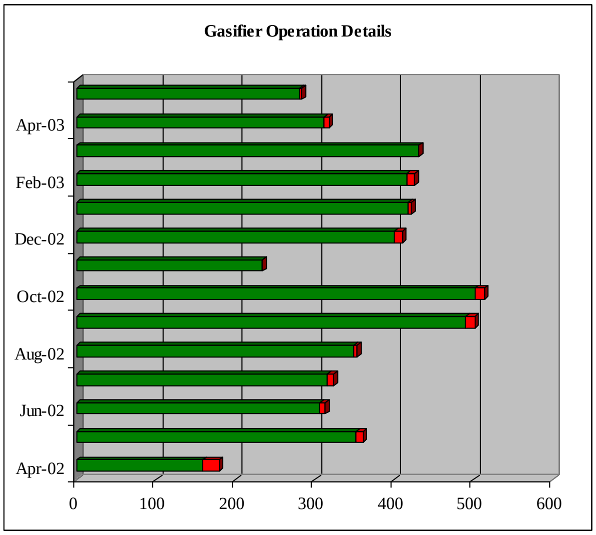

Figure 2: Summary of One year operation at M/S Ideal Crumb rubbers, Pallakad.

Figure 2 presents the summary of the operations during the last 18 months. From table 1 it is clear that the system has operated over 6500 hours. During this period various biomass has been used as fuel. The shaded portion in figure 2 indicates the non availability of the gasifier system as per the requirement in the industry. The system non availability is defined as the time for which the factory operates minus the gasifier operation time. The non availability of the system is related to the maintenance of the gasifier system. It is evident that the availability of the gasifier for operation is around 98% of the required time.

Technical issues addressed during the last 18 months

The gasifier was designed to replace 22 lts per hour of fossil fuel, aiming at 80 – 85 kg/hr biomass input. During the testing of the system, it was found that about 65 to 70 kg per hours would be adequate to meet the energy requirement. On some occasions the system generally clocks 24 hours a day and 6 days a week operation. However during the course it was found that the collection of the particulates in the cyclone was lower than anticipated, this was due to lower than designed flow rates, due to the overall biomass consumption being low. The cyclone inlet area was decreased to increase the gas velocity and there by collection efficiency. The other maintenance aspect that needs to be attended is cleaning of blower once in 750 – 1000 hours of operation and changing of ceramic air nozzles. The bearings of the ash extraction system got jammed and had to be changed. The annual maintenance cost is less than 5% of the investment on the system.

Gasifier at M/S Comorin Polymers, Nagacoil:

Commissioned On	24-6-2002
Designed capacity	75 kg/hr
Biomass used	Coconut shells and cashew nut shells in a mix
Average Biomass Consumption	60 kg/ hr.
Diesel Saving / Hr.	18 Ltrs/hr.
Average Working Of The System	550 hrs/month.
Total duration of system operations till Sep 2003	7025 hours
Total biomass used	408 MT
Total fossil fuel saved	126 kL
Biomass used per liter fossil fuel saved	3.2 kg
Working Temperature (Drier)	102-120 ^{0}C

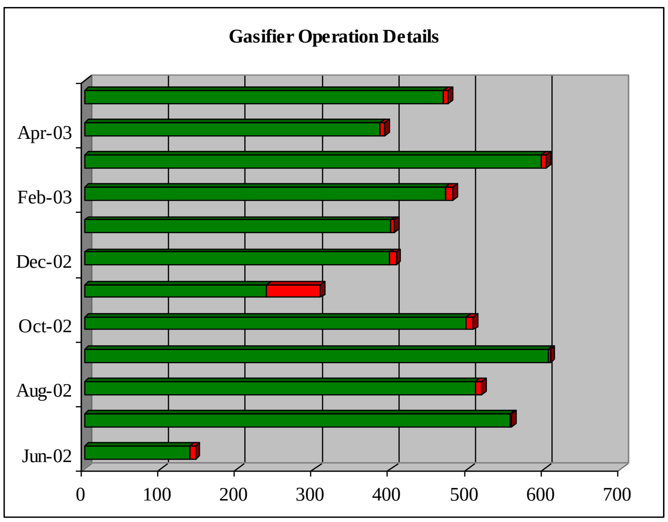

Figure 3: Summary of One year operation at M/S Comorin Polymers, Nagarcoil.

The horizontal bars indicate the factory operation time during the month with green portion showing the gasifier uptime and red portion, the gasifier down time. It is evident that the availability of the gasifier for operation is around 97% of the required time. The large unavailability (red portion) during November 2002 is due to wrong operations leading to melting of screw flights forcing a longer system shutdown.

Technical issues

This system also works round the clock throughout the week. The gas duct made of SS 304 prior to blower and the mist separator below the scrubber has shown pitting related to chemical corrosion. This issue needs further understanding. An unsound operational procedure once has led to melting of flights in the screw of the ash extraction system. This is due to leakage at the flange in the ash extraction system which has led to local combustion and melting of screw flights. This can be avoided by regular tightening of bolts and nuts in hot condition after any removal. The other maintenance aspect that needs to be attended is cleaning of blower once in 750 – 1000 hours of operation and changing of ceramic air nozzles. The annual maintenance cost is less than 8% of system cost for first year mainly due to rework required on screw flights.

4. ECONOMICS OF OPERATIONS

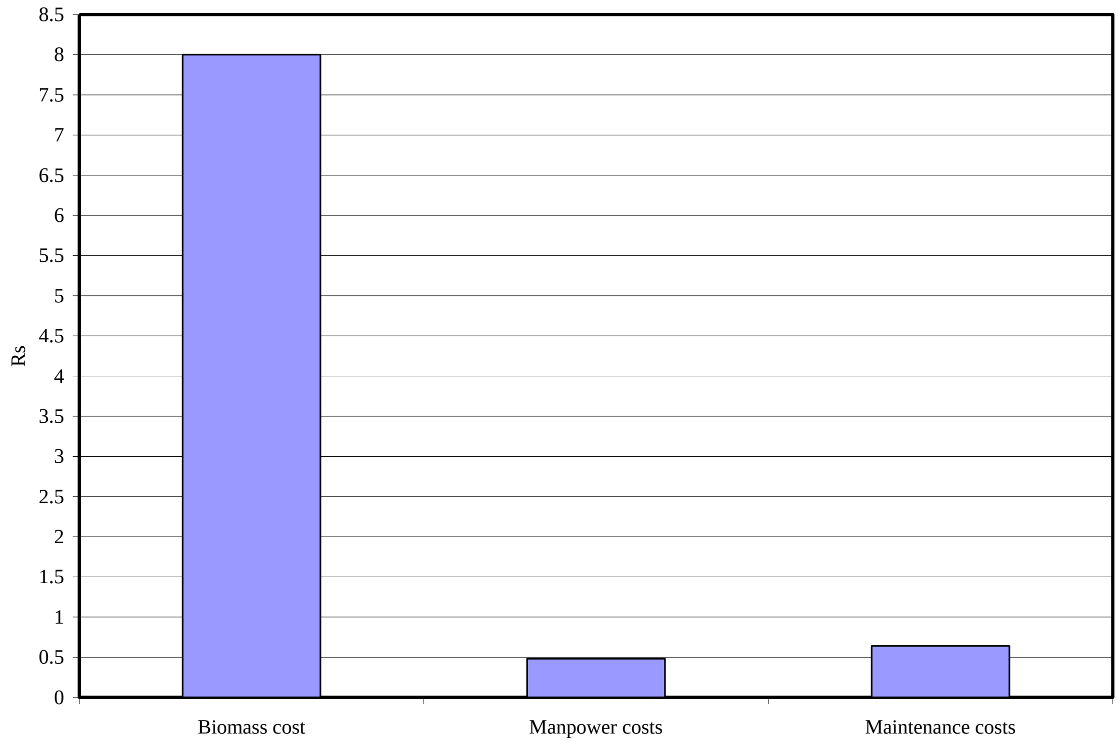

Figure 4: Economics of operations of gasifier based crumb rubber drying in both the cases

The industries source biomass at Rs 2.50/kg, the manpower costs are around Rs 0.15/kg of biomass and maintenance costs are found to be Rs 0.2/kg of biomass. The total operating costs turn out to be around Rs 9.0/liter of fossil fuel saved. This works out to 50% of the cost of LDO which was used in the system previously.

5. SAFETY ASPECTS IN DESIGN OF GASIFICATION SYSTEM

Sound system engineering has led to reliability of operations as demonstrated by the two systems. The operations with respect to temperature requirement as well as plant availability are akin to diesel mode operations. Due consideration is given to safety aspect of the system. Most part of the system experience suction and hence leakage of CO to atmosphere is minimized. The other hazard is related to air entering the system and flame flash back. Towards this an oxygen monitoring system is provided which indicates the oxygen level in the cold gas. Any raise in the oxygen percentage in gas above a set level indicates an alarm for the operator to shutdown the system and take corrective action. In any case water seal is provided in the system for any pressure release to occur. A flame failure system is provided to prevent any entry of un-burnt gas into the system. A thermocouple senses the flame temperature at the gas combustor, if for any reason the temperature sensed is less than preset temperature than the gas is diverted to pilot burner. The cooling water pump has a pressure switch which senses the water pressure ensuring cooling water flow. Any drop in the set pressure would lead to system shutdown by directly switching off the blower.

6. CONCLUSION

The two thermal systems in the field have shown that it is possible to completely replace petroleum fuel for drying in rubber industry. The system reliability is proven with more than 95% uptime and user friendliness in operation, the operation cost has been lowered by 50%. The engineering and safety aspects have not been compromised. The system package is worth reproducing in other industries with similar requirements.

7. ACKNOWLEDGEMENT

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