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Original Research Paper

Scope and Potential of Bio-Diesel Production and Pollution Reduction-A Case Study of Sugar Industry

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ABSTRACT

To carry sugarcane Sonhira Sahakari Sakhar Karkhana Ltd. Kadegaon, Maharashtra utilized 7,42,809 litres of diesel. This emits 6685.4 kg of CO_2, 24531.22 kg of NOx, 4459.94 kg of SO_2, 14856.48 kg hydrocarbon and aldehydes, 4531.22 kg of organic carbon and 11,855.20 kg of particulate matter as air pollutants in environment. The sugar factory will have big scope for bio-diesel production. If 50% land of the total cultivable land is allocated for *Jatropha* cultivation, it will produce 3,71,404.5 litres bio-diesel. This paper highlights the scope and potential of bio-diesel for reducing air pollutants during sugarcane transportation.

INTRODUCTION

India consumes over 3% of world's oil while it produces only 1% of the world production (Pathan 2006). In proportion of consumption, diesel oil is more than petrol (Bhardwaj et al. 2007). Diesel contains higher amount of aromatics and sulphur which cause environmental pollution (Kumar 2007). The sulphur dioxide emission increases one million tones every year. For transportation, the oil demand is likely to increase 60% between 2002 and 2025 (Pathan 2006). The Indian transportation industry requires huge fuel, though it is responsible for environmental pollution. India imports 70% of crude oil, therefore, for transportation, it needs policy for alternate fuel production.

India has huge potential for bio-diesel production (Kumar 2007). Bio-diesel is the name for a variety of ester based fuels generally defined as the monoalkyl esters made from vegetable oil such as *Jatropha, Canola*, soyabean and hemp oil (Pawar 1998). Bio-diesel properties are similar to those of natural diesel (Bhardwaj et al. 2007, Kumar 2007). The sulphur content of bio-diesel is less than 15 ppm (Bhardwaj et al. 2007, Sheehan 1998). In the US, bio-diesel is used as an alternate fuel, which is certified by California Air Resources Board (Pawar 1998). Their experiments showed that pure bio-diesel emissions decrease poly aromatic hydrocarbons (PAH) and nitrated PAH compounds which have potential to cause cancer. A number of independent studies have been completed with bio-diesel and their results show that bio-diesel performs similar functions like petroleum diesel which benefits to environment and human health (Kallingeros et al. 2004). In India, Lucknow-Delhi Shatabdi Express train runs with B5 (blending 5% bio-diesel), which is supplied by IOC (Indian Oil Corporation). Also in Haryana state, the 20 State Transport buses use bio-diesel (Mehendale 2005). The ARAI (Automotive Research Association of India, Pune) certifies that the bio-diesel is environment friendly fuel (http://www.arai.org). Their results showed that emissions of bio-diesel reduce pollutants such as 65% of H &A (hydrocarbon and aldehydes), 47% CO (carbon monoxide), 36%

benzoflurothene, and 7% benzo-a-pyrene. This highlights the rate of air pollutants emitted from sugarcane transporting vehicles, and scope and potential of bio-diesel production by sugar industry for sustainable fuel generation.

A CASE STUDY OF SUGAR FACTORY

Maharashtra state is aggressive in sugar production. Presently 140 co-operatives and 14 private sugar industries run in the State. The sugar industry utilizes huge quantity of natural resources (Dhere & Pardeshi 2005) like diesel for transporting sugarcane from various fields to sugar industry. For the present work, Sonhira Shakari Sakhar Karkhana Ltd., Kadegaon, Dist. Sangli in Maharashatra state was selected for the case study. The sugar factory has cane crushing capacity of 2500 MT/day. The sugar factory collects sugarcane from Sangli, Satara, Solapur and Kolhapur district of Maharashatra and also some parts of Karnataka state (Table 1).

Fuel consumption: The sugarcane is basic raw material for sugar industry. The productivity of sugar industry is based on effective sugarcane transporting system (Dhere & Pardeshi 2005). The Sonhira Shakari Sakhar Karkhana Ltd. has 244 transporting vehicles (lorries and tractors), which consume 7,42,809 litres of diesel (Table 1). The average 2.89 L of diesel is utilized for transporting 1MT of sugarcane. The sugar factory collects and carries sugarcane over 2,500 ha of land. Among that 2041.33 ha sugarcane is carried by vehicles and rest of through bullock carts and labourers (Sonhira Shakari Sakhar Karkhana Ltd. 2005-06).

RESULTS AND DISCUSSION

The results of the study and the data collected are given in Tables 1-6. The sugar factory utilizes 7,42,809 litres of diesel for carrying sugarcane, which emits 6685.28 kg of CO (carbon monoxide), 24512.69 kg of NOx , 4456.85 kg of SO_2, 14,856.18 kg of hydrocarbons and aldehydes, 4531.13 kg of OC (organic carbon) and 11884.94 kg of particulate matter in the environment (Table 2). After considering the rate of diesel consumption and air pollutants generation, it is suggested that the bio-diesel has potential as alternate fuel and efficient for reducing pollution. Many research workers have analysed the potential of bio-diesel production in waste land of India (Chauhan et al. 2007). But this waste land is very important for growing urbanization, increased population, industrialization and allied developmental activities. Though, it is difficult to utilize all waste land for bio-diesel and it will have potential to produce only 12MT of bio-diesel (Bhardwaj et al. 2007). Therefore, it is growing concern that agroindustries meet the self fuel demand through bio-diesel production. If Sonhira Shakari Sakhar Karkhana Ltd. accept a policy for bio-diesel production, then it has huge potential. If the policy is made for 1% land under *Jatropha* cultivation, it will produce 28,470 L of bio-diesel, for 3% cultivated land by *Jatropha* will produce 85,260 L of bio-diesel, under 5% land cultivation by *Jatropha* will produce 1,42,000 L of bio-diesel, for 7% land cultivated with *Jatropha* will produce 1,98,915 L of bio-diesel, and for 10% *Jatropha* will produce 2,48,265 L of bio-diesel (Table 3). The cost of *Jatropha* cultivation is estimated to about Rs. 25,000-40,000 per ha (National Commission on Bio-diesel Report of Planning Commission, Govt. of India 2003), while cost of bio-diesel extraction and transesterification plant is Rs. 90,000-1,00,000 per tonne (Sheehan et al. 1998). The production cost of bio-diesel is Rs. 25 per litre (including taxes and duties) (Bio-diesel Purchase Policy, Ministry of Petroleum and Natural gas, Govt. of India 2006). This means that, bio-diesel use saves the cost. The B100 (absolute bio-diesel) fuel save 28.57% of cost and B20 (blending 20% bio-diesel) fuel save 5.71% of cost (National Commission on Bio-diesel Report of Planning Commis-

Table 1: Sugarcane transportation and diesel consumption.

S. No.	Zones	Sugarcane crop land (ha)	Production of sugarcane (MT)	Diesel consumption (Litres)	Diesel consumption (MT/L)
1.	Kadegaon	74	14,317	16,515	1.2
2.	Amnapur	73.17	8,019	15,400	2.0
3.	Kundal	108.6	13,362	25,675	2.0
4.	Tupari	218.7	24,800	47,675	2.0
5.	Peth Naka	123.9	11,777	6,200	3.7
6.	Bhilawadi	326.9	36,230	97,265	2.69
7.	Aashata	59.3	8,277	25,440	3.07
8.	Vita	97.96	12,183	37,480	3.07
9.	Shenoli Stn	138.2	18,838	36,225	2.4
10.	Wing	194.3	28,835	77,630	2.0
11.	Ojhewadi	114.3	15,721	36,270	2.4
12.	Rahimatpur	33.4	4,238	14,670	3.5
13.	Puse Sawali	6.1	789	2,440	2.9
14.	Udgaon	152	7,998	33,440	4.3
15.	Kurandwad	9.8	1,392	6,420	4.6
16.	Mahud	2.9	246	1,620	6.5
17.	Ruie	2.5	161	5,265	32.7
18.	Kolhapur	1.6	80	80	1.0
19.	Borgaon/Chikkodi(KN)	8.2	1,096	6,590	6.0
20.	Athani (KN)	63.3	9,388	64,950	6.9
21.	Haurgiri (KN)	8.2	1,020	7,020	6.8
22.	Shreepur	7.1	8,998	69,200	7.7
23.	Dighanchi	19.2	2,289	12,320	5.4
24	Phaltan	33.8	4,520	27,260	6.0
25.	Palus	137.4	18,726	36,000	1.9
26.	Other Places	26.5	3,759	3,759	7.0
	Average	2,041.33	2,57,059	7,42,809	2.89

KN - Karnataka state

Table 2: Air pollutants generated by transporting sugarcane.

Sl No.	Air pollutants	Generation rate*	Diesel utilised	Total air pollutant generated, kg
1.	Carbon monooxide (CO)	9	742.809	6685.28
2.	Oxides of nitrogen (NOx)	33	742.809	24512.69
3.	Sulphur dioxide (SO_2)	6	742.809	4456.85
4.	Hydrocarbons & aldehydes (H&A)	20	742.809	14856.18
5.	Organic acids	6.1	742.809	4531.13
6.	Particulate matter (PM)	16	742.809	11884.94

*kg/1000 L diesel burning

sion, Govt. of India 2003). If the sugar factory opts for B20 diesel for sugarcane transporting vehicles, then 1,48,565 L of bio-diesel is required with only 5% land under *Jatropha* cultivation. The B20 diesel will reduce air pollutants like H &A (1931.31 kg), CO (628.42 kg) and SO_2 (891.37 kg). The B50 will require 3,71,404.5 L bio-diesel which will reduce 4828.3 kg of H &A, 1571.04 kg of CO and 2228.43 kg of SO_2 (Table 6). If the sugar factory promotes its farmer members for compulsory cultivation of *Jatropha* crop and starts bio-diesel manufacturing unit then they will produce

Table 3: Air pollutants reduced by bio-diesel.

S. No.	Air pollutants	Rate of reduction
1	Hydrocarbons & aldehydes (H&A)	65%
2.	Carbon monooxide (CO)	47%
3.	Sulphur dioxide (SO_2)	100%

Table 4: Yield of biodiesel originated crops (Sheehan et al. 1998).

S. No.	Crops	Yield	
		Gallon/acer	L/ha
1.	Soybean	40	375
2.	Mustard	140	1,300
3.	*Jatropha*	175	1,500
4.	Palm Oil	650	5,800

Table 5: Potential of *Jatropha* production by sugar industry.

S. No.	Land allocation for bio-diesel	Land (ha)	Bio-diesel production L/ha*	Bio-diesel production L/ha
1.	1%	28.94	1,500	43,410
2.	3%	86.80	1,500	1,30,200
3	5%	144.67	1,500	2,47,000
4.	7%	202.54	1,500	3,03,810
5.	10%	289.34	1,500	4,34,010

* (Sheehan et al. 1998)

Table 6: Bio-diesel production potential and air pollutant reduction during transporting sugarcane.

Type of diesel	Bio-diesel requirement (Litres)	Air pollutant generation (kg)			Air pollutant reduction (kg)		
		H&A	CO	SO_2	H&A	CO	SO_2
B20	1, 48,561.8	12924.65	6059.87	3565.49	1931.1	628.42	891.37
B50	3, 71,404.5	10027.92	5144.24	2228.43	4828.3	1571.04	2228.43
B100	7,42,809	5199.64	3543.20	0.00	9656.52	142.1	4456.86

huge quantity of bio-diesel. The bio-diesel blends B20 and B50 will reduce dependency on diesel, saving on cost and minimize emission of air pollutants.

CONCLUSION

Sugar industry has huge scope for producing bio-diesel. If Sonhira Shakari Sakhar Karkhana Ltd., Kadegaon accept a policy of bio-diesel production, then it has huge potential. If the policy made for 1% land under *Jatropha* cultivation then it will produce 28,470 L of bio-diesel, and for 10% *Jatropha* cultivated will produce 2,48,265 L of bio-diesel. The B20 and B50 bio-diesel blends used for carrying sugarcane will reduce the air pollutants such as H&A (1931.31 kg and 4828.3 kg), CO (628.42 kg and 1571.04 kg), and SO_2 (891.37 kg and 2228.43 kg) respectively. This will minimise the global warming, ozone depletion and emissions of primary and secondary air pollution. The

bio-diesel production by sugar industry saves the cost of diesel and also minimizes diesel dependency which leads to sustainable development approach by agrobased industries.

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