

Managing The Environmental Pollution In Nepal: A Critical Study Of Nepalese Sugar Industries

Sadan Kumar Bhagat

Abstract : *Environmental pollution is a global menace and Nepal is by no means an exception to it. It is steadily growing and adversely affecting every life in the country. The reason for the increase in environmental pollution is in generally attributed to the development endeavour of nations, but in particular their increasing industrial activities are considered major source. This paper particularly deals with comprehending, describing and analyzing the environmental pollution created by sugar mills in Nepal and also probes into its management i.e. adequacy or inadequacy and effectiveness or ineffectiveness of the measures taken so far to control and mitigate its undesirable effects. Management in general has largely been insensitive and not proactive to resolve this hazardous issue. Hence, for effective management of environmental pollution in Nepalese sugar industry some appropriate measures have been suggested to improve the situation.*

I. INTRODUCTION

Industries are essential for economic development but the cost that human being pays in lieu of development is, of course, environmental pollution. Various industries are responsible for pollution and it is important to know the level of pollution created by a particular industry.

Pollution may be understood as an undesirable change in the environment. The detrimental effects of human activities can be health, comfort, convenience efficiency, aesthetics related and long-term effects on the balance of ecosystem and natural resources (Rajvaidya and Markandey, 1998:1). Growing population, intensive industrial development and diversification of human activities are the causes of environmental pollution. The environmental problems and development problems are closely related to one another. The process of development itself may bring in various environmental

problems such as depletion of natural resources, deterioration in the assimilative capacity of ecosystem, air, water and soil pollution, contamination and bioaccumulation of toxic material in environment, destruction of natural ecosystem, unplanned development of settlements with consequential effects, impact on health of the population, climatic influences with resultant effects on agriculture, water resources etc. There is no polite way to say that business is destroying the world (Hawken, 1993:3).

II. OBJECTIVES

The main objective of this paper is to comprehend the environmental pollution created by sugar mills in Nepal. According to Environment Protection Rules 1997, sugar mills require certificate of pollution control so it is worthwhile to comprehend the extent of pollution created by sugar mills and review the control measures adopted by them. Besides this, the other objectives are to identify the producers' and local inhabitants' view (who live around sugar mills) towards the environmental pollution if any, caused by the operation of factory and management's effort to mitigate it. It is also intended to suggest measures to manage and mitigate environmental pollution.

III. METHODOLOGY

At present, eleven large and medium scale sugar mills are registered in Nepal. For the purpose of this study, the population has been defined in terms of not only registration rather operation of large and medium scale sugar mills. Thus, population comprises of only eight operating sugar mills. Khandsari mills have been excluded in this study as they are very small and working irregularly. Among eight operating sugar mills, only following four sugar mills have been selected as samples on the basis of life of organization and production volume:

- a. Indu Shankar Chini Udyog Ltd., Hariwan, Sarlahi
- b. Lumbini Sugar Mills Ltd., Sunwal, Nawalparasi
- c. Sri Ram Sugar Mills Ltd., Garuda, Rautahat.
- d. Everest Sugar and Chemical Industries Ltd., Ramnagar, Mahottari.

To assess the opinion of local inhabitants regarding environmental pollution created by sugar mills a total of 32 persons were selected on the basis of judgmental sampling during FY 2007/08. The management and technical personnel of all selected four sugar mills were approached for opinion survey. Similarly, the views of local administration, politicians, social workers, farmers etc. were also studied. The research report is based on both primary data (opinion survey of local inhabitants, managerial and technical personnel of sugar mills and government officials, field survey etc.) and secondary data (available literature and reports on relevant topic, published data, unpublished official records and information of sugar producers). Considering the nature of the research it was decided to use questionnaire, interview & observation as primary research instruments, in order to develop better understanding of the phenomenon.

Analysis of this study is based on opinion survey, observation, field survey and reports given by sugar mills. Again, various research agencies' publications have also been reviewed.

IV. ENVIRONMENTAL POLLUTION

We know that every natural system on the planet is disintegrating. The land, water, air and sea have been functionally transformed into repositories for waste (Donovan, 2002:344). With the increase in industries, the industrial pollution is also increasing day by day in every country including ours. Outdated technologies are mainly responsible for generating large quantities of wastes. These wastes may be solids, liquids and gases.

The pollutants present in industrial wastewater are numerous in number and highly diversified in nature depending on the industrial process and raw materials used. The waste from the industries thus, contains various substances which may include the raw materials, intermediate products, co-products, by-products and processing chemicals. A major portion of industrial waste discharged by industries reaches either directly to river or indirectly through run-offs. Rest of it either goes underground or is treated through natural process. Industrial effluents being more complex are not easily biodegradable and the natural process of treatment in river may be difficult to assimilate this pollution. Many industries in Nepal discharge their effluents strength enough than the Ministry of Population and Environment (MOPE) industrial effluent standards directly and/or indirectly into land or small channel leading to the nearby rivers. Industrial wastes in most cases are directly discharged into local water bodies without treatment, spoiling the quality of the river water. The wastewater generally contains high load of oxygen demanding wastes, diseases causing agents, synthetic organic compounds, plant nutrients, inorganic chemicals, minerals and sediments (Sah, 2003:1-2).

During past few years, with the support of Environment Sector Program Support (ESPS)/ DANIDA, government had initiated cleaner production policy. But the overall outcome of that program was not significant as it was aimed to be at the cost of foreign investments. ESPS started up its activities in September 1999 in Nepal with the aim of strengthening the overall environmental management of the so-called "brown sector" i.e. the industrial and urban environment. Among the five different components, component 2: promotion of Cleaner Production (CP) in Industry worked with more than 50 industries all over Nepal. Through this work several hundred cleaner production options have been identified out of which several have already been implemented (Mikael, 2001: 50-54).

The second type of pollution created by industry is air pollution. The concept of air pollution has changed significantly during the past several decades. Many years ago, air pollution was only associated with smoke, soot and odors. But the concept of air pollution is comprehensive now. Again, air pollution is the presence of any substance in the atmosphere at a concentration high enough to produce an objectionable effect on human, animal, vegetation or materials, or to alter the natural balance of any ecosystem significantly. These substances can be solids, liquids or gases, and can be produced by anthropogenic activities or natural sources.

The air pollution is seen prominent into the nearby vicinity of the industries. In case of pulp and paler mills, in which rice husk is used as major energy sources. The residues after burning this husk are found to be dumped in nearby land closed to the village. The direct fall out of burned dust particles into the nearest village, the excess hurricanes and multidirectional flow of air during summer season carry away these burned materials far away and deposited on the roofs, drinking water, meals, surface of green vegetable plant leaves of the nearest communities' people. The eye irritation problems were experienced more frequently in these areas. In August 26, 2003, there were leakages of chlorine gas using for bleaching the pulp from Baba Pulp and Paper Industry, Sunsari caused serious health damages to residents of the nearby poor community of about 400 people. Mostly respiratory disease and eye related problems have been observed (Sah, 2003: 4-5).

V. ENVIRONMENTAL POLLUTION FROM SUGAR INDUSTRY

Sugar industries are pollution prone industries. The waste arising from sugar industries are due to spillages and passage of cane juice, molasses and sugar dust in drain during milling, concentration and centrifugal processes. It is reported that the effluent generated from the sugar industries gives rise to high BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), TDS (Total Dissolved Solid), PH (Hydrogen Ion Concentration), color etc., which adversely affect the environment and health. Despite these, most of the industries are still operating in a conventional way without any pollution prevention or control measures. The characteristics of effluent and tolerance limit for sugar industry proposed by Nepalese government (Ministry of Population and Environment) is presented in Table No.1.

Table 1 : Characteristics Of Effluent And Tolerance Limit For Nepalese Sugar Industry Proposed By Ministry Of Population And Environment, Nepal

Characteristics	Concentration/Quantity	Tolerance Limit
PH	4.0-5.1	5.5-8.5
Suspended solids (mg/l)	5,000	100
BOD (mg/l)	1,700-6,600	100
COD (mg/l)	2,300-8,000	250
Effluent (m ³ /T of cane processed)	1.2-1.5	-

Source: Deepak Kumar Singh, Baseline Study Report on Sugar Industries of Nepal, Environment Sector Program Support (ESPS), Kathmandu, Nov. 2002, p.17.

Sugar mills have several operating units and among them some are mainly responsible for pollution. Therefore, it is necessary to recognize those units and their impact on environmental pollution. Table No. 2 reveals environmental concerns of some selected unit operations in Nepalese large and medium scale sugar industries.

Table 2 : Selected Unit Operations And Environmental Concerns In Nepalese Sugar Industry

Selected Process	Inputs/Waste/Emission	Environmental Concerns
Mill house	Sugarcane: - Wastewater containing suspended solids and oil content. Washing from floor cleaning containing sugar. Bagasse	- Resource depletion and water pollution
Process house	Sugar juice: - Filter cake: washing of different components such as evaporator, juice heater, vacuum pan, clarifiers etc. generate aggressive effluents with high BOD ₅ , COD and TDS concentrations. Molasses	- Eutrophication of rivers, lakes - Risk of habitat alteration and impact on bio-diversity - Especially contribution to the global warming caused by emission of carbon dioxide (CO ₂) - Nuisance to neighbors
Boiler house	Bagasse and furnace oil: - Fly ash, smoke, flue gasses. Wastewater from scrubbers	- Resource depletion and air pollution - Especially contribution to the global warming caused by emission of CO ₂ , NO _x causes smog and PAH is carcinogenic. - Pollution of soil and water
Cooling pond	Water and chemicals: - Wastewater	- Resource depletion and water pollution
Distillery (Associated with sugar industry)	Molasses: - Wastewater (spillage) containing very high BOD ₅ , COD and suspended solids.	- Eutrophication of rivers, lakes - Risk of habitat alteration and impact on bio-diversity - Especially contribution to the global warming caused by emission of carbon dioxide (CO ₂) - Nuisance to neighbors

Source : Deepak Kumar Singh, Baseline Study Report on Sugar Industries of Nepal, Environment Sector Program Support (ESPS), Kathmandu, Nov. 2002, p.16.

VI. WASTES AND RISK IN SUGAR INDUSTRY

The wastes associated with cane sugar processing and refining include water and air pollution and the disposal of solid wastes. The huge amount of biodegradable organic wastes from the processing is a major concern. Sugar mill uses large quantity of sugarcane along with various chemicals, lubricants and a lot of water during production season. During production season sugar mills dispose wastewater which contains suspended solids, oil, aggressive effluents with high BOD₅, COD and TDS concentration. This wastewater creates water pollution. Its boiler house uses bagasse, firewood and furnace oil and chimney emits smoke along with dust. It generates air pollution by emission of fly ash, smoke, flue gasses and carbon dioxide. Ultimately it contributes global warming. Its by-product, molasses, created nuisance to neighbors. Similarly, its ancillary unit distillery disposes spent wash with high BOD₅, COD and suspended solids which affect rivers, lakes, ground water, soil, habitants and bio-diversity negatively. Following three types of wastes are produced during the production of sugar:

a. Solid Waste

Two types of solid wastes, i.e. bagasse and press mud are produced during the production of sugar. Bagasse is produced in the mill house in a quantity of about 30 percent of the crushed cane. The bagasse contains 50 percent moisture. Press mud or filter cake is produced in vacuum filters. The mud is produced in a range of 3-8 percent of the crushed cane, depending upon the nature of sugar production process. The mud contains nearly 75 percent of moisture. On dry basis mud contains about 70 percent organic matters and about 29 percent minerals.

Press mud is usually used by nearby farmers as manure although in some cases its application as manure is preceded by bio composting. In few cases brick manufacturers are also using this mud either to mix with clay or directly as fire retainer in kilns. Bagasse is used as fuel for boilers. It is estimated that 70 percent of the power requirements of sugar mill is fulfilled in this way. Everest Sugar and Chemical Industries Ltd., Ram Nagar, Mahottari has plan to supply excess generation of electricity in national grid during production season of sugar. Bagasse is also used for paper manufacturing (by other manufacturers). In the case of Everest Sugar and Chemical Industries Ltd., Ram Nagar, Mahottari it supplied excess bagasse to its sister concern Everest Paper Mills P. Ltd., Mahendranagar, Dhanusha for paper manufacturing. Besides these, certain amounts of solid wastes are also generated from workshop, defective parts and packing materials.

b. Liquid Waste:

Effluent from sugar industry has high ammonium content. Wastewater streams result from cane washing, floor washing, boiler blow down, condensate cooling water, filter washing, bearing and engine cooling water. Most waste streams contain high BOD load. The wastewater may contain pathogens from contaminated materials or production processes.

c. Air Emission:

A sugar mill often generates odor and dust, which need to be controlled. The major source of air pollution in sugar mill relates to boiler emission. Boilers are operated under three different conditions: fuel oil only, bagasse only and mixed fuels (fuel oil and bagasse). The choice of fuel source significantly changes the emissions mix. Carbon-dioxide, water vapour and particulate matters are added to atmosphere from fuel burning. Burning of sulphur in the sulphur furnace for sulphitation also adds sulphur dioxide- gases. Small, fugitive emissions result from juice fermentation; uncondensable gases from the evaporation stage; and sulphurous vapours released from the sulphitation process.

About 5.5 kg. of fly ash per metric ton of cane processed (or 4,500 mg/m³ of fly ash) are present in the flue gases from the combustion of bagasse. Most of the sugar mills use horizontal multi-vortex axial flow multi cyclones for arresting fly ash in the flue gas. The efficiency of cyclones is very low in the order 30-50 percent since mills employ centrifugal type dust collectors. This practice is unsound because the stack has to be operated under pressure and the efficiency of the dust collectors rarely exceeds 20 percent. However, continuous attention of the mills is required for efficient utilization of these installations.

VII. SUGAR PRODUCERS' VIEW REGARDING ENVIRONMENTAL POLLUTION AND ITS MANAGEMENT

One of the objectives of this research was to elicit the view of sugar producers regarding environmental pollution and its management. The management of four selected sugar mills was approached to know their view in this regard.

Indu Shankar Chini Udyog Ltd., Hariwan, the operating oldest sugar mill of Nepal, argued that it had plant and system to control pollution created by mill. It had installed dust catcher in chimney and constructed lagoons to store and treat wastewater. It accepted to dispose wastewater in the nearby river but only after proper treatment in anaerobic lagoon. Although its anaerobic lagoon effluent treatment system was traditional so there was question of its efficacy. It had further plant to establish wastewater recirculation plant so that water pollution could be reduced.

The management was in favor of building public relation so that resentment of society could be reduced to some extent as sometimes local people complained about noise and odor pollution. In this context, it constructed underground pipeline up to the bank of river for the disposal of wastewater. It provided financial assistance to hospitals, local schools, village development committees and local community.

Lumbini Sugar Mills Ltd., Sunwal adopted Anaerobic Lagoon System to treat wastewater and spent wash. After effluent treatment in lagoons it was disposed to nearest Turia River. After 2006 it was handed over to private entrepreneur however, the management of sugar mill did not show much concern to build public relation for the reduction of nuisance to neighbors.

Further, Everest Sugar and Chemical Industries Ltd., Ramnagar had also adopted Anaerobic Lagoon System of effluent treatment and constructed five ponds (lagoons). The management was of the view that the mill was not polluting environment immensely. It reused wastewater and finally water was disposed in lagoons for treatment. Out of five constructed lagoons only one or two lagoons were filled during production season. Hence, there was no need of disposing water outside from sugar mill. The management of sugar mill further argued that chimney was already equipped with dust collector so air pollution was also minimal. Although it accepted to face complaints from local people for odor and flow of dust from muddy road due to frequent movement of sugar cane loaded vehicles, bullock carts in production season of sugar.

Sri Ram Sugar Mills Ltd., Garuda was the only sugar mill in Nepal which had successfully used two stage Anaerobic Digestion Process for the effluent treatment. Management held that Anaerobic Digestion System was one of the most effective treatment plant practices for the effluent of the sugar and distillery plants. The management further opined that it had planned to install modern filter in the chimney of boiler. Although, management accepted that sometimes local inhabitants complained for disposed so called polluted water, odor and dust of bagasse mixed in air. The management of Sri Ram Sugar Mills Ltd. had complaint against the policy of government. It successfully established a separate plant in distillery unit to produce ethanol, environment friendly fuel, from by

product (molasses) as a partial (15 to 20 percent) substitution of costly imported petrol. However, due to non-response and lack of commitment from government, it could not commence commercial production of ethanol. The usage of ethanol will be a step in the reduction of environmental pollution and import substitution of foreign oil (petrol). In Nepal, 101911 kilolitres petrol was consumed in FY 2006/07 (MOF, Economic Survey, 2008: 88). If 20 percent ethanol would be mixed, Nepal had to import 20382 kilolitres less petrol in that fiscal year.

VIII. LOCAL INHABITANTS' VIEW LIVING AROUND SUGAR MILLS

Several inhabitants living around sugar mills expressed common problems regarding environmental pollution created by the mills. Most of them complained about noise, odor of molasses and spent wash of distillery. They observed that mostly sugar mills directly disposed wastewater in the nearby drain or river, which ultimately enter into their farm through irrigation and ground water. As a result, it had negative impact on soil, yield in farm production, inhabitants and bio-diversity. During production season dust of bagasse mixed in air. The boiler house uses bagasse, firewood and furnace oil so chimney emits smoke along with dust. It generates air pollution by emission of fly ash, smoke, flue gases and carbon dioxide. Burning of sulphur in the sulphur furnace for sulphitation also adds sulphur dioxide gases. They felt irritation to eyes, asthma and respiratory problems during production season of sugar. Children and old age inhabitants mostly felt this problem. Skin problem was also noticed in some cases who live very close to sugar mills. The local people had complaints about noise and flow of dust from muddy roads due to frequent movement of sugarcane-loaded vehicles, bullock carts during production season of sugar.

Some people had lodged complaints in local administration regarding the environmental pollution and nuisance created by sugar mill but they accepted that local administration did not take proper action and it was always in favor of sugar producers. However, they accepted that sugar mills helped to repair road, drainage, culverts, bridges and assisted health posts, local community, schools and provided charity for social development. The local community took this positively. Besides these, they perceived economic development of sugarcane growing farmers, labors, transporters and direct employment of local people in the sugar mills.

IX. CONCLUSION

Sugar mills are pollution prone industries. The waste associated with cane sugar processing and refining included water and air pollution and the disposal of solid wastes. However, the major waste arose in sugar mills due to spillages and passage of cane juice, molasses and sugar dust in drain during milling, concentration and centrifugal processes. The effluent generated from the sugar mills gave rise to high BOD, COD, TDS, PH, colour etc., which adversely affected the environment and health. Similarly, bagasse dust, fly ash and high noise levels were also health irritants, because excessive exposure to fly ash and bagasse dust caused irritation to eyes, asthma, and other respiratory diseases.

A major portion of industrial waste discharged by sugar mills either reached directly to river or indirectly through run offs. Rest of it either went underground or treated through natural process. In fact, industrial effluents were not easily biodegradable and the natural process of treatment in river might be difficult to assimilate pollution. Out of four sampled sugar mills only Sri Ram Sugar Mills Ltd., Garuda had proper treatment plant of spent wash and wastewater. It successfully used two stages Anaerobic Digestion Process (ADP) for the treatment of wastewater and spent wash of sugar mill and distillery plant first time in Nepal, which was one of the most efficient Effluent Treatment Plant (ETP). It was cost effective and energy saving too. Rest of the sugar mills were operating in conventional way (lagoon system) without effective pollution prevention or control measures.

The strategies of environment protection in general are source reduction, recycling and reuse, treatment and disposal, but most of the Nepalese sugar mills used treatment and disposal strategies. They faced complaint from local inhabitants against noise, odor, fly ash, mixture of bagasse dust in air and disposal of polluted water in nearby rivers, agricultural land and soil.

X. SUGGESTIONS

Agro-based industries are backbone for the rapid development of agricultural country like Nepal. Agriculture alone is insufficient for rapid development of the country. There must be a combination of agriculture with business (Bhagat, 2008:1). Sugar industries are major agro-based industry and it is the best combination of agriculture and business. Hence, its presence is a must and side by side the negative impact of industry in environment should be minimized as far as possible. There should be recognition among senior management about awareness of environmental issues. Management should take account of environmental impacts in their decision-making, as part of being a good corporate citizen and as part of good business sense (Medley, 1997:598). The following suggestions can be considered to mitigate the health hazard and environmental pollution:

1. The strategy of wastewater management in sugar mill should be that of reuse instead of disposal. After proper treatment the wastewater should be used in less important usage like irrigation, gardening, cleaning etc. It will reduce the consumption of water resources.
2. The waste materials can be reduced with improved technology, better house keeping and good management practices. The preventive approach concentrates on resource conservation, waste minimization and recovery and reuse of wastes to the extent possible through the technology known as clean technology.
3. For the safety of workers, management should consider their health hazards and risks. Dust prone areas should be carefully monitored, nuisance dust levels should be controlled properly and workers should be instructed to use textile masks over the nose and mouth. Protective masks should be provided to those

- persons working in bagasse station, sulphur furnace and those places where toxic gasses are released.
4. Modern and improved filter should be installed in boiler's chimney, because all sugar mills have been running with traditional chimney, which is not efficient to catch fly ash and control air pollution.
 5. For the proper treatment of effluent of sugar mill and distillery unit, all sugar mills should be encouraged to adopt Anaerobic Digestion System like that of Sri Ram Sugar Mills Ltd., Garuda. The success of this effluent treatment system and its economic viability should be encouraged and assisted so that it will become a model demonstration plant for other sugar mills in Nepal. The traditional lagoon system is not considered efficient as Anaerobic Digestion System which produces useful methane gas as an end product and it can be used to burn boiler and generate steam/electricity.
 6. The pollution control certificates should not be provided on ad-hoc basis, rather it should be granted as per the provisions of Environment Protection Act /Regulations only after environmental examination of all the pollution resources and laboratory analysis. The government should strictly implement penalty provision to regulate industries, which are responsible for discharging pollution. Step should be taken to fully comply with the government standard to prevent environmental pollution.
 7. The government should encourage (through providing incentives) sugar producers to adopt pollution control measures. Further, bank and financial institutions should be encouraged to provide loan facility at cheaper rate of interest for the purchase of pollution control plants/equipments.
 8. The commercial production of ethanol (an environment friendly fuel) should be commenced as soon as possible. The domestic production of ethanol and its usage in petrol consumption will be an advance step in the reduction of environmental pollution and partial import substitution of foreign oil (petrol) which is scarce and costly both.
 9. Old and obsolete plant and machinery should be replaced with latest one and amendment should be done in production process especially considering the reduction in environmental pollution.

REFERENCES

- Bhagat, S.K. (2008). Marketing of agro-based products in Nepal (with special reference to cigarette and sugar). Unpublished Ph.D. thesis, Faculty of Management, Tribhuvan University.
- Donovan, G.O. (2002). Environmental disclosures in the annual report-extending the applicability and predictive power of legitimacy theory. *Accounting, Auditing and Accountability Journal*, Vol. 15, No.3.
- Government of Nepal (2008). Ministry of Finance. *Economic Survey FY 2007/08*. Kathmandu:GON.

- Hawken, P.(1993). The ecology of commerce. New York: Harper Collins.
- Medley, P.(1997). Environmental accounting - what does it mean to professional accountants? *Accounting, Auditing and Accountability Journal*, Vol. 10. No. 4.
- Mikael, M.(2001). Air quality management in Kathmandu valley. *Environmental, A Journal of the Environment*.
- Parajuly, S. and Dorfman, M.(1998). An agenda for industrial awareness. Kathmandu: Forum for Protection of Public Interest.
- Rajvaidya, N. and Markandey, D.K. (1998). *Environment Measurement: Concept and Approach*. Vol. 5.
- Sah, R.C.(2003). Compliance monitoring of industrial effluent standards in Nepal. *Paper presented* in 6th Sustainable Development Conference, Islamabad.
- Singh, D.K.(2002). Baseline study report on sugar industries of Nepal. *Study Report*, Environment Sector Program Support. Kathmandu.