Wastewater Disposal at Sugar Factories

A Status Report

by

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ABSTRACT

The Sugar Industry has been working assiduously to comply with the environmental standards set by the National Environment and Planning Agency (NEPA). For most factories, this has been an uphill task, mostly due to financial constraints.

An evaluation of the wastewater quality and disposal practices at sugar factories over the period 1998 to 2001 was done. Waste water samples were collected at three different periods during the crop year and Pollution Control reports submitted to NEPA as stipulated. The major parameters examined as set out in the Trade Effluent Standards include the Biological Oxygen Demand (BOD₅), Chemical Oxygen Demand (COD), Temperature and pH. The paper also discusses prevention and control measures that could move the industry towards compliance and ultimately a cleaner sugar industry.

Results obtained to date, indicate that some factories have made improvements in their wastewater quality and disposal practices while others are yet to show any improvement.
Introduction
Most waste water from sugar cane processing is not toxic, yet harmful to the environment at higher levels of biological oxygen demand. This is due to the carbohydrate content and the products of their decomposition. Organic substances discharged into water (rivers, streams, ponds) are decomposed by micro-organisms which use large quantities of oxygen. As a result the levels of dissolved oxygen into the water are reduced and thus affect the breeding of fish and the ecological equilibrium of the receiving medium. Waste water from sugar processing also contains oil solids, caustic and acid. All of these products cause severe non-biological contamination of the receiving waters.

On land, the use of residual water or by-products for irrigation must be strictly controlled and used according to the requirements of the crop and the soil, and not as a means of waste disposal. With proper management, environmental impacts can be negligible. Wastes in general that results from the processing of sugar cane are generally putrescible organic materials which have the potential for utilization and reuse.

The Pollution Control Programme
The Sugar Industry Research Institute has been working with the factories to become compliant with the Natural Resources Conservation Authority (NRCA) Act which was made into law in July 1991. The Act gives the NRCA, now a part of NEPA, the power to:

- Monitor and regulate (by means of permits) the type and number of establishments that can be developed in any particular area in Jamaica (Section 9);
- Require that Environmental Impact Assessments be prepared, and submitted to the NEPA, by the development of interest in order that a permit or licence can be granted (Section 10);
- Licence the discharge of trade and sewage effluent (Section 12)
- Issue cessation orders for an activity that does not comply with NEPA’s requirement (Section 13);
- Carry out measures to prevent pollution (section 16);
- Request information to be provided by any polluting development, including proposals to remedy the problems (Section 17);
- Issue enforcement notices requiring steps to be taken to cease a polluting activity (Section 18);
- Make regulations for the purpose of giving the provisions of the Act (Section 38).

The Sugar Industry Action Plan was developed out of the need to comply with these regulations. The plan outlined, on a step by step basis, specific areas to be tackled and completion dates for each area. A major aspect of the plan was to provide NEPA with information on the Pollution Control Monitoring Programme at three different periods for the crop year, namely the beginning, ending and out-of-crop periods. Wastewater samples were collected at identified sample points at each factory and analysed. The results were then sent to each factory; a Pollution Control Data Form was completed; and the completed form submitted to NEPA.

Establishment of Environmental Committees at Factories
Another important aspect of the programme was the establishment of factory level environmental committees which were responsible for carrying out certain important functions relative to the programme. These were:

- Identify all sources and volumes of waste generated at the factory.
- Development of flow diagrams; maps of factory drains and wastewater disposal system to include wastewater sampling points.
- Investigate water supply and usage with the aim to utilize the commodity efficiently.
- Implement health, safety, and industrial hygiene programmes.
- Provide the NEPA with information on pollution control monitoring.
- Develop an Emergency Response Plan.

**Achievements by Factory Level Committee**

- Of the eight sugar factories only two have quantified, to a certain degree of accuracy, the amount of wastewater being emitted from their sites.

- Five factories have developed and submitted flow diagrams of factory drains including the wastewater sampling points.

- Only two factories have seriously done any investigation into their water supply and usage. Worthy Park has been practising the recycling and reuse of their water throughout the factory. Frome is presently considering the installation of an automatic valve to control the washing of canes. This is with a view to reduce the use of raw water for cane washing and hence the amount of pollution to the Dutch Canal.

- Most factories have in place an active health and safety committee which is working to improve the safety aspects of their operations.

- All factories have been providing the NEPA with information on their pollution control monitoring programmes.

- Two factories, Frome and Appleton have received approval from the Office of Disaster Preparedness and Emergency Management (ODPEM) for their Emergency Response Plans. Other factories are yet to submit the document for approval.

**Results of Waste Water Monitoring Programme**

The results of wastewater samples done during the processing of sugar cane indicated that factories were still out of compliance with some aspects of the trade effluent standards. Parameters such as the BOD, COD, TSS, fecal coliform and total coliform far exceed the required standard at most of the factories. However, in most instance parameters such as oil and grease, sulphate, pH and temperature were usually within acceptable limits. As expected, the results for the out-of-crop period were usually within the specifications except in a few cases where the pH values were high due to washing of vessels. It must be pointed out that the samples collected are grab samples and not a composite of the total flow. The off season
BOD and COD values were very low as expected and in some case zero. In the off season, the flow of water was negligible at some factories, hence a representative sample could not be collected. (See tables 4, 5, & 6).

**Prevention and Control Measures Implemented at Factories**

Some factories have made significant progress in terms of putting in certain control measures to reduce the levels of pollution in their wastewater. We will look at the individual factories and outline some of the control measures put in place.

**Worthy Park**

Pollution control measures such as the recycling and reuse of water were instituted at Worthy Park. It is said that necessity is the mother of invention. Due to the scarcity of raw water at this particular estate, the selective washing of canes was done.

During the 1999 out of crop period Worthy Park carried out certain modifications to their system to recycle and reuse the water from the vacuum pan booster pumps and also from three boiler-feed water heaters. The total amount of water recycled and reused in the 2000/2001 crop year stood at 76.94 percent. Other measures included the following.

1. Replacement of the head box vapour ports of an evaporator in order to reduce entrainment.
2. Replacement of a defective condenser baffle of a vacuum pan to prevent entrainment to the spray pond.
3. Repaved the No.3 mill imbibition sump area thus eliminating juice leaks into the spray pond.
4. Increasing the height of the concrete wall situated at the Work Shop side of the spray pond thus eliminating contaminants from getting into the spray pond.
5. Modification of the sides of a filter press spreader to reduce spillages.
6. Modification of the filter press overflow trough to eliminate spillages from the filter agitator arm.

Worthy Park made the decision that as of the 2000 crop year the washing of burnt canes would not be done during the dry season. This was on condition that there was no significant impact on steam generation, clarification and filtration.

**Frome**

Frome has been working over the years to reduce the pollution potential of their wastewater to the environment. In recent years there has been more cries from the Big Bridge Community for the factory to clean up their act. Since the past four years there has been more and more dialogue with the community and a working relationship has been developed between the factory and the community to deal with the problem. There has been a concerted effort in recent times to dredge the Dutch Canal and to flush the Carbaritta River. In 1996, a 500m³ demonstration anaerobic sludge bed reactor was installed at Frome. This plant however could only treat approximately 3% of the total wastewater from the factory. Based on a 1999 report on the plant by the Scientific Research Council the COD removal for the crop year 1996/97 and 1997/98, was 81 and 72 percent, respectively. This translated into an average COD reduction from 682 mg/l to
127 mg/l (1996/1997) and 360 mg/l to 101 mg/l (1997/1998). It could therefore be deduced from the results of the Demonstration plant that a full-scale anaerobic treatment plant could reduce the levels of COD to acceptable limits within the trade effluent standards. Guards were also placed at mills to prevent spillage at the mills since the sumps that were built to recover spillage were abandoned due to increased efforts to control dextran. Mild steel tanks were replaced with stainless steel tanks at the mills to lessen the chances of leaks due to rot. A 120,000 lbs/hr suspension type boiler is now being installed and it is hoped that due to the additional steam generation, the washing of canes (in the dry season) will be reduced. Frome has also placed oil traps in place to recover any oil that may be spilt from the mills or boiler area. Waste oils are usually stored and then burnt in the furnaces.

**Appleton**

Appleton has embarked upon a series of modification and automation to their factory with the aim of increasing production, production efficiency and ultimately to reduce pollution to the environment. During the 2000/2001 sugar crop, a project was launched to pipe all the effluent from the distillery to an aeration pond to be used as a fertilizer for cane fields. This has resulted in a drastic reduction of approximately *80%* the COD values from that waste stream. Other measures included the installation of a 250,000 lbs/hr, suspension type boiler which it is hoped will eliminate the washing of canes.

**Bernard Lodge**

Some control measures have also been put in place at Bernard Lodge. All sugar spillage is recycled back into the system. The cane wash water now goes into a settling pond which eventually is used for surface irrigation of cane fields. The overflow from the spray pond is also used for irrigation. Waste oil is stored in drums and most of it is used on cane field intervals to control marl dust.

**Monymusk**

All of the cane wash water at Monymusk goes into a settling pond and then used for irrigation of cane lands. A sump in the boiling house is used for the recovery of massecuities, molasses, or sugar. The spillage is then sent to a remelt tank and put back in the process.

**Long Pond**

Most of the water sent to the cooling tower is recycled and reused in the factory. A concerted effort has been made to correct all leaks in the factory and to cut back on spillage. Plans to repair major drains and install oil traps to recover oil spills are subjected to the availability of funds.

**Hampden & St. Thomas Sugar Factories**

Nothing significant was done at these factories due to lack of resources of one kind or the other. Factories however were aware of the necessary measures that needed to be put in place at their facilities.
Pollution Prevention and Control Methods

**Reduction at Source**
A significant source of waste water loading is due to **poor housekeeping practices**, involving spills of sugar and molasses and **poor maintenance of machinery and equipment**, which also contribute to oil and grease contamination of the effluent. The cost of effective, in-plant control is negligible when compared to the costs of effluent treatment and production losses.

**Recycling and/or By-Product Recovery**
Just about 10% of the sugarcane harvested can be processed into commercial sugar. Furthermore, it is said that for every tonne of cane processed about twenty tonnes of water is needed. Thus, recycling and reuse of process water and residuals are very important both for the protection of the environment and for the overall profitability of operations.

**Waste Separation**
It is important to establish good water management with as recycling of the process water as possible. The separation of waste streams with a low BOD load from streams with a high BOD load is vital. Only a few of the sugar factories separate their waste streams in a systematic way. Ways in which this can be done are:

- Excess condensate water does not need any treatment because of its low pollution load and can be separated from other streams.
- Cooling water for mill bearings contains mineral oils and should not be mixed with other waste streams before passing through an oil separator (this can be made at the wok shop). This water can then be recycled.
- The acid and caustic waste resulting from the cleaning of vessels must be kept separated from other wastes, stored and released gradually by blending with the general effluent. Some factories store their spent caustic for regeneration and reuse.
- Vacuum condenser streams are too large for economical treatment. Entrainment channels should be installed to prevent any contamination of this waste stream.

**By-Products**
In almost all factories, by-products are recovered for industrial use, for animal feeding and for fertilizing.

*Boiler and fly ash*
Boiler ash and fly ash can be used as a basic fertilizer. The average quantity produced is about 0.3% of the weight of cane.

*Filter mud*
About 30 - 35 kg of filter mud are produced per tonne of cane. Filter mud consists of 80% water and 0.9 to 1.5% sugar. It can be spread directly on cane fields or stored for later use as a soil conditioner. Filter mud has a large BOD load.

**Residual Water**
The residual water from cane sugar operations has a high organic content and nutrients and is thus considered a valuable bio-fertilizer. In areas where water is scarce, cane sugar effluent can be used for irrigation. This however must follow strict control depending on the soil requirements and must also comply to irrigation standards.

**Some practical recommendations**

**General Points**

✔ Check cooling water systems and condensers to establish what water is not being recirculated. Study ways to recycle this water.

✔ Check all glands, flanges, valves, pipes and pumps for leaks and implement immediate repairs.

✔ Clean all drains (and remove all collected deposits) both inside and outside the factory as at least once per week. Do not allow water to become stagnant in the drains.

✔ Replace floor washing at different stations within the factory with dry cleaning methods. This can be done by sprinkling water on the floor (if necessary then applying bagasse. The bagasse used for cleaning should then be burnt in the boilers.

✔ Do not allow any overflow to mix with the effluents. The use of open drains is preferred and a dry cleaning system is recommended for the last stages of the process.

✔ Isolate the molasses and magma pumps and the final molasses tank with parapet walls to prevent leakages and overflow. Use bagasse to clean it.

✔ Install grease and oil traps on both the cooling water outlet from the mill bearings and on the main factory drain.

**Conclusion**

There has been an increase awareness by factories of the need to preserve and to protect the environment in which they operate. Some factories have been working despite the financial constraints to implement control measures to reduce the pollution potential of their waste water. Factories in that depends heavily on irrigation must fully explore the option to utilize the waste water for that purpose. However, much more needs to be done in terms of tighter process controls, proper house keeping and a greater commitment by Management to give pollution control the serious attention it requires.