SUGAR INDUSTRY AND ENVIRONMENTAL CHALLENGES

By

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Abstract

Increasing Environmental constrains as outlined in Environmental laws requires Sugar Industry to consider improvement in water management and effluent discharge. Although the Environmental Laws are also applicable on gaseous emissions and solid waste management but at present the real challenge is about effluent discharge. This is more important for Sugar Mills having Distilleries attached with them. After 18TH amendments in the Constitution Environmental issues are handed over to Provincial Governments. It is to point out that out of three provinces having Sugar Industry SEPA is most active probably due to Judicial Commission(Water Commission) .

The Workshop being held today is more important as the Sugar industries in Sindh are required to install Environmental Treatment Plants at the start of crushing season 2019-20. It is therefore responsibility of the Industry to come up with a workable plan to combat the effects of environmental degradation within time limit.

- Mills that are not in a position to install plants should jointly take legal opinion about the possible consequences (Contempt of Court).
- Besides this, one of the major challenges is to clear the misconception about level of environmental threat by sugar industry. Recently SEPA has asked Mills having their discharge in LBOD to be more particular about their discharge as the Government of Sindh intends to utilize water available at LBOD for Thermal Power Stations at Thar. In fact only five sugar mills discharging their effluent in LBOD during season. The major pollution comes from Municipal Waste.

Introduction

Sugar Industry is one of the most important Agro-based industries in Pakistan and has significantly contributed to Countries Economy. Sugar Industry is among the country's leading economy enterprises, directly or in-directly employing a large segment of population in rural areas.

- In the absence of adequate pollution control measure such a large operation brings with it the potential for environmental and health concerns. However sugar industry being seasonal having operation from 100-120 days/year, has minor impact on environment. In real sense sugar industry is an environmental friendly industry but this requires careful operation.

The environmental impact is more significant in case of Distilleries; as their effluent tends to be the biggest polluter. The results of their effluent discharge are alarming.

In view of characteristics of Effluent the Distilleries are placed in A category while Sugar Industry in B category . Table 1&2

- After awareness of the issue many Sugar Mills have successfully controlled the quantity and of effluent discharge. Studies are carried out by the industry for reduction on waste water/effluents parameters which are harmful for environment like pH, COD, BOD, TSS, TDS etc.

Table I

Schedule I

Classification of industrial units for liquid Effluents

Category "A"

- Chlor – Alkali (Mercury Cell)
- Chlor – Alkali (Diaphram Cell)
- Metal finishing and electroplating
- Nitrogenous fertilizer.
- Phosphate fertilizer.
- Pulp and paper.
- Pesticides formulation.
- Petroleum refining.

- Steel industry.
- Synthetic fiber.
- Tanning and leather finishing.
- Textile processing.
- Pigments and dyes.
- Thermal Power Plants (oil fired and Coal Fired)
- Rubber Products.
- Paints, Varnishes and Lacquers.
- Pesticides.
- Printing.
- Industrial Chemicals.
- Oil and Gas production,
- Petrochemicals.
- Combined effluent treatment.
- Ethanol Distilleries.
- Any other industry to be specified by Federal or Provincial Agency.

Category "B"

- Dairy Industry.
- Fruit and vegetable processing.
- Glass Manufacturing.

Sugar.

- Detergent.
- Photographic.
- Glue manufacture.
- Oil and Gas exploration.
- Thermal Power Plants (Gas Fired)
- Vegetable oil and ghee mills.
- Woolen Mills.
- Plastic materials and products.
- Wood and cork products.

- Any other industry to be specified by federal or Provincial Agency.

Category "C"

- Pharmaceutical (Formulation) Industry.
- Marble Crushing.
- Cement.
- Any other industry to be specified by Federal or Provincial Agency.

Major Environmental Challenges

As pointed out the major challenges are to control quantity and characteristics of Effluent. The water scarcity has further necessitated the re-use of effluent water .The real challenge is to properly incorporate the disposal of effluent in such a way that it does not contribute any problem regarding environmental degradation and pollution.

PHYSIO-CHEMICAL CHARACTERISTICS OF WASTE WATER

Now we will have a look at the physio-chemical characteristics of effluent and their impact on environment.

COLOUR:

Color is a qualitative characteristic that can be used to assess the general condition of waste water. Waste water that is light brown in colour in initial stage will turn into dark brown or black in presence of higher COD and BOD. Waste water that is dark brown is very important factor for aquatic life for making food from sun rays. The Photosynthesis activity is found to be reduced due to dark coloration also affect plant germination and other parameter like Temperature, DO and BOD etc.

TEMPERATURE:

The Effluent temperature plays an important role in making an effect on certain chemical and biological reactions taking place in water, which effects organism and inhabitation of aquatic media. The high temperature water discharged from factory also effects the land and the germination process. Solubility of dissolved oxygen also depends on temperature at specific atmospheric pressure.

pH (Potential of Hydrogen):

The pH value of waste water is between 5.5 to 7 in normal conditions which timely vary when C. Soda and acids drained to the waste water channel .This variation effect the rate of biological reactions , survival of various microorganisms and quality of soil.

B.O.D (Biological Oxygen Demand):

Biochemical Oxygen Demand (BOD, also called Biological Oxygen Demand) is the amount of dissolved oxygen needed (i.e. demanded) by biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period. Biological Oxygen Demand is an important water quality parameter because it provides an index to assess the effect discharged wastewater will have on animal and plant life. The higher the BOD value, the greater the amount of organic matter or "food" available for oxygen consuming bacteria. Higher BOD has adverse effect on Dissolved Oxygen in water.

D.O (Dissolved Oxygen):

The D.O has very important role in waste water control. Its presence is essential to maintain variety of biological life in water. The solubility of atmospheric oxygen in fresh water ranges from 14.6mg/l at 0C to about 7.0 mg/ at $35^{o\ c}$. According to standards the D.O should be in between 4 to 6mg/Ltr. The untreated effluent has 1.2 mg/Ltr, which is sufficiently lower then standards.

C.O.D (Chemical Oxygen Demand):

Chemical oxygen demand (COD) is a measure of the capacity of water to consume oxygen during the decomposition of organic matter and the oxidation of inorganic chemicals. COD values are always higher than the BOD values. Because COD includes both biodegradable and non-biodegradable substances whereas BOD contains only bio-degradable. If the BOD/COD ratio for untreated wastewater is 0.5 or greater, the waste is considered to be easily treatable by biological means. If the ratio is below about 0.3, the waste may have some toxic components and acclimated microorganisms may be required in its stabilization.

T.D.S (Total Dissolved Solids):

Total Dissolved Solids (TDS) is a measure of the combined **total** of organic and inorganic substances contained in a liquid. This includes anything present in **water** other than the pure H20 molecules. These **solids** are primarily minerals, salts, and organic matter that can be a general indicator of **water** quality. High TDS in effluent would have adverse impact on aquatic life and agricultural lands.

T.S.S (Total Suspended Solids):

The Total Suspended Solids effects the intensity of water suspended solids is the cause of suspended particle inside the water body influencing turbidity and transparency. Higher T.S.S values can decrease in soil porosity due to salt deposition.

Oil and Grease:

The concentration of dispersed oil and grease is an important parameter for water quality and safety. Among other pollutants oil and grease is one of the most complicated pollutant to remove. The presence of Organic toxic waste (oil and grease (O&G)) causes ecology damages for aquatic organisms plant, animal, and equally, harmful for human being. They form a layer on water surface that decreases dissolved oxygen. O&G layer re around microbes in suspended matter and water. They are also responsible of clogging of pipes .

Table III

Priority Parameters for Monitoring of Liquid Effluents for Category B

S. No.	Industry	Priority Parameters for Normal Plant Conditions to be Reported on a quarterly Basis
1	Dairy Industry	Effluent Flow, Temperature, pH, BOD, TSS, TDS, Oil and Grease
2	Fruit and vegetable processing	Effluent Flow, Temperature, pH, BOD, TSS, COD
3	Glass Manufacturing	Effluent Flow, Temperature, pH, TSS, COD, Oil and Grease
4	**Sugar**	**Effluent Flow, Temperature, pH, BOD., TSS, COD, Oil and Grease**
5	Detergent	pH, COD, Oil and Grease, An-ionic Detergent
6	Photographic	pH,COD, Silver, Cyanide, Fluoride
7	Glue Manufacture	BOD, COD, pH.
8	Oil and Gas Exploration	Effluent Flow, Temperature, pH, COD, TSS, TDS, Oil and Grease, Chloride, BOD, Phenolic compounds.

These parameters as reported by sugar mills for untreated effluent in Pakistan are as follows

Table 4

Pollutant	unit	Raw effluent	NEQS Standards
Chemical oxygen demand (COD)	mg/l	1800-5040	150
Biochemical Oxygen demand (BOD)	mg/l	720-1110	80
Oil and grease	mg/l	20-55	10
Total suspended Solids	mg/l	325-1500	200
Total dissolved Solids	mg/l	2000-3000	3500
pH		5-8	6-9

Indian regulations also have limits on the quantity of effluent discharge Table 5.

S.No	Industry	Parameters	Standards
1	2	3	4
	SUGAR INDUSTRY	EFFLUENTS	All concentration values are in milligrams per litre except for pH
		pH	5.5 - 8.5
		Total Suspended Solids (TSS) milligrams per Litre	100 (for disposal on land) 30 (for disposal in surface waters)
		Biological Oxygen Demand	100 (for disposal on land)

BOD[3 days at 27o C] milligrams per litre	30 (for disposal in surface waters)
Oil & grease milligrams per litre	10
Total Dissolved Solids (TDS) milligrams per litre	2100
Final waste water discharge limit	200 litre /tonne of cane crushed
(Final treated effluent discharge restricted to 100 litres per tonne of cane crushed and waste water from spray pond overflow or cooling tower flow to be restricted to 100 litre per tonne of cane crushed and only single outlet point from unit is allowed.)	

Comparison of Effluent Discharge Standards. Table: 6 A

	India		Pakistan		Bangladesh		Srilanka		Turkish	
	Inland surface water	Land of Irrigation			Inland surface water	Land of Irrigation	Inland surface water	Land of Irrigation		
pH	5.5- 9.0	5.5 – 9.0	6-9		6-9	6-9	6.0 - 8.5	5.5-9.0	6.9-9	
BOD	30	100	80		<50	<100	30	250		
COD	250	....	150		<200	<400	250	400	450	
TSS	100	200	200		<150	<200			<80	
TDS	2100	2100	3,500		<2,100	<2,100	50	2100		
Temperature	N1	....	40		<30	<30				
Oil & Grease	10	10	10		<10	<10	10	10		

N1 5 above receiving body

Standards for effluent discharged to public water in some other countries. Table: 6 B

	COD	BOD	pH	°C	Oil	SS
Australia		20	6.5-8.0	1*		30
Colombia		200	6.0-9.0	40		
Indonesia	200	30	6.5-8.5		1	175
Jamaica	100	30	6.5-8.5	37	10	50
Mauritius	100		6.0-9.0	40	10	60
Philippines	100	50	6.5-8.5	3*	5	70
Reunion Island	125	30	5.5-8.5	30	10	35
South Africa	75		5.5-9.5	35	5	25
Thailand		60	5.0-9.0	40	5	30

- Above receiving body temperature.

Actions Required

PAKISTAN is inching towards a serious water crisis as per capita water availability is falling due to diminishing freshwater supplies and the increasing demands of our growing population. Pakistan began in 1947 with 5,650 cubic meter per capita fresh water annually, the 2017 census data changes the water availability equation altogether making our annual per capita fresh water around 850 cubic meters; it puts us in seriously water-stressed countries' basket. As per international standards (<500 m3 per year per capita) means water scarcity and under "stress" conditions means (between 500 and 1000 m3 per year per capita).

- Fortunately sugar industry is blessed with the 70% water contents in sugar cane. Judicious utilization of this available water and proper management practice can reduce water intake, effluent flow and its pollution load.
- As the cost of the treatment plant depends on these factors.

✓ Pollution Load.

✓ Quantity of Effluent Discharged.

- The first step is to control the above parameters to minimum .Many Sugar Mills have successfully completed this exercise. In a paper published in *Proceedings of the International Society of Sugar Cane Technologists*, volume 29, 2016" Managing sugar-mill liquid effluent to zero discharge, a case study of Mehran Sugar Mills Limited "Mr. Sanaullah[1], Mr.Sharif Khan[2] and Mr. Maren Mogal have discussed regarding results achieved at Mehran Sugar Mills. Since other authors will be discussing this topic I will not go in its detail. Mr. Muneeb Sr. Mechanical Engineer will also present his paper on Water Conservation Practices Adopted at Sanghar Sugar Mills**.**

- **Effluent Treatment.**

The main object of effluent treatment is that its disposal does not create any environmental hazard. The effluent from sugar mills is non toxic and mainly biodegradable. This makes its treatment a feasible proposition. The most appropriate wastewater treatment to be applied is that

- It will produce an effluent meeting the recommended microbiological and chemical quality guidelines in compliance with NEQS.
- Cost effective (both capital and recurring costs).

- Low energy usage.
- Simple to apply/ easy to manage.
- Globally accepted as feasible/sustainable & scientifically tested approach.
- Diversified income generation options (co-benefits)
- Socially/aesthetically acceptable.
- Rehabilitation of natural resources/conservation.
- Locally available Back up services after its installation.
- Conventional wastewater treatment consists of a combination of physical, chemical, and biological processes and operations to remove solids and organic matter from wastewater. Generally treatment is done in different stages given as under:

- **Primary.**

In primary treatment coarse screening, grit removal, flow equalization, sedimentation or dissolved air floatation are used to remove suspended solids .Oil skimmers collect oil & grease. Equalization of pH and temperature is done in equalization tank. Primary treatment is necessary to enhance the operation and maintenance of subsequent treatment units.

- **Secondary Treatment**

Secondary treatment depends on the pollution load of effluent discharge Following methodologies are applied for treatment of sugar mills effluent.

- Bioremediation is a waste management technique, that involves the use of organisms (biological/bio-technological methods) to remove or neutralize (any type of) pollutants. Since sugar industry effluent is easily biodegradable therefore all biological treatments (Anaerobic and aerobic) treatment process are suitable.
- Physio-Chemical Methods
- Adsorption.
- Membrane Treatment.
- Evaporation.
- Electro Chemical
- I will only briefly discuss MVR based Evaporators which have recently used in India.
- As already pointed out above Biological Treatment can be categorized as

- Anaerobic. This takes place in an environment from which Oxygen removed. In case of COD loading above 2000mg/ liter it is used in combination of Aerobic treatment. The key to successful treatment is to maintain a high enough of population of microorganism constituting the active Biomass. A number of steps take place in the system.
- Volatile organic acids are produced in first step . In second step these organic acids are transformed into acetic acid and Hydrogen by acetogenesis. In third step they are converted into methane and CO2by methanogens. This step require a healthy population of methanogens otherwise the acid concentration increases and pH drops. Anaerobic treatment alone does not meet discharge standards and further treatment is necessary.
- Aerobic This is done in the presence of Oxygen. This uses addition of Oxygen to develop a biological culture to breakdown the organic contamination in the effluent. It is most efficient when operated with inflow COD below 2000mg/liter. The Oxygen requirements are roughly 0.5 to 1.5/kg of BOD. The common practice for this treatment is to utilizes Activated Sludge or Constructed Wetlands.
- Activated sludge process requires aeration tank or reactor where the organic pollutants are consumed by bacteria as a source of food. The oxygen need of bacteria in the aeration is provided by surface jet aerators. Nutrient needed by bacteria is provided a nutrient dosing system. The activated sludge is settled and separated from treated effluent in clarifier .

  Part of this sludge is recycled for treatment of effluent and part is removed to keep the sludge age young and efficient to allow the new bacteria to populate.
- A constructed wetland or 'wet park' is an artificial lake created for treatment of waste-water using specialized consortia of select plant species and micro-organisms (lab grown/isolated).This process utilizes Sub-Surface Constructed Wetlands and Free Water Constructed Wetland. Biological chemicals dissolved in tanks keep the Oxygen at desired level for Aerobic Treatment.
- Physio-Chemical Methods .
- Evaporation. Mechanical Vapor recompression is employed for evaporation of Effluent in using Falling Film Type Evaporator to recover clean water by concentrating waste water and reducing its volume .Condensate will be cooled by exchanging its heat with incoming feed through heat exchanger.

- **Tertiary Treatment .**

The effluent water is chlorinated for disinfection and filtered with press/ sand filters or activated carbon for removal of color, micro-suspension and odor.

CONCLUSION

- It is our national responsibility to conserve water by reducing water consumption and pollution load.
- Mills should select the treatment process that is economically viable and meet NEQS standards.
- As seen from the quality parameters there is scope revision of NEQS in Pakistan.

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Literature reviewed

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Notification G.S,R New Dehli 14th January 2016.

SEPA S.R.O 528

Performance and Evaluation of Sugar & Distillery Efluent treatment plant. Prof. Chidanand patil 1, Dr. P.B. Kalburgi2,Ms. Mugdha Ghorpade3

Quality of Management of Wastewater in Sugar Industry

Pradeep Kumar Poddar. Omprakash Sahu

Managing sugar-mill liquid effluent to zero discharge, a case study of Mehran Sugar Mills Limited

Sanaullah[1], Sharif Khan[2] and Maren Mogalle[3]

Category "B"

Sugar

- Textile

- Choloralkali plants.
- Dairy industry.
- Fruits and vegetables.
- Metal finishing and electroplating.
- Boilers, Ovens, furnaces and Kilns (gas fired)
- Any other industry to be specified by Federal or Provincial Agency.

Category "A"

- Cement.
- Glass manufacturing.
- Iron and Steel
- Nitrogenous fertilizer.
- Phosphate fertilizer.
- Oil and Gas production.
- Petroleum refining.
- Pulp and Paper.
- Thermal Power Plants (Coal and oil based)
- Boilers, ovens, furnaces and Kilns (coal and oil fired)
- Bick-Kilns (firewood and bagasse based)
- Any other industry to be specified by Federal or Provincial Agency.

GEL Pvt Ltd

GASEOUS EMISSION TEST REPORT	GEL/FO/FF/510/11 Revision #: 00 ISSUE #: 05 ISSUE DATE: 15/08/2018

Report Reference No: GEL/LAB/3747-D/665/1218 Reporting Date: 29/12/2018

Name of Customer : Sanghar Sugar Mills Limited

Address: 13KM, Sanghar/Sindhri Road Deh Kehore, Sanhgar, pakistan Fuel Used : Baggas

Source: Boiler No 4

Date of Analysis: 25/12/2018

S.No	Parameter	Unit	SEQS Limit	Result	Method
1	Carbon monoxide (CO)	mg/Nm3		520	Testo t350xl
2	Sulphur dioxide (SO2)	mg/Nm3		BDL	Testo t350xl
3	Combined oxide of nitrogen (Nox)	mg/Nm3		289.05	Testo t350xl
4	Smoke	Ringlmann		<1	Ringlmann scale
5	Particulate Matter	mg/Nm^3	.....	40	BS 1747: II : 1969

SEQS = Sindh Environmental Quality Standards
This report is not valid for any negotiations
BDL= Below detectable Limit.

Approved By G.M. Field Operations

End of the Report

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