SUGAR INDUSTRY AND ENVIRONMENTAL CHALLENGES

By

Zahid Mahmood Qureshi

General Manager

Layyah Sugar Mills, Limited

Pakistan Sugar Industry

- Sugar Industry is supporting national economy
- Playing key role in socioeconomic development of society & country
- Sugar Industry is facing serious issues of sustainability & opportunities
- Low & fluctuating profits have created barrier on growth & investment

Challenges for Sugar Industry

- Global climate change
- Industrial waste water pollution
- Urban and Industrial air pollution
- Resource degradation
- Threats to health and prosperity
- Food laced with pesticides
- Urban & Industrial growth
- Regulatory challenges from GOP
- Motor vehicles emission

Impact of Waste Water of Sugar Industry

- Industry is generating effluents & gaseous emissions
- Effluents is hazardous, damaging & degrading the environmental eco system
- High levels of pollutants and serious threats to environment
- BOD, COD, TSS, pH is higher than NEQs

Threats from EPA Punjab

- Notices from EPA to Sugar Mills
- EPA Punjab had meeting with PSMA Punjab & Sugar Mills in October 2018
- Invited time lines and action plan to meet PNEQs
- Local capabilities and consultancies are not upgraded
- High Capex required to meet NEQS/PEQS

Threats for Sugar Industry

The Standard's principles and indicators address the three pillars of sustainability

Food for though for Sugar Industry

- Whether NEQs or PEQs are realistic
- PSST & PSMA needs to dialogue with EPA & GOP to make business sustainable and free from fear for industry
- Sugar Industry also needs to address to EPA to revise the NEQs & PEQs

Guidelines for Effluent Reduction

- Factory water balance be conducted
- Baseline effluent study be performed
- Composite sampling & analysis of waste water be conducted
- Compare the results with NEQs or PEQs
- Action plan be designed and implement

Implementation on flow reduction

- Awareness and training of team on RRR approach

- Maintenance quality standard improvement to control the leakages
- Task force formation for monitoring and control of waste water
- Adoption of Reduce, Reuse, Recycle approach
- Hourly and daily reporting on effluent flow

Waste Water Management

Waste water management encompasses a broad range of efforts that promote effective and responsible water use,

Treatment, disposal and encourage the protection of watersheds

Reduce

- Some relatively clean wastewater can be reused without treatment
- Gray water is wastewater generated by washing, laundry and bathing (not from toilets)
- 50 – 80% of domestic wastewater
- Reused for irrigation or flashing toilets

Reuse

- Wastewater can be treated (on-site or off-site) and reused for nondrinking purposes
- Closed loop treatment system are often used to capture, treat and reuse wastewater on site
- Wastewater reclamation involves treating the wastewater and using it for different purpose

Recycle

- Wastewater is transported to an (on-site or off-site) treatment facility, treated and discharged into water body.
- These treated water can be discharged and reused. Which can be used for watering in gardens or other washing purposes

Final Drain Effluent Results

Table 2: Results for PH

pH	Unit	Final Drain Effluent Results						PEQS
		Day 1 (11:00-22:00)	Day 1 (23:00-10:00)	Day 2 (11:00-22:00)	Day 2 (23:00-10:00)	Day 3 (11:00-22:00)	Day 3 (23:00-10:00)	
	pH Unit	4.62	4.62	5.17	4.75	5.21	6.75	06-09

Table 3: Results for BODs

BODs	Unit	Final Drain Effluent Results						PEQS
		Day 1 (11:00-22:00)	Day 1 (23:00-10:00)	Day 2 (11:00-22:00)	Day 2 (23:00-10:00)	Day 3 (11:00-22:00)	Day 3 (23:00-10:00)	
	mg/1	1824	1699	1720	1170	1955	1011	80
						AV = 1563		

Table 4: Results for COD

COD	Unit	Final Drain Effluent Results						PEQS
		Day 1 (11:00-22:00)	Day 1 (23:00-10:00)	Day 2 (11:00-22:00)	Day 2 (23:00-10:00)	Day 3 (11:00-22:00)	Day 3 (23:00-10:00)	
	mg/1	4800	4360	4460	3172	4980	2590	150
						Av = 4063		

Table 5: Results for TDS

TDS	Unit	Final Drain Effluent Results	PEQS

		Day 1 (11:00-22:00)	Day 1 (23:00-10:00)	Day 2 (11:00-22:00)	Day 2 (23:00-10:00)	Day 3 (11:00-22:00)	Day 3 (23:00-10:00)	
	mg/1	1695	1458	2517	1847	2938	3173	3500
						AV = 2271		

Table 6: Results for TSS

TSS	Unit	Final Drain Effluent Results						PEQS
		Day 1 (11:00-22:00)	Day 1 (23:00-10:00)	Day 2 (11:00-22:00)	Day 2 (23:00-10:00)	Day 3 (11:00-22:00)	Day 3 (23:00-10:00)	
	mg/1	540	788	684	510	1160	430	200
						AV = 685		

Table 7: Results for Settelable Solids

Settleable Solids	Unit	Final Drain Effluent Results						
		Day 1 (11:00-22:00)	Day 1 (23:00-10:00)	Day 2 (11:00-22:00)	Day 2 (23:00-10:00)	Day 3 (11:00-22:00)	Day 3 (23:00-10:00)	
	mg/1	3	2.2	2.6	2.3	2.5	2.0	

Table 8: Results for TS

TS	Unit	Final Drain Effluent Results						
		Day 1 (11:00-22:00)	Day 1 (23:00-10:00)	Day 2 (11:00-22:00)	Day 2 (23:00-10:00)	Day 3 (11:00-22:00)	Day 3 (23:00-10:00)	
	mg/1	2235	2246	3201	2357	4098	3603	

Table 9: Results for TVS

TVS	Unit	Final Drain Effluent Results						
		Day 1 (11:00-22:00)	Day 1 (23:00-10:00)	Day 2 (11:00-22:00)	Day 2 (23:00-10:00)	Day 3 (11:00-22:00)	Day 3 (23:00-10:00)	
	mg/1	1243	1218	1986	999	2400	1464	

Table 10: Results for Oil & Grease

Oil & Greases	Unit	Final Drain Effluent Results						PEQS
		Day 1 (11:00-22:00)	Day 1 (23:00-10:00)	Day 2 (11:00-22:00)	Day 2 (23:00-10:00)	Day 3 (11:00-22:00)	Day 3 (23:00-10:00)	
	mg/1	25	20	18	12	36	22	10.00
						AV = 22.16		

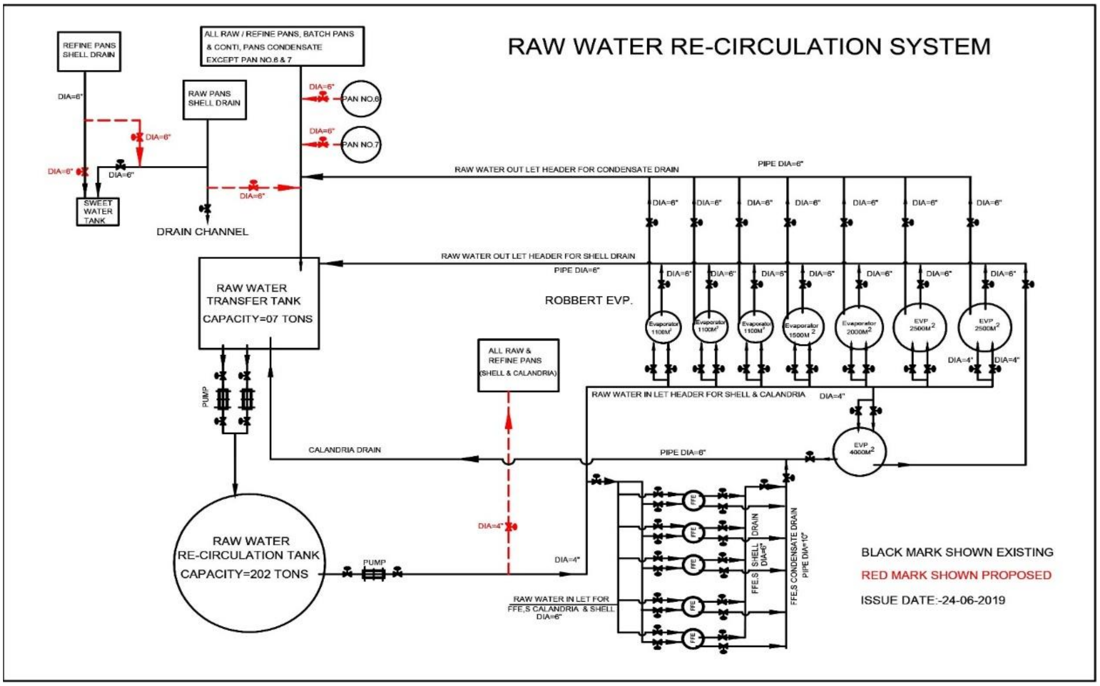
Table 11: Results for TKN

TKN	Unit	Final Drain Effluent Results						
		Day 1 (11:00-22:00)	Day 1 (23:00-10:00)	Day 2 (11:00-22:00)	Day 2 (23:00-10:00)	Day 3 (11:00-22:00)	Day 3 (23:00-10:00)	
	mg/1	6.98	13.36	6.98	5.16	8.20	9.26	

Table 12: Results for Free Ammonia Nitrogen

Ammonia	Unit	Final Drain Effluent Results						PEQS
		Day 1 (11:00-22:00)	Day 1 (23:00-10:00)	Day 2 (11:00-22:00)	Day 2 (23:00-10:00)	Day 3 (11:00-22:00)	Day 3 (23:00-10:00)	
	mg/1	6.07	BDL	BDL	BDL	BDL	BDL	40.0
BDL: Below Detection Limit								

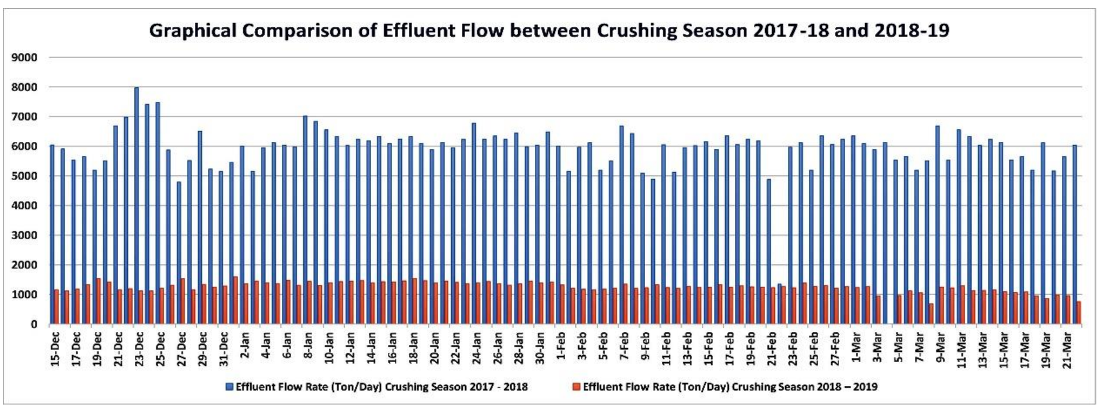
Waste Water Control Practical Plan



Control of Oil & Grease

- Major source of contamination in sugar industry is bitumen based mill lubricant at mill house
- Use of very high viscosity synthesized lubricant at mill house
- Quantity was reduced to 1/5 as compared to sugar mill oil
- No health & safety hazard
- No environmental risk
- Oil skimmers be made effective

LSM Experience on Waste Water Control

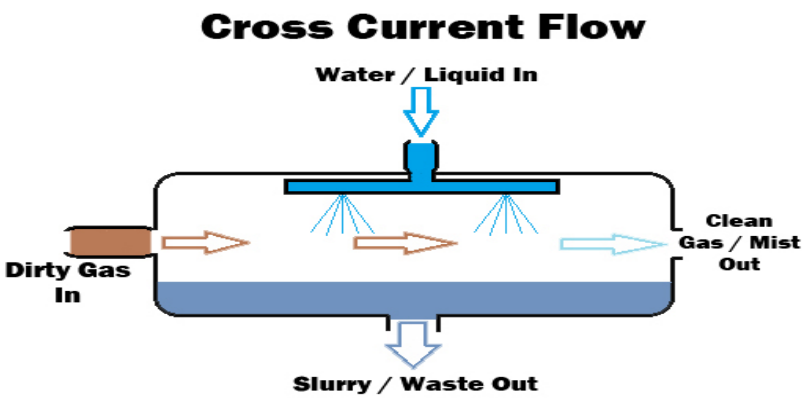


Guidelines for Emission Control

- Dust collectors be improved
- Addition of wet scrubber. This is low cost solution for sugar industry
- Installation of Electrostatic Precipitators ESP on boilers to conform to NEQs
- Installation of fibre filters on boilers

WET SCRUBBERS

- **Principle**
  - Wet scrubbers are used for removal of particles which have a diameter of the order of 0.2 mm or higher.
  - Wet scrubbers work by spraying a stream of fine liquid droplets on the incoming stream.
  - The droplets capture the particles
  - The liquid is subsequently removed for treatment.
- **Construction and Operation**
  - A wet scrubber consists of a rectangular or circular chamber in which nozzles are mounted.
  - The nozzles spray a stream of droplets on the incoming gas stream
  - The droplets contact the particulate matter, and the particles get sorbed.
  - The droplet size has to be optimized.



ELCTROSTATIC PRINCIPLE :-

An **electrostatic precipitator** (ESP) is an device that removes dust particles from a flowing gas (such as air) using the force of an induced **electrostatic attraction** (i.e, like charges repel; unlike charges attract)

Electrostatic precipitators are highly efficient filtration devices that allow the flow of gases through the device, and can easily remove fine particulate matter such as dust and smoke from the air stream.

PRINCIPLES OF ELECTROSTATIC PRECIPITATOR

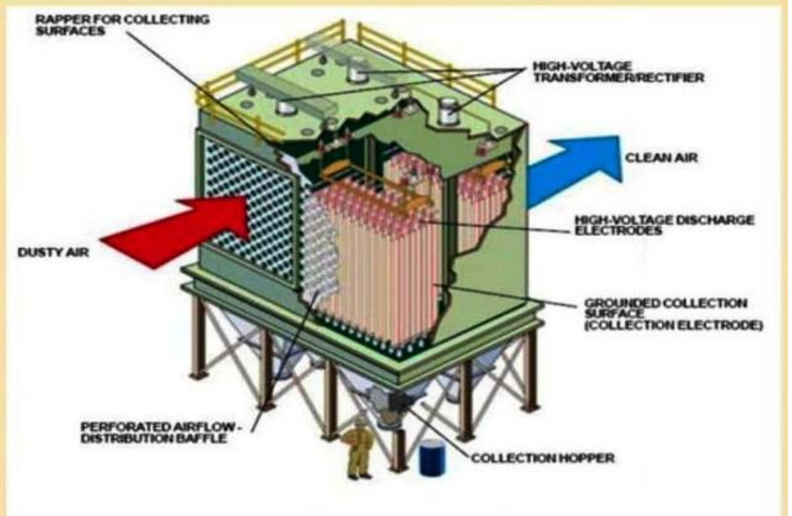
Electrostatic precipitation is a method of dust collection that uses electrostatic forces, and consists of discharge wires and collecting plates.

A high voltage is applied to the discharge wires to form an electrical field between the wires and the collecting plates, and also ionizes the gas around the discharge wires to supply ions.

When gas that contains an aerosol (dust, mist) flows between the collecting plates and the discharge wires, the aerosol particles in the gas are charged by the ions. The Coulomb force caused by the electric field causes the charged particles to be collected on the collecting plates, and the gas is purified.

This is the principle of electrostatic precipitation, and Electrostatic precipitator apply this principle on an industrial scale.

ELECTROSTATIC PRECIPITATOR (ESP)



Sectional View of an Electrostatic Precipitator

MANAGING SUGAR-MILL LIQUID EFFLUENT TO ZERO DISCHARGE, A CASE STUDY OF MEHRAN SUGAR MILLS LIMITED

By

Sanaullah

Matiari Sugar Mills Limited

Javed Sher Bukhari

Mehran Sugar Mills Limited

MSM Journey for Environmental Conservation

INTRODUCTION

- Sugar mill liquid effluents, containing high levels of pollutants, are a threat to our environment.
- Though there are stringent rules and regulations for control of effluents. very few mills are currently addressing these issues. Environment control authorities are now strict for the compliance.
- Usually when the disposal of polluted effluent is not an issue or management is less concerned about the adverse environmental effects of discharging highly polluted effluent, effluent levels are high due to negligence.
- Typically sugar mills generate effluents at the rate of 0.5 – 0.7 tons/tons cane.
- Management of MSM realized the adverse effect of generating polluting effluents and, considering its corporate social responsibility, decided to reduce the effluent flow and COD levels and then treat it to meet the National Environmental Quality Standards (NEQS).
- Mehran Sugar Mills Limited (MSM) started a campaign of reducing the quantity of its liquid effluents and their pollutant parameters in year 2012.
- This paper describes the methodology, implementation, discussions and results of effective EMP and ETP at MSM.

METHODOLOGY

- The cost of an ETP for the base case effluent flow and pollutant concentration was about USD 1.7 million, year (2012). The base case effluent data are given in Table 1.
- As a logical strategy, it was decided to reduce effluent flow and COD levels to the minimum, by improving manufacturing practices and other innovative solutions, before installing any effluent treatment plant (ETP).

Pollutant	Unit	Factory raw effluent data (Base case)(2012-13)	NEQS standard
Effluent discharge flow	m^3/day	6116	-
Chemical oxygen demand (COD)	mg/L	2980	≤150
Biological oxygen demand (BOD)	mg/L	1100	≤80
Oil and grease	mg/L	50	≤10
Total suspended solids	mg/L	1375	≤200
pH	-	5-8	6-9

- A team was constituted, consisting of members from the mechanical, electrical, instrument, health safety and environment (HSE), laboratory and management departments headed by the Process Manager.
- The team prepared a detailed Effluent Management Plan (EMP) for reducing the effluent flow and its pollutant concentration.
- Given that expenditure needed to be utilized for other important projects, the EMP was phased from 2012-2018.
- The object was to reduce effluent flow to a minimum possible value from 6116 m^3/day with reduced COD, to reduce the cost of the ETP, and to meet NEQS standards.
- An additional object of the EMP was to simultaneously reduce canal water requirements for the mill. All projects were initiated relative to their impact on effluent flow and pollutant concentration.

- **Effluent flow reduction**
  - Sugar cane is a unique crop in that it brings all the elements required for sugar manufacturing along with the sugar,
    - ✓ Fiber for energy production
    - ✓ Water for processing
  - Because the cane supply comprised about 70% water and less than this was required for mill operations, we developed the idea to replace canal water with cane water for all of the sugar-manufacturing processes.
  - Ideally, there is no need for additional water if cane water is utilized properly.
  - The following methodology was adopted for reducing the effluent flow:
    - ✓ A water balance of the plant was carried out.
    - ✓ A list of water consuming and draining points was prepared. This was important to know the sources of canal water usage and water draining to effluent.
    - ✓ A list of all the municipal/sewage water points, including bathrooms, toilets and kitchen waters of the factory, was prepared for separate disposal to the nearby town's municipal drain.
    - ✓ The philosophy of 4 R's (Reject, Reduce, Reuse and Recycle) was adopted for conservation of effluent.
  - Water balance of the plant was developed for all the inflows and outflows. The basic equation of the factory water balance is:

- Water In = Water out
- Water In = Water in Cane + Water from other sources (canal/ground water)
- Water Out = Water out from factory through product, by-product, evaporation + effluent.

Water In		**Water Out**		
Source	**Quantity (t)**	**Source**	**Quantity (t)**	**%**
Cane	**6,927**	**Evaporation through spray pond**	**2,732**	**42.87**
		Water in bagasse	**1,588**	**24.92**
		Evaporation from boilers	**1,000**	**15.69**

		gas scrubber		
		Water in filter cake	195	3.06
		Evaporation from juice flash tank	149	2.34
		Evaporation from boiler blow-down	115	1.80
		Evaporation through steam leakage	112	1.76
		Water in boiler ash	100	1.57
		Evaporation through soda boiling	100	1.57
		Evaporation at mills	100	1.57
		Evaporation through NCG Steam	82	1.29
		Evaporation from molasses storage tank	50	0.78
		Water in molasses	17	0.27
		Evaporation from sugar dryer	16	0.25
		Evaporation through vertical crystallizer cooling tower	16	0.25
		Sugar	1	0.02
		Total	6373	100
Canal/Ground Water	5,562	Effluent Water*	6116	
Total Water In	12,489	Total Water Out	12,489	

Effluent flow reduction

- Following Table describes the water balance of the plant (10,000 TCD) for the base-case season of 2012-13.

  * Factory municipal effluent is included.

- The water balance of the factory showed that the amount of water carried into the factory through cane exceeds the amount of water that exits from the factory through products, by-products and vapors. Ideally, only surplus cane water should be the part of effluent. There was only 554 m^3/day (6927-6373=554) surplus cane water, whereas effluent generation was about 6116 m^3/day.

- This indicated inefficient utilization of cane water and unwanted use of canal water for process or drainage of water in effluent.
- If canal water is used for process, the condensate will be in surplus by the same amount.
- The canal water intake quantity was calculated to be 5562 m^3/day.
- A list of water-consuming areas with their water sources was prepared to quantify and identify water consumption and its source.
- This list also identified the areas of water draining to effluent. it is attached with paper as Table-1.
- To maintain the required sanitation standards, washing of house floors is required and this surplus cane water could be used there. Condensate water, which is cane water (if no canal water is used in process), could be efficiently utilized for process operations
- The following innovative solutions have been successfully implemented at MSM for problematic areas to replace canal water:
    - Mills imbibition water. After heat recovery of process condensate water (through condensate juice heater) it was used for mill imbibition. The temperature of this condensate was reduced to 65°C, which is considered ideal for mill imbibition. Canal water used for imbibition was replaced with cane water.
    - Boiler blowdown water. This water, which is high in solids and could not be used for processing, was sprayed onto dry fly ash from the mechanical ash collectors of the boilers. The quantity of blowdown water was reduced by improving process condensate quality. Suitable de-entrainment devices were installed at the evaporators to improve the condensate quality.
- All the surplus condensates were cooled at a cooling tower and this cooled condensate was used for following applications:
    - All the process chemicals were prepared using this condensate, replacing canal water usage.
    - Canal water used for sealing water of Nash vacuum pumps was replaced with cold condensate. This water, after the Nash pump, was collected and pumped to mill house for imbibition.