INDUSTRIAL POLLUTION & MANAGEMENT

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INDUSTRIAL POLLUTION & MANAGEMENT

Industries are generally divided into six groups on the basis of their wastes:

1. Food and drugs
2. Apparels
3. Materials
4. Chemicals
5. Energy
6. Nuclear power and radioactive

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1.Foods and Drugs

- Canned goods
- Dairy products
- Brewed and distilled beverages
- Meat and poultry products
- Animal feedlots
- Beet sugar
- Canned sugar
- Pharmaceutical products
- Yeast
- Pickles
- Coffee
- Fish
- Rice
- Soft drinks
- Bakeries
- Water production
- Agriculture
- Palm oil

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2. Apparel

- Textiles
- Leather goods
- Laundry trades
- Dry cleaning

3.Materials

- Pulp and paper
- Photographic products
- Steel
- Metal-plated products
- Iron-foundry products
- Oil fields and refineries
- Fuel oil use
- Rubber
- Glass
- Naval stores
- Glue manufacturing
- Wood preserving
- Candle manufacturing
- Plywood manufacturing
- Metal container
- Petrochemicals
- Cement
- Wood furniture
- Asbestos
- Paints and inks

4.Chemicals

- Acid
- Detergents
- Cornstarch
- Explosives
- Pesticides
- Phosphate and Phosphorus
- Formaldehyde
- Plastics and resins
- Fertilizer
- Toxic chemicals
- Mortuary
- Hospital and research laboratory
- Chloralkali wastes
- Organic chemicals

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5.Energy

- Steam power
- Scrubber power plant waste
- Coal processing

6. Nuclear power and radioactive material

Apparel

Industries	Origin of major waste	Main Characteristics
Textiles	Cooking of Fibres Desizing of fabric	Coloured, highly alkaline, High BOD, temperature & Suspended Solids.
Leather Goods	Unhairing, Soaking,deliming & bating of hides	High solid, Cr, Salt, hardness, sulphides, pH, Precipitated lime, BOD.
Laundry Trades	Washing of fabrics	High turbidity, alkalinity & Organic solids.
Dry Cleaning	Solvent cleaning of Clothes	vapours

Food and Drugs

Industries	Origin of major waste	Main Characteristics
Canned goods	Trimming, culling, juicing & blanching of fruit & vegetable	High suspended, colloidal and dissolved suspended solids
Dairy Products Organic	Dilution of whole milk, separated milk, buttermilk, whey	High in dissolved matter mainly protein, fat, lactose
Brewed & distilled beverages	Steeping & pressing of grain; residue from alcohol distillation; condensate from stillage vaporation	High in dissolved organic solid, having N2 & fermented starch or their products
Meat & poultry products	Stockyard; animal slaughtering, bone & fat rendering, condensed residues, washing	High in dissolved and suspended organic solid, blood, protein, fat
Animal feedlots	Excreta from animals	High in suspended organic solid and BOD

Materials

Industries	Origin of major waste	Main Characteristics
Pulp and paper	Cooking, refining, washing of fibres, screening of paper pulp	Variable pH, colour, high suspended & dissolved solid, inorganic filters
Photographic products	Spent solution of spent solution of developer and fixer.	Alkaline, having organic & inorganic reducing agent
Steel	Coal coking, washing of blast furnace and pickling of steel	Low pH, acid, limestone, phenol, ore, coke, alkali, oil, fine suspended solid
Metal-plated product	Stripping of oxides, cleaning and plating of metals.	Acid, metal, mineral water
Iron-foundry product	Washing of used sand by hydraulic discharge	High suspended solid mainly sand, some clay & coal
Oil field & refineries	Drilling mud, salt, oil, some natural gas; acid sludge and oil refining	High dissolved salt from field; high BOD, odour, phenol & S compounds from refining
Fuel oil use	Spill from fuel-tank filling; Auto crankcase oil	High in emulsified & dissolved oil
Rubber	Washing of latex, coagulated rubber, exuded impurities from crude rubber	High BOD, odour, suspended solid, chlorides; variable pH
Glass	Polishing & cleaning of glass	Red colour, alkaline suspended solid
Glue manufacturing	Lime wash, acid wash, extraction of protein	High COD, BOD, pH, Cr Mineral acid
Wood preserving	Steam condensate	High COD, BOD, solid, phenols
Beet sugar	Transfer, screening & juicing water; drainage from lime sludge; condensate after evapo… extracted sugar	High in dissolved and suspended organic
Pharmaceutical Products	Mycelium, spent filtrate, wash water	High in dissolved and suspended organic solid, including vitamin
Yeast	Residues from yeast filtration	High in organic solid, BOD
Pickles solid,	Lime water; brine, alum, turmeric, seed, syrup	High in suspended solid, Colour, Organic; Variable PH

Materials

Industries	Origin of major waste	Main Characteristics
Coffee	Pulping and fermenting of coffee bean.	High BOD & Suspended Solid
Fish	Rejects from centrifuge; pressed fish, washing	Very high BOD, organic solids & odour
Soft Drink	Bottle washing; floor & equipment cleaning, syrup storage tank drain	High pH, suspended solids & BOD
Bakeries	Washing & greasing of pan, floor washing	High BOD, grease, sugar, flour & detergent
Water products	Filter backwash, lime-soda sludge; brine, alum sludge	Mineral & suspended solid
Cane sugar	Spillage from extraction; Evaporator entrainment in Cooling & condenser water	Variable pH, Soluble organic matter, high BOD of carbonaceous nature
Agriculture	Agriculture chemical; crop residues, animal waste	High organic, high BOD
Palm Oil	Extraction of crude oil, refining of crude oil into edible	High BOD, COD, solids, oil, pH
Candle manufacturing	Wax spill, stearic acid condensate	Organic acids
Plywood manufacturing	Glue washing	High BOD, pH, phenol
Metal container	Cutting & lubricating metal, can surface cleaning	Fine metal, lub, oil, variable pH, surfactant, dissolved metals
Petro chemicals	Dirty water from production & transportation of 2nd generation oil compounds	High COD, TDS, metals, COD/BOD ratio
Cement	Fine & finish grinding of cement, dust leaching collection, dust control	Heated [illegible] inorganic salts
Wood furniture	Wet spray booth	Organics from staining & sealing wood product
Asbestos	Cleaning and crushing ore	Suspended asbestos & mineral solid
Paints & inks	Rejected solvents, scrubber for paint vapour; refining / removing inks	Organic solids from dye, resin, oil, solvent

NEQS of Pakistan for Industrial Effluents 2001 (mg/l)

PARAMETER	Into Inland Water	Into Sewage Treatment	Into Sea
Temperature	≥3^{0}C	≥3^{0}C	≥3^{0}C
pH Value	6-9	6-9	6-9
BOD_5	80	250	200
COD	150	400	400
TSS	200	400	200
TDS	3500	3500	3500
OIL & GREASE	10	10	10
PHENOL	0.1	0.3	0.3
CL^-	1000	1000	At or below Sea conc.
F^-	10	10	10
Cyanide	1	1	1
An ionic Detergent	20	20	20
Sulphate	600	1000	At or below sea conc

PARAMETER	Into Inland Water	Into Sewage Treatment	Into Sea
Ammonia	40	40	40
Pesticides	0.15	0.15	0.15
Cadmium	0.1	0.1	0.1
Chromium	1	1	1
Cooper	1	1	1
Lead	0.5	0.5	0.5
Mercury	0.01	0.01	0.01
Selenium	0.5	0.5	0.5
Nickel	1	1	1
Silver	1	1	1
Total toxic metals	2	2	2
Zinc	5	5	5
Arsenic	1	1	1
Barium	1.5	1.5	1.5

PARAMETER	Into Inland Water	Into Sewage Treatment	Into Sea
IRON	8	8	8
MAGNESE	1.5	1.5	1.5
BORON	6	6	6
CHLORINE	1	1	1

Source: EPA website

SEWER QUALITY IN INDUSTRIAL AREAS (mg/l) Source KWSB

AREA	BOD_5	COD	TSS
F.B.Area-N.Karachi	670	1,600	600
Kornagi-Landhi	640	2,400	400
SITE-TRANSLAYARI	700	1,500	836
SITE INDUSTRIAL	780	3,500	1,200

US-EPA and WHO Standards for Drinking Water

Contaminants	US-EPA (mg/L)	US-EPA (mg/L)
Temperature	--	12^0C
pH	6.0 -8.5	6.5 – 9.2
DO	4 – 6	3 ppm
TDS	500 ppm	500
TSS	0 – 5	5
Chloride	250	200 – 500
Nitrate/Nitrite	100	45
Calcium	100	100
Magnesium	30	150
COD	4.0	10
Sodium	20	200
Potassium	--	12
EC	300	400
Arsenic	0.05	0.05
Cadmium	0.01	0.05
Fluoride	2.2	1.5
Mercury	0.002	0.001
Iron	0.3	0.3
Manganese	[illegible]	
Zinc	5.0	5.0
Selenium	0.01	0.01
Lead	0.05	0.05

Industries in SITE, Karachi
(Source: SITE web page 2010)

Industries	Units	Industries	Units
Textile	550	Food stuff	35
Engineering	300	Paints	30
Allied textile	250	Oil and Soap	20
Silk	140	Glass	10
Commercial	100	Tannery	10
Garments	80	Optical	1
Plastic	75	Miscellaneous	810
Chemicals	65	Pharmaceuticals	40
		Total	2,516

Industries in Faisalabad
(Source: Asian Urban Information Centre Kobe 2006)

Industries	Units	Industries	Units
Textile Mills	248	Vegetables Mills	5
Hosiery Mills	101	Pharmaceutical	5
Light Engineering	51	Fertilizers	2
Oil Mills	42	Chemical	2
Soap Detergents	34	Dairy Product	2
Flour Mills	33	Pipes	1
Textile Machinery	32	Starch	1
Agricultural Implements	22	Watch/Clock	1
Sugar Mills	6	Plywood Board	1
Poultry/Animal Feeds	6	Miscellaneous	27
		Total	612

Major Industries, their locations and Potential Pollution

Major Sector	Location	Potential Pollution
Chemicals	Karachi Lahore	H2 S04, H No3, NH3 Fluoro carbons
Pesticides	Karachi Lahore	Organobalogen, organo–phosphates, other toxic, Organic, arsenic.
Textiles	Karachi Lahore Faisalabad	Hd, H2 So4, High BOD dyes, detergents various organic chemicals
Pharmaceuticals	Karachi Lahore, Quetta	Ammonia, Acids Zinc
Leather Tanning	Karachi Lahore, Sialkot, Kasur	Heavy metal (Cr), acids High BOD, Various Organic Chemicals
Food Processing	Karachi Lahore, Quetta Peshawar	Ammonia, SO2
Cement	Karachi Lahore Peshawar	Alkaline, Limestone dust
Electronics	Karachi Lahore, Gujrat Gujranwala	Fluorocarbons, Heavy metals, Cd, Ni, Selenium
Glass/ Ceramics	Karachi Lahore Peshawar	Ammonia Phenol
Petroleum Refining	Karachi Multan Rawalpindi	Phenol, sulfides, oily residues, ammonia
Pulp and Paper	Karachi Lahore	Organic sulfides, High BOD, Hg, Organic Solids

Industrial effluents in Pakistan (Source: UNIDO 2000)

Karachi

Name of Industry	pH	SS mg/L	BOD mg/L
Ahmad Food Industry	6.0	220	1,780
A.G.Fisheries	7.3	4,420	11,080
Adamjee Textile Mills	10.3	1,390	5,530
Dadabhoy Paper Mills	7.0	10	130
Karachi Tannery	4.1	1,140	6,780
Indus Alkalies	9.2	3,560	2,240
Buxley Paints Limited	2.1	10	8,080
Karachi Shipyard	2.1	290	30
Javedan Cement	6.3	7,740	50

Multan

Name of Industry	pH	SS mg/L	BOD mg/L
Pak Arab Fertilizer Limited	8.3	2,200	250
Shaikh Fazal Rehman & Sons	6.8	470	600
Khawaja Tannerie			
Alpha Industries	10.5	3,380	
Colony Textile Mills	8.0	610	230

Faisalabad

Name of Industry	pH	SS mg/L	BOD mg/L
The Lyallpur Dairy Farm	5.1	3140	1,790
Army Welfare Food Industries	7.6	690	260
Crescent Sugar Mills Distillery	3.8	2980	1,300
The Chemical Fertilizer Limited	3.9	560	30
Crescent Textile Mills	7.4	280	510

Kala Shah Kaku

Name of Industry	pH	SS mg/L	BOD mg/L
Kohinoor Oil Mills	8.0	680	530
Ravi Rayon Mills Limited	5.8	900	830
National Tanneries	6.7	1,970	590
Ittehad Chemicals	9.0	150	200
Lasani Steel Mills	7.8	50	
Government Weaving and Finishing Centre	7.8	1,720	450
P.Leiner & Sons Chemical & Food Limited	6.5	1,600	390

Peshawar

Name of Industry	pH	SS mg/L	BOD mg/L
Sarhad Food & Vegetable Products	6.9	430	510
Khazana Sugar Mills	6.7	960	30
Makk Beverages & Mineral Waters	8.7	390	50
New Frontier Tanneries	6.1	4,060	770

- More than 130 countries produce either from sugarcane or sugar beet.
- 10 countries produce sugar from both sugarcane and beet crops in which Pakistan. Includes
- Sugarcane crops are tropical and sub-tropical that require lot of water and sunshine.
- Globally 75% sugar is produced from sugarcane while the rest from sugar beet crops.
- Developing countries produce 70% of total global output of sugar.
- Sugar production is increasing in developing countries while it is on decline in the developed countries over the last few decades.
- 67% of global total is consumed in developing countries which are mainly due to rising population, rising income and change in dietary pattern.
- In 1947, Pakistan had two sugar mills. Now there are 77 sugar mills.

- 74 mills produce sugar from sugarcane and 3 mills produce sugar from beet (Khyber Pakhtunkhua).
- 38 mills are in Punjab, 32 mills in Sindh, 6 mills in Khyber Pakhtunkhua and one in Azad Kashmir.
- Sugar industry is the 2nd largest agro-industry after Textile in Pakistan.
- Globally, Pakistan ranks 4th in terms of area and size of crop and 9th in terms of yield.
- Pakistan’s yield per hectare is 45 tons while world average is 60 tons per hectare.

Sugar Production Process

Sugarcane generally contains 70% water, 14% fibre, 13.3% sucrose and 2.7% soluble impurities. The production of sugar from cane has following three major steps:

1. Harvesting
2. Raw sugar production
3. Refined sugar production

Step 1. Harvesting: Mature canes are harvested by cutting them at ground level, removing leaves and trimming the top at last mature joints.

Tops and leaves are removed since they contain little sucrose, high starch and reducing sugar which reduces yield. Leaves also contain silica that wears the mills.

Canes are then tied in bundles t transport them quickly to sugar factory for processing since canes deteriorate rapidly.

Step 2. Production of Raw Sugar

a. Cleansing and Grinding: Canes are thoroughly washed usually with high pressure water. Then rotating crushers and knives crush and shred the hard structure of cane into pieces. Later, multiple-sets of generally 3-roller mills grind them.

b. Juicing: Shredded/crushed canes travel on a conveyer belt to another mill for imbibition, in which water is applied for maximum extraction of juice from the pulp. The crushed cane is then called “bagasse”. Raw juice moves on through the mill for clarification.

c. Clarification: Lime is added to raw juice and heated to around 95 deg C. small amount of soluble phosphate is also added. A heavy precipitate is formed, which is separated from juice in clarifier. This insoluble particulate mass is called “mud”, which is separated by gravity or centrifuge.

Juice then goes to evaporator, while the mud is filtered to extract more juice, which goes for further clarification.

d. Evaporation: Process typically uses a series of 5 evaporators. Steam from large boiler is used to heat 1st evaporator. Steam of 1st evaporator is used to heat 2nd evaporator. Heat transfer process continues through 5 evaporators.

As temperature decreases from evaporator to evaporator, the juice boils at lower temperatures in subsequent evaporators. The juice now contains about 65% solids and 35% water. After evaporation, it goes to clarification.

e. Clarification: Juice is then clarified by lime and phosphoric acid before crystallization.

f. Crystallization: In this process, juice is evaporated in vacuum pan until it reaches super saturation stage. At this point, crystallization is initiated by "seeding" the solution, which is now called massecuite.

The pan is filled with massecuite for evaporation and finally discharged in crystallizer fro maximum removal of sugar from it. From here, massecuite is transferred to centrifugal machine, in which molasses is removed t its outer shell while sugar crystal remains in the inner basket.

Step 3: Refined Sugar Production:

Raw sugar still contains thin film of molasses on its crystal surface, which gives colour to the crystal. Its removal is vital to obtain white sugar. Film contains majority of impurities while minor impurities are occluded in crystal.

a. Affination: In this process, thin films of crystals are removed by centrifugal washing with warm water or warm saturated syrup.

Syrup, now called affination syrup, is sent to remelt process and then to clarification step.

b. Clarification: Two clarification methods are normally used, both require addition of lime.

i. Phosphatation: It uses phosphoric acid, lime, and polyacrylamide to produce calcium phosphate flocculent, which is then skimmed from syrup.

ii. Carbonation: In this process, lime and CO2 is used to produce CaCO3 precipitate, which also precipitate out gum, amino acid and other impurities:

$$Ca(OH)2 + CO2 \quad CaCO3 + H2O$$

c. Decolorization: In this step, activated charcoal is added to the syrup to remove colour and inorganic ash.

d. Evaporator: The decolorized syrup is sent to multiple-effect evaporators and then sent for crystallization by vacuum pans. The sequence of operations is same as raw sugar process. In multiple-effect process, the syrup moves through 5 interconnected vessels. Each step/vessel is called effect.

Thick juice fro

m last effect of evaporator is sent to vacuum pan for super saturation of the syrup. Now the syrup is seeded with isopropyl alcohol to initiate crystallization.

e. Crystallization: In this process, crystals are spun in a centrifuge to separate white sugar from molasses.

f. Drying and Cooling: Damp sugar is first treated with hot air and then cooled in an ambient temperature.

g. Screening: Sugar is then passes over vibrating screen, which separate lumps that are formed during the above process before packaging in bags.

Sugar mills produce many by-products like bagasse, filter mud/press mud, molasses.
A typical sugar mills with a capacity of 1,000 tons per day can produce up to:

1. 145 tons sugar,
2. 2,000 litres alcohol,
3. 1 ton yeast,
4. 5 tons potash fertilizer,
5. 6 ton
6. s pulp,
6. 5 tons wax
7. 50 tons press mud fertilizer
8. 250 kilowatts power from bagasse

By- Products and Waste Generation in Sugar Production

Input	Process	Wastes
Sugarcane	Mill House	* Effluent contains SS, Oil & Sugar content * Bagasse (solid waste)
Sugar Juice	Process House	* Filter Cake or Press mud (solid waste) *Washing evaporators, juice heater, Vaccum Pan, classifier, etc. * Effluents of high BOD, COD, TDS * Molasses
Bagasse, Furnace oil	Boiler House	* Fly ash * Smoke * Flue gas * Wastewater of wet scrubber
Water + Chemicals	Cooling Pond	* Wastewater
Molasses	Distillery	* Wastewater

Characteristics of Sugar Mill Effluents in Different Countries

Source: UNIDO 1998)

Parameter	Puerto Rico	Hawaii	Philippines	Louisiana	India	Pakistan
pH	5.3- 8.8	-	5.3 – 7.9	-	6.8-8.4	4.7– 6.5
BOD (mg/I)	112 - 225	115 - 699	130-1220	81– 562	267-660	600 –4853
COD (mg/I)	385 - 978	942 - 2340	50 – 1880	720 -1430	890-2236	1037- 19234
SS (mg/I)	100 - 700	915 - 3590	240– 5440	150-8120	504-936	-
TSS (mg/I)	500- 1400	3040 - 4500	-	409	792-2043	185-526

Characteristics of Combined Waste Water of Sugar Mill
(Source: ETPI 2001)

Description	Crushing Tons/day	Flow m3/day	pH	COD mg/I	BOD mg/I	TSS mg/I
Mill-1	2,800	3,882	6.00	12,107	2,798	526
Mill-2	3,000	6,187	4.67	19,234	4,853	185
Mill-3	6,647	3,040	6.50	1,037	600	274
Mill-3+Distillery	6,647	3,240	-	7,716	4,319	12,000
Distillery	6,674	200	4.70	108,667	60,830	12,160
NEQS	-	-	6–10	150	80	150

Combined Wastewater: (Mill House + Process House + Cooling Pond flow)

Characteristics of Dry Press Mud from 3 Sugar Mills

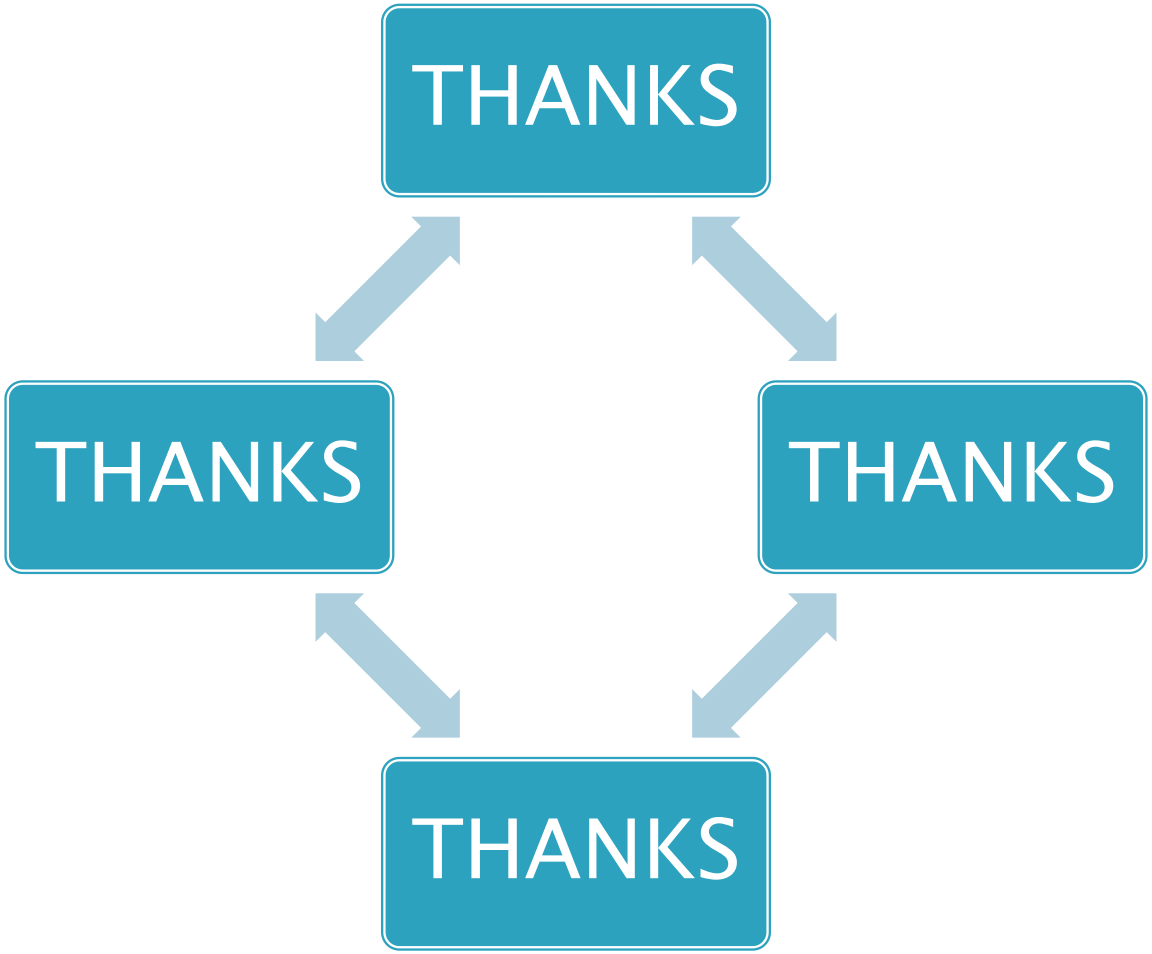
Parameters	Values (%)	Parameters	Values(%)
Organic Matter	71.10	Potassium	0.67
Minerals	28.92	CaCO3	0.48
Sulfur	5.42	Sodium	0.33
Calcium	2.50	Iron	0.06
Nitrogen	1.68	Manganese	0.04
Phosphorous	1.03	Zinc	0.01
Magnesium	1.03	Copper	0.01

Air Emissions from 3 Sugar Mills

Parameter		Boiler Combustion Mode								
(mg/Nm3)	**NEQS**	Fuel Oil			Bagasse			Mixed Fuel		
Mills		1	2	3	1	2	3	1	2	3
CO	800	Nil	851	2.3	404	543	81	346	324	17
S2O	400	132	297	53	Nil	16	Nil	Nil	59	Nil
NOx	400	23	154	46	38	201	30	30	251	34
PM (Fuel	300	73	47	23	-	17	213	219	83	102
Oil)	5.0	0.8	-	0.02	0.55	-	0.14	0.42	-	0.1
Zinc	1.0	Nil	-	Nil	0.08	-	Nil	0.04	-	Nil
Copper										

Noise Level at Different areas of Sugar Mills (NEQS 80dB)

Location	Noise level dB	Location	Noise level dB
Centrifugal machine	86-87	Sugar dry units	91-92
Raw station for sugar	83.5-85	Vacuum release	102-104
Compressor for air supply	90-92	Milling	88-91
Juice clarification station	88-89	Mill turbines	92-94
Juice evaporation station	82-93	Boilers	83-109
Power house turbine	93-105	FD fan	94-96
Delivery pumps for sugar and molasses supply	89-90.5	Control room	92-94
		Air blower station	99-102
Yeast separation station	96-98		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