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Investigations of Some Industrial Air Pollutants Applicable to Sugar Mill Rohtak

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Abstract: The modern industrial and transportation sectors are facing significant challenges as a result of environmental contamination. Since air is a necessity for all living things, air quality is a major concern everywhere in the world. In the current research work, air pollution production and exhaust from sugar mills are taken into account.

Keywords: Environmental pollution, Air pollutants, Industrial and transport sector.

Introduction

Environment refers to the living and inanimate surroundings and how they interact to allow them to coexist; ecological balance results from a balance between interaction and coexistence. Changes in the air, water, and land reflect how human and natural activities affect the equilibrium. Any disruption to the natural equilibrium of living things is reflected in the air, water, and land. Environmental pollution refers to this unfavourable alteration in the nature of the air, water, and land as well as the disturbed ecology. Any atmospheric condition in which pollutants are present at quantities high enough above their usual ambient levels to have a detectable impact on people, animals, plants, or materials is referred to as air pollution. There are both natural and man-made factors that contribute to air pollution.

Natural cycles themselves regulate how much pollution is produced by natural processes. The atmosphere is polluted by human activities like thermal power generation, industry, transportation, nuclear energy, and modern living. Pollutants are additionally produced by exhaust emissions of diverse oxides, hydrocarbons, and chemicals through a variety of atmospheric processes. Air pollution occurs when unneeded gases and materials are added to clean air as a result of natural and human-made processes. Air pollution is typically caused by relatively small concentrations of trace components such hazardous metals, NOX aerosols, dust particles, hydrocarbons, S02, H2S, CO, and CH4 (approximately 1 ppm). Due to the involvement in intricate series of reactions occurring in the atmosphere, the addition of one type of pollution may result in the production of pollutants of other types. The presence of other contaminants significantly alters how one type of pollution behaves. The air is also polluted by different species, bacteria, and pollens. Asbestos, beryllium, and mercury are other air contaminants that are more harmful but do not occur frequently.

Primary and secondary pollutants are separated into two groups from the perspective of the emission source. Primary pollutants result from fuel combustion and degradation reactions, whereas secondary pollutants are mostly the result of chemical interactions between primary pollutants and other atmospheric species in the atmosphere. Some pollutants are attracted to gravity and settle down. Some contaminants are airborne for prolonged periods of time, changing the chemistry of the atmosphere in significant ways. Industries are at blame for about 30% of air pollution. The ultimate sinks for air pollutants, are earth and plants.

After the industrial revolution (after 1850), and more recently during the past 20 to 30 years, the problem of air pollution has gotten worse. Numerous unfavourable gases and chemicals were combined in the air at unfavourable rates as a result of the world's fast industrialization. Primary (source emitted) pollutants such as SO2, NOX, CO, C02, HF, H2S, metal fumes, hydrocarbons, volatile organic compounds, particulates, etc., as well as secondary (air borne) pollutants make up the vast majority of air pollutants (aerosols, acid mist, fog, large number of poisonous compounds which the hydrocarbons form due to reactions with other pollutants in presence of sun light and heat). A range of biological pollutants (pollen, bacteria, viruses, etc.) also contribute to the air pollution burden in addition to gaseous and particle pollutants. Numerous forms of pollutants, such as CH4, CO, S02, NOX, and NH3 dust, are perpetually released and balanced by natural processes (volcano, decay, lightening, photo synthesis, rain, settling etc.). When it comes to many contaminants, industrial activity outpaces naturally occurring pollution loading rates, and a variety of industrial operations raise local pollution levels.

The field of research on air pollution has grown significantly. 10,000 new chemicals are reportedly added to the list of substances each year, according to studies. The scope of the current investigation is just the air pollutants produced by the Sugar Mill Rohtak. Therefore, we'll talk about the air pollution this industry produces.

The oldest industry in India is the sugar industry. The gur manufacturing cottage business in India is the oldest industrial process in the world prior to the introduction of White sugar production from sugar cane. Regarding fuel, the sugar industry is self-sufficient. The main and sufficient fuel for all the steps involved in producing sugar is bagasse, which is the fibrous component of the sugar cane that is left over after the juice has been extracted. Additionally, bagasse, which mostly consists of cellulose and pentosans, can be utilised as a raw material to create pulp, paper, particle boards, and furfural. Bagasse has a moisture content of around 50%, 47% carbon, 6.5% hydrogen, 44% oxygen, and 2.5% ash. 30 percent or so of the crushed cane is bagasse. After addressing the needs of the mill, the average amount of bagasse saved nationwide is around 5% of the crushed sugar cane. The main air pollutants released by burning bagasse are CO2, fly ash, and CO2. Also formed are some NOs. Juice cleansing also requires some sulphur dioxide, the leakage of which increases pollution. From the crushed sugar cane, on average, 9% sugar is produced. Bagasse is created to a degree of 29–31%. One can save almost 5%. As a result, 2.85 kg of bagasse were produced from 1 kg of sugar for fuel. Bagasse produces fly ash at a rate of 1.3%, hence 2.85 kg of bagasse produces around 37 mg of fly ash as SPM pollution in addition to the gaseous pollution. The most popular techniques for reducing fly ash pollution are cyclone separators and wet scrubbing.

The amount of pollutants released by anthropogenic sources is lower than that of natural sources, although the former are more widely dispersed. Anthropogenic forms of pollution, on the other hand, are concentrated in particular areas and accumulate at extremely high levels in the atmosphere. The industries are the next biggest contributors of pollution after vehicles. Industries that burn coal, like thermal power plants and the cement industry, are the main producers of air pollution. The sugar industry is also a significant source of fly ash, a type of particle emission.

Significance of the Present work

The environmental circumstances in every way got worse as industrialization grew. We are compelled to be concerned about the environment we live in. Every country and territory has established minimal requirements for certain pollutants and passed legislation to enact the necessary regulations. The importance of this work lies in the need to comprehend and monitor pollution. Due to the fact that the problem of pollution is multifaceted, we have restricted our research to only three businesses' emissions of air pollutants because air pollution has a very broad spectrum. The amount and types of pollutants produced by the relevant industry are considered in the current study. The study holds the relevance that understanding the issue leads to finding a solution. The control devices necessary to regulate the relevant pollutants have also been studied.

Data Collected for Air Pollutants

Data on the various pollutants have been gathered from sugar mill rohtak in order to analyse the types and quantities of pollution produced by sugar manufacturing.

Methodology to collect data

A number of visits were made to the aforementioned industry to gather the necessary data. Contact was established in the industry with the in-charges of each area, including the coal handling unit, the boiler unit, the turbine unit, the ESP section, and the office of the pollution control unit. The plant in-charges were asked for their approval in order to collect data and comprehend the various procedures used in the concerned business. The managing director of the sugar mill kindly provided the necessary direction and assistance through their respective staff members to get the relevant data.

Sugar making process Essentially, sugar processing consists of five basic processes which are :

- **Juice extraction**: Efficiency of juice extraction is defined as the ratio of sugar extracted to total sugar present in the sugar cane. On an all-India basis, this efficiency amounts to 91.1% of crushed cane. In gur units, its efficiency is 50%, and in Khandsari units, it is 51%. About 9.98% of the sugar from crushed cane is recovered.
- **Clarification**: About 2% of non-sugar solubles are present in sugar cane juice. To generate white crystal sugar, this non-sugar component must be removed because it slows crystallisation. Chemical agents, primarily lime alone or lime combined with S02 or C02, are used to clarify. Phosphate and fresh juice are combined, cooked to 65–75 °C, and then Ca(OH)2 or Ca(0H)2+S02) are added. It is heated to a temperature of 100–102 C. The cleared hot juice is separated from the mud discharge.

- **Evaporation & Concentration**: If the juice is cooked above 60–70°C, the disaccharide sucrose in cane sugar is changed to a mono-saccharide, which does not crystallise (loss due to inversion). The molasses is lost along with the non-crystallized sugar. This shift is accelerated by longer boiling times even at lower temperatures. Vacuum pan technology is used in organised sector sugar mills to decrease the boiling point of juice to 60–70°C and shorten the boiling process.
- **Crystallisation**: The cooling of the massecuite and the depositing of succrose from other liquors onto the developing crystals created in the vacuum pan are the two main characteristics of crystallisation. The A massecuite stays in the crystallisation for about two hours, the B and C massecuites for around ten and twenty-four hours, respectively.
- **Crystal-separation**: A centrifuge is used to separate the crystals from the mother liquid (molasses). Molasses' surface tension is decreased by naturally occurring impurities found in cane juice and molasses. Viscosity rises as surface tension is reduced, which reduces the amount of sugar crystals that can be recovered. Recent studies have demonstrated that adding surface active components can boost crystal yield by 4.53% in concentrated juice.

Fuel used in sugar mill

The primary fuel for the sugar industry is bagasse. Pentosan and cellulose make up the majority of it. Bagasse's cellulose content makes it suitable as a raw material for the manufacture of pulp, paper, and particle boards, while its pentosan content makes it suitable for the manufacture of furfural. It satisfies the sugar manufacturers' needs for heat and motive power in the organised part of the sugar industry. Mill wet bagasse is the term for the bagasse that has between 50 and 56 percent moisture content after it leaves the extraction mills. Bagasse has the following chemical make-up: C=47.0% H=6.5% O=44.0% Ash=2.5%.

For fly ash emissions from boilers burning bagasse, the Central Pollution Control Board has established the following standards. For particle emissions, choose from the following: Spreader Stoker 250 mg/Nm^3, Step Grate Furnace 500 mg/Nm^3, Horse Shoe Furnace 500 mg/Nm^3, and Pulsating Grate Furnace 800 mg/Nm^3. From 1.11.1992 onward, the Haryana State Pollution Control Board has set the particulate limit for all varieties of boiler furnaces at 250 mg/Nm^3.

Pollutants emitted per hours at sugar mill Rohtak during past three years

Furnace Type	SPM (kg)	CO (kg)	SO_2 (kg)	NO_X (kg)	Total (kg)	Gaseous (kg)
Horse Shoe	22.863	2.372	3.253	0.416	28.906	6.042
Step Grate	33.78	5.831	5.888	0.593	46.093	12.313

Pollution generated per day and per ton of bagasse burnt at sugar mill Rohtak

Furnace Type	Per day pollutants (kg)	Total pollutants per day (kg)	Bagasse burnt (ton)	Pollutants per ton of Bagasse burnt (kg)	Total Pollutants per ton of Bagasse (kg)
Horse Shoe	SPM 548.712 CO 56.928 SO_2 78.072 NO_X 9.984	693.744 (all types) 145.008 (Gaseous)	213.5	SPM 2.570 CO 0.266 SO_2 0.366 NO_X 0.046	3.249 (all types) 0.680 (Gaseous)
Step Grate	SPM 810.724 CO 139.948 SO_2 141.312 NO_X 14.232	1106.232 (all types) 295.512 (Gaseous)	341.5	SPM 2.377 CO 0.410 $SO_2$0.413 NO_X 0.041	3.244 (all types) 0.866 (Gaseous)
Total		1800 (all types) 440.520 (Gaseous)	555		

Average pollution load per unit product of the Sugar Mill Rohtak

Sugar Mill Rohtak	Product	Pollution caused per unit product		
		Particulates	Gaseous	Total
	1 kg sugar	8.078 g	2.623g	10.701g

Volume of air polluted daily by Sugar mill Rohtak and its equivalence to human consumption (taking a person's avg. daily consumption of air = 20 kg or 16 Nm^3)

Sugar Mill Rohtak	Av. Value per hr Nm^3	Air pollution per Hr	Air Pollution per day	Human Equivalence
	Horse Shoe furnace 69172 Step Grate furnace 110971	180143	4323432	270215

Waste management Press cake is the byproduct of the clarifying of juice. Press cake made in factories using the sulphitation method is currently used primarily as manure in sugar cane fields; press cake made in factories using the carbonation process has no known commercial application. Additionally, filter cake and fly ash are combined to make fertiliser. Fly ash has a considerable calorific value and can be utilised as fuel because 51.98% of it is lost on ignition. Small balls are formed from the mixture and then dried in the sun before being used as oven fuel. It can be recycled in the boiler furnace with the bagasse.

Molasses, the liquid left behind after crystal sugar is removed, is a source of carbohydrates that can be utilised to make single cell proteins, ethyl alcohol, or dextran, as well as animal feed. In India, there are roughly 200 distilleries, and they use about 35 lakh tonnes of molasses to make 800 million litres of alcohol each year. For the manufacturing of live stock feed, over 2 lakh tonnes of molasses are utilised. Of the crushed sugar cane, 32% filter cake is typically produced.

Discussion

The table below demonstrates that the particle emission from the sugar mill's stacks is far greater than the allowed maximum limits. Indian coals have a low sulphur content, hence their S02 emissions are low and below acceptable standards. The NOX emissions are also within limits.

Sugar Mill Rohtak	Avg. emission rate of pollutants mg/Nm^3				Max. allowed emission limts (mg/Nm3) SPM
	SPM	SO_2	NO_X	CO	
	305	52	6	45	250

The amount of CO being emitted is also within the permitted limits, but it can still be reduced by increasing combustion efficiency, which will result in fuel savings and a reduction in pollution. A lower level of CO is also required for the proper operation of the electronic stability programme (ESP), as a higher level of CO (.4% and above) triggers ESP tripping.

Conclusions and Suggestions

The results of the case study undertaken for sugar mill lead to the following conclusions:

1. The permissible limits established by the central pollution control board are exceeded by the contaminants being studied.
2. The ambient particle emissions are substantially higher than the 250 g/m3 permissible limit. S02 and NOX values are within the acceptable range. However, they still have the potential to harm the ecosystem.
3. In most well-maintained sugar mills, the standard ratio is 2.2 kg of steam generated per kilogramme

of bagasse; however, in Rohtak, this ratio is significantly lower. The boilers at these mills can be modified in order to increase this ratio.

4. The national bagasse save on cane is 5%, while the saving in Rohtak is 0.9%.
5. On average, 50% of the steam utilised in the production of sugar is also used to generate electricity. The consumption rate in Rohtak's sugar processing is greater (about 60%). Power generating should make more use of steam.
6. The population of Haryana has a very high air requirement, and the only source of everyday air pollution is industry.

Suggestions to check Air Pollutants

Improve dispersion: The most common and inexpensive approach of reducing pollution is to spread out the contaminants more evenly. The technique depends on the location's choice of site, high stacks, and the emission source's weather conditions. This approach is useless in locations with a high population density.

Source control methods: The best strategy is to cut back on pollution emissions right at the source. There are two techniques to achieve the reduced emission. First, we make the fuel better by choosing cleaner fuel or purifying the gasoline. substitution of less-polluting fuels such as natural gas, biogas for diesel, wood, kerosene, and treated coal for untreated coal in place of fossil fuels. Less volatile chemicals take the place of more volatile ones (Oil paints by water paints). managing volatile compound leakage, burning volatile organic compounds (VOC) to create less toxic products, or condensing VOC, among other things.

Process Change: Pollutant emissions are decreased as a result of the process modification or enhancement. Changes to the furnace, closed incinerators in place of open ones, etc. The burning of coal or liquid fuel in furnaces and engines is altered to reduce the production of nitrogen and carbon oxides. A process shift is any method that lowers the use of fuel or raw materials, such as encouraging people to do simple tasks with their hands whenever possible or to avoid using automobiles as much as possible. Of course, preventing pollution is preferable to controlling it.

End of Pipe Technology: We have pollution control with this technology. Mechanical (cyclone, bag filter, gravity settler), electrical (electrostatic precipitation, simultaneous removal of SO2 and NOX), and chemical technologies are used (flue gas desulphurisation, dry and wet scrubbings, catalytic reduction etc.)

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