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## ASSESSMENT OF AIR QUALITY FOR PARTICULATES, SULPHUR DIOXIDE AND NITROGEN OXIDES AS OCCUPATIONAL STRESSES AT WORK PLACE ENVIRONMENT OF SUGAR INDUSTRY

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**Abstract:**-Sugar industry is one of the biggest industry in state of Maharashtra, there is an labour intensive employment of about thousands of workman. The occupational health problems in this sector are many and are attributable to variety of occupational stresses such as high concentration of dust ( viz. clay dust, bagasse dust, sugar dust), excessive temperature, high intensity noise, inadequate light and space, night work, shift work, high concentration of Nox, sulphur dioxide etc. In present investigation the sampling of dust, gases viz. sulphur dioxide and nitrogen oxides were done, at the selected spots of various processing units of work place environment of sugar industry. It was found that the concentration of sulphur dioxide in juice section near sulphur furnace is significantly high i.e 87.17 $\mu$ g/Nm<sup>3</sup>.The concentration of nitrogen oxide is comparatively high at cane yard section i.e. 105.54 $\mu$ g/Nm<sup>3</sup>.The workers working in vicinity of sulphur furnace complain of eye and throat irritation, suffocation, cough, etc. The workers working in cane yard boiler, Bagasse, Baling sections complaints for eye irritation, cough, sputum production may be due to increased concentration of NoX and dust and or interaction of both.

**Keywords:**Sugar Industry workers, Occupational hazards, Bagasse, Stress.

### 1.INTRODUCTION

Man can survive and function under a wide range of external stresses, but it is only in a favorable environment that can be produce sustained and repeated effect and at the time remain in good physical condition,working conditions in sugar industry include cleanness, light, temperature, ventilation, noise, vibration, physical energy required, length of the work day, regularity of work hours such as the night shifts, or rotation of shift, physical hazards, exposure to possible industrial stressors and similar conditions that directly or indirectly influence the workers happiness, satisfaction, dissatisfaction at work.

There are physical, chemical and biological agents in the working environment of sugar industry which may adverse to health of worker. The working capacity of the workers is affected by physical agents such as noise, temperature, humidity, light etc. The chemical agents in working environment include dust, toxins, gases and fumes of chemicals which cause health hazards like respiratory illness, injury to skin and have a dexterous effects on other organs of body

Sugar industry is one of the biggest industry in state of Maharashtra plays an important role in national economy. The working and living condition in sugar industry are adverse which affects the health of the worker.

At present there is no comprehensive occupational health survey of sugar industry workers in India .however there are various organizations such as ILO,WHO which are active in the field of occupational health. Industrial workers constitute only a segment of the general population and the factors that influence the health of the population also apply equally to industrial workers. Air borne pollutants and respiratory impairment in textile environment has been studied by Sanandam et al.(2002).

### 2. MATERIALAND METHOD

#### Study area

The present study has been carried out in Hutatma cooperative sugar industry at Walwa, having 4500 tons of crushing

capacity per 24 hour. The processing of sugarcane up to sugar crystallization is carried out in various processing units (sections) of sugar industry viz.

- 1.Cane yard: Unloading of sugarcane loaded in vehicles is carried in cane yard section.
  - 2.Engineering: The complete crushing of sugarcane, extraction of juice, boiling of juice, baling of shredded bagasse and production of electricity is completed in sub sections i.e. mill, boiler, bagasse baling and power turbine.
  - 3.Manufacturing :The clarification of juice by removal of press mud, sulphitation by removing impurities, production and clarification of syrup by removing the molasses and crystallization of sugar by seed treatment is completed in various sub sections viz. juice, pan, and centrifugal section.
  - 4.Sugar house section: The sugar bags are packed in sugar house and sent to godown for storage.
  - 5.Godown: The packed bags having 50 to 100 kg. are lifted by the workers on their back who arrange them in stacks.
- Randomly selected ten workers from each section were assessed for the study. A detailed questionnaire for socio-economic and health information of worker was filled up with due consent from those who volunteered for the study.

**Assessment of Air Quality for particulates, Sulphur dioxide and Nitrogen oxides**

The sampling of particulates sulphur dioxide and Nitrogen oxides in atmospheric air were done at selected spots of various processing units (sections) of sugar industry.

The sampling of dust was done by high volume sampler

**Gaseous Sampling:**

**1) Sulphur dioxide.**

( Sodium Tetrachloromercurate Method )

When sulphur dioxide from the air stream is absorbed in a sodium tetrachloromercurate solution, it forms a stable dichlorosulphitomercurate. The amount of sulphur dioxide is then estimated by the appearance of colour produced when p-Rosaniline hydrochloride is added to the solution. The colour is estimated by a reading from an absorptiometer of spectrophotometer for which a calibration curve has already been prepared.

**2) Nitrogen Oxides**

**Principle and Applicability:**

Nitrogen oxides as nitrogen dioxide are collected by bubbling air through a sodium hydroxide solution to form a stable solution of sodium nitrite. The nitrite ion produced during sampling is determined colorimetrically by reacting the exposed absorbing reagent with phosphoric acid, sulphanilamide and N (t – naphthyl) ethylene diaminedihydrochloride.

The method is applicable to collection of 24 hours samples in the field and subsequent analysis in the laboratory.

**RESULT AND DISCUSSION**

In sugar industry in all the processing units i.e. from cane yard section up to sugar house section noise, heat, dust fumes of gases are the common stress factors.

The questionnaire survey revealed that most of the workers were illiterate, smoker and drinker. Most of the workers complained about back pain, body ache, lower back pain, pains in shoulder and neck, throat infection ,fever cough is very common among all workers at the starting of seasonal work. Some workers also complained about eye irritation, head ache, acidity, suffocation. Some workers also suffered from physical injuries like burns at the time of working. The survey of all the section of processing units of sugar industry reveals that the work place environment is extremely adverse. The health status of the workers is affected by high intensity noise and high temperature as well as high concentration of dust particles, particularly at cane yard, mill bagasse, baling and sugar house sections. Sometimes sulphur dioxide gas spreads in juice section due to leakages which affects the health of workers.

**Dusts**

Dusts are finely divided solid particles with size ranging from 0.1 to 150µ. They are released into the atmosphere during crushing, grinding, abrading, loading and unloading operations. In sugar industry dusts are produced in the cane yard section due to unloading of bullockcarts and other vehicles. Similarly high concentration of dust was observed in the mill section and bagasse baling section. The nature of dust in these sections vary with regard to its composition.

In cane yard section the nature of the dust is inorganic and soluble in nature, while in Mill section, boiler section and

bagasse section main fraction of the dust is tiny bagasse particles organic in nature and insoluble. The larger dust particles are found to be settle down from the air rapidly, While smaller ones remain suspended indefinitely. The fraction of dust from this is respirable dust and likely to be inhaled into the lungs and is retained there, because workers in these section were found to be without any protective equipment such as face mask etc.

Table No. I  
DUST CONCENTRATIONS AT VARIOUS SECTIONS IN SUGAR INDUSTRY

Sr no	Section	SPM ( $\mu\text{g}/\text{Nm}^3$ )	RSPM ( $\mu\text{g}/\text{Nm}^3$ )
1.	Cane –Yard	545	182
2.	Engineering		
	a. Mill	354	135
	b. Boiler	455	150
	c. Bagasse baling	1245	415
	d. Power urbine	93	30
3.	Manufacturing		
	i. Juice section	156	53
	ii. Pan section	183	60
	iii. Centrifugal section	193	64
	B) Sugar house section	508	160
4.	Go down	180	86

Fig. 1,2and 3 shows high concentration of



Workers exposed to high concentration of dust at mill section

Workers exposed to high concentration of dust at boiler section

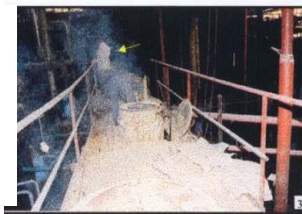


High concentration of bagasse dust at bagasse baling section



Lime stirrer unit: High concentration of lime dust

Hazardous sulphur dioxide fumes generated from sulphur bhatti



bagasse dust at mill boiler and bagasse baling section of the sugar industry due to crushing of sugarcane for the extraction of juice. Bagasse is the first by-product in the form of fiber after extraction of juice from sugarcane. It is used for making board and paper. During drying of bagasse it is shredded to make bales and the workers from bagasse baling section are exposed to clouds of this hazardous dust.

The dust concentration at various sections of sugar industry was recorded and indicated in table no. I. It has been significantly found that the concentration of suspended particulate matter is  $545\mu\text{g}/\text{Nm}^3$  and respirable particulate matter is  $182\mu\text{g}/\text{Nm}^3$  at the cane yard section. In bagasse baling section the concentration of suspended particulate matter is  $1245\mu\text{g}/\text{Nm}^3$  and respirable particulate matter is  $415\mu\text{g}/\text{Nm}^3$ . In sugar house section the concentration of suspended particulate matter is  $508\mu\text{g}/\text{Nm}^3$  and respirable particulate matter is  $160\mu\text{g}/\text{Nm}^3$ . The workers in all these sections were found to work without using any personal protective equipments such as, face masks, ear mufflers, goggles, heavy duty shoes, etc. Gases and chemicals

#### Sulphur Dioxide:

Particulate air pollution is a complex mixture of small and large particles of varying origin and chemical composition. Larger particles, ranging from approximately  $2.5\text{-}100\mu\text{m}$  in diameters, usually comprise smoke and dust from industrial processes, agricultural construction and road traffic. Smaller particles generally come from combustion of fuels. These particles often coated with various chemical contaminants or metals and fine sulphate and nitrate aerosols are formed when sulphur dioxide and nitrogen oxide condense in the atmosphere. Small particles are likely to be most dangerous because they can be inhaled deeply into the lungs. The constituents in small particulates tend to be more chemically active: they may also be acidic and therefore more damaging.

In the sugar industry for the clarification of juice sulphitation process is carried out that requires sulphur dioxide gas which is prepared by burning solid sulphur in furnaces called sulphur furnace the gas bleaches coloured impurities present in the juice and syrup. Fig.No.5 shows the sulphur dioxide fumes generated from sulphur bhatti. During sulphitation workers working in juice particularly on sulphurbhatti are exposed to sulphur dioxide gas. Every two hours the furnace has to be opened and is again charged with fresh sulphur. When this furnace is opened the hot sulphur dioxide gas rushes out and the workers working in juice section are exposed to the sulphur dioxide gas. Sometimes the pipe line which conveys the hot sulphur dioxide gas leaks and the workers in the vicinity inhale this gas.

The questionnaire survey of juice section workers reveals that a worker suffers from eye irritations, inflammations to nasal mucosa. Sometimes workers working on sulphur bhatti enter into unconsciousness for short duration, loss of appetite, suffocation are the common consequences.

The concentration of sulphur dioxide at different sections of sugar industry was recorded and it has been found that the concentration of sulphur dioxide in boiling house section near sulphur furnace was significantly high i.e.  $87.17\mu\text{g}/\text{Nm}^3$

#### Nitrogen Oxides:

There are many oxides of nitrogen. At the ground level the combination of nitrogen and oxygen takes place thermally in flames, explosion and electric discharges. It is difficult to estimate how many people are exposed to oxides of nitrogen. Since hazardous occupations also involve all workers located in the vicinity of operations or processes having conditions conducive to the generation of nitrogen oxides for example, furnaces, boilers, welding, internal combustion engines and nitrogen oxides produced from numerous chemical processes. Carl Zenz (1994) reported 3,00,000 tones of nitrogen oxides are produced annually from industrial processes.

In sugar industry the nitrogen oxides are produced due to incoming vehicles loaded with sugarcane, due to furnaces, boilers, welding processes and internal combustion engines, the questionnaire survey reveals that workers complain for cough, sputum production, chest pain etc, The concentration of nitrogen oxides at the various sections of sugar industry is indicated in Table No. II. Note that the concentration of nitrogen oxides is high

i.e.  $105.54\mu\text{g}/\text{Nm}^3$  at the cane yard section as compare to rest of the sections.



Table No. II. CONCENTRATION OF SULPHUR DIOXIDE AND NITROGEN OXIDES AT VARIOUS SECTIONS IN SUGAR INDUSTRY

Sr. No.	Section	No <sub>x</sub> ug/ Nm <sup>3</sup>	So <sub>2</sub> ug/ Nm <sup>3</sup>
1.	Cane- Yard	105.54	13.78
2.	Engineering		
	a. Mill	42.92	9.82
	b. Boiler	85.51	10.93
	c. Bagasse bailing	08.48	11.61
	d. Power turbine	02.51	05.16
3.	Manufacturing		
	I. Juice section		
	i. Lime house	38.94	15.76
	ii. Sulphur furnace	20.97	87.17
	II. pan Section	25.46	04.44
	III. Centrifugal Section	19.80	06.75.

In sugar industry sulphur dioxide gas is prepared from sulphur in sulphur bhatti. The Fig.5 indicates the poisonous gas spreads in the boiling house section. In present investigation it was observed that the high concentration of sulphur dioxide gas which is 87.17µg/Nm<sup>3</sup> near sulphur furnace. According to ambient air quality standards the permissible concentration of sulphur dioxide at residential zone is about 80 µg/Nm<sup>3</sup>. The workers working in boiling house section particularly in vicinity of sulphur furnace complain of eye and throat irritation, suffocation, cough etc.

Increase in concentration of sulphur dioxide above permissible limits causes suffocation, irritation of throat and eye. Repeated exposure to 10 ppm concentration of sulphur dioxide results into upper respiratory irritations. (Federal, 1975).

Sulphur dioxide gas is severe irritant to the eyes, mucus membranes and skin. Its irritant properties are due to the rapidity with which it forms sulphuric acid on contact with moist membranes (Carl Zenz, 1994).

In sugar industry environment due to burning of bagasse in boilers, furnaces, welding operations nitrogen oxides are formed. In present investigation it was found that the concentration of nitrogen oxides in cane yard section is 85.51µg/Nm<sup>3</sup>. According to ambient air quality standards the permissible concentration of nitrogen oxides at residential zone is 80µg/Nm<sup>3</sup>.

Exposure to nitrogen oxides causes cough, mucoid or frothy sputum production, increasing dyspnea, chest pain and symptoms of pulmonary edema with cyanosis, tachypnea, tachycardia and eye irritation (Carl Zenz, 1994). Exposure to nitrogen oxide and nitrogen dioxide increase the possibility of acute respiratory infections and bronchitis (Wark, 1981).

In our present investigation it has been observed that workers from cane yard and boiler section complaints for eye irritation, cough, sputum production may be due to increased concentration of No<sub>x</sub> and or dust or interaction of both.

It was found that in sugar industry welding processes are used extensively in different areas. The welders and workers working near the areas where welding process is carried out complain of eye irritation, fever, cough, suffocation etc, the scars were also observed on the skin of welders.

Occurrence of pulmonary edema due to high concentration of nitrogen dioxide created by welding processes (Lindqvist T, 1944, Norwood et al. 1966). Metal fumes formed during welding can cause fever (Ross, 1974).

Agarwal and Agarwal (1994) suggest that the exposure to dust produces pulmonary edema, bronchial asthma, pulmonary mycosis, bronchopulmonary aspergillosis, rhinitis, sinusitis, otitis, irritability and inflammation of heart.

In present investigation, it has been demonstrated that the concentration of respirable dust particles is significantly high at cane yard and bagasse baling section. In cane yard section due to vehicle transportation and unloading of sugarcane, concentration of clay dust is high. In bagasse baling section bagasse dust formed after the extraction of juice from sugarcane is found in high concentration. These respirable dust particles easily reach the wall of alveoli and may cause inflammation leading to the respiratory impairments.

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