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Study of occupational health and safety conditions of a sugar mill in Pakistan

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Abstract

An occupational hazard is usually a situation that has enough potential to damage workers. There are two types of occupational hazards i.e. health hazards and safety hazards. Some occupational health and safety hazards are expected in sugar mills including health irritants such as high noise, bagasse dust and fly ash. Environmental monitoring of different parameters in different sections of industry was carried out during three selected months. A questionnaire and checklist was made according to occupational safety and health standard in order to evaluate occupational health and safety conditions in industry. Hazard identification and risk assessment was done to point out occupational safety conditions at the sugar industry. The results of environmental monitoring showed that noise level during was high in most of the sections of industry. Noise level of packing house and turbine section in January was 93.3dB and 95.4dB. Temperature of boiler section was exceeding the standard value during study period. Humidity level was within the range except in process house and packing house in January and March. The level of particulate matter was higher when compared to NEQS standards. However in January the level of particulate matter of packing and boiler section was 656µg/m³and 560µg/m³ while in March the particulate matter in packing house was also high. The drinking water quality parameters were in compliance with WHO standards. The results revealed that health and safety committee was not present in the sugar industry to keep check and balance.

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Introduction

To meet the demand of growing population sugar industry plays an important role. Sugar is considered staple food in some countries and sugarcane is usually grown in Asian countries, Caribbean and the South America (Khan, Deshmukh, 2015).

Sugarcane is an important crop in Pakistan. Pakistan lies in top 10 countries which supply a large amount of sugar to the world. In recent era, occupational diseases and accidents have increased due to lack of health and safety awareness and poor workplace environment. In Pakistan workers are exposed to hazardous chemicals on daily basis so occupational health risks are very high in industry. Most of the workers are not aware of protective measures because they are uneducated (Ashraf, 2011).

The objectives of this study were to:

- Identify environmental, health and safety conditions in selected sugar industry
- Monitor air, noise, temperature, humidity and water in sugar industry and to carry out risk assessment
- Conduct a gap analysis of health and safety conditions in sugar industry according to OSHA.

In Pakistan industries play an essential role in economic development. Serious problems are creating for workers due to bad environmental conditions in industries. The study was carried out in Bhalwal sugar mill to observe the impacts of that industrial environment on workers health. Various workers were selected to collect questionnaires data. Results showed that physical as well as social environment of the industry was affecting the workers health status. Depression and nervousness was found among workers (Bhatti and Shaikh, 2015).

An occupational hazard is usually a situation that has potential to harm workers. There are two types of occupational hazards i.e. health hazards and safety hazards. If any worker suffers from illness due to hazards then this hazard would be health hazard. On other hand if hazards physically injure employees due to any accidents then it is called safety hazards (Jadab, 2012).

In Pakistan, very less data is available on occupational diseases and accidents because most of the accidents are not reported. Cases of injuries vary from minor to major. About 40% sugar industry workers suffered from different disorders according to the report of 2011. Workers of other developing countries are also facing more workplace health related disorders (Phoolchund, 1991).

There are some important environmental concerns associated with sugar's processing in industry for example air pollution, noise pollution, water pollution and solid waste. For sugar cane processing a large amount of water is used which can cause water pollution if not treated properly. And water pollution can be produced due to the effluent which is produced during equipment cleaning (Saiyed; Tiwari, 2004). Mechanical devices generate high noise level and can cause health hazards to the workers (Plog *et al* 2002).

The potential risks to safety and health for those who work outside their house is called occupational health hazard. According to World Health Organization, 70% of young men and up to 60% young women enter the workforce worldwide each year. Protection and promotion of health of workers by reducing occupational accidents, diseases and hazards at workplace is the aim of occupational health. It is necessary to develop safe and healthy working environment (Robson, 2007).

In developing countries workers are facing many problems such as health issues in various industries. But this study focuses on sugar industry health issues. Sugar cane employees have more risk to expose pesticides and these pesticides have high toxicity. Lung cancer has increased among sugar industry workers. When cane is cut and foliage is burned it may create problems. With the exposure of bagasse bagassosis issue can be created. The productivity of workers is also reduced due to chronic infections (Phoolchund, 1991).

Inhaling bagasse dust in sugar mill causes lung disease called bagassosis. Chemical burning may cause dermatitis and sometime dermatitis due to interaction with sugar and lime. At different phases of the process various poisonous gases are released which are hazardous for human health (Harry and Henels, 1991).

In sugar industry large amount of bagasse is produced during sugar manufacturing so workers may be at risk. The exposure to airborne bagasse dust can cause diseases. A study was conducted in KhonKaen to assess the exposure of laborers to bagasse dust. 0.08 to 9 mm is the bagasse dust particles size range and it may be 2.1 to 4.7 mm. It was found that workers in KhonKaen industry were exposed to bagasse particles which were high in concentrations. They were at risk of diseases like respiratory diseases. Due to bagasse exposure bagassosis problem has increased in sugar industry workers. Chronic respiratory problem has increased due to bagasse exposure that could decrease the productivity of workers. Due to diseases, worker's family suffers in term of cost of his treatment (Balge MZ, Krieger GR. 2012).

A study was conducted in Iranian sugar mill to assess the prevalence of musculoskeletal disorders and exposure level to that risk among production workers. Randomly 116 laborers from industry were selected for study. Musculoskeletal disorders were found among 87.1% workers. 58.6% prevalence was recorded in knees of workers and it was much more prevalence. Musculoskeletal disorders had increased in developing countries due to absence of good working conditions. In Iranian sugar mill, lifting of heavy load was common; so many workers suffered from musculoskeletal disorders (Kroemer and Grandjean, 1997).

On environmental health and safety problems various studies have been conducted. In Pakistan sugar industry was selected to evaluate occupational health conditions. Main agro based mill is sugar mill in Pakistan.

Different processes are carried out in sugar industry and it may cause frequent accidents if the occupational health and safety regulations are not implemented. In sugar industries many injuries had happened but on worker health and on ergonomics little research was done. With the help of surveys and questionnaires the quantitative and qualitative data of various sugar mills were collected. From the results it was concluded that workers in Pakistan sugar industry that had injuries were 15 to 20%. Only 40% labors of sugar industry were using such safety equipment. Noise level in the sugar industry was recorded which was 85 to 112 dB and it affected the hearing sense of workers very badly. From results it was indicated that existing conditions were not acceptable in sugar industry regarding occupational health. It is necessary to minimize accidents in industry by creating awareness among workers (Asad *et al.,* 2013).

Materials and methods

Selection of study area

The Sugar mill was selected for the study of health and safety conditions. It is located in District Mandi Bahauddin of Punjab province in Pakistan.

Data Collection

Questionnaires and Checklist Designing

Questionnaire survey and checklist was designed by following occupational health and safety standard questionnaire/checklist. Through checklist, information regarding industrial physical conditions (light, floor, and ventilation), list of equipment, personnel protective equipment, first aid and environmental conditions was obtained. Questionnaire survey was conducted to get information regarding mental and physical health of workers and satisfaction of workers regarding safe and better working environment of sugar industry. Forty workers participated in the survey.

Survey for gap analysis

To evaluate the health and safety conditions in sugar industry, checklist survey was conducted to carry out gap analysis according to OSHA's standards.

Secondary data was collected from Literature review, books, journals, published articles and related organization etc while primary data was collected through questionnaires and checklist surveys, monitoring and sampling.

Sample collection

Drinking water sample was taken from the tap to assess the quality of drinking water of industry by analysis.

Environmental Monitoring

The following parameters were monitored in industry.

- Noise monitoring
- Air monitoring (PM)
- Temperature
- Humidity

Noise monitoring

Noise level was measured by using sound level meter 840029 (SPER SCIENTIFIC) in the industry. The sound level meter was placed at 7.5m distance from the centre of source. Noise level from various sections such as mill section, process house, packing house, boiler house and turbine section was measured.

Air monitoring

In air monitoring, dust level (particulate matter) was measured from different sections of sugar industry such as mill section, process house, packing house, boiler house and turbine section by using Casella model. No CEL-712 Microdust Pro.

Temperature and humidity

Temperature and humidity was measured by using Digital temperature humidity meter HTC-1. Various sections were selected for temperature and humidity measurement because mostly workers are exposed to these sections such as mill section, process house, packing house, boiler house and turbine section. The instrument automatically showed temperature and humidity level when it was placed at sugar industry selected sections.

Analysis of drinking water quality parameters

Different parameters of drinking water were determined for example pH, DO, temperature, TSS, TDS, and total hardness

Table 1. Instruments used for drinking water quality parameters.

Sr. no	Parameters	Instrument	Method no
1	pH	PC 510 pH meter	ASTM D1293-12
2	DO	970 DO2 meter JENWAY (DO meter)	ASTM D 888-12e l
3	Temperature	Thermometer	_
4	TSS	Analytical balance/Filtration	D5907-13
5	TDS	China dish	2540C (2012)
6	Total Hardness	Titration	ASTM D 1126-12

Hazard identification and risk assessment

Hazards were identified in the sugar industry through inspection. By using risk evaluation matrix risk assessment was conducted and in terms of Risk Prioritization Number that is product of severity and likelihood the risk was evaluated. If RNP was greater than 6 then other control measures were recognized. To check the additional control measures effectiveness, in terms of RNP the risk was again evaluated.

RPN= Likelihood * Severity

Results and discussion

Environmental monitoring

Environmental monitoring of different sections of sugar industry was done in three different months i.e. November, January and March because the most of the processing of sugarcane is dine during this time period. Five sections of mill section, process house, packing house, boiler section and turbine section were selected for monitoring purpose because most of the workers work in these sections. Parameters monitored were noise, temperature, humidity and particulate matter.

Table 2. Results of Environmental monitoring.

Parameter	Month	Mill section	Process house	Packing house	Boiler section	Turbine section	Standard value OSHA
Noise(dB)	November	84	84.4	92.1	87.1	93.4	85
	January	85	86.2	93.3	88.2	95.4	85
	March	83	84.1	90.2	85.6	91.3	85
	Average	84	84.9	91.8	86.9	93.3	85
Temperature (°C)	November	24	28	24.7	38	31	25
	January	26	30.4	25.6	41	29.7	25
	March	25	29.8	24.5	40	27.8	25
	Average	25	29.4	24.9	39.6	29.5	25
Humidity (%)	November	56.4	57	59.7	57	58	20-60
	January	59.2	67	64.4	59	54	20-60
	March	57.6	65.6	62.5	60	56.8	20-60
	Average	57.8	63.2	62.2	58.6	56.2	20-60

The table above shows that the noise levels in mill section was within permissible limits but in process house it was slightly higher in January. In boiler and turbine sections, it was found to be higher than OSHA's limit during all three months.

As far as temperature is concerned the boiler and turbine sections were found to be hotter than standard value in all three months. This may cause heat stress among workers. Humidity of process and boiler sections was found to be higher during January and march. The values of environmental parameters were exceeding during January and march, it was due to the increase in processing activity during these months.

PM10 was found to be higher in packaging house. The level of particulates matters in boiler section was high due to bagasse dust. In packing house, due to the inadequate ventilation system the level of particulate matter was high. In sugar industry large amount of bagasse is produced during sugar manufacturing so workers may be at risk. Chronic respiratory problem has increased due to bagasse exposure that could decrease the productivity of workers. Due to diseases, worker's family suffers in term of cost of his treatment. In sugar mills the main health irritants are high noise, bagasse dust and fly ash. Asthma, eye pain and respiratory diseases are major problems usually due to bagasse dust and excessive fly ash exposure. Due to bagasse dust a lung disease create called bagassosis when we inhale dust particles.

In present research drinking water samples were collected to check the water quality of it and following parameters such as hardness, DO, temperature, TSS and TDS were analyzed. Tests were done three times in each month like November, January and March hence average value was calculated and it was compared with WHO standard. All the parameters were within permissible limits.

Table 3. Results of Air Monitoring.

Sr. no	Month		Mill section (µg/m³)	Process house (µg/m³)	Packing house (µg/m³)	Boiler house (µg/m³)	Turbine section (µg/m³)	NEQS (µg/m³)
1	November	Maximum	480	389	595	518	335	550
		Average	200	230	478	359	220	
2	January	Maximum	495	420	656	560	347	550
		Average	370	295	530	415	256	
3	March	Maximum	430	359	560	510	320	550
		Average	365	215	445	347	215	

Table 4. Drinking water quality parameters.

Sr. no	Parameter	Results			WHO standards
		November	January	March	
1	pH	6.60	6.64	6.62	6.5-8.5
		6.62	6.68	6.61	
		6.64	6.69	6.64	
	Average	6.65	6.67	6.62	
2	DO	1.12mg/L	1.21 mg/L	1.15 mg/L	5mg/L
		1.1mg/L	1.23 mg/L	1.2 mg/L	
		1mg/L	1.20 mg/L	1.26 mg/L	
	Average	1.07mg/L	1.23 mg/L	1.20 mg/L	
3	Temperature	24.2°C	22.1°C	25.4°C	40°C
		24.1°C	22.4°C	26°C	
		24°C	22.2°C	25.3°C	
	Average	24.1°C	22.2°C	25.6°C	
4	TSS	0.006mg/L	0.007 mg/L	0.004 mg/L	<1000mg/L
		0.005mg/L	0.008 mg/L	0.009 mg/L	
		0.004mg/L	0.006 mg/L	0.008 mg/L	
	Average	0.005mg/L	0.007 mg/L	0.007 mg/L	
5	TDS	0.003 mg/L	0.002 mg/L	0.002 mg/L	<1000mg/L
		0.002mg/L	0.003 mg/L	0.005 mg/L	
		0.001mg/L	0.004 mg/L	0.001 mg/L	
	Average	0.002mg/L	0.003 mg/L	0.002 mg/L	
6	Total hardness	0.435mg/L	0.544 mg/L	0.531 mg/L	500mg/L
		0.434mg/L	0.546 mg/L	0.499 mg/L	
		0.42mg/L	0.55 mg/L	0.528 mg/L	
	Average	0.42mg/L	0.54 mg/L	0.51 mg/L	

Results of questionnaire survey

Questionnaire survey was conducted in sugar mill to get the information regarding workers physical health, satisfaction of workers regarding safe and better working environment and personal protective equipment. Results of questionnaire survey showed that the work environment was not up to the mark. As many factors were not according to OSHA's standards as shown below.

Section 1 (Demographic Information)

Table 5. Frequency distribution table of demographic information.

Characteristics	Percentage (%)
Gender	
Male	100
Female	0
Age	
21-30	45
31-40	42
Above 40	13
Weight	
60- 75	45
76-90	55
Work duration	
7hours	22
8hours	53
9hours	25
Previous work experience	
1-4years	47
5-8years	17
More than 8years	13
None	23
Smoke at your workplace	
Yes	12
No	88

Section 2 (Working conditions)

Table 6. Working condition.

Working conditions	Percentage (%)
Company provide safe and healthy work environment	
Always	57
Sometimes	43
Workers and management work together to ensure the safest possible working conditions	55
Agree	45
Disagree	
Floors clean and dry	
Yes	75
No	25
Lights working properly	
Yes	90
No	10
Fire extinguishers installed at your work place	100
Yes	0
No	
Job satisfaction	
Very satisfied	25
Satisfied	67
Not satisfied	8
Current work load manage	
Easily managed	75
Heavy	25

Section 3 (Environmental conditions)

Table 7. Environmental conditions.

Environmental conditions	Percentage (%)
Ventilation system adequately removes toxic dust and gases	
Agree	45
Strongly agree	5
Disagree	50
Noise level within acceptable level	
Yes	77
No	23
Awareness about harms of noise	
Agree	80
Disagree	20
Records helpful	
Yes	85
No	15
Inspection at what time interval	
Monthly	42
Yearly	58
Employees participation in OSHA committees	
Yes	32
No	68

Section 4 (Personal protective equipment)

Table 8. Use of PPEs.

PPEs	Percentage (%)
Supply of PPEs	
Yes	90
No	10
Use of safety gloves and masks	
Yes	60
No	40
Use of earmuffs	
Yes	25
No	75
Maintenance of PPEs in sanitary conditions	
Yes	75
No	25

Section 5 (Health hazards)

Table 9. Health hazards.

Health hazards	Percentage (%)
Awareness about term of OSH hazards	67
Yes	33
No	
Currently have hearing problem	
Yes	10
No	90
Have any Bagasse related disease	
Yes	20
No	80
Have any heat related illness	
Yes	15
No	85
In past 12months any injury	
Yes	30
No	70

Table 10. Gap Analysis.

Hazard Assessment		
1	Do you conduct a pre analysis for new processes, materials?	No
2	Do you conduct periodic self inspections?	No
3	Is there a medical program in place?	No
Housekeeping		
1	Are floors clean and dry?	Yes
2	Are all work areas are adequately lighted?	Yes
3	Is the work area's ventilation system appropriate for the work being performed?	No
Noise		
1	Are noise levels in work areas within acceptable level?	No
2	Are noise measurement records maintained for at least two years?	No
Fire protection and prevention		
1	Have procedures been established for sounding emergency alarms in the workplace?	Yes
2	Does the company have a written fire prevention plan?	No
3	Are fire extinguishers provided in adequate number?	No
4	Is the fire alarm system tested as required?	No
Electrical Equipment		
1	Is adequacy of lighting satisfied?	Yes
2	Are switches/fuses/circuit breakers Labeled?	Yes
3	Is storage of electrical equipment satisfied	No
Emergency response		
1	Is there an emergency response plan for your facility?	Yes
2	Do employees know how to contact and what to do in emergency?	Yes
3	Does the facility have a workplace violence awareness and prevention Program?	No
Medical services and first Aid		
1	Has an emergency medical plan been developed?	Yes
2	Are medical personnel readily available for advice and consultation on work related health issues?	No
3	Are emergency phone numbers posted?	Yes
Personal protective equipment		
1	Are personal protective equipment like hats, gloves, ear plugs, and masks	Yes

	provided at workplace?		
2	Is hygiene and effectiveness of protective equipments maintained?	Yes	
3	Is training on the use, care and disposal of PPE conducted and documented?		No
Records keeping			
1	Are employee safety and health training records maintained?		No
Environmental control			
1	Is environmental monitoring (air, noise, and water) performed on a periodic basis?		No
2	Are restrooms and washrooms kept clean and sanitary?	Yes	
Employee Participation			
1	Are the employees involved in the safety and health program?		No
2	Do the employees participate in safety and health committees?		No
Exit			
1	Are there sufficient exits to permit prompt escape in case of emergency?		No
2	Are doors which are required to serve as exists designed and constructed so that the way of exit travel is obvious and direct?		No
Injury and illness prevention program			
1	Is there a system in place to identify and control workplace hazard?		No
2	Are systems in place to ensure management and labor accountability?		No
General			
1	Zoning of noise or other hazard area		No
2	Awareness of personnel to occupied hazards		No
3	Safety training programmers		No

Source [13]

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