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# Detection of VOC in blood of workers of a rice mill and their occupational health and safety conditions

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**Key words:** VOC, Rice mill.

**Abstract**

An occupational health hazard is defined as the potential risks to health and safety for those who work outside the home. Some occupational health and safety hazards are expected in rice mill and psychological and social issues are very common in industries. These issues can be excessive work load, physical assort, asthma, headache and volatile organic compounds in blood etc. The objective of this study is to identify the environmental health and safety hazards in Rice mill. Monitoring and experimental work are also done to check the environmental conditions. To check the quality of water, some tests are done e.g pH, TSS, TDS, hardness and temperature. Noise is measured by noise level meter and dust analyzer is used to monitor particulate matter. The technology is used for determination of volatiles organic compounds is Gas chromatography. Results shows that highest value of pH is 6.59, DO is 1.75mg/L, TSS is 0.006g, TDS is 0.002g, noise is 105 dB, TSP is 3350µg/m3. So water quality is good and noise level and total particulate matters are high. Benzene, ethyl acetate and toluene are detected in blood samples. For fulfilling the requirement of sustainable operation, both government and industrial members have to work in coordination with each other.

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**Introduction**

Due to increase in population, there is an increased demand of products. Industries increase their production capacities in order to fulfill the demand of people. In industry (rice mill) selected for research, environmental health and safety regulations are not implemented. During rice production, there are several environmental issues associated with processing for example air pollution, water pollution, and noise pollution and these environmental hazards can cause serious health problems e.g. deafness, lung diseases, allergic skin diseases and respiratory disorder in workers.

These problems arise due to absence of implementation of occupational health and safety regulations, technologies and unawareness in people. Lack of implementation of occupational health and safety regulations not only impact the environmental conditions but also affect the workers' health at the workplace. This research will help in identifying and evaluating environmental health and safety hazards in industry to mitigate problems by implementation of occupational health and safety regulations and by creating awareness in people.

Several reports have suggested that hematological disorders occurred due to dust exposure in agricultural setting. Rice mill workers were exposed to dust and rice husk at their workplace so their hematological parameters could be affected.

Exposure to Rice husk has a long history association with disease, and it could cause adverse effect on organ such as skin, eyes, lung, nose and the hematological parameters. Rice husk have a high silica content and Rice Husk dust could damage to bronchial passage and elastic component of alveolar walls. Rice husk dust contains air borne endotoxins which could cause inflammatory reaction in bronchopulmonary system. (Shobha 2012, Levy and Wegman 2000).

The majority of health hazard arose when the workers breathe in the environment containing poisonous gases.

Moreover, it also damaged lungs and caused fatal diseases. Most of the workers usually did not take precautionary measures as they delivered the factory products. As the products could pollute the air so they can also affect the workers if they had prolonged exposures (European Foundation 1996).

Health and safety professionals recognized these occupational factors by carefully observing the ingredients used in the producing certain product and also noticing the things produced at the end and by also taking the unnecessary things into the account. Researchers got this knowledge by a survey i.e. they distributed some sheets asking certain questions in different industries that are hazardous and the estimated the result form this data and this was done under an international organization (European Foundation 1996).

A number of researches have done on the environmental health and safety issues. Workers in rice mill are exposed to rice husk dust and they were also exposed to pesticides during harvesting. Pesticides are source of VOCS.

The study suggested that workers in mill were also working as farmers. Exposure to husk and pesticides affect their hematological parameters. Some studies were conducted in order to study the effect of rice dust and husk on workers in rice mill.

The study was conducted in Lucknow District to determine the relationship between adverse health impacts and exposure to rice husk dust and it was observed that husk effect various organ such as nose, eyes, skin, lung of workers because it have a high silica content (Anisha and Bansode, 2014).

The objective of this study is to identify the environmental health and safety hazards in Rice mill. Monitoring and experimental work are also done to check the environmental conditions. To check the quality of water, some tests are done e.g pH, TSS, TDS, hardness and temperature.

## Materials and methods

*Selection of study area*

The Ameer rice mill is selected for the study of environment, health and safety conditions. It is located in district Mandi Bhudin.

*Data Collection*

Primary data was collected through Questionnaire, Checklist and Analysis (Particulate emissions in air, Drinking water and noise). Secondary data was collected through Literature review, from books, journals, and related data from organization etc.

*Questionnaires and Checklist Designing*

Questionnaires and checklist were designed by following OSHA checklist to get the information of industry regarding area of the industry, surrounding, location, solid waste, water pollution, air emission, noise, light intensity, list of machines and equipment, physical condition (floor, roof, walls, light and ventilation) and environmental condition, personnel protective equipment, first aid and firefighting). The questionnaire and checklist also covered the following aspects.

a) Relations between employees
b) Health
c) Working environment

*Collection of Samples*

Samples of drinking water and blood samples of employees were collected for analysis. In order to assess drinking water quality of the study area, samples were collected from the tap.

*Monitoring*

*Noise monitoring*

Sound level meter 840029 (SPER SCIENTIFIC) was used for determining noise level in industry. Sound level was measured at house mill. The instrument was placed at a distance of 7.5 m from the center of source. Noise level was measured in decibel (dB).

*Air monitoring*

For air monitoring, Casella model no. CEL-712 Microdust Pro was used, to determine particulates at the selected site. Air monitoring was done in the house mill where processing of rice occurred.

Ambient air quality was monitored for 24 hours at the center of the rice mills for total suspended particulates.

*Blood Sampling*

Blood samples were collected by following these steps

*Consent form*

According to international ethical guidelines for biomedical research consent should be taken from those workers who voluntarily participate in the research. Therefore consent form were signed by the workers before taking samples. In the present research participation of workers was voluntary. Blood samples were taken after 8 hours work shift and were labelled and preserved with a private code number.

Fourteen blood samples of workers were collected from rice mill and these workers were also working as farmers. Following VOCs were selected to be analyzed in blood of workers based on literature and primary data collection.

- Isopropyl alcohol
- Phenol
- Benzene ethanol
- Ethyl acetate.

*Experimental work*

*Chemicals*

The laboratory grade purity chemicals which were used while conducting present study were

- Methanol
- Isopropyl
- Benzene
- Dichloromethane
- Ethanol Ethyl acetate.

*Blood collection Method*

For the collection of blood samples from worker a trained paramedical staff member was hired. Samples were collected after 15 to 20 minutes of 8 work shift. For VOCs analysis in blood especially treated vial known as gray top vacutainers of 5 ml was selected depending on the need of sample.

These vacutainers contain sodium fluoride and potassium oxalate as preservative and anticoagulant respectively. The blood samples of workers were obtained by venipuncture (using BD 5ml syringe).after blood collection the vial was shaken well 2 to 3 times to prevent blood clotting. Blood samples were then immediately placed in a container containing ice cubes. Finally the samples were transferred to laboratory and were stored at 4 degree centigrade. The collected blood samples were analyzed within ten days of collection.

*Blood sample preparation method*

On the day of running sample on GC, vacutainers containing blood samples were removed from refrigerator at least 30 minutes before the sample preparation in order to bring them room temperature. After 30 minutes blood samples preparation was started with great care. whole blood of approximately 1.5 mg/L was taken from vacutainers with the help of syringe.

Then the blood was injected in another vial containing 1.5 mg/L of methanol. The vial was shaken carefully. After shaking, 3mg/L of sample was taken by syringe. Then this syringe was replaced by another syringe on which a micro filter was attached. Then through microfilter blood was poured into another vial containing 1mg/L of methanol. Finally 4mg/L blood sample was ready to run on GC.A discard box was prepared to pull all the used syringes, vacutainers, micro filers, gloves and other hazardous waste. Every time after sample preparation the discard box was immediately sent to the nearest hospital waste bin with great care.

*Analysis*

There are many techniques which can be used to analyze VOCs in blood. These techniques are gas chromatography-mass spectrometer (GC-MS), headspace gas chromatography along with mass spectrometer (HS-GC-MS) and gas chromatography with flame ionization detector (GC-FID).In this study GC-FID was used to analyze VOCs presence in blood. VOCs analysis was done qualitatively and quantitatively.

*Qualitative analysis*

Qualitative analysis was done to determine the presence of different VOCs in the prepared blood samples. Peak showing the maximum height was selected from the chromatogram of standard and then this selected peak was found in sample chromatogram. Peak, retention time (min) for each standard was noted. The noted retention time (min) of the peak in chromatogram of standard solution was then taken to make comparison with the retention time (min) of the peaks in the sample chromatogram.

*Quantitative analysis*

Quantitative analysis of results was done by calculating response and relative response factor (RRF).

*Response factors*

From results of analytes, peak area and concentration were taken to calculate response factor following equation (i) and (ii) were used to calculate response factor Response factors =Peak area of standard (A) Equation (i) Concentration

Response factors = Peak area of sample (B) Equation (ii)

**Results and discussion**

pH is very important. It has been reported that pH below 4 can cause redness and irritation of the eyes. pH below 2.5 can damage the epithelium which is irreversible and extensive. Exposure to extreme pH values results in irritation to the eyes, skin and mucous membrane Results analysis of pH has showed its compliance with WHO Standard i-e 6.5-8.5. As far the odor is concern none of the samples has exhibited any objectionable smell. The results has shown that all source were clean and free of impurities (Table 4.1).

In present research drinking water samples were collected. Turbidity, DO, TSS TDS and hardness were the parameters which were analyzed to check the drinking water quality of the industry.

**Table 1.** Drinking water quality.

| Parameters | Results | | | WHO standards | Instruments |
|---|---|---|---|---|---|
| | October | December | March | | |
| pH | 6.59 | 6.60 | 6.48 | 6.5-8.5 | pH meter |
| TDS(mg/L) | 0.002 | Nill | Nill | <1000mg/L | China dish |
| TSS(mg/L) | 0.006 | 0.005 | 0.002 | 1000mg/L | Filtration |
| DO(mg/L) | 1.75 | 1.70 | 1.58 | 5mg/L | DO meter |
| Total hardness (mg/L) | 0.435 | 0.402 | 0.394 | 500mg/L | Titration |
| Temperature (°C) | 22 | 21 | 20 | 40°C | Turbidity meter |

A positive effect of the presence of suspended solids in water is that toxic chemicals such as pesticides and metals tend to adsorb to them or make complexes with them which make the toxics less available to be absorbed by living organisms. The current study has shown the value of TSS, TDS, DO, temperature and hardness of drinking water.

Test for the detection of TSS and TDS were done in October, December and March. These three months were selected because in October, both harvesting and processing of rice was done and in December, only processing of rice was done and in March, neither harvesting nor processing was done. And all the water source were clean so results analysis of all parameters showed their compliance with WHO Standard (Table 4.1)

**Table 2.** Noise level.

| Parameter | Results | | | | | | Standard (NEQS) | Instrument |
|---|---|---|---|---|---|---|---|---|
| | October | | December | | March | | | |
| | min | max | Min | Max | Min | max | | |
| Noise | 43 | 105 | 42 | 103 | 29 | 70 | 85dB | Noise level meter |

Noise pollution was also monitored by noise level meter. Noise monitoring was done in three months October, December and March. These three months were selected because in October, both harvesting and processing of rice was done and in December, only processing of rice was done and in March, neither harvesting nor processing was done. In October, minimum value was 43dB and maximum values was 105dB which show that these values do not comply with NEQS standard value 85db. In December, maximum value of noise was 103db which does not fall in permissible limit (Table 4.2).

**Table 3.** Total particulate matter.

| Parameter | Results | | | | | | Standard (NEQS) | Instrument |
|---|---|---|---|---|---|---|---|---|
| | October | | December | | March | | | |
| | average | max | average | max | average | max | | |
| Total particulate matter | 1644 | 3350 | 1005 | 2456 | 200 | 480 | 550 µg/m3 | Dust analyzer |

Total particulates matter was monitored in three months October, December and March. In October, average value was 1644 µg/m3 and maximum values was which 3350µg/m3 which show that these values do not comply with NEQS standard value 550 µg/m3. In December, average value was 1005 µg/m3 and maximum values was which 2456 µg/m3 which show that these values also do not comply with NEQS standard value.

In March, average value was 200 µg/m3 and maximum values was which 480 µg/m3 which means that these values were not exceeding the standard values given by NEQS (table 4.3). The reasons behind the high concentration of total suspended particulate in October and December was that processing of rice was done in October and December. The value was high in October because only in October both harvesting and processing of rice was

done and due to inadequate ventilation system in industry, more concentration of particles were present. In March, TSP values were not exceeding the standard values because processing was not done in this month. Husk produce from the rice husk would affect various organs such as eye and lungs [11].

**Table 4.** light intensity.

| Parameter | Results | | | Standard (NEQS) | Instrument |
|---|---|---|---|---|---|
| | October | December | March | | |
| Light intensity | 4.7 | 4.4 | 3.9 | 5 foot candles | Lux meter |

Light intensity was also monitored in three months October, December and March. In October, value was 4.7 foot candles and the standard value was 5 foot candles. In December, value was 4.4. In March, value was 3.9 because no processing was done in March (Table 4.4).

*Results of Questionnaire survey*

**Q (1):** Workers and management work together to ensure the safest possible working conditions.

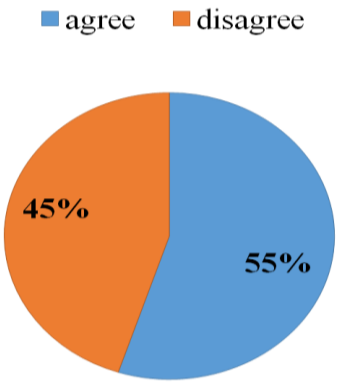


**Fig. 1.** Working condition.

This Fig. shows that 45% people were agreed that Workers and management work together to ensure the safest possible working conditions and 55% were disagreed.

**Q (2):** Are Floors are clean and dry?

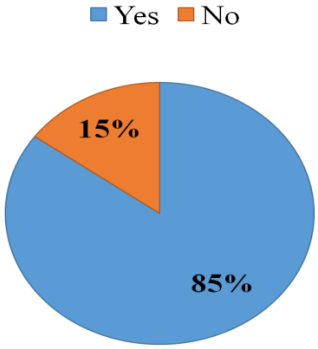


**Fig. 2.** Cleanliness.

This Fig. shows that 85% people were agreed that floor are clean and dry in industry while 15% disagreed to this statement.

**3)** In the past 12 months, have you been injured during your work?

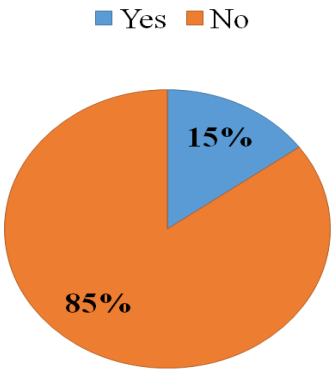


**Fig. 3.** Injury.

This Fig. shows that 15% workers were agreed that in the past 12 months, they have been injured during your work and 85% were disagreed.

**4)** Do you have any dust related disease like asthma and allergies?

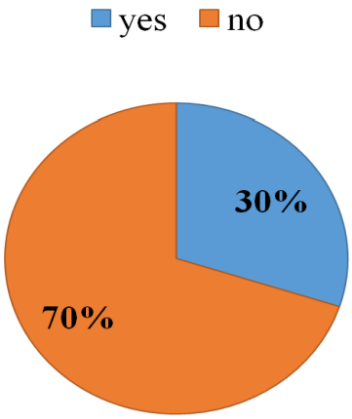


**Fig. 4.** Dust related disease.

It depicts that 30% workers said that they have dust related diseases and 70% said that had not any dust related diseases.

**5)** Do you have lung disease?

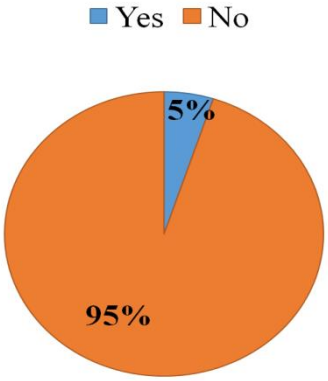


**Fig. 5.** Lung disease.

This Fig. shows that 5% people were agreed that they have lung disease and 95% were disagreed to this statement.

**6)** Are the lights working properly at work place?

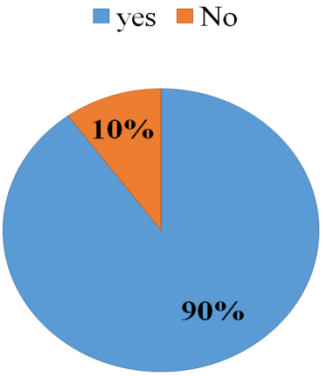


**Fig. 6.** Light.

This Fig. shows that 90% workers said that lights were adequate at work place and 10 % were disagreed.

**7)** Are personal protective equipment provided?

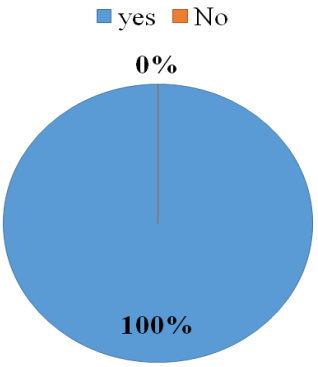


**Fig. 7.** Availability of personnel protective equipment.

It shows that 100% workers were satisfied with the availability of personnel protective equipment.

**8)** Have you installed fire extinguishers at your work place?

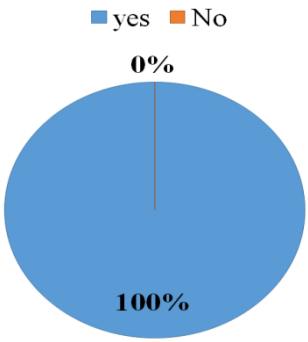


**Fig. 8.** Installation of fire extinguishers.

Fig. 4.8 shows that 100% workers were satisfied with the installation of fire extinguishers

**Checklist survey, Gap Analysis**

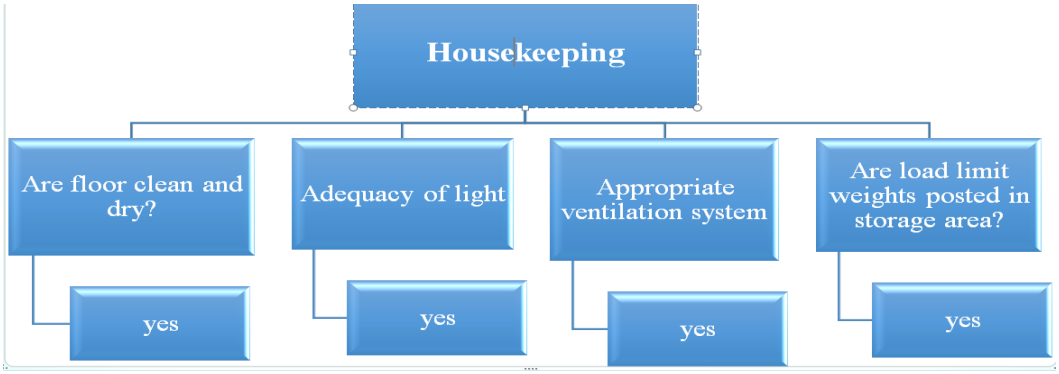


**Fig. 9.** Housekeeping.

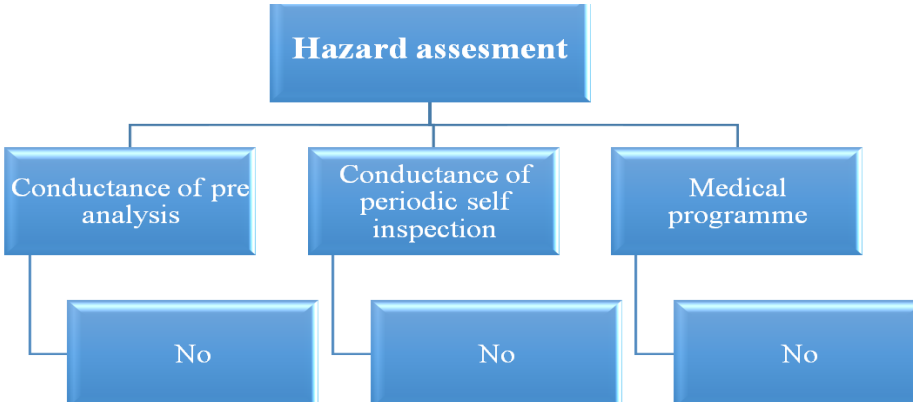


**Fig. 10.** Hazard assessment.

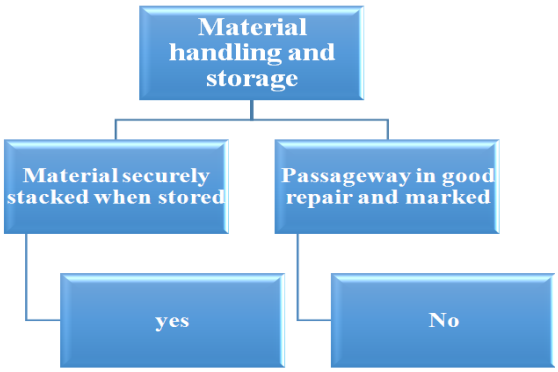


**Fig. 11.** Handling and storage.

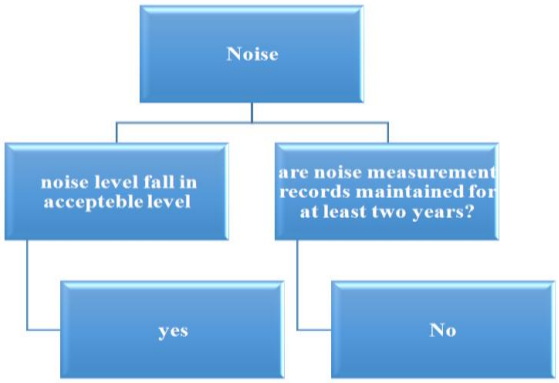


**Fig. 12.** Noise.

*Qualitative Analysis*

To determine the presence of VOCs in blood samples, qualitative analysis was done. Following steps are carried out for this purpose:

*Peak Identification*

Chromatograms of standards were obtained. Highest peak in chromatogram was selected. The selected peak is then located in each samples chromatograms. Peak, retention time (min) was noted for each standard. The noted retention time (min) of the peak in the chromatogram of standard solution was then taken to make comparison with the retention time (min) of the peaks in the sample chromatogram.

The presence or absence of priority benzene in all the samples were checked by comparing the retention time of standards (ethyl acetate, ethanol, DCM, Benzene, Toluene and xylene) with the samples retention time.

**Table 5.** Peak height and retention time of standards.

| Serial number | Standards | Peak Height | Retention Time (min) |
|---|---|---|---|
| 1. | Phenol | 2.35149e4 | 3.505 |
| 2. | Benzene | 2.65744e5 | 2.531 |
| 3. | Toluene | 2.48527e5 | 2.989 |
| 4. | Xylene | 1.20836e5 | 4.038 |
| 5. | DCM | 5.74967e4 | 2.375 |
| 6. | Ethyl acetate | 1.07008e5 | 2.445 |
| 7. | Ethanol | 6.71836e4 | 2.356 |

**Table 6**. VOCs detection in samples.

| Sample name | Phenol | Benzene | Toluene | Xylene | ethanol | Ethyl acetate | DCM |
|---|---|---|---|---|---|---|---|
| FH2020350 | ✘ | ✘ | ✘ | ✘ | ✘ | ✔ | ✘ |
| FH2020528 | ✘ | ✔ | ✘ | ✘ | ✘ | ✘ | ✘ |
| FH2020866 | ✘ | ✔ | ✘ | ✘ | ✘ | ✘ | ✘ |
| FH2020247 | ✘ | ✔ | ✘ | ✘ | ✘ | ✘ | ✘ |
| FH2020905 | ✘ | ✔ | ✘ | ✘ | ✘ | ✔ | ✘ |
| FH2020873 | ✘ | ✘ | ✘ | ✘ | ✘ | ✘ | ✘ |
| FH2020852 | ✘ | ✔ | ✘ | ✘ | ✘ | ✘ | ✘ |
| FH2020838 | ✘ | ✔ | ✘ | ✘ | ✘ | ✘ | ✘ |
| FH2021013 | ✘ | ✔ | ✘ | ✘ | ✘ | ✔ | ✘ |
| FH2020367 | ✘ | ✔ | ✔ | ✘ | ✘ | ✔ | ✘ |

Above table shows that ethyl acetate, Benzene and Toluene were detected in different samples while xylene, DCM, ethanol and phenol were not detected in any sample.

*Quantitative Analysis*

After the qualitative analysis quantitative analysis was done to check the concentration of ethyl acetate, Benzene and toluene in different water samples. Following steps are involved in this purpose.

*Response Factor*

Peak area and concentration will be taken from results of analytes to calculate response factor. Following equations (i) and (ii) will be used to calculate response factor. Response Factors= Peak Area of Standard (A) Equation (i) Concentration. Response Factors= Peak Area of Sample (B) Equation (ii) Concentration.

**Table 7.** Response factor of Benzene, ethyl acetate, and toluene.

| Serial number | Standards | Standard concentration | Peak area Standard | Response Factor = Peak area (A) Standard concentration |
|---|---|---|---|---|
| 1. | Benzene | 1000000 | $1.30x10^6$ | $1.30x10^6/1000000=1.3ppm$ (a) |
| 2. | Ethyl acetate | 1000000 | $3.72\ x10^5$ | $3.72\ x10^5/1000000 = 0.3ppm$ (b) |
| 3. | Toluene | 1000000 | $1.38x10^6$ | $1.38x10^6/1000000 =1.3ppm$ (c) |

**Table 8.** Concentration of VOC in blood sample.

| Sample Info | Peak Area | Retention time | Concentration of Benzene in sample (ppm) |
|---|---|---|---|
| FH2020528 | 2164.25415 | 2.572 | 1657.15 |
| FH2020350 | 59.59418 | 2.450 | 45.62 |
| FH2020247 | 772.37393 | 2.580 | 591.40 |
| FH2020866 | 159.50624 | 2.574 | 122.12 |
| FH2020852 | 30.95767 | 2.574 | 23.69 |
| FH2020838 | 3833.36133 | 2.572 | 2935.19 |
| FH2020905 | 6434.22461 | 2.570 | 4926.66 |
| FH20201013 | 658.20728 | 2.457 | 503.98 |

**Table 8.** Quantification of VOC's in Blood samples.

| Sample info | Benzene | Ethyl acetate | Toluene | Phenol | Ethanol | DCM | Xylene |
|---|---|---|---|---|---|---|---|
| FH2020528 | 2089.04 | ✘ | ✘ | ✘ | ✘ | ✘ | ✘ |
| FH2020350 | 57.51 | 160.18 | ✘ | ✘ | ✘ | ✘ | ✘ |
| FH2020247 | 745.53 | ✘ | ✘ | ✘ | ✘ | ✘ | ✘ |
| FH2020866 | 153.95 | ✘ | ✘ | ✘ | ✘ | ✘ | ✘ |
| FH2020852 | 29.87 | ✘ | ✘ | ✘ | ✘ | ✘ | ✘ |
| FH2020838 | 2.572 | ✘ | ✘ | ✘ | ✘ | ✘ | ✘ |
| FH2020905 | 2.570 | 164.35 | ✘ | ✘ | ✘ | ✘ | ✘ |
| FH2021013 | 2.457 | 1769.35 | ✘ | ✘ | ✘ | ✘ | ✘ |
| FH2020367 | ✘ | 3347.7 | 32.67 | ✘ | ✘ | ✘ | ✘ |
| FH2020359 | ✘ | ✘ | ✘ | ✘ | ✘ | ✘ | ✘ |

## Conclusion

Due to increase in population, there is an increased demand of consumer based products. Industries increase their production capacities in order to fulfill the demand of people. In industry (rice mill) selected for research, environmental health and safety regulations are not implemented and some issues are expected in mill. During rice production, there are several environmental issues associated with processing for example air pollution, water pollution, noise pollution and VOCS in blood. Although the results of environmental conditions show that environmental hazards are less except noise and particulate matters. The results of health and safety conditions suggest that industry is lacking health and safety committee that can keep a check and balance on the safety, training and maintenance of these conditions. For fulfilling the requirement of sustainable operation, both government and industrial members have to work in coordination with each other.

## Acknowledgment

Firstly I want to thank Allah for giving me an opportunity to study in such a prestigious institution with hard working teaching faculty who helped me a lot throughout the study. I would like to thank Dr. Rukhsana David (principal of Kinnaird College) and Miss Almas (Head of Environmental Sciences Department) to providing all the facilities to carry out the research.

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