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Original Research Paper

Environmental Profile of a Rubber Industry

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ABSTRACT

Rubber manufacturing industry is associated with emissions to the environment. The emission of the rubber industry has been linked to various diseases and diverse impacts on human health. Data are available which correlate the adverse health impacts with occupational hazards to the pollutants in the rubber industry. In order to characterize and quantify the pollutants being generated and discharged from various industrial outlets and their impacts on relevant air, water and noise quality, monitoring is required. The study highlights the environmental hazards due to air, wastewater and noise pollution in selected rubber manufacturing industry, located at Wazirabad. Monitoring of selected parameters was carried out for three months. Substantial concentration of volatile organic matter and particulate matter are present in the air in the unit place and the facility which poses a number of health and environmental hazards. Also, different chemicals used during manufacturing processes are discharged in effluent as wastewater. The determination of VOCs and PM in the air was carried out through VOC meter and HAZ-Scanner respectively. Parameters for wastewater analysis included pH, TSS, TDS, COD, cadmium, chlorine and iron. The noise level was also monitored. The results showed that the VOCs and PM concentration in the air were above the standard value limit. The concentration of VOCs ranged from 25.3-28.8 mg/m^3 while that for PM varied from 588.5-593.6 ppm respectively. The noise quality from two of the sources exceeded the limit value, while all the wastewater parameters were within the limit.

INTRODUCTION

Hazards caused by the industries to our environment come primarily in the form of air water and noise pollution. There are a number of industries producing different synthetic and non-synthetic products among which rubber industries play a role of giant backbone. Rubber manufacturing industry not only produces rubber goods as the prime product, but indeed produce massive amount of air, noise and water pollution as their by-products (Dlamini et al. 1996). There are various processes involved in the industry through which a raw form of rubber called latex starts its journey and passing through different steps and stages it comes to its final shape in the form of different products. The literature gives evidence that rubber industries are one of the major causes of air, water and noise pollution. A lot of volatile organic matter and other particulates are present in the air in the unit place and the facility. Also, different chemicals are used during manufacturing processes that are discharged as effluent into the environment. So the study was carried out in order to assess the air and noise quality of the work place and Wastewater characteristics so that necessary measures can be taken to protect workers from occupational exposure.

Many of the rubber mixing compounds, used within the industry, are fire explosives that includes sulphur and organic peroxides (usually used as curing agents) and azodicarbonamide used as a blowing agent in some open celled rubber.

There have been some historical records of mishandling of components in such departments, resulting in high explosions. During this process, a significant amount of highly reactive and flammable dust particles are released into the air. When these dust particles are released out of factory premises, they are transported to nearby areas and constitute a potential source of explosion at very low temperature (Akrill et al. 2002).

The extrusion process involves forcing uncured rubber through a die under pressure to form a shaped profile or sheet. Rotating knives can then cut the extruded material into pellets for further processing. This process poses potential mechanical hazards like the risk of a hand trap at point of feed and others (Akrill et al. 2002). A calendaring machine consists of a number of horizontal rolls usually called bowls. These bowls may be heated or unheated through which rubber is passed under high pressure to form sheets or thin cloth linings. This is also known as fractioning. Both the processes i.e. calendaring and extrusion are well known as giant noise makers within the industry. Their operating noise is so loud that a worker may get his eardrums dam-

aged due to continuous exposure to sound.

Generally the gases released from the rubber industry consist of chemical particulates such as CO_2, CO, sulphates, NOx, lead and other carcinogenic compounds which not only degrade the environment, but are also cause of numerous health problems in humans, such as skin cancer, irritation and damage to eyes and, bronchitis and lung cancer (Akrill et al. 2002).

According to the report of IARC (International Agency on Research for Cancer), rubber manufacturing industry has proven to be a great contributor towards air pollution. This industry basically adds unwanted latex vapours into the air during the process of heating and forming latex sheets. These serums of latex along with the heat fumes produce harmful toxic substances, especially carbon black in the air, which are seriously spreading the threat of skin cancer. The particles are irritant to eyes and distort the vision of the human being. In more severe condition total vision lost has been recorded in a massive rubber production zone. When these particulates are inhaled by living beings, these acts like irritants to the vocal and cause massive mucus production in humans and ultimately cause the air sacs in lungs to burst decreasing their air capacity and ultimate bronchitis and lung cancers. A person in such condition cannot revert at this stage and this keeps on getting worse by time. A person affected by bronchitis keeps on constant coughing and cannot relief even while asleep (Akrill et al. 2002).

Various toxic compounds are released into the air whenever rubber is heated in any of the process to mould its shape or to add mixtures to it. These emissions takes place nearly at every stage as rubber is a material that needs heat to be softened and then react with any of the additives to alter its shape. The studies show that the rubber industry releases large amount of hazardous compounds into the air including PAH, VOCs dust and other particulate particles. All this has a devastating effect upon humans, especially labour working in the industry (Akrill et al. 2002).

A short term exposure of humans to benzene may result in numbness of central nervous system (CNS) dysfunction and narcosis, cardiac arrhythmias (irregular heartbeats), irritation of upper respiratory tract, eye itchiness, involuntary eye movements, nausea, skin conditions and difficulty with sleep. Women exposed to benzene in their pregnancy have their children with growth deficiency, attention deficit, and limb anomalies. Both acute and chronic exposure to formaldehyde can lead a healthy person to suffer from eye, nose and throat irritation, coughing, chest pain and bronchitis. Reproductive effects such as, menstrual disorders and pregnancy problems have also been reported in exposed female workers. Animal inhalation studies have reported in increased incidence of nasal squamous cell cancer. It is considered as a human carcinogen (Beaulieu & Schmerber 2002).

Methanol exposure may lead to blurred vision, headache, dizziness and nausea. While birth defects in off-springs of rats and mice have been observed, no such information about reproductive, developmental, or carcinogenic effects in humans is available. Styrene, like formaldehyde, is also classified as a human carcinogen. It may effect the human CNS in much familiar way to formaldehyde. It may cause effects such as headaches, weakness, fatigue, and depression and hearing loss (Beaulieu & Schmerber 2002).

Excessive noise is created in rubber industry during the process of pressing latex sheets and by the working of its heavy machinery. This noise is so loud that it can be heard up to several miles in surrounding areas. When the factory workers are exposed to such noise, they are always at a high risk of losing their audible ability. Exposure to such high frequencies also hinders the communication ability of workers and may result in physiological and psychological effects including nervous breakdown, mental disorders, heart problems, high blood pressures, dizziness, inefficiency and insomnia (Savale 2014, Ismaila & Odusote 2014).

Rubber industry is one of the major water polluting industry. The effluents discharged by such industries consist of 30-40% of rubber and 60-70% of serum. These serum substances contain carbohydrates, amino acids and plant growth substances along with lactic acid, which is formed in the latex. The strong chemicals added in the rubber production are also present in the same quantity in serum. These include sodium sulphites, ammonia, axiloacid, bisulphate, metabisulphite and xylyl mercaptan. Water contaminated by such particulates cannot be used for any other domestic purposes. It also has the potential to pollute the ground water (Edirisinghe 2013).

The wastewater effluents from a rubber industry also contain oil contaminations found in latex. These oils when added into river bodies form a layer of algae over the surface disallowing the oxygen to dissolve with water which results in suffocation of marine life. It also prevents sunlight from entering and reaching to the river beds, to river plants and disrupts the process of photosynthesis, depriving fishes of oxygen and resulting in the ultimate death (Mensch 2003).

The emission of the rubber industry has been linked to various diseases and diverse impacts on human health. Data are available which correlate the adverse health impacts with occupational hazards to the pollutants in rubber industry (Mohammadi et al. 2010).

The present study was carried out to monitor selected

environmental parameters in order to identify the hazards caused by a leading export oriented rubber manufacturing industry.

MATERIALS AND METHODS

The study was carried out to identify environmental hazards related to rubber manufacturing. A rubber industry located in Wazirabad, Pakistan was selected as a study area. The industry manufactures rubber products since 1953. The industry has a complete manufacturing plant that is involved in production of the products through compounding, calendaring, extrusion, fabric braiding, knitting, and moulding, testing and at last finishing stage. Since 1953, the industry has been at the forefront of manufacturing industrial synthetic rubber products. Due to its popularity and work at a massive scale, it has achieved the loyalty of its customers including major wiring harness industries and air conditioning industries. Its main products include rubber automotives hoses which are now exported globally to various countries.

Monitoring of environmental parameters: After detailed study of production process and identification of the emissions from the industry, the task was to monitor air emissions.

Parameters selected for air monitoring included VOCs and PM. VOCs were monitored at the mixing department using VOC meter (PGM 3000) with a range of 1000-2000 mg/m^3 while PM measurement was done using Haz-Scanner, a portable device used to monitor ambient air quality.

Table 1: Wastewater parameters.

Parameters	Instrument/Equipment Used	Method Number
TSS	Filter paper, conical flask	APHA 2540
COD	COD reactor block	Hach method 8000
Cadmium	Atomic absorption spectrometer	APHA 3500
pH	pH meter	APHA 4500
TDS	Weighing balance, china dish	APHA 2540
Iron	Atomic absorption spectrometer	APHA 3500
Chloride	Atomic absorption spectrometer	APHA 3500

The device is specifically designed to measure the amount of USEPA criteria pollutants in the atmosphere.

Noise monitoring was carried out at the Mixing Department and Industrial Boundary Walls (North, South, East, West). Northern Side included: Raw Material Store, Western Side contained the: Hoses Manufacturing Area, Southern Side: Main Gate; Scrap area, Eastern Side houses: Tooling Store

Sound Level Meter was used to measure the noise values in units of dB(A). Sper Scientific 840029 sound meter was used in this regard. Reading of noise level was taken at a distance of 7.5 m from the centre of the source.

Wastewater collection and analysis: The Wastewater samples from the industry were collected for the purpose to analyse selected priority parameters. The sampling point selected was the main drain where effluent was released. Table 1 lists the priority parameters along with the standard method number and instruments used for effluent analysis.

RESULTS AND DISCUSSION

Air Monitoring

VOCs and PM in air- Mixing Department: The standard for VOCs has been taken from the Indoor Air Quality Guidelines and Standards of the National Research Council Canada (Charles et al. 2005).

The three month monitoring of the selected rubber industry for air quality showed a high amount VOCs and PM in the air (Figs. 1 & 2). The high amount was due to the fact that mixing department is the stage where raw rubber is mixed with different chemicals via mixing mills, thus using a lot of chemicals including, PVCs, elastic polymers, methyl ethyl ketone (MEK), toluene, benzene, ethyl chloride, dibutyl phatalate and zinc oxide, therefore emitting large concentration of dust, VOCs and particulate matter in the air. The results are given in Table 2.

The noise level was monitored from the mixing department as well as from four of the industrial boundary walls.

Table 2: Results of indoor air monitoring.

Sr. No.	Parameter/Units	Sampling months and average concentration			Standard
		Dec	Jan	Feb	
1	VOCs, mg/m^3	25	26.2	28	0.4(Japan) mg/m^3
		25.2	26.9	28.6	
		25.8	26.4	30	
	Average	25.3	26.5	28.8	
2	PM 10, ppm	588.6	586.2	592.6	150(NEQs) ppm
		588.2	587.4	593.4	
		588.7	590.1	594.8	
	Average	588.5	587.9	593.6	

Table 3: Summary of noise monitoring results.

Sr. No.	Source	Sampling Months & Average Noise Level dBA (Leq)		
		Dec	Jan	Feb
1	Mixing Department	78.5	80.6	82.9
		78.9	81.5	83.4
		79.6	83.0	85.2
	Average	79	81.7	83.8
2	Northern Side	58.1	61.9	63.6
		60.4	62.5	63.9
		62.8	62.8	64.8
	Average	60.4	62.4	64.1
3	Western Side	79.7	80.6	81.7
		79.9	82.7	82.8
		80.4	83.9	86.5
	Average	80	82.4	83.6
4	Southern Side	54.7	55.1	56.5
		56.2	56.8	56.7
		56.8	55.9	57.9
	Average	55.9	55.9	57.0
5	Eastern Side	51.9	56.2	59.1
		53.5	58.0	62.4
		53.7	58.7	63.9
	Average	53.0	57.6	61.8
	NEQs dBA(Leq)		75	

Table 4: Summary of wastewater analysis results.

Sr. No.	Parameters	Sampling months and average concentration, mg/L			NEQs mg/L
		Dec	Jan	Feb	
1	pH	7.61	7.76	7.82	6-9
2	TDS	398	406	412	3500
3	TSS	65	68	70	150
4	COD	25	27	28	200
5	Cadmium	0.01	0.01	0.02	1.0
6	Chlorine	6.4	7.2	8.0	1000.0
7	Iron	0.06	0.09	0.11	8.0

The results showed that the noise level at the mixing department and that of the western boundary wall, where the automotive hoses were manufactured, exceeds the NEQs (Figs. 3 & 4). These two sites were mainly involved in the production of rubber products, whereby rubber was manufactured, so has the highest noise level, thus exceeding the limit as compared to other three of the industrial boundary sites that were store house for the raw material and tooling house (Table 3).

Wastewater analysis: The results of Wastewater analysis (Table 4) showed that all the parameters were well within permissible limits. The Wastewater did not have short term effects on the environment as well as on humans. But it will affect the environment as long term exposure.

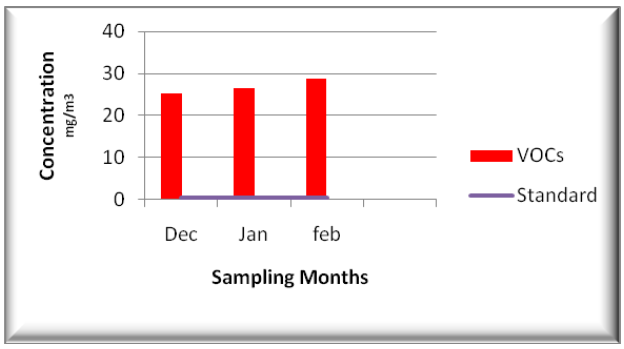

Fig. 1: Concentration of VOCs for Dec, Jan and Feb.

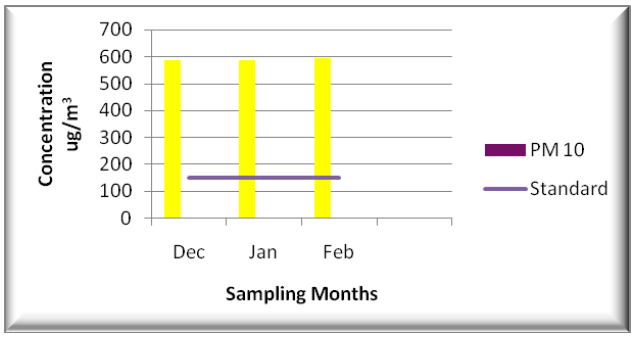

Fig. 2: Concentration of PM for Dec, Jan and Feb.

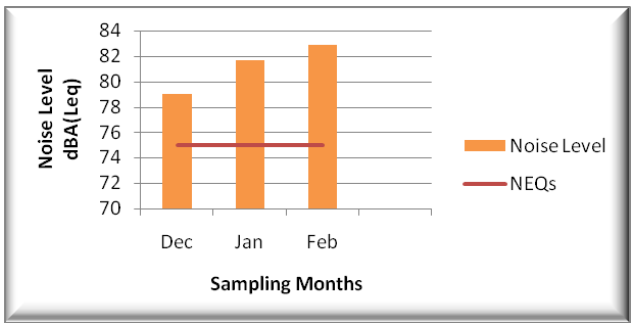

Fig. 3: Noise level from mixing department for Dec, Jan and Feb.

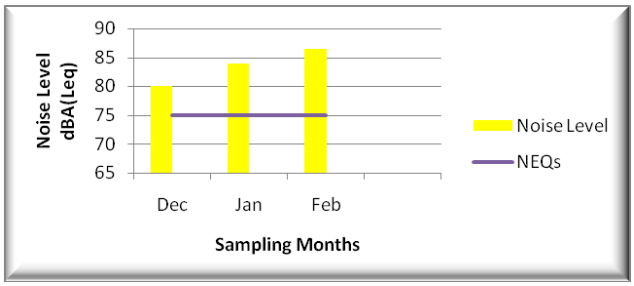

Fig. 4: Noise level from western side of boundary wall for Dec, Jan and Feb.

CONCLUSION

The research was about identifying environmental hazards at the rubber industry through environmental monitoring of air, wastewater and noise in the industry. It is concluded that the selected rubber industry may result in environmental and health impacts if proper controls are not put in place. The VOCs, particulate matter and noise pollution level within the industry were above the limits thus degrading the environment while the selected water parameters were below the limits. The industry should design and implement control measures to mitigate emissions in order to become sustainable.

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