

# Analysis of Occupational Hazard Factors and Control Measures at a Shoe Factory

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**Abstract.** Shoe factory workers are exposed to many kinds of occupational hazard factors, including organic solvents, dust and noise. In order to prevent and control occupational diseases and protect the health of workers, the situation of occupational harmful factors in production site of shoe factory was investigated. The concentrations of toxic substances in air were measured. The results showed that benzene, toluene, ethylene dichloride and noise exceeded the standards by 13.0%, 8.7%, 26.1% and 8.7%, respectively. The effect of occupational hazards management and control is poor, and the qualified rate of monitoring in workplaces is low. The employers should strengthen the management and control of benzene series, dust and noise in the workplace to reduce the health hazards to workers.

**Keywords.** Occupational hazard factors, toxic substances, environment monitoring

## 1. Introduction

Since organic solvents are used in the process of footwear assembly line products, shoe factories are an industry with many occupational disease hazards, and their occupational disease hazards should not be ignored [1-5]. The occupational hazards in shoe factories mainly come from chemical materials used in shoes. With the appearance of various kinds of shoe fabrics, new adhesives have come into being, which make the occupational hazards in shoes factory more and more. Workers with long-term exposure to organic solvents often suffer from fatigue, forgetfulness, and difficulty concentrating [6-10]. In order to prevent occupational diseases, protect workers health, find out the occupational hazards factors in shoe factories, and provide basis for enterprises to control and manage occupational hazards, we have investigated and tested the current situation of occupational hazards in a shoe factory in Guangzhou city.

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## 2. Subjects and Methods

### 2.1. Subject of Investigation

The company was sino-foreign joint ventures, the main development, production and high profile leather shoes. The company employed over 210 people. It was officially put into production in 2007, with an annual output of more than 400000 pairs of leather shoes. There were four identical shoes in the workshop. The shoe making enterprises in China were still using raw materials containing benzene, toluene and xylene used as solvents. The main production process included leather material, cut out, glue brushing, needle car, bake, pull the gang, purging, heat setting, pull-out pin, spray light, waxing, glue brushing, bottom pressing, set type, last pulling, rubbing glue, insole, QC inspection, etc.

### 2.2. Standard of Sample Collection

In accordance with the requirements of “specifications of air sampling for hazardous substances monitoring in the workplace” [11], on-site sampling and on-site testing were carried out while the workers were working. According to the characteristics of the occupational hazards of the project, 23 representative sampling sites were set up. The concentrations benzene, toluene, xylene, n-hexane, ethylene dichloride, dichloroethane, acetone, butanone total dust and noise were measured. The same sampling point was tested three times, and the results were averaged.

### 2.3. Standard for Analysis and Evaluation

Detection and analysis of occupational hazards occurred in main production line of the shoe factory were carried out, according to “determination of toxic substances in workplace air part 66: Benzene, toluene, xylene and ethyl benzene” [12], “determination of toxic substances in workplace air part 60: pantane, hexane, heptane, octane and nonane” [13] and “determination of toxic substances in workplace air part 103: acetone, methyl ethyl ketone and methyl isobutyl ketone” [14]. Dust in the air of workplace was measured by “Determination of dust in the air of workplace part 6: total number concentration of ultrafine and fine particles” [15]. Noise was measured by “physical agents in the workplace” [16]. The chemical factors were analysed according to “occupational exposure limits for hazardous agents in the workplace part 1: Chemical hazardous agents” [17]. The physical factors were evaluated according to “occupational exposure limits for hazardous agents in the workplace part 2: physical agents” [18].

## 3. Result and Discussion

### 3.1. Main Chemical Glues and Toxic Substances

Chemical glues for shoes were mainly divided into the following categories. They included waterlogging, toluene water, ink solvent, AP-86 glue, fast drying, etc. The raw materials included benzene, toluene, xylene, n-hexane, ethylene dichloride, heptane, acetone and ethyl acetate. From the analysis of the ways of toxic substances invading human body, most of them enter by inhalation, some of them enter human body through

skin and digestive tract. Preventing the inhalation of toxic chemicals into human body was the main way to prevent occupational poisoning. Toxicological characteristics of chemical reagent were shown in table 1.

**Table 1.** Toxicological characteristics of chemical reagent.

Name	Access route	Acute toxicity	PC-TWA and PC-STEL limited quantity (mg/m <sup>3</sup> )	Hazard factor
Benzene	Breath, skin, mouth	Highly toxic	6/10	Irritating to eyes and skin
Toluene	Breath	Low toxicity	50/100	Stimulating activity and anaesthesia
Xylene	Breath	Moderate toxicity	50/100	Respiratory tract irritation and anaesthesia
N-hexane	Breath	Low toxicity	100/180	Anesthesia and irritation
Ethylene Dichloride	Breath, skin, mouth	Low toxicity	7/15	Irritating to eyes, respiratory system and skin
Dichloroethane	Breath, skin, mouth	Micro toxicity	200/300	Nerve anesthesia
N-heptane	Breath, skin, mouth	Low toxicity	300/450	Mild irritation to skin
Acetone	Breath, skin, mouth	Low toxicity	300/450	Anesthetic effect of central nervous system
Butanone	Breath, skin, mouth	Low toxicity	300/600	Irritant to eyes, nose, throat and mucous membrane

3.2. Results of Occupational Disease Inductive Factor

3.2.1. Chemical Substances

In the production process, the factory involves a variety of toxic, chemical substances, dust, noise and other harmful factors. 23 sites of the shoe factory were monitored. The on-site monitoring results showed that the exceedance rates of benzene, toluene and ethylene dichloride in the workplace were 13.0%, 8.7% and 8.7%, respectively. The test results of the percentage of exceedance monitoring sites are shown in table 2. The occupational hazards in shoe factories mainly came from the chemical materials used in shoes. The volatile components in the glue seriously affected the health of the workers, the following measures were recommended for shoe factories. Shoe factories should strengthen the use of benzene and benzene homologue materials management, as far as possible do not use benzene as a diluent or solvent. According to the specific circumstances, set up local or all-face mechanical ventilation equipment to reduce the concentration of air, toxic substances, prevent benzene, poisoning. Workers should strengthen occupational safety and health training and personal protection, improve self-protection awareness. Workers in shoe factory should have occupational health check before, during and before leaving their jobs. Workers engaged in benzene operations should be examined once a year.

**Table 2.** The concentration of toxic substances and over standard rate.

Name	Test results (mg/m <sup>3</sup> )	Monitoring sites	Monitoring sites exceeding limits	Proportion of monitoring sites exceeding limits (%)
Benzene	<0.3-13.4	23	3	13.0
Toluene	3.5-104.8	23	2	8.7
Xylene	<0.2	23	0	0
N-hexane	0.4-6.4	23	0	0
Ethylene dichloride	0.2-14.74	23	2	8.7
Dichloroethane	0.4-42.2	23	0	0
N-heptane	0.7-48.0	23	0	0
Acetone	0.2-52.2	23	0	0
Butanone	<0.5-41.0	23	0	0
Total dust	<8	23	0	0
Noise	65.3-88.2 dB(A)	23	3	13.0

3.2.2. Dust Analysis

A large amount of dust was mainly produced in the production process of peeling, blowing dust and roughing and so on, which directly threatens the health of workers in shoe factories. The dust irritates the eyes, skin and airways. The dust inhalation could cause cough and lung discomfort. Long-term inhalation of dust could cause respiratory tract damage. Protective measures were taken to collect dust by dust collectors, ventilation equipment and dust masks for workers. However, on-site investigation revealed that dust collectors had not been installed, dust masks were not worn by workers, and some workers wore ordinary masks or did not provide any protection. The following dust-proof measures could be adopted. The first, the dust-producing area of the polishing car could be closed into a separate area, and dust-removing facilities could be installed. The second, workers were required to wear dust masks for polishing work.

3.2.3. Noise Analysis

All of workshop's noise in the factory had come mainly from the mechanical operation. The noise intensity of 23 workplaces was measured, three of them exceeded the "occupational exposure limit for hazardous factors in workplace-part 2: physical factors", with an exceedance rate of 13.0% and a maximum noise value was 88.2 dB (A). Long-term exposure to high-intensity noise could cause neurasthenia syndrome such as headache, dizziness, tinnitus, heart palpitations and sleep disturbances. Studies have shown that noise can cause a stressful response in the body that increases adrenaline, which in turn can cause changes in heart rate and blood pressure. The noise value was mainly related to mechanical positions, such as stamping, die casting, grinding, sandblasting, etc. At present, it was difficult to improve the production process. As the service life of the equipment was extended, the noise would increase. In order to protect workers' health, low-noise equipment should be selected as far as possible to ensure that the noise intensity of the working environment was up to the relevant health standards. For equipment or posts that could not meet the noise health standard after taking measures, the personal protection of the operator should be strengthened and the noise-proof earmuffs or earmuffs should be worn.

#### 4. Conclusions

There were many occupational hazards in a shoe factory. The main chemical hazards and physical hazards are benzene, toluene and ethylene dichloride and noise respectively. To strengthen the physical examination of workers is a significant measure to protect the health of the workers.

#### Acknowledgments

This study was financially supported by the medical and health science and technology project of Guangzhou (20171A010285).

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