Investigation on Occupational Hazards and Control Measures in an Optical Enterprise

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Abstract: In this paper, the hazard factors of an optical enterprise were analyzed, and the appropriate prevention and control measures were discussed. The field investigation and detection of occupational health was applied. The on spot monitoring results showed that the over-standard rate of acetone in the workplace was 10.0\%, the over-standard rate of trichloroethylene was 25.0\%, the over-standard rate of dichloromethane was 50.0\%, and the over-standard rate of noise was 23.8\%. Acetone, trichloroethylene, dichloromethane and noise were the key points of prevention and control in this optical enterprise. It was suggested that the ventilation system of the cleaning workshop should been improved comprehensively, and the workers' hearing protection measures should been increased to effectively protect their health.

1. Introduction
Optical enterprises were an industry with many risk factors for occupational diseases, which could not be ignored due to the use of more organic solvents in the process of lens processing. In recent years, with the continuous and rapid development of optical enterprises and technological upgrading, great changes had taken place in material use and product structure, and the degree of environmental pollution had been greatly reduced. However, many kinds of toxic and harmful chemicals were still needed in the production of optical lenses. To understand the occupational disease risk factors in optical enterprises was helpful to control and prevent the occurrence of occupational disease among workers. In order to provided scientific basis for the improvement of working environment and the health of workers, the present study investigated the status of occupational health in an optical enterprise.

2. Subjects and methods
2.1. Subjects
The company is specialized in design, development and production of different kinds of optical lenses and optical component. The company employs over 200 people. Main products are wide-angle lens, megapixel lens, standard auto-focusing lens, day and night lens, board Lens etc. Annual output of lens are over 6 million pieces, the precision optical component is 2 million, and the scenes are beyond 3 million pieces. The main production process was shown in figure 1.

2.2. Monitoring locations and indicators.
Representative sampling sites were selected according to the types of occupational exposure to occupational hazards. A total of 72 monitoring points are set up. The monitoring items included acetone, isopropel alcohol, trichloroethylene, metal, lead smoke, cadmium, xylene, dichloromethane, hydrofluoric acid, potassium hydroxide, alumina oxide, total dust, noise, high temperature, etc. Three concentrations were measured at each sampling site.

2.3. Monitoring methods and standards
Sampling specification for workplace according to specifications of air sampling for hazardous substances monitoring in the workplace (GBZ159-2017) [1], measurement of physical agents in the workplace (GBZ/T189) [2] and method for determination of dust in the air of workplace part 1: total dust concentration (GBZ/T192) [3], sampling and testing were carried out on the production site of the factory. The analysis was carried out according to occupational exposure limits for hazardous agents in the workplace part 1: chemical hazardous agents (GBZ2.1-2007) [4], occupational exposure limits for hazardous agents in the workplace part 2: physical agents (GBZ 2.2-2007) [5]. Sites were chosen and hazardous factors of occupational diseases were evaluated by the methods of investigation, monitoring, checklist and quantitative classification.

3. Result and discussion

3.1. Main raw materials
The main raw and auxiliary materials included CR39, IPP27/IPP10, DPDJ, WTS332, WTS350, dichloromethane, 141b, trichloroethylene and acetone in the production process of the enterprise.

3.2. Distribution of occupational hazards
Occupational hazards in the production process include alumina dust, other dust, dichloromethane, isopropanol, methanol, xylene, acetone, trichloroethylene, tin dioxide, lead smoke, cadmium and its compounds, hydrofluoric acid, noise, high temperature, etc. The distribution of occupational hazard factors is shown in table 1.

### 3.3. Results of occupational disease inductive factor

The results of the major occupational hazards were shown in table 2. The exceeding rate of acetone was 10.0%, that of trichloroethylene was 25.0%, that of dichloromethane was 50.0% and that of noise was 23.8%. The remaining test items were lower than the national occupational health standards. A large amount of organic reagents were used in optical lens manufacturing enterprises, and long-term exposure to organic solvents might cause harm to the respiratory tract and lungs of workers.

The dichloromethane is volatile at room temperature and is classified as a class 2A carcinogen by the International Agency for Research on cancer of the World Health Organization, although it is of low toxicity [6]. In China, there had been some cases of dichloromethane poisoning [7]. The trichloroethylene is classified as a carcinogen by the list of carcinogens published by the International Agency for Research on cancer of the World Health Organization. There were many reports of occupational trichloroethylene dermatitis caused by trichloroethylene in China [8].

| Number | Workshop     | Type of work in production | Hazardous factors                                                                 |
|--------|--------------|----------------------------|----------------------------------------------------------------------------------|
| 1      | BO workshop  | cleaning operation         | acetone, dichloromethane, noise                                                  |
| 2      | installation | isopropanol, dichloromethane, potassium hydroxide, noise |
| 3      | AO workshop  | trimming, cleaning         | trichloroethylene, dichloromethane, noise, potassium hydroxide, total dust       |
| 4      | Injection molding workshop | clamping fixture cleaning | acetone                                                                        |
| 5      | mould cleaning | mould cleaning | acetone                                                                        |
| 6      | DIP workshop | coating film, stripping     | methanol, acetone, isopropanol                                                   |
|        | UV operation | coating machine operation, cleaning machine operation | methanol, trichloroethylene, isopropanol, dichloromethane |
| 7      | COAT workshop |  | hydrofluoric acid                                                             |
| 8      | RX workshop  | FPAL operation             | acetone, dimethylbenzene, noise, total dust                                      |
|        | PPAL operation | | acetone, dimethylbenzene, stannic oxide, lead, cadmium, noise                   |
| 9      | INS workshop | Final inspection. | acetone, dimethylbenzene                                                        |

Table 1. The main occupational hazards in the workshops
According to the actual situation, the unqualified work posts should been rectified and the corresponding occupational protection facilities should been adopted to ensure the workers health. After the rectification, the factory provided splash-proof masks for cleaning workers, dust-proof masks and protective glasses for polishing workers, and anti-toxic masks for workers exposed to toxic and harmful gases.

Five workshops noise exceeded the occupational exposure standard. The noise intensity of 21 workplaces was detected, and 5 of them exceeded the occupational exposure limit of national standards, the rate of exceeding the occupational exposure limit was 23.8%. The rest of the results were lower than the occupational exposure limits. Through the implementation of corrective measures, after workers correctly wearing the earmuffs, workers exposed to noise was less than 80 dB(A).

4. Conclusions

There were many harmful factors in the production process of optical enterprises. The main chemical hazard factors included acetone, trichloroethylene and dichloromethane. The main physical hazard was noise. In order to protect the health of the workers, it was necessary to strengthen the physical examination of workers.

**Table 2.** Test results of occupational hazards

| Items                  | Test results       | Monitoring sites | Monitoring sites exceeding limits | Proportion of monitoring sites exceeding limits (%) |
|------------------------|--------------------|------------------|-----------------------------------|---------------------------------------------------|
| Acetone                | <0.05-5.955 (mg/m³) | 10               | 1                                 | 10.0                                              |
| Isopropyl alcohol.     | <0.05 (mg/m³)      | 2                | 0                                 | 0.00                                              |
| Trichloroethylene      | 5.94-258.8 (mg/m³) | 4                | 1                                 | 25.0                                              |
| Methanol               | <0.08 (mg/m³)      | 3                | 0                                 | 0.00                                              |
| Lead smoke             | <0.005 (mg/m³)     | 1                | 0                                 | 0.00                                              |
| Cadmium                | <0.001 (mg/m³)     | 1                | 0                                 | 0.00                                              |
| Dimethylbenzene        | <0.05 (mg/m³)      | 3                | 0                                 | 0.00                                              |
| Dichloromethane        | <4.0-1494.7 (mg/m³)| 8                | 4                                 | 50.0                                              |
| Hydrofluoric acid      | <0.019 (mg/m³)     | 1                | 0                                 | 0.00                                              |
| Potassium hydroxide    | <0.004-0.012 (mg/m³)| 6               | 0                                 | 0.00                                              |
| Aluminium oxide        | <4 (mg/m³)         | 2                | 0                                 | 0.00                                              |
| Total dust             | <8 (mg/m³)         | 5                | 0                                 | 0.00                                              |
| Noise                  | 61.3-105.2 dB (A)  | 21               | 5                                 | 23.8                                              |
Temperature 18.9-19.8 (°C)  5  0  0.00

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