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Analysis of Occupational Disease Hazard Factors in a Steel Structure Manufacturing Enterprise in Shaanxi Province

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Abstract: This paper aims to understand the occupational disease hazards in the production process of a steel structure production enterprise in Shaanxi Province, and to propose corresponding measures to protect workers' health. Occupational disease hazards in a steel structure production enterprise in Shaanxi Province include chemical hazardous factors and physical factors. The time-weighted average permissible concentrations of welding fume, other dusts, manganese and its inorganic compounds, nitrogen oxides, carbon monoxide, benzene, toluene, xylene, ethylbenzene, ethyl acetate, and butyl acetate are as follows: 8mg/m^3, 4mg/m^3, 0.15mg/m^3, 5mg/m^3, 20mg/m^3, 6mg/m^3, 50mg/m^3, 50mg/m^3, 100mg /m^3, 200mg/m^3, 200mg/m^3; The permissible short-time exposure concentrations of nitrogen oxides, carbon monoxide, benzene, toluene, xylene, ethylbenzene, ethyl acetate and butyl acetate are 10mg/m^3, 30mg/m^3, 10mg/m^3, 100mg/m^3, 100mg/m^3, 150mg/m^3, 300mg/m^3, 300mg/m^3 respectively, and the test results of the above chemical hazardous factors are in line with the Occupational health requirements. The occupational exposure limit value of noise in the workplace is 85dB(A), and the noise test result of the riveter workplace is 88. 0dB(A), which exceeds the occupational health exposure limit value, and the test results of the rest of the workplaces are in line with the occupational health requirements. The exposure limit value of UV radiation is 0.24μW/cm^2, and the test results of each workplace meet the requirements. Thus, the monitoring results of productive dust, chemical hazardous substances and ultraviolet radiation in the workplace of a steel structure production enterprise in Shaanxi Province meet the requirements of occupational hygiene, while the noise exposure level exceeds the limit value, and effective measures need to be taken to control the noise and effectively protect the health of workers.

1. Introduction

The design, production and installation of steel structures have always been in high demand, and

generally enterprises can design and produce various types and specifications of steel structure products according to the different needs of customers [1]. A steel structure production enterprise in Shaanxi Province uses steel, welding rods and other raw and auxiliary materials, the main components of which are complex, and according to the current level of production technology, manufacturing processes, etc. , occupational disease hazards such as dust, nitrogen oxides, carbon monoxide, noise and other hazards will be generated. In order to effectively safeguard the health of workers, the enterprise's occupational disease hazards were tested and analysed, and relevant protective measures were proposed in response to the presence of risk factors.

2. Objects and methods

2.1. Objects

2.1.1. Enterprise overview

Shaanxi Province, a steel structure production enterprise belongs to the metal structure manufacturing industry, to produce for the steel structure products, the main raw and auxiliary materials, including steel, welding rods, paint and steel sand, the annual output of up to 10,000t / a. The enterprise has three workshops, respectively: steel structure production workshop, paint spraying workshop and sub-steel workshop, with the door-type automatic submerged arc welding machine, digitalized gas-shielded welder, CO2 gas-shielded welding, plasma cutting machine, airless spraying machine and welding machine and so on 44 sets of equipment. The enterprise has 40 staff members, among which 30 are front-line workers and 10 are management, administration and logistics.

2.1.2. Production processes and procedures

According to the requirements of the design documents, the physical and chemical indexes of the main materials and auxiliary materials are inspected, and the qualified steel is stacked according to the variety and model of steel; based on the review of the civil engineering drawing samples, and the production of not easy to deform the sample plate, the sample as a basis for the sample plate, in the raw materials of the actual samples marked out and typed with the number of the processing machine; according to the requirements of the steel cutting, and through the bending, rolling, folding, molding; according to the requirements of assembly components, through welding to integrate the different parts of the correction and grinding and surface painting; finally, according to the design requirements of spatial relationships for test assembly and stock inspection and awaiting shipment. Assemble the components according to the requirements, integrate the different parts into one by welding, straighten, polish and paint the surface; finally, test-fit according to the spatial relationship of the design requirements, stock inspection and wait for shipment. The specific production process is shown in Figure 1.

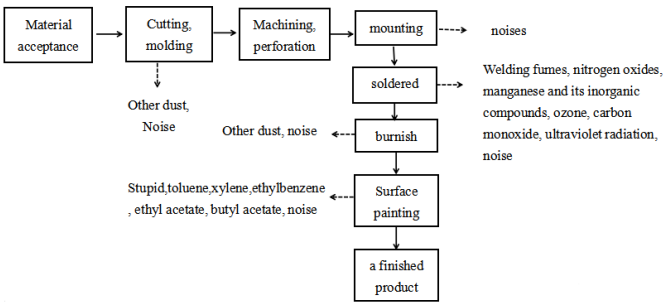

Figure 1: Schematic diagram of the production process

2.2. Methods

2.2.1. Basis for testing

On-site inspection is carried out in accordance with the Law of the People's Republic of China on Prevention and Control of Occupational Diseases [2], Classification Catalogue of Occupational Disease Hazardous Factors[3], Risk Classification Management Catalogue of Occupational Disease Hazards in Construction Projects [4]0, and Management Specification for Periodic Detection of Occupational Disease Hazardous Factors in Employing Units [5] and other laws and regulations.

2.2.2. Detection categories

This test is a regular test.

2.2.3. Scope of testing

The scope of this inspection includes the steel structure production workshop (the shot blasting machine is not in operation), the secondary steel workshop and the paint spraying workshop.

2.2.4. Detection methods

According to GB/T18204.1-2013 "Examination methods for public-Part 1:Physical parameters" [6], GBZ 159-2004 "Specifications of air sampling for hazardous substances monitoring in the workplace" [7], GBZ 2.1-2019 "Occupational exposure limits for hazardous agents in the workplace Part 1: Chemical hazardous agents" [8], GBZ 2.2-2007 "Occupational exposure limits for hazardous agents in the workplace Part 2: Physical agents" [9], GBZ/T 160.29-2004 "Methods for determination of inorganic nitrogen compounds in the air workplace" [10], GBZ/T 189.8-2007" Measurement of Physical Agents in Workplace Part 8: Noise" [11] and other national standards ,the occupational disease hazards of the enterprise are tested .

2.2.5. Testing and analyzing instruments

It mainly uses EM-1500 atmospheric sampler, EM-5000 atmospheric sampler, FCC-30 mining explosion-proof two-way dust sampler, EM-300 atmospheric sampler, GXH-3011ACO infrared gas meter, UV-A single-channel ultraviolet irradiator, UV-B dual-channel ultraviolet irradiator, AWA6228 multifunctional sound level meter, WFX-130B atomic absorption spectrophotometer, AUW120D electronic balance, Trace1300 gas chromatography and other instruments for sampling and detecting the factors of occupational disease hazards.

3. Results

3.1. Exposure of operators to occupational disease hazards

According to the on-site investigation, the main occupational disease hazards for the operators of this enterprise within the scope of this inspection include dust, noise, welding fume, manganese and its inorganic compounds, and carbon monoxide. See Table 1.

Table 1: Exposure of operators to occupational disease hazards

Workplace	Job category	Working position	Occupational disease hazards	Contact time	Number of contacts
Steel Structure Production Workshop	laborers who work in the shop floor	Flame cutting machine operating position	Other dust, noise	5h/d ×5d/w	3
	Drilling machine operator	drill press	noises	4h/d ×5d/w	1
	Shearer Operator	shearer's workstation	noises	4h/d ×5d/w	1
	erector	assembly station	noises	5h/d ×5d/w	2
	solderer	Welding stations	Welding fumes, manganese and its inorganic compounds, nitrogen oxides, ozone, carbon monoxide, ultraviolet radiation, noise	5h/d ×5d/w	2
	tack welder	Welding stations	Welding fumes, manganese and its inorganic compounds, nitrogen oxides, ozone, carbon monoxide, ultraviolet radiation, noise	5h/d ×5d/w	6
	corrector	Correcting the work position	noises	3h/d ×5d/w	1
	worker with rivets	Riveting and welding station	Welding fumes, manganese and its inorganic compounds, nitrogen oxides, ozone, carbon monoxide, ultraviolet radiation, noise	5h/d ×5d/w	6
	shot blaster	shot peening station	Other dust, noise	2h/d ×5d/w	2
Paint shop	sprayer	spraying station	Benzene, toluene, xylene, ethylbenzene, ethyl acetate, butyl acetate, noise	2h/d ×5d/w	4
		Paint mixing station	Benzene, toluene, xylene, ethylbenzene, ethyl acetate, butyl acetate, noise	0. 5h/d ×5d/w	
Secondary steel workshop	solderer	Welding stations	Welding fumes, manganese and its inorganic compounds, nitrogen oxides, ozone, carbon monoxide, ultraviolet radiation, noise	3h/d ×5d/w	2

3.2. Test results and analysis

3.2.1. Detection results of chemical hazards in the workplace

3.2.1.1. Productive dusts

The enterprise's productive dusts are other dusts and welding fume, with time-weighted average permissible concentrations of 8mg/m3 and 4mg/m3 respectively, and the test results are in compliance with the occupational exposure limits. See Table 2.

3.2.1.2. Chemically hazardous substances

The chemical hazardous substances generated during the production process of this enterprise mainly include manganese and its inorganic compounds, ozone, nitrogen oxides, carbon monoxide, benzene, toluene, xylene, ethylbenzene, ethyl acetate and butyl acetate, and the test results include the time-weighted average permissible concentration of the chemical hazardous substances in the air,

the permissible concentration of short-time exposure and the maximum permissible concentration. The test results all complied with the occupational exposure limits. See Table 2.

Table 2: Detection results of chemical hazardous factors in the air at the workplace

Testing Program	Detection points	MAC (mg/m^3)	PC-TWA (mg/m^3)	PC-STEL (mg/m^3)	qualifying point	Pass rate (100%)
Other dust (total dust)	1	-	8	-	1	100%
Welding fumes (total dust)	4	-	4	-	4	100%
Manganese and its inorganic compounds	4	-	0.15	-	4	100%
ozone (O3)	4	0. 3	-	-	4	100%
nitrogen oxide	4	-	5	10	4	100%
carbon monoxide CO	4	-	20	30	4	100%
benzene	4	-	6	10	4	100%
toluene C6H5CH3	4	-	50	100	4	100%
xylene	4	-	50	100	4	100%
ethylbenzene	4	-	100	150	4	100%
ethyl acetate	4	-	200	300	4	100%
butyl acetate	4	-	200	300	4	100%

Note: PC-TWA: the average permissible exposure concentration (AEC) for an 8-h working day and a 40-h working week, weighted by time; PC-STEL: the concentration at which a short-time (15-min) exposure is permissible while complying with the PC-TWA; MAC: the concentration of a toxic chemical that should not be exceeded at any time during a working day at a workplace.

3.2.2. Results of testing physical factors in the workplace

3.2.2.1. Workplace noise test results

The noise exposure level was measured in 11 different workplaces in 3 workshops of the enterprise respectively, and the results of the inspection show that: the highest noise intensity of the riveters in the steel structure production workshop was 88. 0dB(A), and the noise exposure level did not meet the occupational exposure limit, and the results of the rest of the positions met the occupational exposure limit of the staff in each workplace. See Table 3

Table 3: Measurement results and evaluation of 8h equivalent sound level of job noise at workplace

Workshop/location	Job category	Point of detection (POD)	Measurement results (dB(A))	LEX, 8h (dB(A))	Exposure limit (dB(A))	Judgment
Steel Structure Production Workshop	laborers who work in the shop floor	Flame cutting machine operating position	80. 6	78. 6	85	in line with
	Drilling machine operator	drill press	86. 5	83. 5	85	in line with
	Shearer Operator	shearer's workstation	87. 8	84. 8	85	in line with
	erector	assembly station	77. 9	74. 9	85	in line with
	solderer	Welding stations	84. 4	81. 4	85	in line with
	tack welder	Welding stations	84. 4	81. 4	85	in line with
	corrector	Correcting the work position	80. 3	76. 0	85	in line with
	worker with rivets	Riveting and welding station	88. 0	86. 0	85	falling short (of expectations)
Paint shop	sprayer	spraying station	82. 5	77. 0	85	in line with
		Paint mixing station	80. 3			
Secondary steel workshop	solderer	Welding stations	82. 3	78. 0	85	in line with

3.2.2.2. Results of workplace ultraviolet radiation testing

The UV radiation exposure levels of the operators of the various welding and riveting operations in the steel structure production workshop and secondary steel workshop of the enterprise were measured in this test, and the measurement results are in line with the requirements of the UV radiation exposure limits in the workplace. See Table 4.

Table 4: Measurement results and evaluation of ultraviolet radiation in the workplace

workplace	position	measuring point	Ultraviolet type	Measurement results (μW/cm²)				Standard limit (μW/cm²)	judgment
				Corrected value (in mask)					
				eyes	Eeff	Face	Eeff		
Steel Structure Production Workshop	solderer	Welding stations	254nm	<0. 1	<0. 1	<0. 1	<0. 1	0. 24	in line with
			297nm	<0. 1		<0. 1			
			365nm	<0. 1		<0. 1			
	tack welder	Welding stations	254nm	<0. 1	<0. 1	<0. 1	<0. 1	0. 24	in line with
			297nm	<0. 1		<0. 1			
			365nm	<0. 1		<0. 1			
	worker with rivets	Riveting and welding station	254nm	<0. 1	<0. 1	<0. 1	<0. 1	0. 24	in line with
			297nm	<0. 1		<0. 1			
			365nm	<0. 1		<0. 1			
Secondary steel workshop	solderer	Welding stations	254nm	<0. 1	<0. 1	<0. 1	<0. 1	0. 24	in line with
			297nm	<0. 1		<0. 1			
			365nm	<0. 1		<0. 1			

4. Discussion

It was found that the occupational disease hazards in the workplace of a steel structure manufacturing enterprise in Shaanxi Province mainly involved chemical and physical hazards. In accordance with the "Construction Project Occupational Disease Hazard Risk Classification and Management Catalog" State Health Office Occupational Health Development (2021) No.5 [4], the steel structure production enterprise belongs to "C331 Structural Metal Products Manufacturing" listed in the catalog. The occupational disease hazard risk category of the employer is serious. The test results show that the chemical hazardous factors in a steel structure manufacturing enterprise in Shaanxi Province meet the requirements of occupational exposure limits; in the measurement of physical factors, the noise measurement results of the riveting and welding workplace exceed the occupational exposure limits and do not meet the requirements of occupational exposure limits, while the rest of the test results meet the requirements. Relevant studies have shown that noise not only damages the human auditory system, but also affects the nervous system, digestive system, etc. It also increases the risk of hypertension and leads to the occurrence of ECG abnormalities [12]. According to the site investigation found that the welding machine welding process noise intensity, welding operation time is long, the enterprise for the noise operation of the laborers issued NRR value of 29dB, the actual noise reduction value of 11dB (A) of the 3M1110 type protective earplugs, correctly wear earplugs can play a role in noise prevention. Therefore, it is possible that the noise measurements at the site exceeded the occupational exposure limit because the riveters did not wear earplugs and other protective equipment correctly.

5. Recommendations

According to the results of this occupational disease hazards detection, in order to effectively prevent and control occupational disease hazards in the production process and protect the health of workers, it is suggested that the following measures can be taken: (1) Strengthen the occupational

hygiene knowledge training for workers, so as to enable them to master the relevant occupational hygiene laws, rules and regulations and the correct fitting of personal protective equipment and other occupational disease prevention and control knowledge, and to improve the awareness of personal protection, in order to maximize the protection of workers' health. To maximize the protection of workers' health. (2) Warning signs and Chinese warning instructions, instruction signs and occupational disease hazard notification cards are set up at conspicuous positions in the workplace and replaced regularly. (3) Set up bulletin boards in conspicuous places to publicize regulations and rules on prevention and control of occupational diseases, operation procedures, emergency rescue measures for occupational disease hazards and test results of occupational disease hazards in workplaces. (4) Entrust qualified occupational health checkup organizations to conduct occupational health checkups for employees before, during and after their employment, and establish occupational health monitoring files.

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