CHEMICAL ENGINEERING TRANSACTIONS
VOL. 71, 2018
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.aidic.it/cet
Guest Editors: Xiantang Zhang, Songrong Qian, Jianmin Xu

ISBN 978-88-95608-68-6; **ISSN** 2283-9216
DOI: 10.3303/CET1871031

Occupational Disease Health Survey and Disease Prevention of Chemical Workers Based on Questionnaire Analysis

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The purpose of this study is to grasp the current situation of the pneumoconiosis incidence and prevention in coal chemical workers, and find out the countermeasures of pneumoconiosis control. To this end, questionnaires were used in this paper to carry out research on occupational disease health survey and disease prevention work, and in-depth statistical analysis was also conducted about the occupational health status and protection of coal chemical workers. The study found that the age of workers was statistically significant for the probability of pneumoconiosis, and chemical workers aged 40-50 years and older were more likely to suffer pneumoconiosis, reaching 5.84% and 12.77%, respectively; the probability of workers suffering from pneumoconiosis varies significantly for different work types, length of service, and smoking index, and smoking can also increase the probability of pneumoconiosis; the detection rate of cardiovascular system, liver and lung function and abnormal electrocardiogram (ECG) in patients with pneumoconiosis is significantly higher than that of non-pneumoconiosis workers; most workers have a certain understanding of the hazards and protective knowledge of productive dust, but chemical enterprise should still pay attention to and strengthen the safety knowledge education and training of workers. The above research provides theoretical guidance for controlling and preventing coal chemical workers from suffering from pneumoconiosis.

1. Introduction

With the rapid development of the social economy and the improvement of people's quality of life, the total amount of energy required for industry has been increasing, esp., the coal chemical industry, as one of the most important components in the global energy structure, is closely related to our lives (Baste et al., 2013; Zhang and Yu, 2008; Caldera et al., 2018; Sorahan et al., 1998). In recent years, the development of the coal chemical industry and the application of chemical technology have promoted the rapid development of China's social economy (Kawada et al., 2012; Kang & Kim, 2010; Wang, 2018). However, there exist many hazards in the mining, processing, and production processes of the coal chemical industry (Huang and Finkelman, 2008; Baur and Latza, 2005). These have become serious occupational hazards in the coal chemical industry, greatly increasing the probability of workers suffering from occupational diseases (Chen et al., 2013; Band et al., 1990).

Studies have shown that the dust generated in the production process of the coal chemical industry has an adverse effect on various systems of the workers' body. Among them, the respiratory system is most seriously damaged, easily causing pneumonia, lung cancer and other lung diseases and respiratory diseases (Borm, 1997; Petrova, 2009;). According to the survey data, nearly 30,000 people die every year from pneumoconiosis (Petrova, 2009; Volobaev et al., 2016; Weeks and Wagner, 1986).

With the rapid development of coal chemical industry, the number of workers suffering from occupational diseases has been also increasing, so the study of the chemical workers' occupational health has become a top priority (Crowley, 2017; Volobaev et al., 2015). For this, by selecting a city with a large amount of certain coal resource exploitation as the survey area in this paper, the questionnaires were used to study the occupational disease health survey and disease prevention work of chemical workers, to further analyse the coal workers' occupational health and protection situation, which aims to guide workers in the field of disease prevention, enhance self-protection awareness, and prevent the occurrence of occupational diseases.

Please cite this article as: Zhao W., Wang W., Chen X., Geng R., 2018, Occupational disease health survey and disease prevention of chemical workers based on questionnaire analysis, Chemical Engineering Transactions, 71, 181-186 DOI:10.3303/CET1871031

2. Occupational health, disease prevention and questionnaire

2.1 Selecting the research object

In this paper, the overall sampling method was used to extract the dust and noise works from 5 coal-fired, coal-based chemical olefins and coal-to-oil coal chemical enterprises in certain urban area in 2016-2017. According to the research data, the prevalence of pneumoconiosis in the coal dust workers in this area was 4.01%. By the statistical analysis method, at the test efficiency of 80% and the test level of 0.05, the calculated sample content should be 650.

2.2 Occupational health examination

In this study, according to the *Occupational Health Management Measures*, occupational disease health examinations were conducted for these chemical workers, using the state-defined occupational disease examination form. The physical examination mainly includes personal basic information, medical history, internal medicine examination, X-ray, lung function test, ECG, blood pressure, etc.

2.3 Questionnaire survey and statistical analysis

The questionnaires based on the existing research were designed. They were used in the study after on-site filling and recovery of questionnaires. The questionnaire mainly includes the following five aspects: (1) Basic information such as name and gender; (2) Occupational characteristics; (3) Knowledge level about health protection; (4) The use method, frequency and maintenance of protective equipment; (5) Satisfaction degree of workers about the comfort, the effectiveness of protection, frequency of distribution, etc. of chemical workers on protective equipment. A total of 720 questionnaires were distributed in this survey, and 686 effective questionnaires were collected, at the effective recovery rate of 95.3%. Afterwards, the valid questionnaires were numbered uniformly. The number of workers for fuel operation, boiler operation, turbine operation, centralized control operation, equipment maintenance and logistics and management positions are 138, 194, 36, 165, 138 and 15, respectively.

The Epidata3.1 software was used to establish a database of the survey information. Then, the workers' physical examination results and the questionnaire related information were entered into the system. Finally, statistical analysis was performed using the $\chi 2$ test (test level $\alpha=0.05$) and logistic regression analysis.

3. Analysis for occupational health examination results and questionnaire results

3.1 Occupational health examination results

Table 1 lists the physical examination results of 686 chemical workers with valid recovered questionnaires.

Table 1: Examination results of various physical examination items

Medical Project	Grouping	Detectable numbers	Detection rate/%
High kilovoltage X ray chest radiograph	No neumoconiosis	658	95.9
	Stage I pneumoconiosis	28	4.1
Electrocardiogram	Normal	522	76.1
	Abnormalities in heart rate	98	14.3
	ST segment change	24	3.5
	T wave change	6	0.9
	Other abnormal changes	36	5.2
Pulmonary function	Normal	641	93.4
	Obstructive ventilation dysfunction	26	3.9
	Restrictive ventilation dysfunction	16	2.3
	Mixed ventilation dysfunction	3	0.4
B-ultrasound	Normal	513	74.8
	Abnormal	173	25.2
Blood pressure	Normal	595	86.7
	Abnormal	91	13.3
Liver function	Normal	626	91.3
	Abnormal	60	8.7

It can be seen that the detection rate of I-stage pneumoconiosis in the lung X-ray test was 4.1%, and the stage II pneumoconiosis was not detected; the detection rate of abnormal ECG was 23.9%; the detection rate of pulmonary dysfunction was 6.6%; the abnormal detection rate of B-ultrasound was 25.2%; the detection rate of blood pressure was 13.3%; the detection rate of abnormal liver function was 8.7%.

3.2 Analysis for examination results and influencing factors of pneumoconiosis

(1) Population characteristics

The pneumoconiosis examination and analysis results for workers with different population characteristics were shown as Table 2. Workers under the age of 40, 40-50 years old, 50 years old and over, the prevalence of pneumoconiosis in the corresponding age group was 0.63%, 5.84% and 12.77%. After the χ2 test at the 0.01 test level, gender and education levels have no statistically significance for the prevalence of pneumoconiosis. But the age of workers is statistically significant for the probability of pneumoconiosis.

Table 2: Results of pneumoconiosis examination in different populations

Essential information	Group	Number	Stages of pneumoconiosis		Prevalence rate	χ^2	*P*
			Stage I	No			
Sex	Male	463	23	440	4.96	1.240	0.323
	Female	223	7	216	3.13		
Age/Year	<40	318	2	316	0.63	27.864	<0.001
	40~	274	16	258	5.84		
	50~	94	12	82	12.77		
Degree of Education	Junior middle school	62	4	58	6.45	4.738	0.093
	High school	218	14	204	6.42		
	Bachelor degree	406	12	394	2.96		

(2) Occupational characteristics

Through analysis for the probability of pneumoconiosis among chemical workers of different types of work, length of service and smoking index, using χ2, the pneumoconiosis examination and analysis results for workers with different occupational characteristics were obtained (Table 3). The prevalence of chemical workers in different length of service also varied, i.e., that of pneumoconiosis for workers under 20 years, 20-29 years, 30-39 years, and 40 years old and above is 0.25%, 8.47%, 13.19% and 6.67%, respectively. In addition, smoking also increases the probability of workers suffering from pneumoconiosis.

After the χ2 test, it was found that the three factors of worker type, length of service and smoking index have statistical significance for the prevalence of pneumoconiosis.

Table 3: Examination results of pneumoconiosis in different occupations

Essential information	Group	Number	Stages of pneumoconiosis		Prevalence rate/%	χ^2	*P*
			Stage I	No			
Post	A	138	4	134	2.90	12.394	0.03
	B	194	7	187	3.61		
	C	36	2	34	5.56		
	D	165	3	162	1.82		
	E	138	12	126	8.70		
	F	15	2	13	13.33		
Length of service	<20	391	1	398	0.25	40.502	<0.001
	20~	189	16	173	8.47		
	30~	91	12	79	13.19		
	40~	15	1	14	6.67		
Smoking index	<400	97	12	85	12.37	14.395	0.001
	400~	29	4	25	17.39		

Note: A- Fuel operation, B-Boiler operation, C- Turbine operation, D- Centralized control operation, E-Equipment maintenance, F- Logistics and management positions.

(3) Analysis for physical examination results of pneumoconiosis patients

Table 4 lists the relationship between pneumoconiosis and pulmonary dysfunction in coal chemical workers. The abnormal rates of pulmonary function in pneumoconiosis and non-pneumoconiosis workers were 10.71%

and 6.38%, respectively. Then, the statistical χ2 test was performed on the ratio of pneumoconiosis to pulmonary dysfunction, finding that the pulmonary function abnormalities have no statistical significance for the prevalence of pneumoconiosis.

Table 5 lists the relationship between pneumoconiosis and ECG abnormalities in coal chemical workers. The abnormal rate of ECG in patients with pneumoconiosis was significantly higher than that in non-pneumoconiosis workers. Then, the statistical χ2 test was performed on the ratio of pneumoconiosis to electrocardiogram abnormalities, finding that the ECG abnormality are statistically significant for the prevalence of pneumoconiosis.

Table 4: Results of pulmonary function test in pneumoconiosis patients

Stage of pneumoconiosis	Number	Pulmonary function				Abnormal rate/%	χ^2	*P*
		Obstructive	Restrictive	Mixed	Normal			
Stage I	28	2	1	0	25	10.71	0.407	0.463
No	658	24	15	3	616	6.38		

Table 5: Results of Electrocardiogram test in pneumoconiosis patients

Stage of pneumoconiosis	Number	Electrocardiogram					Abnormal rate/%	χ^2	*P*
		A	B	C	D	E			
Stage I	28	2	7	0	3	16	42.86	4.314	0.050
No	658	96	17	6	33	506	23.10		

Note: A- Abnormalities in heart rate, B- ST segment change, C- T wave change, D- Other abnormal changes, E-Normal.

In addition, Table 6 compares the results of blood pressure, B-ultrasound and liver function tests of pneumoconiosis patients and non-pneumoconiosis workers. It can be seen that the detection rate of hypertension in pneumoconiosis patients was higher than that of non- pneumoconiosis workers; the probability of abnormal liver function and B-ultrasound in patients with pneumoconiosis is significantly higher than that of non- pneumoconiosis workers. Then, statistical analysis was performed on the abnormal rate of physical detection in both. Using the χ2 test, it was found that the difference in the detection rate of hypertension and abnormal liver function are statistically significant for the prevalence of pneumoconiosis, while the differences in the detection rate of B-ultrasound abnormalities have no statistical significance.

Table 6: Results of B-ultrasound, blood pressure, liver function test in pneumoconiosis patients

Stage of pneumoco-niosis	Dysarteriotony		Abnormal liver function		Abnormality of B-ultrasound	
	Abnormal number	Abnormality rate/%	Abnormal number	Abnormality rate/%	Abnormal number	Abnormality rate/%
Stage I	11	39.29	8	28.57	12	42.86
No	80	12.16	52	7.90	161	24.47
χ^2	24.23		12.15		3.61	
P	<0.001		0.003		0.084	

3.3 Personal protection survey

Table 7: Preparation of dust respirators for different types of workers

Type of work	Number	Dust respirators		Allocation rate/%	χ^2	*P*
		Yes	No			
Fuel operation	138	118	20	85.51		
Boiler operation	194	190	4	97.94		
Turbine operation	36	36	0	100		
Centralized control operation	165	141	24	85.46	39.64	<0.001
Equipment maintenance	138	136	2	98.55		
Logistics and management positions	15	14	1	93.33		
Total	686	635	51	92.57		

(1) Dust respirators preparation

Table 7 shows the preparation of dust respirators for different type of workers. It can be seen that among the six types of work, the rate for equipping dust respirators in fuel operation, boiler operation, turbine operation, centralized control, maintenance, logistics and management are 85.51%, 97.94%, 100%, 85.46%, 98.55% and 93.33%, respectively, and the total rate is 92.57%. Using the $\chi 2$ test, it's found that the rates for preparing the dust respirators in each type of work have statistical significance.

(2) Protection knowledge

Table 8 shows the understanding level of 686 chemical workers on self-safety protection knowledge. It can be seen that most workers are aware of the harmful effects of productive dust on the health and have a certain understanding of protection knowledge. However, these chemical enterprises should still strengthen the safety knowledge education of workers and enhance their self-protection awareness.

Table 8: Self-protection knowledge master status

Investigation project	Know	Number	Percent/%
Requirements for occupational hazards protection	Yes	594	86.6
	No	92	13.4
Laws and regulations about PPE	Yes	398	58.0
	No	288	42.0
Awareness of the characters of productive dust	Yes	643	93.7
	No	43	6.3
Awareness of harm of dust to human body	Yes	664	96.8
	No	22	3.2
Awareness of protective measures	Yes	672	98.0
	No	14	2.0

(3) Workers' protective attitude and protective behaviour

Table 9 lists the statistics results on the wearing of dust respirators for 686 chemical workers by questionnaire. According to the survey results, 6.1% of workers still think that they can wear or not wear it, and 1.8% think that it is not necessary to wear them. For the use frequency of dust respirators, 1.1% of the workers never wear the respirators. The above results indicate that some chemical workers still have a weak sense of self-protection and need professional safety protection training.

Table 9: Protective related behaviours and attitudes

Investigation project	Group	Number	Percent/%
Necessity of wearing dust respirators	Need to wear	632	92.1
	Both of wear or do not wear are ok	42	6.1
	Do not need to wear	12	1.8
Wearing of dust respirator	Wear all the time	94	14.8
	Wear it for most time	439	69.1
	Wear it occasionally	95	15.0
	Never wear	7	1.1

4. Conclusions

This study investigates the occupational health status, safety protection measures and disease prevention of coal chemical workers through questionnaires, and further analyses the factors affecting the occupational diseases of chemical workers. The main findings are as follows:

(1) Smoking can increase the probability of workers suffering from pneumoconiosis; the three factors (worker type, length of service and smoking index) have statistical significance for the prevalence of pneumoconiosis;

(2) Pneumoconiosis has adverse effects on the cardiovascular system, pulmonary function, liver function and electrocardiogram response of patients. The prevalence of cardiovascular system abnormalities and hypertension in pneumoconiosis patients is significantly higher than that of non-pneumoconiosis workers;

(3) Most workers are aware of the harmful effects of productive dust on the health and have a certain understanding of the protection knowledge. However, chemical enterprises should still strengthen their workers' safety knowledge education and enhance their self-protection awareness.

Acknowledgement

This paper is supported by Provincial and higher discipline basic scientific research expenses scientific research project in Heilongjiang, the project name is Implementation of Healthy China Strategy Based on Mismatch Diseases Prevention (No. 2017-KYYWFMY-0695).

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