

Statistical Analysis and Safety Management on China's Coal Mine Gas Accident from 2006 to 2015

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Abstract. From 2006 to 2015 the causes and characteristics of coal mine gas accidents are analyzed from the aspect of the death toll and number of accidents in China based on the theory of statistics. And the results show that the level of gas accident casualties is obviously regional distribution and points and time distribution is relatively concentrated as well. Therefore, the corresponding management and measures are put forward based on Orbit Intersecting theory.

Introduction

According to coal industry association statistics, China's coal production in 2014, declining 1.64% lower than in 2013, accounts for about 66.03% of the total primary energy production. Although at present our country coal industry is downturn that is difficult to improve in short term, but our country is still a coal consumption and coal consumption still accounts for the total primary energy production in China firstly, which determines that coal will still be the main energy in our country in the future. Although this year to our country coal accident death toll gradually decline, but it is still far above levels in the developed countries.

Gas accident is one of the most common accidents in coal mine accidents. With the increase of mining depth, the scale of mining expansion and the application of new technology, the increasingly gas outburst accident in coal mine accidents is more serious. The downhole mismanagement is likely to be derived for gas explosion accidents^[1], which not only cause serious economic losses to the state and greatly threatened the life safety to the coal mine workers. From 2006 to 2015 the causes and characteristics of coal mine gas accidents is analyzed through the state administration of coal mine safety website query "accident query"^[2], aiming to explore the rule of casualties and looking for safety management and measures for the prevention of coal gas outburst accident.

Statistical Analysis of China's Coal Mine Gas Outburst from 2006 to 2015

Introduction of Accident Statistics

Through our country coal mine gas outburst accident statistics in recent 10 years. The regulations on the production safety accident report and investigation and handling of accidents rank classification standard as follow table 1.

Table 1 Level of accident classification standard

Level	Condition	Death Toll	Injured People	Direct Economic Loss
Ordinary Accident		<3	<10	<¥10,000,000
Lager Accident		≥3, <10	≥10, <50	≥¥10,000,000 < ¥50,000,000
Major Accident		≥10, <30	≥50, <100	≥¥50,000,000 <¥100,000,000
Extra Serious Accident		≥30	≥100	≥¥100,000,000

Table 2 China's situation of coal and gas outburst from 2006 to 2015

year	Ordinary Accident		Lager Accident		Major Accident		Extra Serious Accident	
	Number of Accidents	Death Toll	Number of Accidents	Death Toll	Number of Accidents	Death Toll	Number of Accidents	Death Toll
2006	7	10	85	378	19	300	3	96
2007	2	1	57	288	15	230	2	140
2008	0	0	42	206	9	145	0	0
2009	3	0	35	160	3	37	3	216
2010	6	4	39	203	84	0	0	0
2011	6	8	24	143	102	102	1	35
2012	1	1	20	98	65	65	1	48
2013	0	0	13	78	184	184	1	36
2014	2	2	10	40	77	77	0	0

2015	0	0	6	27	2	29	0	0
Total	27	26	331	1621	80	1253	11	571

From January 2006 to December 2012, there were altogether 449 gas accident in our country with the death toll at 3471 people, including general accidents for the 27 times with 26 deaths, larger accidents for 331 times with 1621deaths, major accidents happened more about 80 times with 1253 deaths and extra serious accidents only a total of 11 times with a total of 571 people. Details are shown in table 2.

Analysis of Characteristics

(1)Distribution of region. The relationship number and deaths with regions from 2006 to 2015 coal and gas outburst accidents in China as shown in figure 1. The figure 1 shows that the occurrence of coal and gas outburst accidents has certain regularity on regional distribution. In addition to the northern provinces such as Henan, death of coal and gas outburst accidents mostly happened in Guizhou province, Shanxi, Hunan, Yunnan, Sichuan, Chongqing and Heilongjiang seven provinces. The distribution is south more than north and west more than east that show obvious regional. The 7 provinces and cities account for 72.83% of the total accidents, which means that the above seven provinces and cities is more dangerous. According to the analysis of geological tectonics theory of plates, most of the seven provinces and cities in south China plate and south China plate are the most serious plate of the occurrence of coal and gas outburst[3]. Death of coal and gas outburst accident and times of Guizhou province are the most that number of accidents for 84 with 529 people killed, accounting for 18.71% of the total and 15.24% respectively.

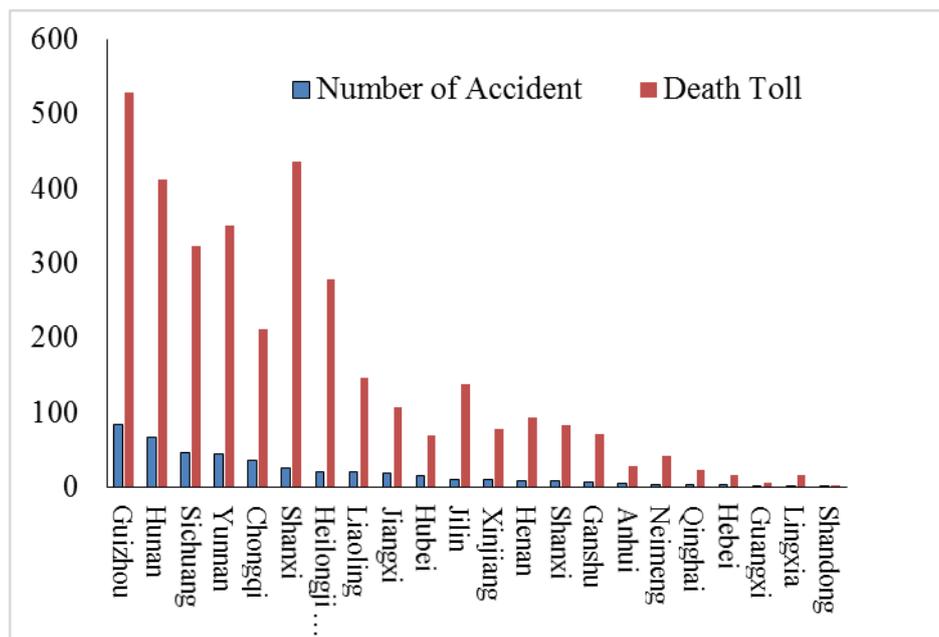


Fig.1 Columnar relationship with number of accident-provinces and death toll-provinces

(2) Distribution of time. China's coal mine coal and gas outburst has fatal accident on time distribution, tend to occur in 3, 4, 5, 8 and November, as shown in figure 2. The five months, a total of 228 death of coal and gas outburst accidents occurred, killing 1889 people, account for 50.78% of the total and 54.42% respectively. The main reason may be 3, 4, 5 month for the spring period, and China's coal industry workers, especially Workers at the grass-roots level are mostly migrant workers, the workers leave work after busy spring back to work with weak safety consciousness, safety does not reach the designated position as a result of accidents. So in this period of time strengthening safety management, supervisory personnel to intensify supervision and the awareness of production safety reduce or control the happening of the accident. But August is the summer, workers suffer from hot weather and mosquito bites. In addition, from the point of view of physiology, the period of large inertia of workers and the management of personnel management oversight are important reasons for and August every year our country coal mine coal and gas outburst accident[4]. On November 10 after the Mid-Autumn festival, National Day holiday, workers just got back from vacation month with the safety consciousness weakly causing accidents frequently.



Fig.2 Relationship between number of accident-month and death toll-month

(3) Major heavy accidents. There are more large accidents of coal and gas outburst with more deaths. From figure 3 and 4, it can be seen that from January 2006 to December 2006, the occurrence of coal and gas outburst death large accidents are 331 times with 1621 deaths, accounting for the 73.72% and 46.7% of the total number of accident and death respectively. And major accident happened 80 times, killed 1253 people, accounting for 17.82% and 36.1% respectively. In the coal mine safety production activities, therefore, making efforts to prevent the coal and gas outburst, reducing or controlling large accidents that our country's coal and gas outburst accident death can drop on the whole. At the same time, major accidents also need to avoid, although this kind of accident is rare, but in the event of the death toll.

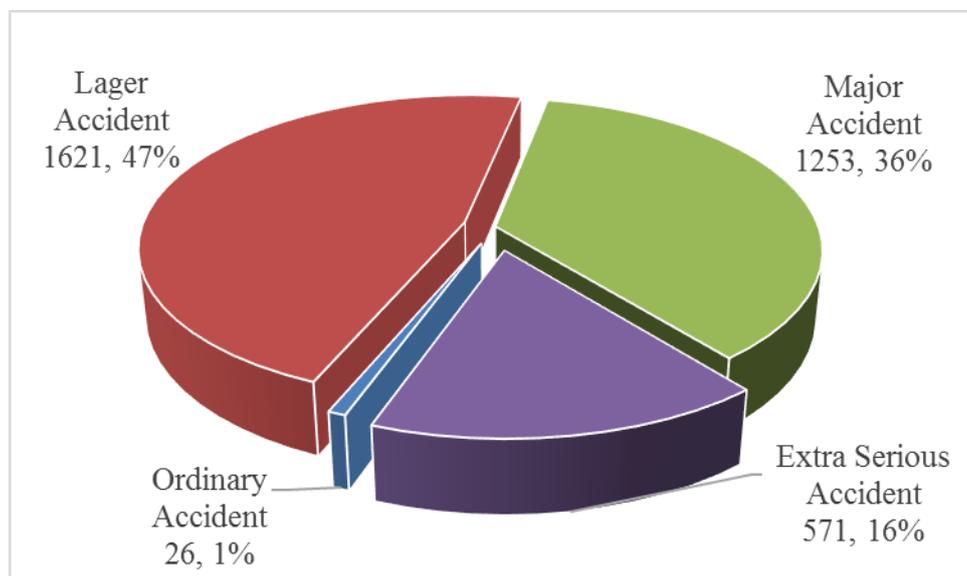


Fig.3 Proportion of number of coal and gas outburst accident

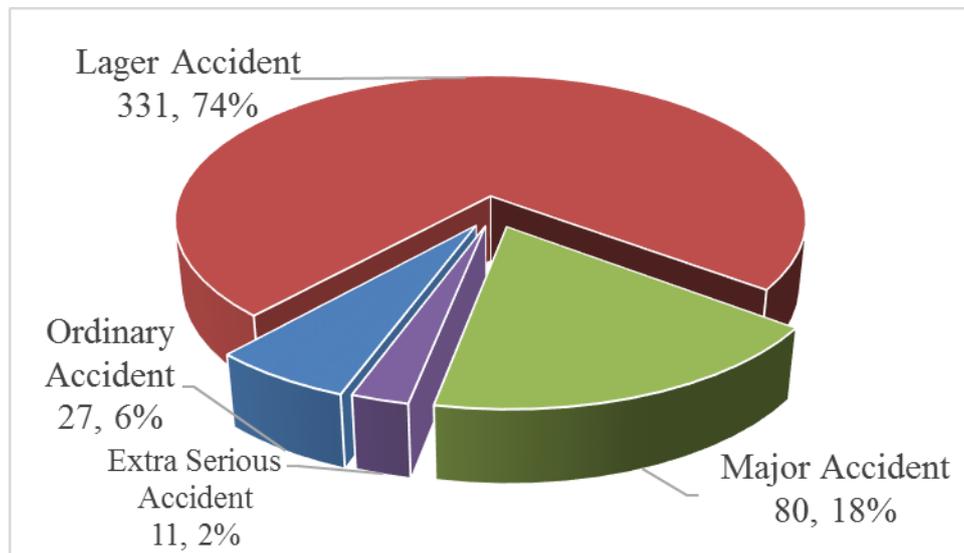


Fig.4 Proportion of death toll of coal and gas outburst accident

(4) Variation tendency. In January 2006 ~ December 2015, China's coal and gas outburst accidents deaths showed a trend of gradual decline, the number of deaths also showed a trend of gradual decline. Accidents and deaths occurred from 2006 to 2008 by the 114,784 a sharp decline to 51,351. Then the total number of accidents and deaths slight ups and downs, but overall it was a downward trend year by year. 8 accidents occurred in 2015, and the death toll was 56 people. As can be seen from Figure 5, China's coal and gas outburst accident death has been effectively curbed in the past 10 years.

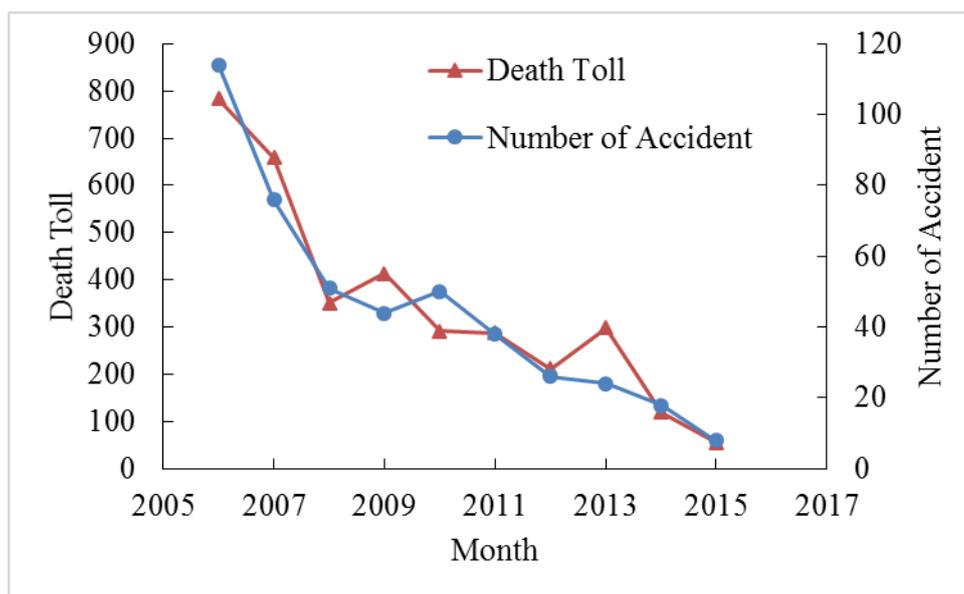


Fig.5 Tendency of number of accidents and death toll

Analysis of Accidents

China's coal and gas outburst accident death frequent reason can be summarized in the following four areas:

(1) The contradiction between the mine complex geological conditions and unilateral pursuit of production highlights^[5]. China's vast majority of the coal mine is the underground mine with complex geological conditions, mining difficulty, disaster types, wide distribution. One of the reasons for the gas accident-prone is that the complex geological conditions of the coal mine itself affect the drainage and treatment of the gas in the mining process. With the increase of mining depth, the coal seam gas pressure, gas content, in-situ stress is growing day by day, and the gas control is becoming more and more difficult. The original mine outburst danger is more serious, the prominent frequency increases, the outburst intensity increases, and the casualty accident caused by outburst increases. A part of the original high gas mine and even low gas mine began to appear dynamic phenomenon, and the outburst was upgraded to outburst mine. The outburst of such mine is serious, which is easy to cause a large number of casualties and property loss, because it is the absence of any outburst prevention measures.

(2) China's small and medium-sized coal mines, which small village and township coal mines accounted for about 35% of China's coal mine production, is an important part of China's coal mining. Since 2000, the situation of coal mining industry began to turn for the better in China. Some of the managers of small coal mines one-sided improve the production due to be driven by the benefit, and despise the importance of safety in coal mine production. Many producers willing to take the risk by reducing security input means to reduce production costs in order to maximize the excess profits. Many producers willing to take risks, and reduce production costs by reducing the safety input to obtain the maximum excess profits. The consequence of this is that the coal and gas outburst accidents happen frequently, which seriously restrict and influence the healthy and rapid development of our country's economy, and affect the stability of the society.

(3) The software and hardware investment of coal mine safety in China are not enough and can't be used effectively. For a long time, the research of coal mine gas accident and the implementation of the new safety technology transformation can't be guaranteed. Compared with foreign countries, China's coal mine safety equipment is relatively backward, and there is no equipment should be equipped with safety facilities. In addition, some coal mine have the completed facilities, but these facilities has not been effectively used which lead to gas accidents still occur. For years experts have suggested that lack of investment in the supervision departments of production safety and research work of safety in

production in China, resulting in the specific measures of coal mine safety supervision is not in place, particularly for the monitoring and prevention of gas prediction and early warning. The shortage of investment in safety production research is a direct result of the study of coal mine safety theory behind the actual safety production of the coal mine ^[6].

(4) Coal mine personnel lack of safety knowledge and management organizations have defects, illegal operations and illegal organization of production is serious. Coal mine workers lack of professional knowledge and relevant safety technology training, the phenomenon of illegal operation is common. The management personnel’s level of coal mine accident is limited, and the traditional management system can’t meet the needs of coal mine safety production.

Safety Management and Measures

Orbit Intersecting theory which is a cross theory starting from the direct and indirect reasons of accident studies accident cause theory. Its basic idea is that accidents are the result of the development of many interrelated events that can be divided into people and objects (including environment) two series of development. When people's unsafe behavior and unsafe state occurred in the same time, space, or the intersection of people's unsafe behaviors and objects insecurity, forming trajectory intersection point, is the space and time of the accident.

Orbit intersecting theory emphasizes the factors of people and objects in the cause of the accident in the equally important position. By eliminating the unsafe behavior of people or the unsafe condition of things or avoid the trajectory cross all can avoid the happening of the accident, It points out the direction of the accident prevention. Therefore, based on point of the theory, corresponding measures to eliminate people's unsafe behavior and unsafe state must be taken. The model as shown in figure 6.

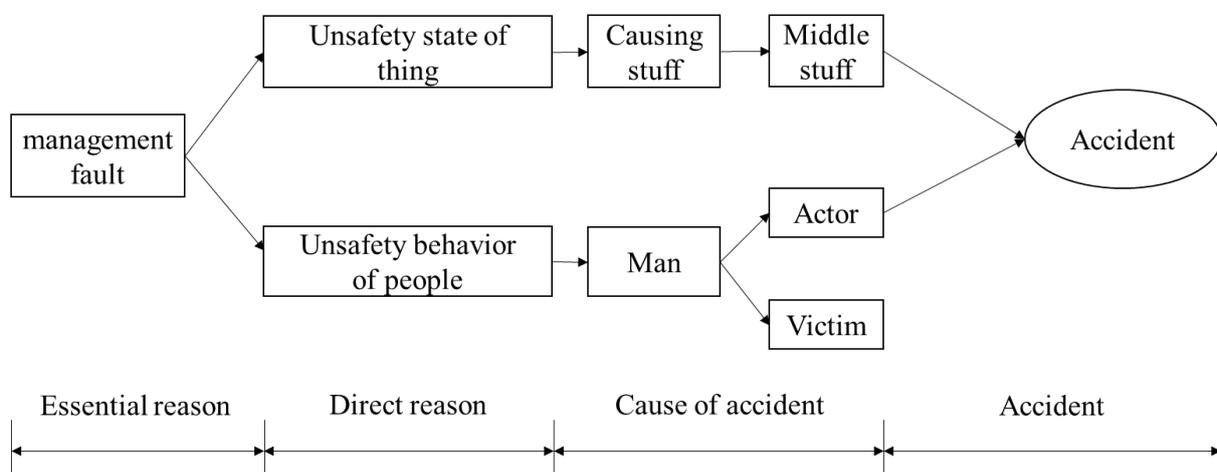


Fig.6 Model of orbit intersecting theory

According to the orbit Intersecting theory can be seen that the cause of the accident includes two aspects: people's unsafe behaviors and the unsafe state of things. When the unsafe state of things cross the unsafe behavior of people is an accident. The content of unsafe state is caused by people's unsafe behavior, therefore, in the final analysis is artificial reasons. Essential reason is that the errors in the management. From the aspect of coal and gas outburst accident reasons, complex geological conditions, the one-sided pursuit of yield, insufficient safety investment, and low coal mine personnel quality and management organization defects are the highlight of the main causes of frequent accidents. Therefore, the corresponding safety management and measures are put forward as follows:

(1) From the aspect of people, safety management is the root of accident prevention at the coal industry. Safety management is in order to prevent accidents so the enterprise must establish a safety management plan, and improve the quality of the safety management plan and operation mode are the basic means of reducing accidents and improve safety performance^[7] for enterprise safety management. More importantly, the enterprise organization and safety management system must be established by implementation in the daily work of the production to play an important role. Employees and leaders must establish safety responsibility consciousness, strictly carrying out the safe production management system. Staff should have qualified professional and technical to ensure safety in production.

(2) From the aspect of stuff, through the gas extraction to make gas under a state of low gas mine mining that is to ensure the coal mine safety production; Monitoring is the guarantee of safety production. Both production and capital construction, technological transformation of mine must be equipped with monitoring system. "Yield is dependence on wind" is the core and basis of the mine ventilation management that is the reason why that mine have a reasonable way of ventilation and ventilation system^[8].

Conclusion

(1) From 2006 to 2015 the coal mine gas accidents in China show that larger accident death toll is also the most, and the accident obvious regional distribution, occurrence time and bulge distribution is concentrated.

(2) Using the orbit Intersecting theory it can be known that unsafe behavior of people or the unsafe condition of things cause the accident.

(3) Safety management play a significant role in coal enterprise production. Through establishing perfect safety management system, continuously improving the level of safety management of coal enterprises are the key to accident prevention.

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