



Comprehensive and Integrated Mine Ventilation Consultation Model – CIMVCM



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ABSTRACT

Since the beginning of mining, the problems induced by ventilation in underground coal mining practices have prompted great needs of reliable consulting tools to assist mining engineers, government agencies or researchers' investigating and analyzing the mine ventilation system, or making any ventilation managements. Due to the development of mining method and modern mining (e.g. longwall mining) employed in recent years, the mentioned needs become more and more critical for mine operators. In this paper, a PC based computer mine ventilation consultation software model developed by the authors is introduced. This model is called CIMVCM (*Comprehensive and Integrated Mine Ventilation Consultation Model*). The computer model is a comprehensive, reliable and user-friendly one. The nature of "comprehensive" means the model can be used to consult the system's rational reliability allocation, can assist engineers to select the best ventilation plan from multiple candidate ones, can quantitatively rate a system's potential risk and safety degree and also can check the system's reliability based on field observations. All of those works are very important to mine operators understanding the system and then taking proper measures to control the potential risk. In addition to that, usages of developed computer program are also very easy. Users can operate the program without possessing an in-depth knowledge on computer and mathematical theory. Until today, CIMVCM has been successfully employed in numerous cases of designing and assessing various mine ventilation systems during the past decades. The reliability of mathematical models used in CIMVCM has also been proven by such applications.

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1. Introduction

The importance of mine ventilation has not just newly been recognized. As early as 40,000 B.C. in Palaeolithic times, when miners faced oxygen deficiency, toxic gases, harmful dust, etc., they had to develop some methods to course the air through shafts or tunnels to provide fresh air to the underground (Hartman et al., 1997). Until today, delivering a flow of air to the underground workings of a mine of sufficient volume to dilute and remove noxious gases (typically NO_x, SO₂, methane, CO₂ and CO) (Wikipedia, 2013) is still the first and primary objective for an underground coal mine. However, under the background of modern mining methods extensively applied nowadays, the challenges that a mine ventilation engineer faces are not just limited in delivering fresh air from surface any more. As the powerful and mechanized mining equipment employed today, both the underground mining intensity and the coal production scale are expanded by multiple times, which

brings great changes in the mine ventilation network designing, topological characterises, controls, etc. During the time of such changes happened, although the mining system becomes much simpler than old time, the system's reliability is placed more emphasis than ever before. Numerous demands or considerations coming from various aspects, such as geology, regulations, local environment, economic factors, and disaster management, are now needed to balance by engineers. The tasks that a ventilation engineer currently taken are no longer just performing simple ventilation surveys and routinely recording ventilation parameters any more, but instead of a number of complex calculations, comparisons, interdisciplinary decisions.

Generally speaking, an eligible mine ventilation system of a modern coal mine should have the following characteristics: (a) Simple and practical; (b) Safety and reliable ventilation facilities (Chang, 1987); (c) Steady underground air flow; (d) Low ventilating resistance and reasonable distribution (Xenergy, 1997, 1998); (e) Strong capabilities to prevent disasters (Zhou, 2009).

Concentrating on mentioned problems in the mine ventilation engineering, many researchers started numerous researches

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including planning, optimization, environmental control, automation, monitoring, etc. to find solutions. For the mine ventilation systematic reliability design. Chen et al. (2003) applied multiple fuzzy synthesis estimation methods to assess the safety and reliability of mine ventilation system. In addition, a simulation program SIMURES was developed to model the reliability and maintainability analysis of an iron ore mine (Kumar and Huang, 1993). The ventilation design strategy has also been improved a lot in recent years. Engineers now have considered more factors

in mining practices in addition to VOD (Ventilation on Demand) (Rocque and Sletmoen, 2002; Isaksson et al., 2009), such as hazards reduction (Rawlins, 2006; Brake, 2009; Panigrahi et al., 2009), and face ventilation layout (Zhang et al., 2009). To upgrade or optimize a mine ventilation system, some researchers also carried out a lot of work and obtained well outcomes (Myasnikov and Patrushev, 1981; Prosser et al., 2002; Roman et al., 2002; Loring and Nelson, 2006; Wallace and Sletmoen, 2009). For evaluating the system, back to 1960s or 1970s, only one or two single criteria was popular used to evaluate a system if it can be ventilated easily or not, such criteria including equivalent orifice (Murgue, 1883), total air quantity to working faces, ventilation efficiency, etc. However, Because of the complexity that a modern coal mine ventilation system has, in order to consider all influence factors, comprehensive evaluation models have been gradually developed and also accepted by researchers. Zhou and Wang (2002) tried to make the selection procedure into a mathematical process using twelve quantitative indices to evaluate candidate plans. Fault tree analysis method was also used for evaluating the underground mine escape way (Goodman, 1988).

However, although a great of research works has been carried out so far, such new findings and developments in recent years are not systematically summarized. Hence, this research work has contributed to an improved ability to control and operate the mine ventilation system for engineers when they face some complicated and challenge problems in practices. In order to aid their working and improvements on the mine ventilation system, a PC-based computer package CIMVCM (Comprehensive and

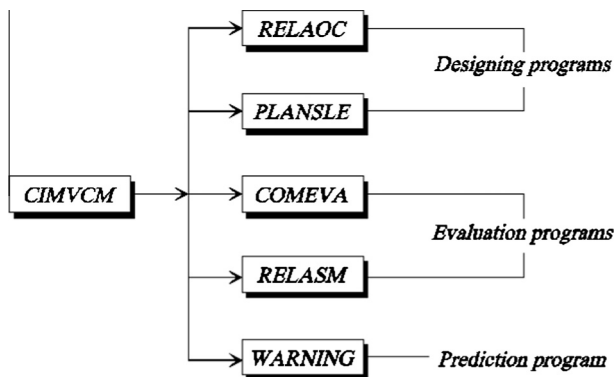


Fig. 1. Structure of CIMVCM program package.

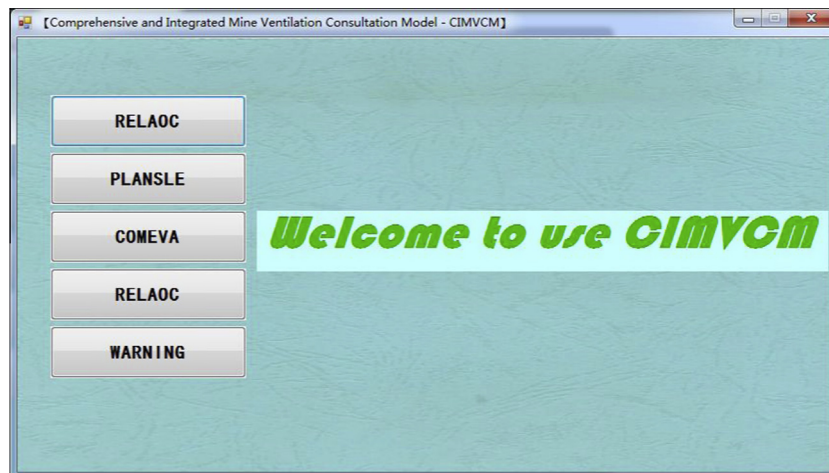


Fig. 2. CIMVCM main screen.

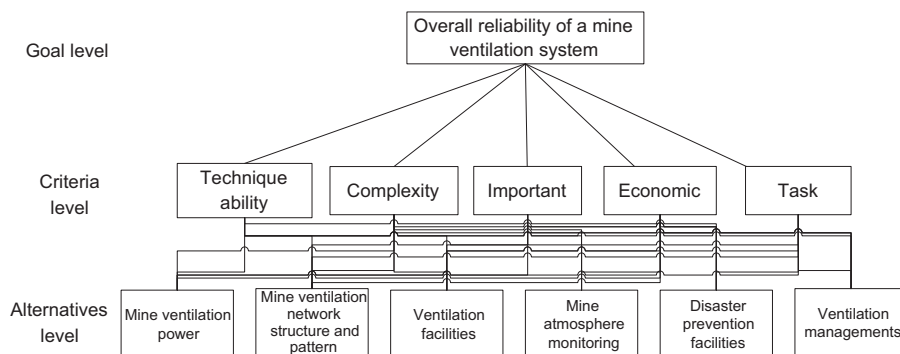


Fig. 3. Schematic for analytical structure using the AHP method.

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