

Preface

Coal and gas outburst is one of the most severe hazards threatening safe coal mine production. Characterized by its suddenness and immense destructive power, it often results in heavy casualties and substantial property losses. As the world's largest coal producer and consumer, China faces complex coal resource endowment conditions. With the progressive depletion of shallow resources, mining depths are extending downward at a rate of 10 - 25 m per year, giving rise to increasingly serious problems of “four highs and one low”—high in-situ stress, high gas pressure, high temperature, low permeability—that have unprecedentedly increased the difficulty of outburst prevention and control. Against this background, the mechanism and prevention technologies for outburst disasters in close-distance coal seam groups (closely spaced coal seam groups or close-interval coal-seam groups), which are characterized by multiple seams, multiple hazard sources, superimposed mining-induced stresses, and coupled gas fields, have become one of the core bottlenecks constraining the safe and efficient exploitation of deep coal resources in China.

This book has been written on the basis of a profound understanding of this major engineering and scientific issue and long-term research accumulation. Under the occurrence conditions of close-distance coal-seam groups, because the inter-seam spacing is small (typically less than 10 m), mining of any one seam exerts significant mining-induced influence on its adjacent upper and lower seams, creating a pattern of “mining one seam, relieving pressure in multiple seams”. This causes large volumes of relieved gas from adjacent seams to flow into the working space, resulting in extremely high gas emission rates at longwall faces and exponentially increasing the difficulty of gas control. At the same time, the superimposed mining-induced stresses from multiple mining passes can easily form local stress concentration zones. Combined with possible low permeability, soft and broken coal-rock properties, the disaster-inducing mechanisms of coal and gas outburst become even more complex. Traditional single-measure

outburst prevention approaches often prove ineffective, necessitating a systematic, three-dimensional comprehensive management strategy.

This book presents research work on outburst prevention technologies for close-distance coal-seam groups. The core concept of this book is to extend the outburst prevention of a single seam to a progressive, multi-level joint prevention framework of “multi-seam, regional, local”, and to upgrade traditional static prediction to intelligent early warning based on “multi-source information fusion and dynamic continuous monitoring”.

The distinctive features of this book are as follows:

First, close integration of theory and practice, with a typical coal mine as an engineering case study. The book reviews fundamental theories including outburst mechanisms, protective seam mining, gas drainage, and combined outburst prevention, and innovatively introduces the Yilan No. 3 Mine as the engineering case background throughout. As a typical deep, close-distance outburst-prone multi-seam mine in northeast China, Yilan No. 3 Mine combines unfavorable conditions such as deep high in-situ stress, extremely close multi-seams, a thick overlying oil shale layer, complex geological structures, low-permeability soft coal-rock, and high gas pressure. The gas control difficulty at Yilan No. 3 Mine is highly representative both in China and worldwide. The book describes the full-process technical scheme, from the selection of the first-mined seam, design of regional outburst elimination measures, comprehensive gas management during extraction, to outburst prevention management models and emergency response plans.

Second, a complete technical system with comprehensive and systematic coverage. The book covers the “whole chain” of outburst prevention in close-distance coal-seam groups: from analysis of mine gas-geological laws and outburst hazard assessment, to design of regional and local outburst prevention measures, to face prediction, effectiveness verification and safety protection during excavation and extraction, as well as mine outburst prevention management, organizational structure, training, and emergency plans. In addition, the book covers “soft science” aspects such as establishment of outburst prevention institutions, personnel training, and management systems, embodying the modern safety concept of

“equal emphasis on technology and management”.

Third, emphasis on cutting-edge technologies reflecting contemporary trends. The book closely tracks the latest domestic and international advances in outburst prevention technologies, proposing typical models of “coordinated drainage through boreholes in coal-seam groups” and “enhanced permeability stimulation + refined drainage” for both close-distance and long-distance seam groups. These contents represent important development directions of current outburst prevention technologies and provide valuable references for guiding future technological upgrades in mines.

Fourth, detailed and reliable data with strong operability. The book cites a large number of measured gas parameters from Yilan No. 3 Mine and related research findings, with reliable data sources. All proposed technical schemes are based on rigorous field investigations and theoretical calculations, giving them strong engineering guidance and practical applicability.

The completion of this book embodies the wisdom and painstaking efforts of many experts, scholars, and engineers. I would like to express my sincere gratitude to China Coal Technology & Engineering Group Shenyang Research Institute Co., Ltd. for providing the valuable research platform and project support, and to Yilan No. 3 Mine for its full cooperation and data sharing in engineering practice. Special thanks go to Professor Wang Chunguang, Associate Professor Li Yanzeng, Professor Qiu Haisheng, and Professor Cao Yaolin of China Coal Technology & Engineering Group Shenyang Research Institute for their solid theoretical guidance in the writing of this book. Thanks to Senior Engineer Xie Yuxiang, Senior Engineer Wu Haijun, and Engineer Zhang Zhen of Yilan No. 3 Mine for their on-site technical support.

The prevention and control of coal and gas outburst is a long-term and arduous task. Although we have made some progress in the field of close-distance coal-seam groups, numerous scientific questions and technical challenges remain to be addressed, such as refined description of outburst mechanisms, dynamic coupled simulation of mining-induced stress fields and gas fields in coal-seam groups, and intelligent and unmanned outburst prevention technologies. The publication of this book is intended to serve as a modest spur to induce further

contributions, and to provide a systematic and practical reference for researchers, engineers, and graduate students in related disciplines in the field of coal mine safety. We hope it will be beneficial to the cause of safe and efficient coal mining in China.

Owing to the limitations of our knowledge, errors and omissions are inevitable in this book. We sincerely welcome criticism and corrections from all readers.

The Author

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