National Institute for Occupational Safety and Health (NIOSH) Mining Abstracts: Chinese Translations

美国国家职业安全与卫生研究所(NIOSH) 矿山安全资料

--研究报告摘要

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The National Institute for Occupational Safety and Health (NIOSH)
美國國家職業安全與衛生研究所 (NIOSH)

The National Institute for Occupational Safety and Health (NIOSH)
美國國家職業安全與衛生研究所（NIOSH）

The National Institute for Occupational Safety and Health (NIOSH) is the U.S. federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. NIOSH is part of the Centers for Disease Control and Prevention (CDC) in the Department of Health and Human Services.

美國國家職業安全與衛生研究所（NIOSH）負責從事為預防與工作相關的損傷和疾病的科學研究並提出建議，是美國疾病控制與預防中心(CDC)的一部分，隸屬於美國衛生與公眾服務部。

NIOSH Origins and Mission

The Occupational Safety and Health Act of 1970 created both NIOSH and the Occupational Safety and Health Administration (OSHA). OSHA is in the U.S. Department of Labor and is responsible for developing and enforcing workplace safety and health regulations. NIOSH is in the U.S. Department of Health and Human Services and is an agency established to help assure "safe and healthful working conditionals for working men and women by providing research, information, education, and training in the field of occupational safety and health."

NIOSH的創立和使命

1970年通過的職業安全與衛生法創立了NIOSH和美國職業安全與衛生管理(OSHA)。OSHA隸屬於美國勞工部,負責制定和執行工作場所安全與衛生法規。NIOSH隸屬於美國衛生與公眾服務部, "通過提供職業安全與衛生領域的科研、信息、教育和人員培訓,協助確保全國勞工安全和健康的工作條件" 。

NIOSH provides national and world leadership to prevent work-related illness, injury, disability, and death by gathering information, conducting scientific research, and translating the knowledge gained into products and services.

通過收集信息、進行科學研究和將所獲得的成果轉化為產品和服務, NIOSH在預防與工作相關的疾病、傷害、殘廢和死亡方面擔負著全國和全球的領導地位。

Strategic Goals

The Institute's responsibilities include:

- Conducting a focused program of research to reduce injuries and illnesses among workers in high-priority areas and high-risk sectors.
- Implementing and maintaining a system of surveillance for major workplace illnesses, injuries, exposures, and health and safety hazards.
- Increasing prevention activities through workplace evaluations, interventions, and recommendations.
- Providing workers, employers, the public, and the occupational safety and health community with information, training, and capacity to prevent occupational injuries and illnesses.

戰略目標

- 進行重點項目的科學研究以減少高優先領域和高風險行業工人的工傷和疾病;
- 實施和維持工作場所重大疾病、傷害、有害物質接觸、以及健康和安全危害的監測系統;
- 通過對工作場所的評價以及提出相應的干預措施和建議,增加對工作場所疾病和傷害預防的力度;
- 為工人、雇主、公眾和職業安全及衛生社團提供信息和人員培訓，以提高預防職業傷害和疾病的能力。

NIOSH Locations

NIOSH has a staff of over 1,400 people. NIOSH is headquartered in Washington, DC, with research laboratories and offices in Cincinnati, Ohio, Morgantown, West Virginia, Pittsburgh, Pennsylvania, Spokane, Washington, Atlanta, Georgia, and Denver, Colorado.

NIOSH所在地

NIOSH共有1400多工作人員,總部設在華盛頓。研究實驗室和辦公室位於俄亥俄州的辛辛那提市、西維吉尼亞州的摩根城、賓夕法尼亞州的匹茲堡市、華盛頓州的斯波坎市、喬治亞州的亞特蘭大市和科羅拉多州的丹佛市。

NIOSH Research

NIOSH scientists carry out a focused program of intramural and extramural research to prevent or reduce work-related injury and illness. The National Occupational Research Agenda (NORA) provides a framework to guide the efforts of the occupational safety and health community in selected priority research areas, such as agriculture, forestry & fishing, construction, healthcare & social assistance, manufacturing, mining, services, transportation, warehousing & utilities, and wholesale and retail trade.

NIOSH研究

NIOSH科研人員從事研究所內外的重點研究項目以防止或減少與工作相關的損傷和疾病。國家職業研究議程（NORA）為指導職業安全及衛生社團選擇重點研究領域提供一個總的框架。該重點研究領域涵蓋農業、林業和漁業、建築、醫療保健及社會救助、製造業、採礦業、服務業、交通運輸、倉儲及公用事業以及批發和零售貿易。

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傳真號碼：513-533-8573，或瀏覽NIOSH網站: www.cdc.gov/niosh

Focus on Prevention:
Conducting a Hazard Risk Assessment

Michael J. Brnich, Jr., CMSP and Launa G. Mallett, Ph.D.

Focus on Prevention: Conducting a Hazard Risk Assessment
http://www.cdc.gov/niosh/mining/pubs/pdfs/2003-139.pdf

Overview: The first step to emergency preparedness and maintaining a safe workplace is defining and analyzing hazards. Although all hazards should be addressed, resource limitations usually do not allow this to happen at one time. Risk assessment can be used to establish priorities so that the most dangerous situations are addressed first and those least likely to occur and least likely to cause major problems can be considered later.

Purpose: This training package was developed to assist instructors as they (1) determine how to use risk assessment to improve safety preparedness and (2) present risk assessment concepts and tools to trainees. The concepts and tools presented here can be applied to any mine hazard.

Audience: Information in this package is appropriate for workers from all types of mines. A risk analysis can be conducted by anyone familiar with the location being studied.

以防為主:災害風險的評估

Michael J. Brnich, Jr., CMSP 和 Launa G. Mallett 博士

概況: 災害的界定與分析是應急準備和維護工作場所安全的第一步。雖然所有的災害因素都應加以考慮,但資源的限制往往不允許我們同時考慮所有問題。風險評估可用於優先次序的確定,從而首先解決那些最具危險的問題,而將最不可能發生和最不可能引發重大事故的災害留待以後考慮。

目的: 本培訓教材的開發旨在協助講員(1)確定如何利用風險評估以提高安全防範, (2)為受培訓人員闡明風險評估的概念和工具。本教材涉及的概念和工具適用於任何礦業的危險。

讀者: 本教材適用於從事各種礦業的工人。任何熟悉其工作場所的人都可以進行災害風險的分析。

PROCEEDINGS OF THE SECOND INTERNATIONAL WORKSHOP ON COAL PILLAR MECHANICS AND DESIGN

http://www.cdc.gov/niosh/mining/pubs/pdfs/tn492.pdf

Edited by Christopher Mark, Ph.D.,[1] Keith A. Heasley, Ph.D.,[1] Anthony T. Iannacchione, Ph.D.,[2] and Robert J. Tuchman[3]

ABSTRACT

Pillar design is the first line of defense against rock falls—the greatest single safety hazard faced by underground coal miners in the United States and abroad. To help advance the state of the art in this fundamental mining science, the National Institute for Occupational Safety and Health organized the Second International Workshop on Coal Pillar Mechanics and Design. The workshop was held in Vail, CO, on June 6, 1999, in association with the 37th U.S. Rock Mechanics Symposium. The proceedings include 15 papers from leading ground control specialists in the United States, Canada, Australia, the United Kingdom, and the Republic of South Africa. The papers address the entire range of issues associated with coal pillars and have a decidedly practical flavor. Topics include numerical modeling, empirical design formulas based on case histories, field measurements, and post failure mechanics.

第二屆煤柱力學與設計國際研討會文獻彙編

Christopher Mark 博士, Keith A. Heasley 博士,
Anthony T. Iannacchione 博士, Robert J. Tuchman 主編

摘要

煤柱設計是防止岩石崩落的第一防線–岩石崩落系美國以及其它國家井下煤礦工人面臨的最大單一安全危險。為提高采礦基礎科學水準,美國國家職業安全與健康研究所組織了第二次煤柱力學與設計國際研討會。該研討會於 1999 年 6 月 6 日在美國科羅拉多州的 Vail 市與美國第 37 屆岩石力學學術報告會合作舉辦。該國際研討會文獻彙編了包括來自美國,加拿大,澳大利亞,英國,以及南非共和國從事地面控制的一流專家的 15 篇論文。這些論文涵蓋了煤柱設計的所有問題,並且側重於它們的實際應用。其內容包括數值模擬,基於實例的經驗性設計公式,實地測量,以及事故之後的相關力學分析。

FIRE RESPONSE PREPAREDNESS FOR UNDERGROUND MINES

http://www.cdc.gov/niosh/mining/pubs/pdfs/2006-105.pdf

By Ronald S. Conti,[1] Linda L. Chasko,[2] William J. Wiehagen,[3] and Charles P. Lazzara, Ph.D.[4]

ABSTRACT

Fire has long been a concern for underground mine workers. A mine fire can occur at any time and can result in a partial or total evacuation of mine personnel and the loss of lives. Fires can grow rapidly. Time is the critical element. Prompt detection, timely and accurate warnings to those potentially affected, and a proficient response by underground miners can have a tremendous impact on the social and economic consequence of a small underground fire. Fire preparedness and response have components of technology and people. These components can work synergistically to reduce the time it takes to bring the system back in balance. This report deals with the preparedness of miners to respond to underground mine fires. It is intended to aid the mining industry in understanding the various roles of emergency responders and the training techniques used to increase their skill levels. The report also presents a technology overview to assist in effective response to mine fires.

地下礦井的消防應急

Ronald S. Conti, Linda L. Chasko,
William J. Wiehagen, Charles P. Lazzara 博士

摘要

火災是井下礦工長期以來所關切的問題。礦井火災可以在任何時間發生並導致部分或全部井下人員的撤離及生命損失。火災能迅速蔓延,而時間則是關鍵的因素。及時探測,並及時準確預警那些可能受危及的人員以及井下礦工的熟練反應能夠對小型井下火災的社會和經濟後果產生巨大影響。消防防備和應急是由技術和人員兩個方面組成的。兩方面可以協同工作,以縮短系統恢復平衡的時間。本報告涉及井下火災的消防應急,旨在幫助採礦業了解緊急救援的各種作用及其培訓技術,以提高其技能水平。報告還列出了技術概況以協助有效應對礦井火災。

AN UNDERGROUND COAL MINE FIRE PREPAREDNESS AND RESPONSE CHECKLIST: THE INSTRUMENT

http://www.cdc.gov/niosh/mining/pubs/pdfs/ic9452.pdf

By Ronald S. Conti,[1] Linda L. Chasko,[2] Charles P. Lazzara, Ph.D.[3] and Gary Braselton[4]

ABSTRACT

Preparedness is an important element of any underground mine's strategic plan in dealing with an unexpected event, such as a fire. A fully implemented fire preparedness and response plan is essential in reducing the probability and seriousness of a mine fire. This report describes the development of an underground coal mine fire preparedness and response checklist (MFPRC). The checklist is a data collection instrument for profiling both the fire prevention and response capabilities of a mine site and usually requires 3 to 4 days to complete. The checklist encompasses conditions, procedures, and equipment that have frequently been identified as the primary or contributing causes of underground coal mine fires. At least 1 day is needed underground to evaluate the water system. This entails measurements of waterflows and pressures at fire hydrants, and water throw distances of fire hose and nozzles at several locations (mains and branch lines). A few of the other topics that are discussed with mine personnel include detection and suppression systems, combustible materials, mine rescue and fire brigades, and firefighting equipment.

井下煤礦火災防備和反應清單:文件

Ronald S. Conti, Linda L. Chasko,
Charles P. Lazzara 博士, Gary Braselton

摘要

防備是所有地下礦井處理突發事件如火災的應急方案的一個重要方面。一個全面完整的火災防患和應急計劃對於減少礦井火災的可能性和嚴重性是必不可少的。本報告介紹煤礦井下火災防患和應急清單的開發(MFPRC)。該清單是一個描述礦區火災預防以及應急能力的數據採集文件,通常需要 3 至 4 天來完成。清單包括通常被認為是主要的或可導致礦山火災的因素,程序,以及設備等。地下水系統的評價需要至少 1 天時間。這包括測量消防水龍頭的水流和壓力,消防栓及噴嘴在不同地點水的噴射距離(包括總管和分支線)。與煤礦人員討論的其他幾個議題包括探測和滅火系統、可燃材料、礦山救援及消防隊、以及消防設備等。

ROOF AND RIB FALL INCIDENTS AND STATISTICS: A RECENT PROFILE (No link available)

By Deno M. Pappas,[1] Eric R. Bauer,[2] and Christopher Mark, Ph.D.[3]

ABSTRACT

During 1998-99, groundfall incidents resulted in 27 fatalities and were responsible for over 70% of all deaths in U.S. underground coal mines. To obtain a better understanding of where and why these incidents occurred, a comprehensive analysis of groundfall injuries and fatalities was conducted. The first portion of the study examined various factors associated with roof and rib fall injuries and reportable roof fall noninjuries that occurred during 1995-98. The study found that the room-and-pillar mining method has twice the groundfall incident rate than the longwall method. Mine locations with high groundfall rates seem to correlate to regions where there is a higher concentration of problematic coalbeds. For example, the Illinois Basin has very high groundfall rates, which can be traced back to several key coalbeds-Kentucky No. 13, Herrin/No. 6/ Kentucky No. 11, and Springfield No. 5/Kentucky No. 9. High rib fall rates were found in mines located in thick seams. Groundfall rates were found to be 30% to 40% higher during the months of July through September, possibly due to high humidity that may cause the shale mine roof to deteriorate. The second part of the study examined the root causes of failure by reviewing all groundfall fatality reports for 1996-99. Primary and secondary hazard factors were assigned to each groundfall incident. The primary factors resulting in these groundfall fatalities were pillar extraction, traveling under unsupported roof, skin failure, construction, longwall faces, intersections, and geologic discontinuities. Defining prominent ground control incident trends and hazards will identify areas where additional study is needed and where innovative solutions need to be developed to reduce these severe occupational hazards.

冒頂和片幫事故及其統計數據:最新概況

Deno M. Pappas, Eric R. Bauer, Christopher Mark 博士

摘要

在 1998 至 1999 兩年期間,頂板冒落事故在美國造成了 27 人死亡,並與七成以上美國井下煤礦死亡事故直接關聯。為了進一步了解何處以及為什麼會發生這些事故,我們對頂板冒落傷亡進行了全面分析。本研究報告的第一部分調查了各種因冒頂和片幫致傷的相關因素,以及發生在 1995 至 1998 年秋季有記載的冒頂非傷亡事故。研究發現,房柱式開采的事故發生率比長壁式開採高一倍。頂板冒落的區域似

乎與局部有較多問題煤層呈相關。例如,美國伊利諾伊盆地的高頂板冒落率可以追溯到幾個關鍵煤煤層,包括肯塔基 13 號,赫林/6 號/肯塔基 11 號,以及斯普林菲爾德 5 號/肯塔基 9 號煤層。研究還發現高片幫率發生於厚煤層的礦區。7 至 9 月份的頂板冒落率比其它月份高出 30%至 40%。這可能是由於這些月份的高濕度導致礦井頁岩頂板惡化的緣故。本研究報告的第二部分通過對發生於 1996 至 1999 年期間頂板冒落死亡報告的審查,分析了事故發生的根源。導致這些頂板冒落事故的主要和次要危害因素包括煤柱回採,行進於無支撐的頂板底下,頂板表層破壞,施工方法,長壁工作面,交叉口,以及地質上的不連續。判斷比較突出的地層控制事故的發生趨勢及其危害將有助於確定哪些方面需要進行更多的研究和開發新的解決辦法以減少這些嚴重的職業危害。

HANDBOOK FOR DUST CONTROL IN MINING
(No link available)

Fred N. Kissell, Ph.D.,[1] Editor

ABOUT THIS HANDBOOK

This handbook describes effective methods for the control of mineral dusts in mines and tunnels. It assumes the reader is familiar with mining. The first chapter deals solely with dust control methods, regardless of the application. It is a brief tutorial on mining dust control and will be of help to the reader whose dust control problem does not conveniently fit any of the mining equipment niches described in later chapters.
The subsequent chapters describe dust control methods for different kinds of mines and mining equipment. This includes underground coal and hard-rock mines, as well as surface mines, stone mines, and hard-rock tunnels. Because dust sampling has so many pitfalls, a chapter on methods used to sample dust is included. For those occasions when there is no practical engineering control, a chapter on respirators is also included.
Except for those listed as “future possibilities” in the longwall chapter, the dust control methods described are practical and cost-effective for most mine operators. If controlling dust were a simple matter, dust problems in tunnels and mines would have been eradicated years ago. Unfortunately, most underground dust control methods yield only 25% to 50% reductions in respirable-sized dust. Often, 25% to 50% reductions are not enough to achieve compliance with dust standards. Thus, mine operators must use several methods simultaneously, usually without knowing for sure how well any individual method is working. In fact, given a 25% error in dust sampling and day-to-day variations in dust generation of 50% or more, certainty about which control methods are most effective can be wanting. Nevertheless, over the years, some consensus has emerged on the best dust control practices. This handbook summarizes those practices.

礦山防塵指南

弗雷德 Fred N. Kissell 博士主編

關於本手冊

該手冊為熟悉採礦業的讀者評述控制礦山和隧道粉塵的有效方法。第一章著重於粉塵的控制方法,但不涉及其應用。這是一簡要的礦山防塵指南,它將幫助讀者解決那些通常情況下不適用於後面章節涉及到的採礦設備場所的粉塵控制問題。緊接的幾個章節描述不同類型的礦山和採礦設備的粉塵控制方法,包括井下煤礦,硬岩礦山,露天礦山,石灰窯,和硬岩隧道等。鑑於粉塵採樣有許多陷阱,該手冊將粉塵採樣的各種方法專立一章。有些工作場所難於實行粉塵的實際工程控制,故本手冊也

包括呼吸防護器一章。除了那些列為"未來可能"的方法外,本手冊介紹的粉塵控制方法適用於大部分礦山作業,實用並且成本低效益高。假如控製粉塵是件簡單的事,那麼隧道與礦山的粉塵問題可能早已不存在了。不幸的是,多數礦井粉塵控制方法只能降低 25%至 50%呼吸性粉塵。而這 25%至 50%的減少往往不能滿足粉塵的衛生標準。因此,礦山經營者必須同時使用幾種降塵方法,但他們往往不知道其中某一方法是否起作用。考慮到 25%的粉塵採樣誤差和 50%以上粉塵產生量的正常波動,實際上很難確定哪種粉塵控制方法最有效。然而,人們在過去幾年對最好的防塵措施已經形成某些共識。這本手冊對此作了概述。

HANDBOOK FOR METHANE CONTROL IN MINING

http://www.cdc.gov/niosh/mining/pubs/pubreference/outputid1779.htm

Fred N. Kissell, Ph.D.,[1] Editor

ABOUT THIS HANDBOOK

This handbook describes effective methods for the control of methane gas in mines and tunnels. It assumes the reader is familiar with mining. The first chapter covers facts about methane important to mine safety, such as the explosibility of gas mixtures. The second chapter covers methane sampling, which is crucial because many methane explosions have been attributed to sampling deficiencies. Subsequent chapters describe methane control methods for different kinds of mines and mining equipment, primarily for U.S. coal mines. These coal mine chapters include continuous miners and longwalls, including bleeders. Coal seam degasification is covered extensively. Other coal mine chapters deal with methane emission forecasting and predicting the excess gas from troublesome geologic features like faults. Additional coal chapters contain methane controls for shaft sinking and shaft filling, for surface highwall mines, and for coal storage silos. Major coal mine explosion disasters have always involved the combustion of coal dust, originally triggered by methane. Thus, a chapter is included on making coal dust inert so it cannot explode. Methane is surprisingly common in metal and nonmetal mines around the world, as well as in many tunnels as they are excavated. Accordingly, a chapter is included on metal and nonmetal mines and another on tunnels.

Proper ventilation plays the major role in keeping mines free of hazardous methane accumulations. The ventilation discussed in this handbook, except for the chapter on bleeder systems, deals only with so-called face ventilation, i.e., ventilation of the immediate working face area, not ventilation of the mine as a whole. The omission of whole-mine ventilation was necessary to keep this handbook to a reasonable size and because a huge amount of excellent information is available on the subject.

礦山開採中瓦斯控制指南

主編: Fred N. Kissell 博士

摘要

這本指南介紹了礦井和隧道中瓦斯控制的有效方法。這裡假設讀者已經熟悉採礦。第一章描述瓦斯對礦山安全的重要性如氣體混合物的爆炸特性。第二章介紹瓦斯採樣。這是很重要的一環,因為很多瓦斯爆炸都是由於採樣存在問題所造成。接下來的章節敘述不同礦井和採礦設備的瓦斯控制方法,這些主要針對美國煤礦。有關煤礦的章節包括連續採煤機和採用滲透通風的長壁開採。對煤層的瓦斯抽放也做了很

多介紹。其它和煤礦有關的章節闡述瓦斯釋放預報以及預測有地質缺陷如斷層問題時瓦斯的大量釋放。另外跟煤有關的章節包括豎井挖掘和封閉, 表面邊坡礦井以及煤儲藏過程中的瓦斯控制。重大煤礦爆炸事故總是涉及由瓦斯引爆的煤塵爆炸, 因此本指南專門一章介紹如何使煤塵惰性化而不致發生爆炸。瓦斯在世界各地的金屬和非金屬礦以及許多挖掘的隧道中也出人意料的經常出現, 因而專門一章討論金屬和非金屬礦, 另外一章專門討論隧道。正確的通風對防止礦井有害瓦斯的積累具有重要的作用。除了有關滲透通風的一章外, 這本指南里討論的通風只涉及所謂的工作面通風, 也即直接對工作面通風而不涉及整個礦井的通風。由於有關整個礦井通風的重要信息已經足夠多, 為確保本指南不要太厚, 因此有必要對整礦通風部分加以省略。

LABORATORY AND FIELD PERFORMANCE OF A CONTINUOUSLY MEASURING PERSONAL RESPIRABLE DUST MONITOR

http://www.cdc.gov/niosh/mining/pubs/pdfs/ri9669.pdf

By Jon C. Volkwein,[1] Robert P. Vinson,[2] Steven J. Page,[3] Linda J. McWilliams,[4] Gerald J. Joy,[5] Steven E. Mischler,[6] and Donald P. Tuchman[5]

ABSTRACT

The National Institute for Occupational Safety and Health (NIOSH), through an informal partnership with industry, labor, and the Mine Safety and Health Administration, has developed and tested a new type of instrument known as the personal dust monitor (PDM). The dust monitor is an integral part of the cap lamp that a miner normally carries to work and provides continuous information about the amount of respirable coal mine dust in the breathing zone of that individual. Testing was conducted on 25 prototype instruments in the laboratory to verify the instruments' accuracy as received from the manufacturer and after a period of underground use. The laboratory testing verified previous work; there is a 95% confidence that the individual PDM measurements were within ±25% of reference measurements. In-mine testing determined the precision, durability, and miner acceptance. Data from the mines showed a field precision of 0.078% relative standard deviation for the PDM and 0.052% for the recognized standard—the coal mine dust personal sampler unit. The PDM had about 90% availability for collecting valid information in over 8,000 hr of underground use. Anecdotal comments by miners indicated that they found the PDM more convenient to wear for sampling than currently used instruments because of the integration of the sampler into the normally worn cap lamp. The means of the instruments' pre- and postmine accuracy verification test values were statistically equivalent. Additional data were collected to measure the equivalency of the PDM to the U.K. Mining Research Establishment sampler, as required by U.S. law. However, analysis of the data was more complex than originally anticipated because the variance with increasing concentration required use of a more sophisticated statistical model. Explanation of and results from this work will be the subject of a second publication. Under the broad range of test conditions covered in this work, the PDM functioned as well as the current sampler in terms of availability for use, accuracy, precision, and miner acceptance.

可連續測定呼吸性粉塵的個體監測器的實驗室和現場性能試驗

Jon C. Volkwein, Robert P. Vinson, Steven J. Page, Linda J. McWilliams, Gerald J. Joy, Steven E. Mischler, Donald P. Tuchman

摘要

美國國家職業安全與健康研究所(NIOSH)通過與工業界,勞工部門,以及礦山安全與衛生管理局的非正式夥伴關係,開發並測試了一種新型的個體粉塵監測器(PDM)。該粉塵監測器位於礦工上班攜帶的礦燈電池部分(見下頁圖),用以連續測定礦工呼吸帶的呼吸性煤塵總量。經過一段時間的井下使用之後,對25個由製造商提供的監測器樣機準確度進行了測定。實驗室測試驗證了前期工作; 結果表明95%置信界限內個體監測儀的檢測結果在±25%的參考測量值之內。礦井現場的測試則用於確定儀器的精確度,耐久性,和礦工的接受程度。所得的數據顯示,該監測儀礦井實地檢測的精確度為0.078%相對標準差。與公認的標準儀器--煤塵個體採樣儀相比,PDM的誤差為0.052%。在超過8000小時的井下使用過程中,PDM顯示出90%左右的有效測定。樂於評論的礦工表示,由於PDM融入礦燈的一部分,它比目前使用的採樣儀器更便於攜帶。井下測試前後儀器檢測的準確度沒有統計意義上的差別。根據美國法律的要求,我們還另外收集數據以測定PDM和英國採礦研究所採樣儀的等同性。不過由於測量值的波動隨濃度的增加而增大,數據的分析比原先預期的更複雜,因而需要採用更高級的統計模型。該項研究工作的結果及其分析將作為我們的第二篇論文發表。在本研究一系列的試驗條件下,PDM的功能包括有效測定,準確度,精確度,以及礦工的接受程度與目前使用的採樣器一樣令人滿意。


採樣進氣口位置
礦燈電池和個
體粉塵監測器
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Experimental mine and laboratory dust explosion research at NIOSH

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Abstract

This paper describes dust explosion research conducted in an experimental mine and in a 20-L laboratory chamber at the Pittsburgh Research Laboratory (PRL) of the National Institute for Occupational Safety and Health (NIOSH). The primary purpose of this research is to improve safety in mining, but the data are also useful to other industries that manufacture, process, or use combustible dusts. Explosion characteristics such as the minimum explosible concentration and the rock dust inerting requirements were measured for various combustible dusts from the mining industries. These dusts included bituminous coals, gilsonite, oil shales, and sulfide ores. The full-scale tests were conducted in the Lake Lynn experimental mine of NIOSH. The mine tests were initiated by a methane–air explosion at the face (closed end) that both entrained and ignited the dust. The laboratory-scale tests were conducted in the 20-L chamber using ignitors of various energies. One purpose of the laboratory and mine comparison is to determine the conditions under which the laboratory tests best simulate the full-scale tests. The results of this research showed relatively good agreement between the laboratory and the large-scale tests in determining explosion limits. Full-scale experiments in the experimental mine were also conducted to evaluate the explosion resistance characteristics of seals that are used to separate non-ventilated, inactive workings from active workings of a mine. Results of these explosion tests show significant increases in explosion overpressure due to added coal dust and indications of pressure piling.

Keywords: Explosion; Mining; Flame propagation; Deflagration

1. Introduction

There has been a notable decline in the frequency and severity of mine explosions since the early part of the twentieth century. Among the major safety measures responsible for this decline are the use of general rock dusting, development of permissible explosives and electrical equipment, improved ventilation, and improved methods for detecting hazardous conditions. Although these advances in mine safety are noteworthy, the problem of mine explosion prevention is not completely solved, for serious mine explosions still occur (Sapko, Greninger & Watson, 1989; Dobroski, Stephan & Conti, 1996). For many mines, the almost continual deposition of fine-sized float coal dust on the floor, ribs, and roof of mine entries and returns, coupled with the intermittent application of rock dust, has resulted in stratified layers of dust (Sapko, Weiss & Watson, 1987a). Over the years, changes in mining technology have produced increased amounts of finer float coal dust, which has compounded safety matters (Sapko, Weiss & Watson, 1987a). Frictional ignitions of methane are also a serious concern, and their potential for disastrous consequences is well known.

Much knowledge has been obtained from the full-scale explosion research conducted by mine safety research establishments during the past two decades (Sapko et al., 1989, 1987a; Weiss, Greninger & Sapko, 1989; Cashdollar, Sapko, Weiss & Hertzberg, 1987; Nagy, 1981; Michelis, Margenburg, Müller & Kleine, 1987; Reeh & Michelis, 1989; Sobala, 1987; Cashdollar, Weiss, Greninger & Chatrathi, 1992; Greninger, Cashdollar, Weiss & Sapko, 1990; Sapko, Weiss & Watson, 1987b; Lebecki, 1991; Michelis, 1996). This research has provided important practical data and a better understanding of the fundamental explosion processes. Previous Pittsburgh Research Laboratory[1] (PRL) experi-

[1] The Pittsburgh Research Laboratory was part of the U.S. Bureau of Mines before its transfer to the National Institute for Occupational Safety and Health (NIOSH) in October 1996.

美國職業安全與健康研究所在實驗礦井和實驗室開展的粉塵爆炸研究工作

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Issac A. Zlochower

摘要

這篇文章介紹了美國職業安全與健康研究所的匹茲堡實驗室在其實驗礦井和 20 升的實驗容器裡開展的粉塵爆炸研究工作。這項研究工作的主要目的是改善煤礦安全,但實驗數據對其它行業如製造,加工或使用可燃粉塵等行業也有一定的價值。實驗測定了來自礦井含有不同可燃成份的粉塵的爆炸性能如最小爆炸濃度以及用岩粉惰性化的具體要求。這些粉塵來自煙煤,黑瀝青,油頁岩和硫化物礦石。全尺寸的實驗是在美國職業安全與衛生研究所的實驗礦井中進行的。工作面(封閉端)的甲烷和空氣混合物首先被點燃用來卷吸並引爆粉塵。實驗室的測試是在一個採用不同能量點火器的 20 升容器裡進行的。將實驗室測量結果和全尺寸實驗相比較的目的之一是確定在什麼條件下,實驗室測量可以最好地模擬全尺寸實驗。研究結果顯示實驗室測量和全尺寸實驗在確定爆炸極限方面的吻合相對較好。在實驗礦井中還開展了全尺寸的實驗用來評估用於分隔已採區和回採區的密閉牆的防爆性能。這些爆炸實驗的結果顯示由於煤塵的存在爆炸衝擊波有顯著的增加並出現疊加。

Technology News

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Coal Dust Explosibility Meter

http://www.cdc.gov/niosh/mining/pubs/pubreference/outputid290.htm

Objective

To enable mine operators and mine inspectors to make quick and accurate measurements of the explosible nature of coal and rock dust mixtures.

The Problem

Past research has shown that the accumulation of coal dust in underground coal mines can be rendered nonexplosible by adding sufficient quantities of inert rock dust, such as limestone dust. Federal regulations for underground coal mines require mine operators to dust mine corridors with an inert rock dust and maintain a total incombustible content of at least 65% in the entries and at least 80% in the returns, where the coal dust is expected to be finer in size. Currently, samples of the deposited coal and rock dust are collected for aboveground analysis of the inert percentage, which consists of rock dust, ash, and moisture. The processing time for this analysis can be as long as 2 weeks. In addition, research has shown that measuring the incombustible percentage is not always sufficient to determine the explosibility of a sample, especially for finer coal dust. The National Institute for Occupational Safety and Health (NIOSH), Pittsburgh Research Center (PRC), has devised a prototype handheld instrument that can provide a direct assessment of the potential explosibility of a coal and rock dust mixture.

How It Works

The coal dust explosibility meter (CDEM) is a portable optical device that determines whether or not a coal and rock dust mixture is explosible (figure 1). It consists of an optical probe connected to a small electronics box with a digital display. The principle of operation of the CDEM is based on the measurement of infrared radiation reflected from the surface of a homogeneous mixture of two substances with different optical reflectances, such as light colored rock dust and dark coal dust (figure 2). Near-infrared radiation is emitted by a light-emitting diode in the optical module located behind the window of the optical probe. When the meter is inserted in the dust mixture, the infrared radiation reflects off the dust's surface and back to the silicon photodiode sensor, also located in the optical module. For a given coal volatility, the normalized optical reflectance of such mixtures is relatively constant at the limit of explosibility (the amount of rock dust required to inert) and independent of the coal dust particle size. Samples whose normalized reflectance measures below the threshold would be identified as explosible; samples with reflectances greater than the threshold would be nonexplosible.

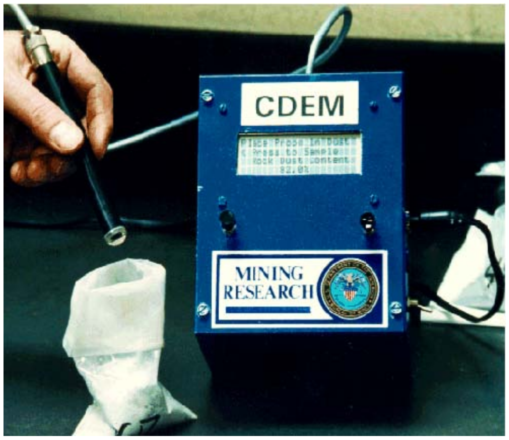

Figure 1. – The CDEM is used to analyze the composition of a coal and rock dust mixture.

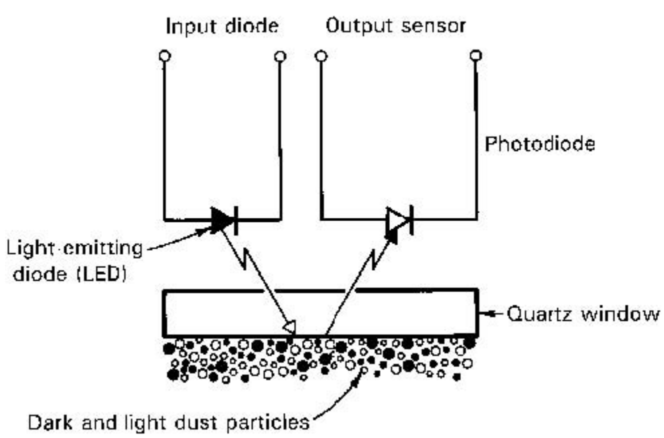

Figure 2.—Drawing depicting principle for measuring the optical reflectivity of a coal and rock dust sample.

Test Results

The limit of explosibility for many coals was determined in PRC's 20-liter explosibility chamber using several types of rock dust. As expected, the percentage of rock dust required to inert the coal dust increases for finer coal dust size. Coals with mass median particle sizes in the range of 10 to 70 μm required 90% to 60% rock dust, respectively, to be inerted. At the finest particle sizes, mixtures are still explosible even above the federally mandated 80% rock dust requirement for return airways, confirming the fact that measuring the rock dust concentration is not sufficient to determine the explosibility of a sample. For each mixture, the CDEM optical reflectance was measured at the limit of flammability and was found to be constant over the range of particle sizes for a given coal volatility. In practice, the normalized reflectance to which the meter alarm would be set would depend on the volatility of the coal seam in which the instrument was being used.

The CDEM thus provides a measurement of the explosibility of a dust sample over the entire range of coal dust sizes, rather than being restricted to the two coal sizes (intake and return) in current regulations.

Continued Efforts

Currently, the CDEM could provide an efficient method to determine the explosibility of air-dried, homogeneous samples at aboveground laboratories at the mine site. Research is in progress to measure and correct for the presence of moisture in the samples by measuring the electrical resistivity in addition to the reflectivity. This correction would allow the CDEM to be used on samples directly from the mine and possibly to provide an in situ explosibility measurement to eliminate the danger of operating under hazardous conditions while samples are processed. The CDEM could provide mine operators and safety inspectors with a valuable means for determining the explosible nature of coal and rock dust deposits.

Efforts are currently underway to commercialize the CDEM, along with a related instrument, the reflectance rock dust meter, which provides a direct measurement of the rock dust percentage in mine dust samples.

For More Information

To obtain a free copy of a technical paper on the CDEM or answers to technical questions about the device, contact Carrie E. Lucci or Kenneth L. Cashdollar, National Institute for Occupational Safety and Health (NIOSH), Pittsburgh Research Center, Cochrans Mill Rd., P. O. Box 18070, Pittsburgh, PA 15236-0070, phone (412) 892-4308 or (412) 892-6753, fax (412) 892-6595, e-mail: **chl4@cdc.gov** or **kgc0@cdc.gov**

To receive additional information about mining issues or other occupational safety and health problems, call **1-800-35-NIOSH (1-800-356-4674)**, or visit the NIOSH Home Page on the World Wide Web at http://www.cdc.gov/niosh/homepage.html

As of October 1996, the safety and health research functions of the former U.S. Bureau of Mines are located in the National Institute for Occupational Safety and Health (NIOSH).

煤塵爆炸性測量儀

目的

使礦區負責人和礦井監測人員能快速而準確地測量煤塵和岩粉混合物的爆炸性能。

研製的背景

過去的研究發現,通過加入足量的惰性岩粉如石灰石粉可以把在地下煤礦中積聚的煤塵變為不具爆炸性。地下煤礦安全的聯邦法規要求礦區負責人用噴灑惰性岩粉的辦法把進風巷的總不可燃成分控制在至少 65%,把回風巷的總不可燃成分控制在至少 80%,因為那裡的煤塵粒徑更小。目前的作法是把沉降的煤塵和岩粉樣品收集起來,送到井上分析其惰性成份,包括岩粉,灰和水蒸汽。這種分析的處理時間可以長達兩個星期。另外,研究發現測量不可燃成份並不足以確定樣品的爆炸性,特別是對粒徑很細的煤塵。美國職業安全與衛生研究所匹茲堡實驗室研製出了手持的產品樣機。該產品能直接測量煤塵和岩粉混合物潛在的爆炸性。

工作原理

煤塵爆炸性測量儀(CDEM)是一個便攜式光學裝置,能確定煤塵和岩粉的混合物是否具有爆炸性(見圖 1)。它包括一個光學測頭和與之相連的一個小的電子盒和一個數字顯示面板。測量儀的工作原理是基於測量不同反射率的兩種同類物質的混合物如淡色的岩粉和深色煤塵表面的紅外輻射(見圖 2)。在光學測頭窗口背後有一個光學模塊,它裡面的一個發光二極管發出近紅外輻射。當把測頭插入粉塵混合物中時,表面的紅外輻射被返射到光學模塊中的硅光電二極管。對含有固定揮發份的煤,混合物的標準光學反射率在爆炸性極限範圍內(惰性化所需的岩塵量)相對不變,而且與煤塵的粒徑無關。如果測得樣品的標準反射率低於這個閾值就被認為具有爆炸性;如果高於此閾值就被認為不具有爆炸性。

圖 1.用煤塵爆炸性測量儀分析煤塵和岩粉混合物的組份

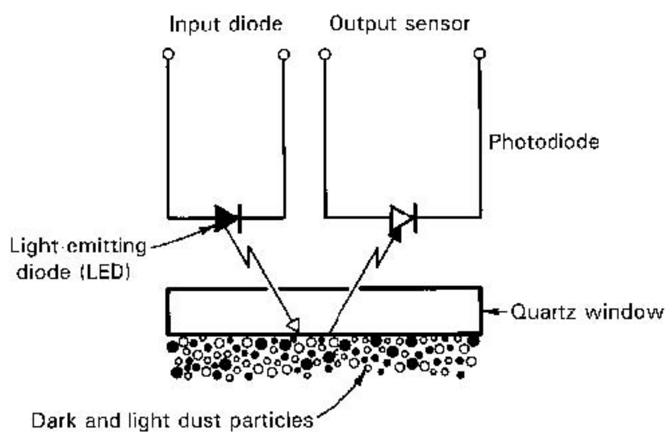

圖 2.煤塵和岩粉樣品光學反射率測量原理示意圖。

測試結果

許多煤的爆炸性範圍先用幾種岩塵在匹茲堡實驗室的 20 升爆炸性測試容器裡進行測定。和預料的一樣,煤塵惰性化所需的岩粉百分比隨著煤塵粒徑的減小而增加。為惰性化質量中位粒徑在 10 到 70 微米之間的煤塵,所需岩粉的百分比在 90%到 60%之間。對於回風巷中極細的煤塵,即使岩粉濃度超過聯邦法規規定的 80%,仍具有爆炸性,證明了測量岩粉濃度並不足以確定樣品的爆炸性。對每一個混合物,再用煤塵爆炸性測量儀在爆炸極限內測量其光學反射率。對於含有固定揮發份的煤樣,測量值在一定的煤塵粒徑範圍內內是一常數。在實際應用中,設置測量儀報警的標準反射率還取決於使用該儀器的煤層的揮發性。

煤塵爆炸性測量儀能在整個煤塵粒徑範圍內測量粉塵樣品的爆炸性,而不是僅局限於目前規範中的兩個地方的煤塵粒徑(進風巷和回風巷) 。

下階段工作

目前,煤塵爆炸性測量儀能夠提供一種有效的辦法在煤區的地面實驗室測量乾燥均勻樣品的爆炸性。進行中的改進工作通過測量反射率和電阻率來測量和校正含有水蒸汽的樣品。這種校正讓煤塵爆炸性測量儀可以測量直接來自礦井的樣品,進一步實地測量爆炸性,這樣可以消除在危險情況下處理樣品的風險。煤塵爆炸性測量儀為煤區負責人和礦井安全監測人員提供了一個有效手段來確定煤塵和岩粉積聚物的爆炸性能。

目前正在努力實現煤塵爆炸性測量儀的產品化以及相關的裝置,和岩塵反射率測量儀。後一種儀器能直接測量煤塵樣品中岩粉的百分比。

更多的信息

獲取關於煤塵爆炸性測量儀技術論文的免費拷貝或有關該裝置技術問題的信息,請聯繫: Carrie E. Lucci 或 Kenneth L. Cashdollar, National Institute for Occupational Safety and Health (NIOSH), Pittsburgh Research Center, Cochrans Mill Rd., P. O. Box 18070, Pittsburgh, PA 15236-0070,電話: (412) 892-4308 或(412) 892-6753,傳真: (412) 892-6595, e-mail: chl4@cdc.gov 或 kgc0@cdc.gov

獲取更多有關採礦或其它職業安全與健康方面的信息,請聯繫: 1-800-CDC-INFO (1-800-232-4636),或訪問美國職業安全與健康研究所網址: http://www.cdc.gov/niosh/homepage.html

從 1996 年 10 月起,原美國礦山局有關安全與衛生方面的研究職能已被轉移到了美國職業安全與健康研究所。

CDC Workplace Safety and Health NIOSH Technology News
Milestones in Mining Safety and Health Technology

Float Coal Dust Explosion Hazards

http://www.cdc.gov/niosh/mining/pubs/pdfs/2006-125.pdf

Objective

To increase awareness of float coal dust explosion hazards in the mining industry.

Background

In underground coal mining, dust is produced at the face, at conveyors, at transfer points, and by the normal movement of workers and machines. The coarse coal dust particles settle rapidly. However, the fine coal particles remain airborne much longer, and the ventilating air can move this fine dust relatively long distances into the returns before settling. This fine dust is called float coal dust. It generally consists of particles of coal that pass a 200-mesh sieve (particles smaller than 75 µm).

Generalized rock dusting is currently the primary means of defense against coal dust explosions in U.S. mines. 30 CFR 75, Subpart E (Combustible Materials and Rock Dusting), requires the use of rock dust in bituminous coal mines (30 CFR 75.402). The regulations state that rock dust shall be distributed upon the top, floor, and sides of all underground areas of a coal mine in such quantities that the incombustible content of the combined coal dust, rock dust, and other dust shall be not less than 65%, and the incombustible content in the return air courses (where the dust is expected to be finer) shall be no less than 80% (30 CFR 75.403). These incombustible concentrations assume that the coal and rock dust are not layered, but are intimately mixed. Float coal dust is a serious explosion hazard if it accumulates on top of the rock dust and is not mixed thoroughly with the rock dust. An example of this is shown in Figure 1.

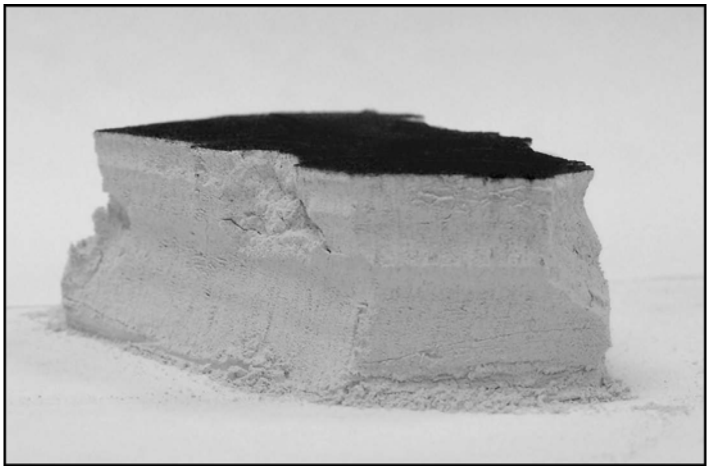

Figure 1.—Cross-section of a very thin (0.01-inch) explosible float coal dust layer deposited on top of a 3/4-inch (20-mm) thick layer of rock dust.

Approach and Results

The explosion hazards of float coal dust have been studied over many decades in the Experimental Mine at Bruceton, PA. The position of coal dust along the perimeter of an entry is a more important factor affecting explosion propagation than is often recognized. The dust on the ribs, roof, and other elevated surfaces (overhead dust) can be dispersed much more readily by an explosion than dust on the floor. If the overhead dust is mainly coal dust, the explosion hazard is intensified. If the overhead dust is primarily rock dust, the explosion hazard is reduced. Depending on the quantity, the overhead rock dust can compensate somewhat for a deficiency of rock dust on the floor. However, thick layers of rock dust on the floor cannot compensate for float coal dust on overhead surfaces.

For some of the Experimental Mine explosion tests, trays of color-coded dust layers were substituted for the floor layer in strategic locations throughout the test zone. The results showed that, for a typical float coal dust explosion, only the top 3/32 to 5/32 inches (2 to 4 mm) of the floor dust layer is stripped off or entrained in the air. It was also found that a minimum 5/l,000- inch (0.12-mm) thick layer (about the thickness of a sheet of paper) of pulverized float coal dust deposited on top of a 3/8-inch-thick uniform concentration of 80% rock dust and 20% float coal dust would propagate an explosion. The thicker the float coal floor layer, the more violent the explosion.

Recommendations

Research has shown that when the overhead dust is primarily rock dust, the explosion hazard is reduced. Depending on quantity, the overhead rock dust can compensate for a deficiency of rock dust on the floor. However, since rock dust on the floor cannot compensate for the float coal dust on surfaces above the floor, special attention toward increasing the rock dust content on these elevated surfaces is recommended.

Float coal dust deposits can be neutralized by new applications of rock dust (such as trickle rock dusting or bulk rock dusting), by mixing the float coal dust with the underlying rock dust, by general cleanup, and/or by washing down the rib and roof surface.

For More Information

For more information on the explosion hazards of float coal dust, contact Michael J. Sapko (412–386– 6619, MSapko@cdc.gov), Eric S. Weiss (412–386– 5050, EWeiss@cdc.gov), or Kenneth L. Cashdollar (412–386–6753, KCashdollar@cdc.gov), NIOSH Pittsburgh Research Laboratory, Cochrans Mill Rd., P.O. Box 18070, Pittsburgh, PA 15236–0070; fax: 412–386–6718.

To receive other information about occupational safety and health topics, call 1–800–35–NIOSH (1–800–356–4674), or visit the NIOSH Website at www.cdc.gov/niosh

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漂浮煤塵的爆炸危險性

目的

增強人們對礦井漂浮煤塵爆炸危險性的認識。

背景

在井下採煤的同時,煤塵出現在工作面,傳送皮帶,中轉點以及人員和設備的正常運輸過程中。較大的煤顆粒會很快沉降,但細小的煤顆粒在回風巷中要經過較長的距離後才會沉降。這些細小的煤塵被稱為漂浮煤塵。它一般包括可通過 200 目分子篩(即小於 75 微米)的煤顆粒。

美國礦井中防止煤塵爆炸最主要的方法是規範化的噴灑岩粉。聯邦法規 30 CFR 75 (可燃物和岩粉噴灑)要求在煙煤礦井中噴灑岩粉(30 CFR 75.402)。規則規定岩粉需噴灑在所有井下煤礦的頂板,地板和煤壁上。使用的岩粉量應滿足煤塵,岩粉和其它葉岩粉混合物中不可燃成份不低於 65%,在回風巷中(那裡的粉塵被認為比較細小)不可燃成份不低於 80%(30 CFR 75.403)。這些不可燃濃度是假定在煤塵和岩粉沒有分層且很好地混合的情況下得到的。 如果漂浮煤塵積聚在岩粉上表面而沒有與之很好混合的話,它就會具有很嚴重的爆炸危險。圖 1 就是這樣一個例子。

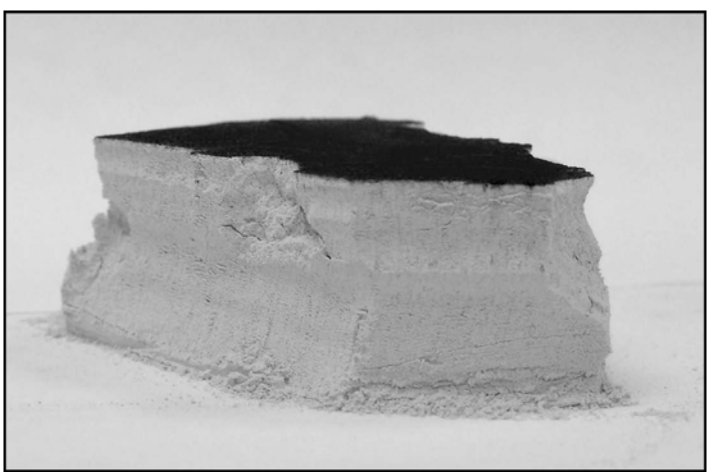

圖 1.一薄層(0.01 英寸)可爆炸的飄浮煤塵沉降在一 3/4 英寸(20 毫米)厚的岩粉層上

方法和結果

在賓夕法尼亞州 Bruceton 的實驗礦井已經開展了很多年飄浮煤塵爆炸危險性的研究。煤塵在巷道周邊積聚的位置對爆炸傳播的影響遠比人們所認識的更重要。積聚在煤壁,頂板和其它一定高度表面上的粉塵(上部粉塵)當爆炸發生時比在地板上的粉塵更容易被分散。如果上部粉塵主要是煤塵,爆炸的危險會增大。如果上部粉塵主要是岩塵,爆炸的危險則會減小。取決於具體的數量,上部岩塵可以彌補地板上岩塵的不足。但是,地板上的厚層岩粉並不能對上部飄浮煤塵起作用。

在有些實驗礦井開展的實驗中,實驗區地板上某些重要的地方使用了一層加彩的岩粉。結果顯示對一個典型的飄浮煤塵爆炸,地板上的粉塵只有最上面 3/32 到 5/32 英寸(2 到 4 毫米)厚的一層被帶走或捲入空氣中。實驗還發現對 3/8 英寸厚均勻含有 80%岩塵和 20%飄浮煤塵的混合物,只需要最小 5/1000 英寸(0.12 毫米)厚(相當於一張紙的厚度)的粉末飄浮煤塵積聚在其表面即可傳播爆炸。飄浮煤塵越厚,爆炸就會越劇烈。

建議

研究已經發現如果上部粉塵主要是岩塵的話,爆炸的危險就會減小。取決於具體的數量,上部岩塵還可以彌補地板上岩塵的不足。但是,因為地板上的岩粉並不能對上部飄浮煤塵起作用,所以當增加一定高度表面上的岩粉濃度時必須特別小心。
可以通過重新噴灑岩粉(如機器噴灑或人工噴灑)對飄浮煤塵的積聚物進行中和,也可以通過一般清掃或沖洗頂板和煤壁使飄浮煤塵和下面的岩塵進行混合。

更多的信息

獲取關於飄浮煤塵爆炸危險性的更多信息,請聯繫: Eric S. Weiss (412-386-5050, EWeiss@cdc.gov 或 Kenneth L. Cashdollar (412-386-6753, KCashdollar@cdc.gov), National Institute for Occupational Safety and Health (NIOSH), Pittsburgh Research Center, Cochrans Mill Rd., P.O. Box 18070, Pittsburgh, PA

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REMOTELY INSTALLED MINE SEALS FOR MINE FIRE CONTROL

http://old.smenet.org/digital_library/library_preprints.cfm

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Abstract
Mine fires constitute one of the greatest threats to the health and safety of those working in the underground environment and each event has the potential for disastrous consequences. Of the major mine fires and thermal events that have occurred in the United States in the last 6 years, it is estimated that remotely installed seals could have been used in 63% of the events to control fire growth or to aid in fire suppression work. The National Institute for Occupational Safety and Health (NIOSH) is conducting full-scale tests at the NIOSH Lake Lynn Experimental Mine to evaluate and improve remote mine seal construction technology. The main focus of this work is to develop reliable technology that will completely close the mine opening from floor-to-roof and rib-to-rib. This paper presents the results of remote seal installations using grout-based materials.

遠程安裝密閉牆以控制礦井火災

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摘要

礦井火災係對井下工作人員的健康和安全造成最大的威脅之一。並且每次事故都潛在著災難性後果。過去 6 年中發生在美國礦井的重大火災事故中,估計 63%的事故是可以用安裝遠程密閉牆來控制火災的發展或協助滅火工作的。為了評估和改善遠程密閉牆的建造技術,美國國家職業安全與健康研究所(NIOSH)目前正在其 Lake Lynn 實驗礦井對這項技術進行全尺寸實驗測試,重點在於開發能夠從地面到頂板,

從煤壁到煤壁完全密閉的可靠技術。本文介紹採用灰漿型材料建造的遠程密封牆的研究結果。