



## Review article

## Coal fires in China over the last decade: A comprehensive review

Zeyang Song<sup>a,b,\*</sup>, Claudia Kuenzer<sup>b</sup><sup>a</sup> Faculty of Resources and Safety Engineering, China University of Mining and Technology (Beijing), Beijing 100083, PR China<sup>b</sup> Earth Observation Center, EOC, German Aerospace Center, DLR, Oberpfaffenhofen, 82234 Wessling, Germany

## ARTICLE INFO

## Article history:

Received 15 July 2014

Received in revised form 4 September 2014

Accepted 4 September 2014

Available online 18 September 2014

## Keywords:

Coal fire  
China  
Geophysical detection  
Greenhouse gas  
Trace element  
Grout and gel injections

## ABSTRACT

Coal fires pose great threats to valuable energy resources, the environment, and human health and safety. They occur in numerous countries in the world. It is well-known that China, the largest coal producer and user globally, is one of the countries that have badly suffered from coal fires. Thus, over the course of the last decade, a lot of local research studies on coal fires in China have been published in international and Chinese scientific journals. The goal of this paper is to set the scene on past and current coal fire research in China. In this review we explore multidisciplinary investigations undertaken during the last decade associated with coal fires in China including fire detection, modeling, the assessment of environmental and human health impacts as well as fire-fighting engineering. We outline a systematic framework of research on coal fires and address inter-relations of sub-topics within this systematic framework. Additionally, the scientific and technical studies and their advantages, shortcomings and challenges for coal mine administrations are discussed. It is hoped that this comprehensive overview provides scientific guidance for management and coordination of coal fire projects.

© 2014 Elsevier B.V. All rights reserved.

## Contents

1.	Introduction	73
2.	Coal fires in China	75
2.1.	Ancient coal fires	75
2.2.	Coal fire distribution and development	75
2.2.1.	Reasons for coal fire distribution in the north of China	75
2.2.2.	Coal fire development and distribution during the last decade	75
3.	Detection and monitoring of coal fires	75
3.1.	Underground detecting techniques	77
3.1.1.	Index gases	77
3.1.2.	Radon gas	80
3.2.	Ground detecting techniques	80
3.2.1.	Temperature measurement	80
3.2.2.	Self-potential method	82
3.2.3.	2-D electrical imaging and electromagnetic techniques	82
3.2.4.	Magnetic techniques	84
3.2.5.	Ground penetrating radar	85
3.3.	Airborne remote sensing	85
3.3.1.	Multi-spectral and thermal remote sensing	85
3.3.2.	Unmanned aerial vehicle (UAV) sensing	85
3.3.3.	Hyperspectral remote sensing	85
3.4.	Space-borne remote sensing	86
3.4.1.	Methods to detect thermal anomalies and demarcate coal fire areas	86
3.4.2.	Coal fire dynamics	87
3.4.3.	Subsidence detection	88

\* Corresponding author at: Faculty of Resources and Safety Engineering, China University of Mining and Technology (Beijing), Beijing 100083, PR China.  
E-mail addresses: [szycumtb@126.com](mailto:szycumtb@126.com) (Z. Song), [claudia.kuenzer@dlr.de](mailto:claudia.kuenzer@dlr.de) (C. Kuenzer).

4.	Modeling of underground coal fires . . . . .	88
4.1.	Thermal, hydraulic and chemical couplings . . . . .	88
4.2.	Chemical reaction . . . . .	88
4.3.	The varying timescales of concurrence of kinetic reaction and oxygen transport . . . . .	89
4.4.	Thermo-mechanically coupled processes . . . . .	89
5.	Environmental and human health impact assessments . . . . .	90
5.1.	Greenhouse gas (GHG) emissions . . . . .	90
5.1.1.	CO <sub>2</sub> emission assessment on local scales based on in-situ gas measurements . . . . .	90
5.1.2.	GHG assessment on large scales based on burnt coal amount and local knowledge . . . . .	90
5.1.3.	Potential CO <sub>2</sub> emission assessment on large scale based on spaceborne remote sensing . . . . .	90
5.2.	Toxic gases . . . . .	90
5.3.	Toxic trace elements . . . . .	90
5.4.	Polycyclic aromatic hydrocarbons (PAHs) and soil pollutions . . . . .	92
6.	Fire-fighting engineering and reclamation . . . . .	92
6.1.	Preparation . . . . .	92
6.2.	Excavation . . . . .	92
6.3.	Water penetration . . . . .	92
6.4.	Injection . . . . .	92
6.4.1.	Water injection . . . . .	92
6.4.2.	Grout injection . . . . .	93
6.4.3.	Gel injection . . . . .	93
6.5.	Coverage . . . . .	93
6.6.	Reclamation . . . . .	94
7.	Discussion . . . . .	94
8.	Conclusions . . . . .	94
	Acknowledgment . . . . .	95
	Appendix A. . . . .	95
	References . . . . .	96

## 1. Introduction

Coal fires occur most frequently in exposed or underground coal seams (Kuenzer and Stracher, 2012). They are often triggered via spontaneous combustion of coal, which is an exothermic oxidation reaction

between coal and air. Coal temperature will increase if heat released by coal oxidation is not sufficiently dissipated. When the temperature reaches a critical temperature (80–130 °C), the coal will start to smolder and burn (Taraba and Michalec, 2011; Yuan and Smith, 2008; Zhang and Kuenzer, 2007; Zhu et al., 2013). A large number of factors influence



**Fig. 1.** Coal fires and their hazards in the Wuda Coalfield, Inner Mongolia Autonomous Region. (a) Burning coal; (b) a coal dust explosion triggered by a coal fire when the bulldozer move the burning coal; (c) pungent gas and smoke emitting from an underground coal fire; (d) a crack induced by a coal fire. Its width and temperature are approximately 40 cm and 177.8 °C, respectively.

Photos by Zeyang Song (2014).

Download English Version:

<https://daneshyari.com/en/article/1753165>

Download Persian Version:

<https://daneshyari.com/article/1753165>

[Daneshyari.com](https://daneshyari.com)