View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by IntechOpen

We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

4,800
Open access books available

122,000
International authors and editors

135M
Downloads

Our authors are among the

154
Countries delivered to

TOP 1%
most cited scientists

12.2%
Contributors from top 500 universities

CLARIVATE ANALYTICS BOOK CITATION INDEX INDEXED

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

2

Surface Coal Mining Methods in China

Changsheng Ji
School of Mines, China University of Mining and Technology
Xuzhou, Jiangsu,
PR China

1. Introduction

China is the largest coal producing country in the world with annual production rate of 324 Mt in the year 2010 [1]of which surface mining production is only about 9 percent of the total production because the coal reserves suitable for surface mining is not large enough compare with the other major coal producing countries. Surface coal mining methods used in China have also been limited because the geological, topographical and coal occurrences conditions.

2. Recoverable coal deposits to surface mining

2.1 Introduction

Coal reserves are available in almost every province in China, with recoverable reserves in around 334.1billion tons[2]. At current production levels, proven coal reserves are estimated to last not more than 50 years. In the recoverable coal reserves, only about 4.5~7.0 percent can be mined by surface mining method under current mining technology. There are 13 surface mining coal areas located around northern China, Shanxi-Shannxi-western Inner-Mongolia, northeasten China, southwest and Xinjiang, and about 70% is lignite coal, the others are mostly steaming coal.

Surface mining of coal was started around 1900 in China and in 1949 (the founding year of the People's Republic of China) the total production of coal was only 32.43Mt, in the longer period of coal extraction from the beginning of the 20th century to 1980s, surface coal mining production was no more than 4% of the whole country's production rate because the most coal beds are not suitable for surface mining methods to exploit. By the end of the year 2010, the annual coal production rate reached 3.24 billion tons, of which surface mined production was about 9 percent.

2.2 Steeply pitching seams

Surface coal mining methods used in China from 1949 to 1980 were mostly open pit method to excavate steeply buried pitching seams, in which the shovel-train system was prevalent, the overburden was transported from the pits to external spoil dumping areas.

2.3 Flat buried seams

After 1980, in the new developed surface mines shovel truck system has been broadly selected for the overburden removal and shovel-truck with crushing plant and belt conveyor system for the coal transportation from pit to the washing plant or storage areas. Since the coal seams in those mines are usually flat or shallow buried, the first cut overburden of those mines is hauled out of the pits and then the following cuts overburden is dumped in the previous cuts.

3. Coal surface mining methods

The major types of surface mining methods[3,4] presently employed in China can be classified into: (1) Openpit mining; (2) Area Type Mining; and (3) Contour Mining.

3.1 Openpit mining[5,6]

Open pit mining method was used broadly in Chinese surface coal mines in the years from 1949 to 1980, these mines were characterized by dipping seams with the slope of more than 12 degrees to 45 degrees.

Open Pit Mining was almost exclusively employed in China's state owned surface mines with pitching or steeply pitching seams in flat, rolling or hilly topography. Open Pit Mining of coal seams (usually from 10 up to 100 meter thick) involved removal of overburden in flat terrain, rolling or hilly topography. Shovels of 3 to 4 cubic meter dippers were the most common equipment used to remove overburden and coal into a series of benches 8 to 10 meters high, and the haulage equipment was usually steam engine or DC driven locomotives with 7 to 14 railcars depending on the tractive effort of the engines. The ratio of overburden to coal varied from 1.0 to 10 cubic meters per ton of raw coal.

This type of Open Pit Mining is performed by having the stripping operation follow the coal down-dip, overburden is placed outside of the pit. Direct backfilling is not feasible in these kinds of mines.

Case study of openpit mining

Haizhou openpit coal mine is located at Liaoning province in northeast of China, started construction in 1950 and put into operation in 1953 with designed production rate of 3.0Mt/a to 5.0Mt/a in 1987, 3 Jurassic steaming coal seams mined of composition thick about 40 to 120 meters with an average 82 meters, with a dipping angle of 18 to 22 degree. The pit length is 4km from east to west and 2km from north to south and 350m in depth. Figure 1 shows the mine is under operation.

The mining system used in Haizhou mine was shovel train system with a dipper size from 4 to 10 cubic meters and the electrified locomotive with 60t side dumping railcars, the overburden was transported from pit to external dumping areas. Figure 2 illustrates the 150 ton DC locomotive used in the mine and figure 3 shows the power shovel with a dipper size of 4 cubic meters.

3.2 Area type mining

Area type mining in China is characterized by removal of one or two moderately thick to thicker coal seams (usually between 6 and 30 meters thick with some more than 100 meters),

Fig. 1. Haizhou Openpit coal mine.

Fig. 2. Electrified train locomotive used in Haizhou Openpit mine.

Fig. 3. Power shovel used in Haizhou Openpit coal mine.

with extraction activities ultimately progressing over a relatively large tract of land. The topography is usually flat or gently sloping, after the first cut overburden being dumped outside the pit, spoil is directly placed in adjacent previous cuts, using shovels and fleet of trucks for excavation.

In area type mining, coal is commonly hauled by fleet of trucks from the pit to crushing plant located outside the pit limit or directly loaded into mobile crusher on the working benches and then conveyed by belt conveyor to the washing plant or railroad station for out of mine transportation. In some mines, bucket wheel excavators and conveyors are used to extract soft loess strata and there is also a 90 cubic meter bucket dragline directly overcast the overburden into the adjacent previously mined out cuts with some pre-stripping of BWE and shovel truck combination. The overburden removal equipment utilized in these kinds of mines varies from dipper sizes from 10 to 60 cubic meters, the truck fleet payload from 32 to 362 metric tons. The coal loading equipment of single bucket machines varies from 10 to 55 cubic meters which is either electric or diesel engines.

Area type mining is broadly used in the surface coal mines established after 1980 with the coal seam of flat or gently sloping with varied topography, about more than 20 surface coal mines of over 10.00Mt/a designed production rate in operation or under construction.

Case study: An Tai Bao surface coal mine

An Tai Bao surface coal mine is located in Shuozhou, Shanxi province, started operation in 1985, with designed production rate of 15.00Mt/a dry raw coal. The average mineable thickness of the coal seams is 7 meters for No. 4 seam, 14 meters for the No.9 seam, and 3 meters for the No. 11 seam. The cover over the No. 4 seam varies from 80 to 120 meters thick. The interburden between No.4 and No. 9 seam is 35 to 45 meters thick, and the parting between the No.9 and the No. 11 seam is 6 to 10 meters thick. The average seam dip as a result of an anticline trending northeast and plunging southwest is from 2 to 6 degree. Figure 4 shows the total reserve area and the mining pits with the direction of mining indicated.

Excavation of pit 1 occurs in two phases, development and full production. The development phase is the mining work done prior to the preparation plant beginning full production. The full production phase is the time required to complete Pit 1 and to establish a normal haul back operation mining north in Pit 2.

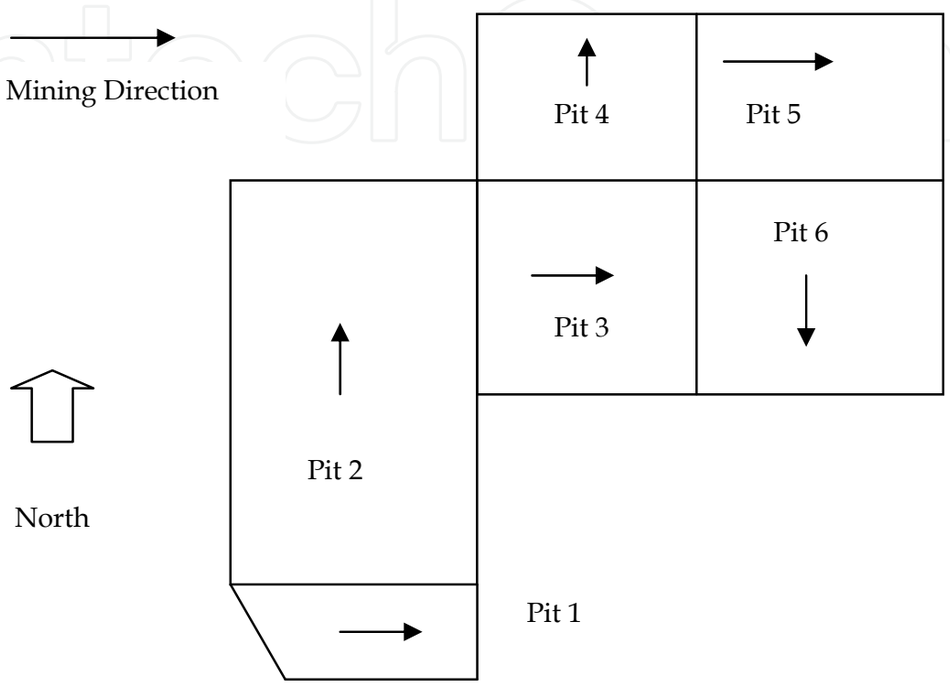


Fig. 4. An Tai Bao surface coal mine mining areas and pits.

During the development phase, all the excavated material must be hauled out of the pit to the waste area or the coal stock pile area. The full production phase of Pit 1 requires the waste material above the No.4 seam to be hauled to the waste areas outside of the pit and the waste bellow the No.4 seam to be backfilled in the mined out area of Pit 1. The coal is hauled to the raw coal dump at the plant site by the 154-tonne end dump trucks.

The excavation equipment includes the bucket of 25 cubic meters in size to be used in overburden removal, large hydraulic shovels, front end loaders in various sizes selected for coal loading and miscellaneous work.

3.3 Contour mining

Contour mining has been used only in Dafeng surface coal mine which located in Ningxia Hui Autonomous region northwest of China with mountainous topography. The working face of the mine is digging along the contour line to form the first cut and the spoil is hauled along the bench to fill in the nearby valley or hollows. Fig 6 shows the bench level of 1120m cut digging and waste materials hauled to fill nearby valley.

Fig. 5. An Tai Bao surface coal mine in operation.

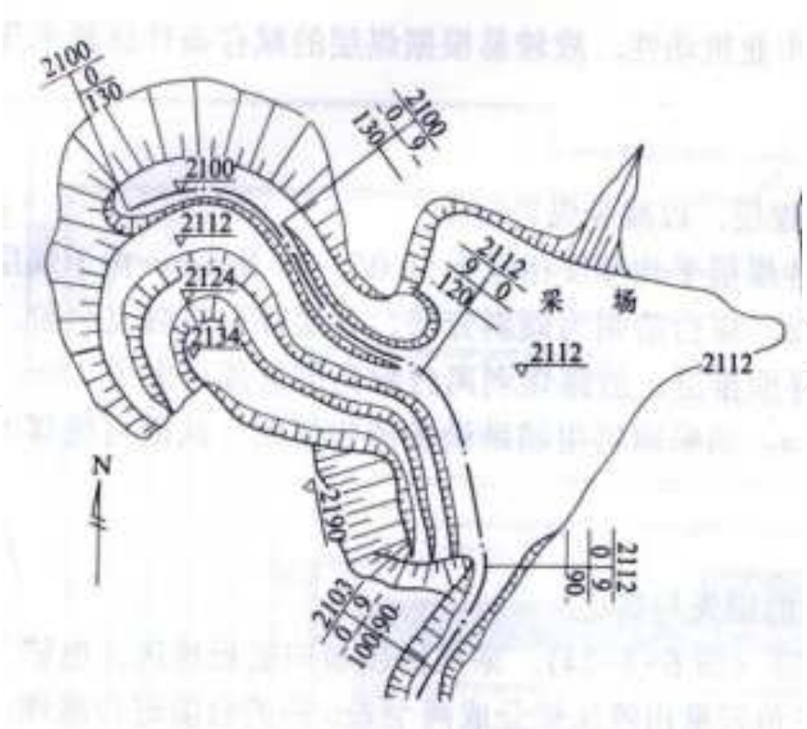


Fig. 6. From higher contour dropping to 2100m cut in Dafeng mine.

Dafeng mine is designed with annual output 0.9Mt anthracite and power shovel of 3 to 4 cubic meter dipper size for loading on 27 to 32, 45 ton off-highway trucks. The coal seams total thickness is 38.77 meters with a dipping angle from 5 to 17 degrees.

"Mountaintop removal mining" (MTR) is also used in this mine that uses explosives to blast "overburden" off the top of some higher mountains.

Fig 7 shows the large scale throw blasting used to move mountain top for underneath coal extraction.

Fig. 7. Throw blasting in Dafeng mine.

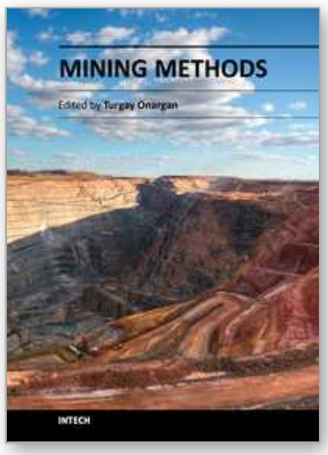
4. References

[1] National Bureau Statistics of China, Statistic yearly data, 2011.2.
[2] Weitong, Zhangxianchen, Wangyujun et al, Research of the strategy of China's coal development, Shanxi science and technology press, 1995.11.
[3] Kennedy B A. Surface Mining, 2nd Edition, Society of Mining, Metallurgy and Exploration Inc., Littleton, Colorado. 1990.

[4] Fung R, Surface Coal Mining Technology, Engineering and Environment Aspects, Noyes Data Corporation. Park Ridge. New Jersey. USA. 1981.
[5] Atkinson. T, Burdon R. G., Advanced Surface Mining Technology Project Report, The University of Sydney, 1984.
[6] Martin C H, Australasian Coal Mining Practice, The Australasian Institute of Mining & Metallurgy. 1986.

IntechOpen

IntechOpen



Mining Methods

Edited by Prof. Turgay Onargan

ISBN 978-953-51-0289-2
Hard cover, 64 pages
Publisher InTech
Published online 09, March, 2012
Published in print edition March, 2012

An economic viability of a modern day mine is highly dependent upon careful planning and management. Declining trends in average ore grades, increasing mining costs and environmental considerations will ensure that this situation will remain in the foreseeable future. This book describes mining methods for the surface and underground mineral deposits. The methods are generalized and focus on typical applications from different mining areas around the world, keeping in mind, however, that every mineral deposit, with its geology, grade, shape, and volume, is unique. The book will serve as a useful resource for researchers, engineers and managers working in the mining industry, as well as for universities, non-governmental organizations, legal organizations, financial institutions and students and lecturers in mining engineering.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Changsheng Ji (2012). Surface Coal Mining Methods in China, Mining Methods, Prof. Turgay Onargan (Ed.), ISBN: 978-953-51-0289-2, InTech, Available from: http://www.intechopen.com/books/mining-methods/surface-coal-mining-methods-in-china

INTECH
open science | open minds

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

© 2012 The Author(s). Licensee IntechOpen. This is an open access article distributed under the terms of the Creative Commons Attribution 3.0 License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

IntechOpen

IntechOpen