DRY JIGGING OF COALS

Ulziisaikhan Purevsuren
Department of Mechanical Science
School of Mechanical Engineering and Transportation
Mongolian University of Science and Technology
Ulaanbaatar, Mongolia
ulziisaikhan_p@must.edu.mn

Namnan Tumurpurev
Director of International High Education Research Center
Mongolian University of Science and Technology
Ulaanbaatar, Mongolia
namnan@must.edu.mn

Enkhbat Dombon
Department of Mining
School of Geology and Mining Engineering
Mongolian University of Science and Technology
Ulaanbaatar, Mongolia
enkhbat@must.edu.mn

Abstract — The coal industry, including coal mining and preparation, coal-fired power generation is one of the most water-intensive industries. Water problem in coal wet processing of South Gobi dessert region of Mongolia is one of serious problem. One of possible methods in arid regions to save water is using dry separation in coal industry. This study investigates the coal particle separation in an air jigging lab device. Tests were conducted with a coal from Mongolian Southgobi dessert region Nariinsukhait mining camp in the size range from 0.5-5 mm.

KEYWORDS *— PARTICLE SEPARATION; AIR JIGGING.*

I. INTRODUCTION

Mongolia is rich with coal. According to preliminary geological estimates, the resource base of the country includes 16 billion mt of coal, which places Mongolia among the top 15 countries in the world with the largest reserves of coal. The coal reserves are distributed uniformly throughout the country. However, the quality of the coal differs in the eastern and western parts of the countries. Lignite is found in East Mongolia, in the Suha Bator district. The Talbulag deposit has a calorific value of 2,400 Kcal/kg. In the western part of the country, there are large deposits of bituminous coking coals. To date, the biggest and most promising proven reserves of coking coal in Mongolia are located in the Tavan Tolgoi deposit of the South Gobi dessert, about 600 km south of Ulan-Bator. The proven reserves of the deposit are 6.4 billion mt, of which more than 40% accounts for high-quality coking coal [1].

There are seven large coal producers in Mongolia, including MMC, South Gobi, MEC, Aspire, Xanadu, Prophecy Coal and SharynGol. The largest customer for coal was China, accounting for over 82% of all exported coal, Fig 1 [2].

Technology of enrichment coal is a prerequisite for improving the quality of values, but also coking coal, coal gasification and liquefaction as the implementation of the country's economy, with a large value to increase the export potential, as well as the development of coal chemical industry.

Wet processing of coal in arid regions of Mongolia is limited by water. Currently, very actual the development of dry separation technology of coal industry in our country.

This study investigates the air jigging coal particle separation of Mongolian Nariin Sukhait deposit of the South Gobi desert, in the coal size range from 0.5-5 mm.

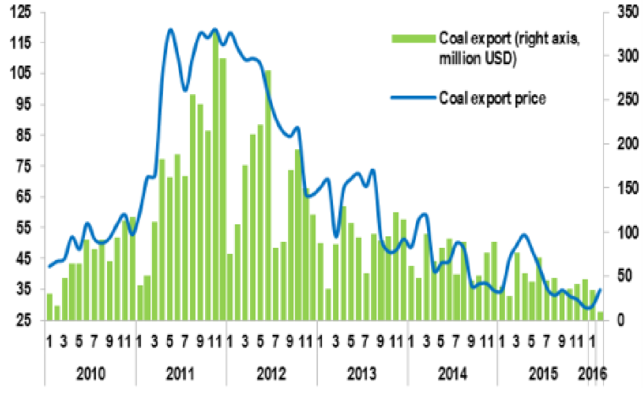


Fig. 1. *Coal export, market price (USD) [12].*

In Mongolian mining industry use different types of dry separation of coal: 1) air dense medium fluidized bed separation with/without external force field; 2) fluidized bed separation based on the difference of settling velocity; 3) compound dry separation; 4) triboelectrostatic separation; 5) magnetic separation. These five categories of technologies have their own advantages respectively in processing certain coal or yielding clean coal product with certain quality. Generally speaking, technologies belong to the categories (1), (4) and (5) usually have high separation efficiency but high operational cost, which are suitable for producing highquality clean coal. In contrast, technologies in categories (2) and (3) don't need additional dense medium or power and usually have larger capacities and low processing cost, but low separation efficiency due to the original limitation of separation mechanism. These technologies are suitable for producing steam coal. Besides, the electrostatic separation technologies and the magnetic separation technologies have high requirements for coal properties and certain degree of dissociation, thus, the handling capacities are limited. Considering these limitation, these two types of beneficiation technologies are only used in very special purpose [3].

II. PREPARATION OF COAL SAMPLE AND AIR JIGGING EXPERIMENTS

In laboratory performed two types of experiments: Coal crushing test and Dry jigging test.

A. Coal crushing test

The Nariin Sukhait deposit coals is high-ash coals with an ash content of 40 %. For air jigging separation use coal with size between 0.5-50 mm. In lab experiments divide this mass in following three categories: separation of 0.5-5 mm coal, separation of 1-5 mm coal and separation of 5-40 mm coal [4].

Coal crushing test for determine mechanical strength and in order to study the quality and wholesale disintegration of execution sample selected in accordance with ASTM D440, Fig 2.

The separation results of 5-40 mm coals with an ash content of 25 % show that a clean coal product with an ash content of 10 % was produced. The detailed separation results are S total 22 %, is shows the this type of coal is soft and easy to aeolian [4].

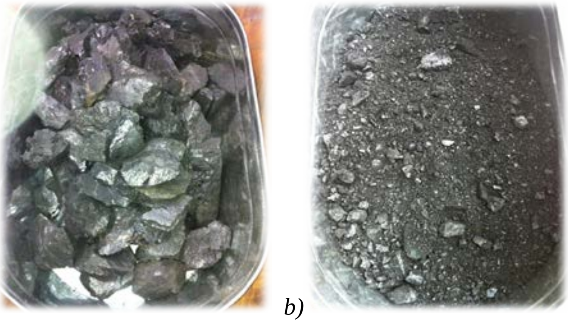


Fig. 2. *a) Preparation of 23 kg coal with size 50-75 mm; b) Crushed coals for lab experiments with size 0-50 mm.*

B. Dry jigging test

The dry beneficiation of coal are based on the physical properties of coal and its associated mineral matters. Different types of equipment for dry beneficiation have been developed, based on the exploitation of physical properties such as density, size, shape, magnetic susceptibility, and electrical conductivity [5].

Before the laboratory experiments, we are prepared 60 kg of coals and 20 kg associated mineral matters (Pebbles & Gravel) from Nariin Sukhait deposit. For prepare this mass divided in following four categories: with size 15-10 mm, 10-5 mm, 5-1 mm and 1-0.5 mm, Fig 3.

For air jigging experiments use all four size coals, but in our lab equipments more good results of separation is observed in size between 5-1 mm and 1-0.5 mm from Nariin Sukhait deposits.

The tests were performed in a laboratory scale designed air jig model, Fig.4. The cylindrical column of separation with internal diameter is 60 mm and the length 200 mm joined together with air distributor and porous plate. The airflow is produced by the air compressor (P=0.3-0.7 MPa).

Fig. 3. *Prepared coals and mineral matters for air jigging experiments.*

During the tests, the mixed particles are placed into the container and subjected to vibration by one streams of air flow which enter by the bottom plate of the jigging chamber. The active pulsating airflow is produced by solenoid valve. The frequency of the pulsating air can be adjusted with a frequency converter by solenoid valve. One cycle of the pulsating air valve changed from 0.8-1 second by this valve.

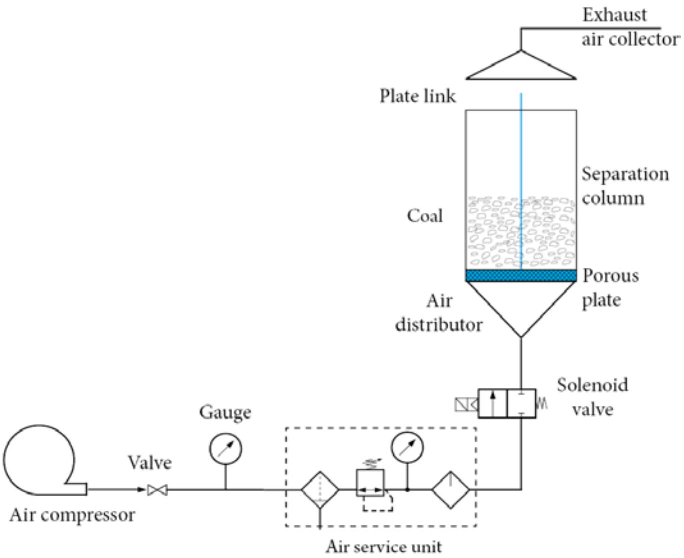


Fig. 4. *Schematics of laboratory air jigging separator.*

Also in experiments for the determine flow effects in separation we are use different types of porous plate with various hole (3 types), Fig 5.

Fig. 5. *Different hole types in porous plate (hole diameter 2-5mm).*

From the experimental results (Fig. 6) observed, these types of plate holes is not very effective for the equal separation by layer. Experiment data shows in Table 1 depending by percentage of coal and gravel, weight, air pressure, duration of the experiments and particle size.

TABLE I. EXPERIMETS DATA

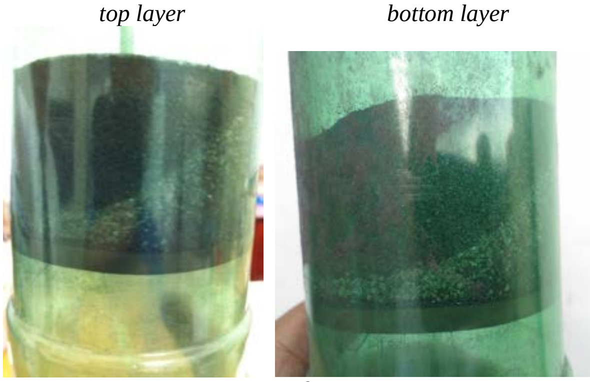
	1st experiment			
	Size, mm	***Weight, g***	***Air pressure, MPa***	***Duration time, min***
Coal	1-0.5	60	0.45	3
Gravel	1-0.5	20		
	2nd experiment			
Coal	1-5	60	0.35	3
Gravel	1-5	20		
	3th experiment			
Coal	1-5	10	0.55	3
Gravel	1-5	8.8		
	4th experiment			
Coal	1-5	50	0.55	3
Gravel	1-5	30		
	5th experiment			
Coal	1-5	60	0.45	3
Gravel	1-5	20		

The experimental results is different. Three layers of particles were produced after the separation process. The top layer consisted of small coal particles, the middle layer contained predominantly mixed products and the bottom layer comprised of higher density coal, stones and gravels.

III. RESULTS AND DISCUSSION

Air jigging separation effects by height in picture (top and bottom layer) shown in Fig 6. The best separation results for 1-5 mm coals with an gravel content of 25 % show that a clean coal in 1st layer content of 5.3-8.7 % was produced.

top layer *bottom layer*



side view of separation layer

Fig. 6. *Results of experiments.*

The three layers were identified visually, removed from the top using dragging slice by move plate, their masses recorded and, each subjected to analysis. This was conducted for all test runs under different operating conditions and is presented in Table 1.

In laboratory experiments after air jigging process the separation layer is not equal in height, that is shows of air flow is not uniform (Fig. 6). Its need to design more air inlet stabilizer for establish this layer effects.

IV. AIR FLOW SIMULATIONS

For studying the coal separation in lab fields, simulations were prepared for laboratory experimental tests. It is assumed that the air velocity is symmetrical at the inlet and that the cross air velocity, perpendicular to the direction of inlet airflow, is zero. The boundary condition is no slippage at all sides. In lab experiments airflow is within a low speed range (<100m/ s), the flow of air can be regarded as uncompressed flow. The simulation parameters are shown in Table 2.

TABLE II. PARAMETERS FOR THE AIR FLOW SIMULATION

Parameters	***Values***
Airflow velocity at the inlet	10.0 m/s
Pressure at the exit	0 MPa
Air temperature	20 °C
Air density	1.205 kg/m3
Air viscosity	1.8135×10-5 Pa.s

To study the air flow with and without plate hole in simulation the fluid computation software ANSYS Fluid Flow for air flow pattern analysis was used. Presimulation results in Fig. 7.

But It should be noted that this simulations is without coal particles in separation area, only the flow distribution across the area. Results is to study the air flow with and without plate hole in cylindrical separation area.

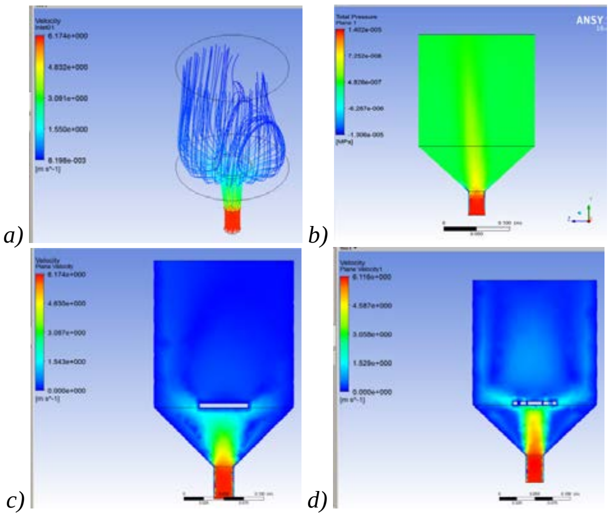


Fig. 7. *The air flow simulation results. a) results without plate; b) results with plane plate without hole; c) results with hole plate.*

CONCLUSION

Nariin Sukhait deposit coals of the South Gobi desert has an ash content up to 18.9 % and coal with size between 0.5-50 mm takes all deposit content up to 40 %. Exploration results show that from 310.4 billion tons of coal reserves 53.6% of all deposits are not directly selled, its need to beneficiation [6].

Dry cleaning of coal offers a new alternative approach in coal cleaning in Mongolia. Some of the dry coal-cleaning processes such as air dense-medium fluidized Bed (ADMFB), Air jig AllAir®, and FGX Separators are being using on an industrial scales around the Mongolian coal mining deposits [6]. For Nariin Sukhait deposit coals of the South Gobi desert, the best beneficiation technology is dry separation by pulsating of air flow would seem more appropriate. The separation results of coal with size between 0.5-50 mm in batch pilot-scale air jigging equipments, the clean coal amount 63.9-77.8%, an ash content of 18.9-25 % [6]. This laboratory results show possibility to use dry jigging benefication. For the best results we need to design or use in testing foreign air jigging equipments batch pilot-scale air jig model.

In order to perform pre-experiments in lab designed experimental dry jigging system. Results shown that a layer of fines accumulates in the top of the bed, while a greater proportion of coarse material is observed in the bottom of the bed.

We need to apply the comparison of the computer simulation result and the laboratory separation performance, with the current pulsating. Specifically need to simulate air jigging process with coal particles in separation area, jigging of particulate mixtures of variable size and density. Computing the motion and effect of a large number of small particles of coals in pulsating air flow.

REFERENCES

[1] http://www.coalage.com/. 18 March, 2015.

[2] http://mongolia-mining.org/

[3] Yuemin Zhao, Xuliang Yang, Zhenfu Luo, Chenlong Duan and Shulei Song, "Progress in developments of dry coal beneficiation". 2014.

[4] Ts.Duuren-Ulzii, "Research work of Mongolian Naryn Sukhait coal mine dry jigging beneficiation technology", UB., 2016.

[5] R.K.Dwari and K.Hanumantha Rao, "Dry beneficiation of coal-a review" page 177-234, 2007.

[6] Report of Mongolyn Alt Corporation. "Report of Mongolian Naryn Sukhait region coal mine beneficiation of coal with pollution and ash, high sulfur in semi-industrial FGX equipment " UB., May 2016.

[7] Li Zheng, Pan Lingying, Liu Pei and Ma Linwei, "Assessing Water Issues in China's Coal Industry"

www.cornerstonemag.net/assessing-water-issues-in-chinas-coal-industry/

[8] Philip Hall, "Dry Jigging (University of Nottingham) trial report". May 2009

[9] В.А.Адов, В.В.Морозов, "Разработка и применение критерия формы для оценки обогатимости угля пневматическим способом". 2010

[10] http://www.coalage.com/

[11] http://mongolia-mining.org/

[12] www.mongolbank.mn

[13] M.Kademli and O.Y.Gulsoy, "Investigation of using table type air separators for coal cleaning" Jan., 2014