



Coal Mining and Coal Preparation in Vietnam

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<http://doi.org/10.29227/IM-2018-01-40>

Abstract

The article deals with issues related to the hard coal mining sector and coal processing in Vietnam. Socialist Republic of Vietnam Vietnam main coal basins is Quang Ninh and Red River Delta and in this basins is currently being run exploitation and preparatory work before building new coal mines. VINACOMIN Company is the biggest coal producer in the country which is 100% dependent on state policy. The final part of the article will discuss a simple preliminary coal enrichment system at mining plants and coal processing plants with schemes in Vietnam. The summary will be the description of future plans for coal mining industry and enrichment systems.

Keywords: coal preparation, coal resources, coal basin, coal industry, coal processing, coal preparation flowsheet

Introduction

Vietnam is one of the most important producers of anthracite. After 1995 position of coal industry and coal in economy in Vietnam has changed. VINACOMIN is the leading company in Vietnam coal market. Coal industry play as important role in fast growing economy in Vietnam and also in energy production. Vietnam start putting more responsibility on environmental protection but another thing is increasing production efficiency in processing plants, build new underground mines and close open-pit mines.

Coal resources and coal basins in Vietnam

Currently available data shows that coal reserves in Vietnam is about 49.8 billion tons. Coal resources is classified into few categories: measured & indicated reserves (categories A+B+C1) is 33%, inferred (C2) 39% and prognostic resources (P) is 28%. In Vietnam appeared all types of coal: anthracite (already mined), bituminous coal, subbituminous coal, lignite coals and peat coal. To describe all coal resources Vietnam Government by VINACOMIN start cooperating with several companies and organizations from Japan like JCOAL (Japan Coal Energy Center), NEDO (New Energy and Industrial Technology Development) and JBIC (Japan Bank of International Cooperation). Coal play the key role in Vietnam economy and energy sector. Most important coal basins are located in Quang Ninh, Red River Delta, Thai Nguyen, Backan, North Path, Da River, Ca River, Na Duong, Nong Song, Ba River, Mekong River Delta (Fig. 1). Vietnam got one of the biggest resources of anthracite. Key role have Quang Ninh coal basin where is almost all currently coal mines and coal preparation plants. Quality parameters of raw coal in Vietnam from few coal mines is described in Table 1.

Two most important coal basins in Vietnam:

– Quang Ninh basin is located in northeast part of the country, it occupies the area of about 5900 km² of which 2800 km² is forest land and 510 km² is agricultural. Coal fields in this area are located very close to coast so it is very good location to send coal for international coal market. Exploitation begins in this basin at 1839. Quang Ninh coalfield got 8.7 billion tons of coal resources (anthracite). Most important coal deposits in Quang Ninh basin: Mao Khe, Trang Bach, Nam Mao, Vang Danh, Uong Thuong, Dong Vong, Nga Hai, Khe Tam, Giap Khau, Nui Bao etc. and are showed on Figure 2. Most important ports are Cam Pha Port and Hon Gai.

– Red River Delta basin was discovered in 1960 during the search for oil and gas.

The 39.4 billion tons lie beneath Red River coal basin (sub-bituminous coal) with the area of 2000 km². The coal deposits are located to depth 2500 m. Seam thickness of coal deposits in Red River Delta is 1.0 to 10.0 m. VINACOMIN develop here projects for few coal mines like Binh Minh, Khoai Chau I, Khoai Chau II. Development plan here need to face two big problems which is local people who are afraid of pollution here and second one is that in this area are located the biggest rice fields in Vietnam [4, 5, 6, 7, 8, 9, 13].

Vietnam coal industry policy, companies and production trends

The most important institution is Ministry of Industry and Trade (MOIT) and is responsible for the state management of all energy industries, namely electricity, new and renewable energy, coal and the oil and gas industries. The Ministry is not only determine first-line policy it has also supervisory responsibilities for ener-

Tab. 1 Parameters of coal from opencast mines in Vietnam [13]

Tab. 1 Parametry węgla wydobywanego w kilku wietnamskich kopalniach [13]

Quality factor	Coc Sau	Cao Son	Deo Nai	Ha Tu	Nui Beo
Ash [%]	2.24 – 40.0	8.08 – 11.27	2.49 – 39.28	2.64 – 28.33	2.52 – 30.6
Inherent moisture [%]	1.42 – 4.92	0.35 – 3.5	0.99 – 3.56	1.88 – 13.83	1.82 – 14.2
Volatile matter [%]	2.82 – 9.86	7.0	4.2 – 24.51	4.48 – 13.83	4.52 – 13.96
Sulfur (natural) [%]	0.1 – 1.64	0.01 – 2.72	0.07 – 0.6	0.24 – 0.33	0.23 – 0.35
Heat content [kJ/kg]	25.79 – 36.26	28.45 – 35.56	31.17 – 39.31	29.31 – 35.77	29.1 – 34.9
Density [t/m ³]	1.39 – 1.46	1.38 – 1.46	1.39 – 1.44	1.38 – 1.45	1.37 – 1.5

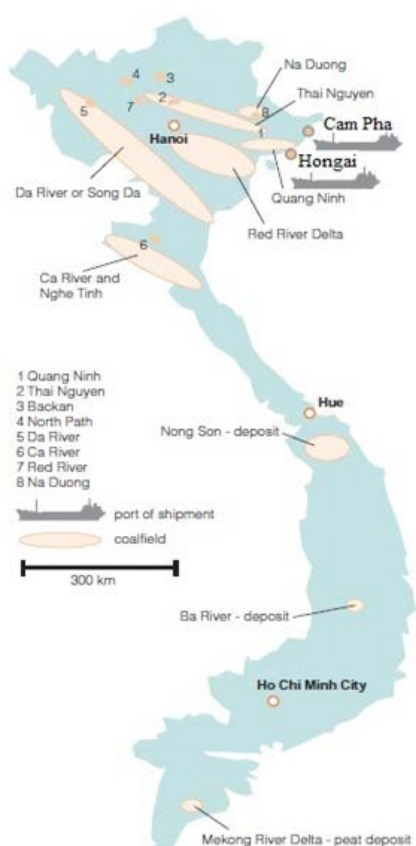


Fig. 1 Map of Vietnam coal resources [9]

Rys. 1 Mapa złóż węgla w Wietnamie [9]

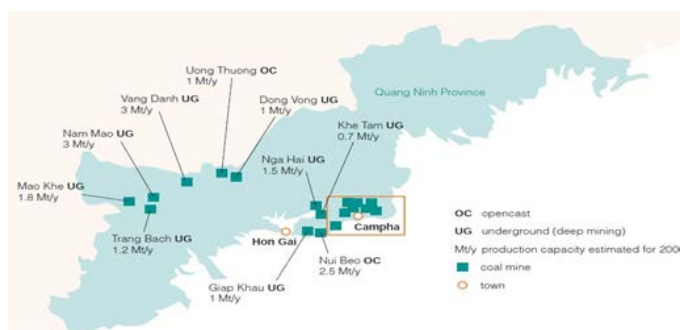


Fig. 2 Main coal deposits in Quang Ninh basin [9]

Rys. 2 Główne złoża węgla w Zagłębiu Quang Ninh [9]

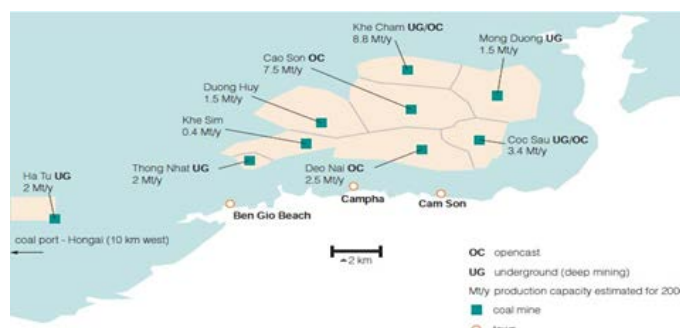


Fig. 3 Main coal mines in Cam Pha area [9]

Rys. 3 Główne kopalnie węgla w rejonie Cam Pha [9]

gy sector such as a state owned companies VINACOM- IN and Electricite de Vietnam (EVN). The Ministry is also responsible for master plans for electricity, coal, oil and natural gas exploitation and supply. Other important institutions:

- The Ministry of Planning and Investment (MPI) – responsible for the country economic development.
- The Ministry of Finance (MoF) – arranges Government guarantees for export credits etc.,
- The Ministry of Natural Resources and Environment (MONRE) – is responsible for environmental regulation.

- The State Bank of Vietnam (SBV) – responsible for allocation of foreign exchange and a key agency for implementing guarantees for foreign exchange convertibility.
- Provincial Peoples Committees (PPC) – are responsible for overseeing local government including all government functions delegated by the central government. Local plans still should be accepted by PPC and MOI.
- Institute of Coal (VINACOMIN),
- Hanoi Technical University (HTU); Ministry of Education and Training (MET),

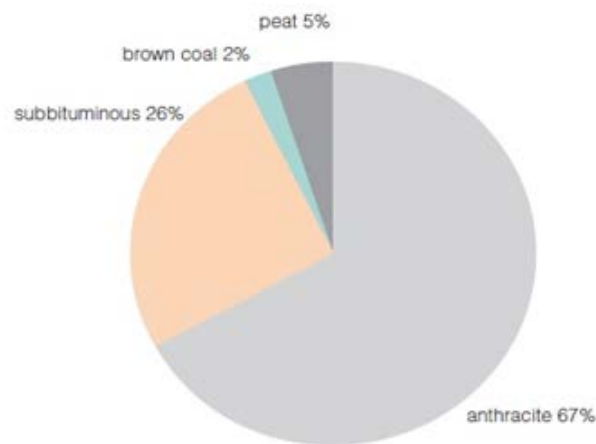


Fig. 4 Percentage of coal types in all coal resources in Vietnam [9]

Rys. 4 Procentowy udział typów węgla w całkowitych zasobach Wietnamu [9]

- Institute of Oil & Gas (I of O&G); Vietnam Petrol & Gas Corporation (PETROVN),
- Energy Department (ED); National Centre of Natural Science & Technology (NCNST),
- Development Strategy Institute (DSI); Ministry of Planning & Investment (MPI).

Coal industry have very strategic position in Vietnam economy. Government still accept new plans for new coal-fired power projects. It will need more coal supply from coal mines. All this project will bring more supply of electricity to the main demand centers in the north and south of country. This decisions will change policy of Vietnam and maybe even stop export of anthracite coal. Government focus now on developing and increasing coal industry practice and productivity. Very important government decisions was No 20/2003/QD-TTg from 29th January 2003 and No 89/2008/QD-TTg from 7th July 2008.

Coal production in Vietnam before 1995 comprised five companies. Under Government (Ministry of Energy) control was four of them Hon Gai Coal Company, Campha Coal Company, Uong Bi Coal Company and Interior Coal Company. Last one is Coal Import-Export and Materials supply Company (Coalimex). In 1995 Vietnam Government create new corporation Vietnam National Coal Corporation (Vinacoal) to modernize and develop coal industry. In 2005 was founded VINACOMIN from the merging of Vinacoal and Vietnam Mineral Corp (or Vimico). VINACOMIN Holding Corporation Ltd. with 54 coal mines it is the biggest coal mining company in Vietnam. Beginning of VINACOMIN is in 2005. VINACOMIN hold 5 big opencast mines, 15 open pits, some smaller coal mining sites and 30 underground coal mines. This is an economic Corporation with 100% owned by the State. 95% of coal production in Vietnam is from

VINACOMIN Company. Most important washing plants:

- Hon Gai (2 million tons/year),
- Cua Ong (10 million tons/year),
- Vang Danh (3 million tons/year).

According to the Master Plan of coal industry development in Vietnam by 2020, with perspective to 2030 the total coal output will reach 60 million tons (in 2020), 65–70 million tons (in 2025) and 65–75 million tons (in 2030).

Other coal producer in Vietnam is Vietmindo and it is operating in Vang Danh-Uong Bi area of Quang Ninh province. It is a joint venture between an Indonesian partner and the Uong-Bi Coal Company (VINACOMIN subsidiary company). First operations started in 1997 but first sales was in 1998. Annual production is just 0.6–0.7 million t/year with ROM production near 1 Mt/year between 2000 and 2004. Coal reserves in company is 36.7 million tons from total area of 1300 ha. Concession is for 30 years and can be renewed for another period if company still need more time to achieve longer term production goals [4, 5, 6, 8, 9, 10, 11].

Coal mining methods and coal preparation status

Coal exploitation in Vietnam is carried out in two ways:

- Opencast coal mining – currently is dominated by truck and shovel methods. Some of major kit used in opencast mining for the important task of earth moving included Russian EKG hydraulic shovels. Overburden and rock haulage is carried out using 27–50 tons dump trucks from manufactures like BalAZ (Belarus), Komatsu (Japan) and Caterpillar 769C (United States). Coal haulage is done by using smaller 10–30 tons payload trucks (mostly from Russia, Japan or Sweden). In Quang Ninh province the dragline mining method

Tab. 2 Total coal resources in Vietnam (Mt) [12]

Tab. 2 Całkowite zasoby węgla w Wietnamie (Mt) [12]

Mine areas	Total resources (A+B+C1+C2+P)	Measured resources (A+B)	Indicated resources (C1)	Inferred resources (C2)	Prognostic resources (P)
Total	49.777	285	2.220	2.928	44.344
1. North-East basin	9.904	236	1.468	2.234	5.966
+ VINACOMIN	3.826	234	1.325	1.663	604
+ Government	6.078	2	143	571	5.362
2. Other investor basins	191	49	99	24	19
3. Peat basins	332		129	107	96
4. Red River Delta Basin	39.352		525	564	38.263
+ Khoai Chau area (80 km ²)	1.581		525	564	492
+ Phu Cu-Tien Hai area 2000 km ²	37.771				37.771

can't be used due to difficult geology complex. Typical opencast mine is showed on photography 1 (Coc Sau opencast mine). Opencast coal mines in Vietnam under VINACOMIN control: 5 large with production more than 2 million tons per year (Cao Son, Coc Sau, Deo Nai, Ha Tu, Nui Beo), 15 opencast mines with total year capacity between 0.1 to 0.7 million tons per year and also some smaller less than 0.1 million tons per year. Coal basins located in Quang Ninh have a complex geological structure with many faults and folds (most of coal seems need to be exploited by selective mining technologies to ensure the required factors of loss and dilution), rocks in surface coal mines are conglomerate of sandstone or mudstone (rocks are broken by blasting and drilling methods), the last problems in surface mining is about environmental protection (how to locate waste dumps, ways of dumping, the stability of waste dumps, waste water draining and the processing water before it flows into rivers and seas).

b) Underground coal mining – currently depth of mining in Vietnam is on 300 meters. Most important in underground mining is to implement more automatic equipment and develop mining safety. Implement systems to control water level in underground mines, training systems for workers to increase they knowledge and work skills. Under VINACOMIN control is also 30 underground coal mines. 9 mines have capacity more than 1 million tonnes per year (Mao Khe 1.6 million tonnes, Nam Mau 1.5 million tonnes, Vang Danh 3.1 million tonnes, Ha Lam 1.77 million tonnes, Quang Hanh 1.05 million tonnes, Khe Cham 1.01 mil-

lion tonnes, Duong Huy 2.0 million tonnes, Thong Nhat 1.59 million tonnes and Mong Duong 1.5 million tonnes). Rest of coal mines have annual capacity less than 1 million tonnes, small reserves and can't apply mechanical technologies.

Coal mining industry in Vietnam lead coal preparation into two stages. First stage is to implement the ROM coal pre-treatment system by handpicking, screening, grinding or blending. Only 30% of ROM coal can be cleaned by coal preparation plants. To enrichment the remaining part of ROM coal the coal mines use self-producing option and sell clean coal directly to the domestic market. All of coal mining companies own pre-treatment systems. The second one is typical simple coal preparation in coal preparation plants. Management system in Vietnam coal preparation industry is showed on Fig. 5.

Figure 6 shows the pre-treatment of ROM coal for 30% of coal. This coal is selling later for coal preparation plants. This system is using screening with size of 100mm, 70mm and 50mm to classify the coarse coal. Upper product (size >70 mm) from this sieving system is being sold to coal preparation companies. Lower product (size <70 mm) after sieving process is grinded to fine coal and mixed with good fine coal. Later is sold to domestic holders.

Coal preparation plant in Vietnam use many different methods for enrichment process jigs, washery plate, spiral separators, cyclones and flotation process. Coal preparation flowsheets and technology can be described on few examples.

Tab. 3 Types of coal exploited in Vietnam separated by exploited coal basin [13]

Tab. 3 Typy węgla eksploatowane w danych zagłębiach węglowych Wietnamu [13]

Coal fields	Anthracite & semi-anthracite	Bituminous	Lignite & sub-bituminous
Quang Ninh	X		
* Uong Bi	X		
* Hon Gai	X		
* Cam Pha	X		
Thai Nguyen	X		
Bac Kan	X		
North Path		X	
Da River		X	
Ca River		X	
Red River Delta			X
Na Duong			X



Phot. 1 General view of opencast coal mine Coc Sau [7]

Fot. 1 Widok na kopalnię Coc Sau [7]

a) Cua Ong Coal Preparation Company:

The plant No. 1 – flowsheet of this coal preparation plant is on Fig. 6. Cua Ong Coal Preparation Plant No. 1 was built by French 1894 but production was started in 1924. Annual capacity in first years of running plant was 1 million tonnes per year but later this preparation plant was modified many times. In 2006 capacity was 2.5 Mt/y, in 2010 was 3.5 Mt/y and in 2014 annual capacity reached 5 Mt/y.

The plant No. 2 – flowsheet of this coal preparation plant is on Fig. 7. First coal preparation plant Cua Ong CPP II was designed and built by Polish engineers in the 1970s. Production was started in 1980. First using capacity was 3.2 Mt/y and used equipment was Dense Medium Separators DISA. In 1990s the Cua Ong Coal Preparation Plant No 2 was remodified by Australian. Technology used DISA was replaced by a line of jigs and DMS cyclones.

The plant No. 3 – main used technology is dry screening and handpicking.

b) Hon Gai Coal Preparation Plant – Nam Cau Trang Coal Preparation Plant, which is run by Hon Gai Coal Company – VINACOMIN, was designed by Australian's with capacity of 2.0 Mt/y. The actual capacity of the Coal Preparation Plant is now over 3.2 Mt/y (from 2013).

c) Vang Danh Coal Preparation Plant – this coal preparation plant was designed by Russian in 1972 with designed capacity of 0.6 Mt/y. Then the plant modified to adopt the capacity of 2.7 Mt/y. Current flowsheet of Vang Danh coal processing plant is showed on Figure 8.

d) Coal preparation plant Cam Pha Port:

Cam Pha Port No. 1 – raw coal is screened on

Tab. 4 List of opencast mines ordered by coal field [13]

Tab. 4 Lista odkrywkowych kopalń węgla w Wietnami uporządkowana wg. rejonu wydobywczego [13]

Coal field	Mine
Cam Pha field	Coc Sau
	Cao Son
	Dong Cao Son
	Deo Nai
	Quang Loi
	Dong Da Mai
	Tay Nam Da Mai
	Tay Bac Da Mai
	Duong Huy (surface part)
	Mongduong (surface part)
	Bang Nau
	Hong Gai field
Nui Beo	
Dong Bac mines	
917 mine	
Uong Bi field	Uonghuong - Vietminho
Other fields	Khanh Hoa
	Nui Hong
	Na Duong

screens 50mm and 15mm, grain class > 50mm is enrichment by handpicking (picking belts), grain class 50-35mm is washed in long washers, grain class 35-15mm is separated in long washers and grain class lower than 15mm is not separated.

Cam Pha Port No. 2 – can be described in 2 versions. First version was designed by Main Study and Design Office for Coal Processing “Separator” (Polish design). Technological line in Polish design can be distinguished: raw coal was screening on 35mm screen, grain class bigger than 35mm was separated in dense media separator DISA, grain class 35-5mm was enriched in OBM-10 jigs, water sludge circuit was closed. In 1990 this coal preparation plant was modernized by Australian company BMCH (Bulk Material, Coal Handling). Raw coal (100-0) after preliminary screening is put into two-products jigs, clean coal is classified on screens (6mm, 15mm and 35mm), coal grains < 1mm is washed in spirals, when grain class 6-35mm does not fulfill the quality norms is rewashed once again in dense medium cyclones, in water-slime circuit is used flocculants, for dewatering system is used belt filter-press [1, 2, 3, 9, 10, 11].

Development plans & challenges to overcome

In Vietnam between year 2011 and 2030 will be closed 19 mines with total capacity 11 million tons/year.

Which 9 opencast coal mines with total capacity 8.2 million tons/year: Nui Beo (3.5 mln tons/year), Ha Tu (1.65 mln tons/year), South west Da Mai (1.0 mln tons/year), East Da Mai (0.4 mln tons/year), Bang Nau (0.55 mln tons/year), North west Khe Tam (0.03 mln tons/year), Khe Sim (1.05 mln tons/year), West Khe Sim (0.05 mln tons/year) and 10 smaller opencast mines (2.7 mln tons/year). The share of underground coal mines will increase from 45% in 2011 to 75% in 2020 and 80% in 2030 (Government plan for coal industry).

Between 2015 and 2030 coal mining industry will invest to open 19 new mines, 5 mines will be owned by VINACOMIN in North East basin (Quang Ninh), 9 new mines (North East basin) and 5 pilot mines (Hung Yen, Thai Binh in Red River Delta basin). Between years 2016-2030 will be constructed few new preparation plants Khe Than 2, Bao Dai, Dong Trieu-Pha Lai and in 2017 was started test phase of coal preparation plant Khe Cham IV. Master plan are also presented for coal mining industry in table [3, 4, 5, 6, 8, 9, 10, 11].

Other plans for coal preparation industry:

– Invest in modern preparation technologies and decrease the level of not so effective old equipment and technologies – most of screening systems was designed and constructed in the 1960s and 70s. This equipment

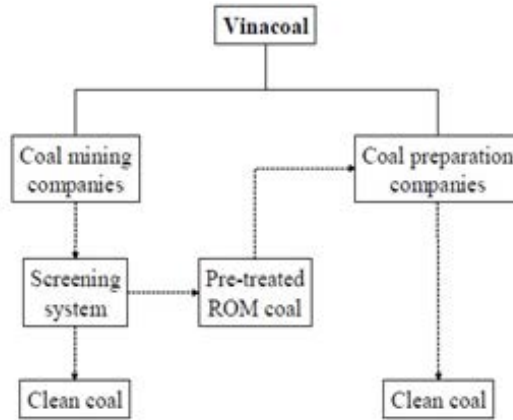


Fig. 5. Management system of the coal preparation industry in Vietnam [1]
 Rys. 5 Schemat zarządzania sektorem przeróbki węgla kamiennego w Wietnamie [1]

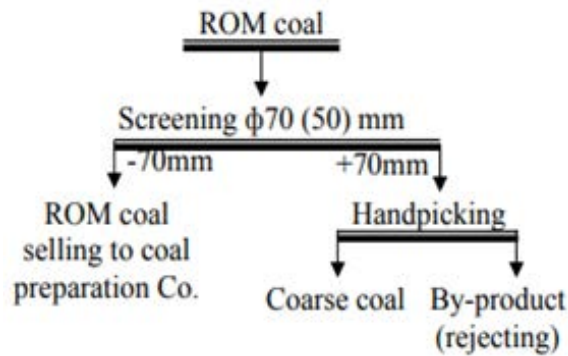


Fig. 6 Flow diagram of ROM coal pre-treatment system before selling coal to coal processing plant [1]
 Rys. 6 Schemat wzbogacania wstępnego przed sprzedażą węgla do zakładów przerobczych [1]

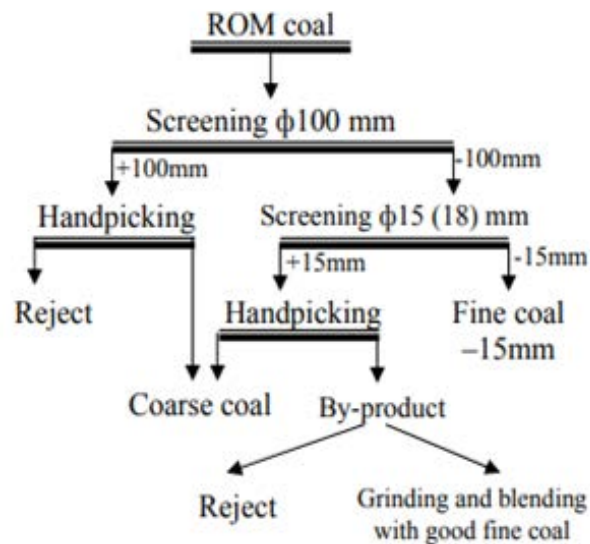


Fig. 7. Simple treatment system for ROM coal in Vietnam coal mining companies [1]
 Rys. 7 Schemat prostego procesu wzbogacania w wietnamskich zakładach górniczych [1]

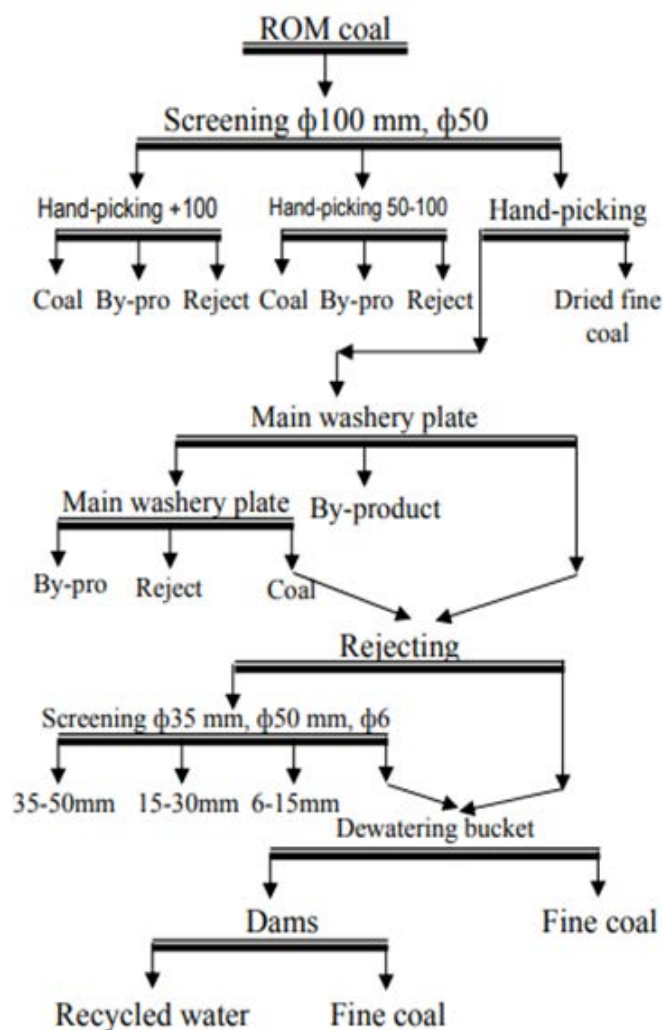


Fig. 8 Coal preparation plant Cua Ong No. 1 [1]

Rys. 8 Schemat zakładu przerobczego Cua Ong nr 1 [1]

Fig. 8 Coal preparation plant Cua Ong No. 1 [1]

Rys. 8 Schemat zakładu przerobczego Cua Ong nr 1 [1]

<i>Coal area</i>	<i>2020</i>	<i>2025</i>	<i>2030</i>
<i>Total run-off-mine coal</i>	92,430	119,250	120,732
I. North-East basin	72,330	85,050	83,282
I.1. VINACOMIN	64,530	67,150	59,782
In which: banned area & coal bearer	6200	7400	7300
I.1.1. Uong Bi coal field	19,280	20,550	20,950
I.1.2. Hon Gai coal field	9,350	9,800	8,800
I.1.3. Cam Pha coal field	35,900	36,800	30,032
I.2. New coal mines	7,800	17,900	23,500
II. Other interior basins	3,050	2,650	2,700
III. Out of Vinacomin	3,550	6,550	9,750
IV. Red River Delta basin	13,500	25,000	25,000

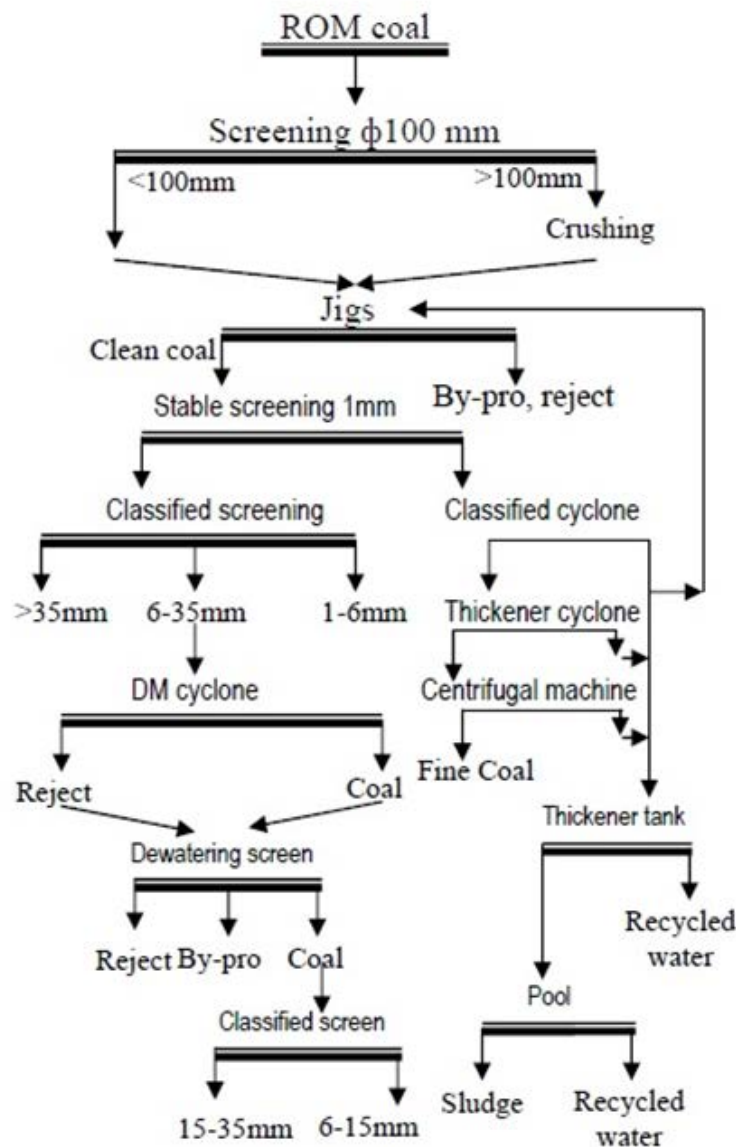


Fig. 9. Coal preparation plant Cua Ong No. 2 [1]

Rys. 9 Schemat zakładu przerobczego Qua Ong nr 2 [1]

and most of activities are held on open air. Efficiency are low and they are affected by the weather,

- High volume of fresh water is consumed – Quang Ninh Province is located near sea and in mountains are, most of preparation plants need a lot of fresh water (Cua Ong Coal Preparation Company consumes 3,000 m³/day of fresh water). In future this demand for fresh water will increase against new coal preparation plants and the industry should pay more attention to finding new fresh water sources,

- Increase technology to recover magnetite after dense medium separation – Cua Ong Coal Preparation Plant No. 2 use 1–2 kg of magnetite per each ton of ROM coal. This amount is 1-2 times higher than in other coal preparation plants in the world,

- Increase technology and invest in equipment to separate coal from by-products – old technologies used in screening process are not so effective. The quality of produced by-product is low (ash content between 35–65%) and it is stored in stockpiles to reclaim coal in the future,

- Decrease the level of slurry production – demand for slurry coal is consumed domestically by brick producers or householders,

- Highly increasing economy will need more coal. To find solutions VINACOMIN start cooperate with foreign countries like Australia, Indonesia, Russia to find good market and import coal from foreign markets,

- Centalization of coal preparation plants with modern processing lines – decrease the level of environ-

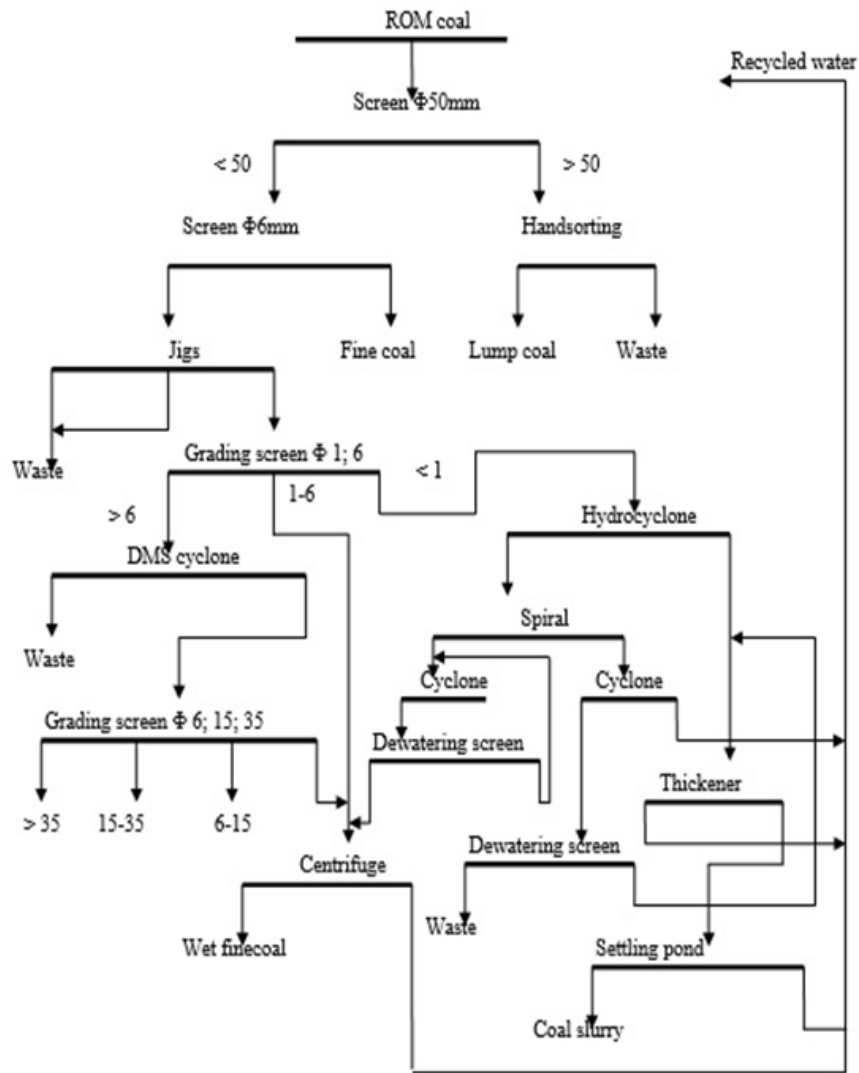


Fig. 10 Flowsheet of Nam Cau Trang coal preparation plant (managed by Hon Gai Coal Company) [-]

Rys. 10 Schemat zakładu przerobczego Nam Cau Trang (zarządzanego przez firmę Hon Gai) [-]

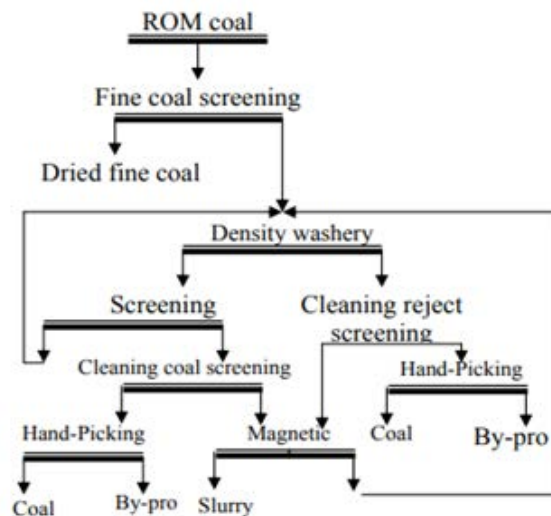


Fig. 11 Flowsheet of Vang Danh coal processing plant [1]

Rys. 11 Schemat technologiczny zakładu przerobczego Vang Danh [1]

mental impact in very specific areas (Quang Ninh Province is located near sea and in mountains area), decrease the transportation and production costs,

- Enhance mechanization in underground coal mines,

- Construct a terminal for coal import in the Southern part of country,

- Increase the control level of all technological processes in coal preparation plants,

- Establish environmental management system.

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Górnictwo węglowe oraz przeróbka węgla w Wietnamie

Artykuł porusza kwestie związane z sektorem wydobywczym węgla kamiennego oraz jego przeróbki w Wietnamie. Socjalistyczna Republika Wietnamu posiada kilka regionów ze złożami węgla, a głównymi zagłębiami węgla, gdzie prowadzona jest obecnie eksploatacja bądź prace przygotowawcze pod wydobywanie węgla są Quang Ninh i Red River Delta. Główny wpływ na sytuację węgla posiada Ministry of Industry and Trade (MOIT), a za produkcję węgla na potrzeby kraju, a także na eksport odpowiada firma VINACOMIN, która w 100% zależna jest o polityki państwa. W końcowej części artykułu zostanie omówiony system wzbogacania węgla w Wietnamie, na który składa się wzbogacanie wstępne na zakładach górniczych oraz typowe uszlachetnianie węgla w zakładzie przerobczym. Podsumowaniem będzie opisanie planów na przyszłość dla obu omówionych systemów wzbogacania węgla.

Słowa kluczowe: przeróbka węgla, zasoby węgla, zagłębła węglowe, przemysł węglowy, schematy przeróbki węgla