Batubara dan Lingkungan

Ferian Anggara

JADWAL KULIAH GEOLOGI BATUBARA
SM II TA 2014-2015
KULIAH: KELAS B RABU (09.00-11.00, R 32)
KULIAH: KELAS A JUMAT (14.00-16.00, R 33)

NO.	MATERI	Februari 18/20	25/27	Maret 4/6	11/13	18/20	25/26	April 1/3	UTS	UTS	22/24	29/1	Mei 6/8	13/15	20/22	27/29	Juni 4/6	MT	UAS	UAS
1	Pendahuluan	DHA																		
2	Pembentukan batubara (Mire)		DHA																	
3	Pembentukan batubara (Dep. Env)			SSS																
4	Geokimia batubara & Pembatubaraan				DHA	DHA														
5	Petrologi Batubara						DHA													
6	Analisa Batubara							DHA												
7	Ujian Tengah Semester																			
8	Klasifikasi batubara										DHA									
9	Eksplorasi Batubara											SSS	SSS	DHA						
10	Eksploitasi Batubara														DHA					
11	Pemanfataan Batubara & Lingkungan															FA				
12	Teknologi Batubara																FA			
13	Ujian Akhir Semester																			

3 April Libur Wafat Isa Almasih
1 Mei Libur Hari Buruh

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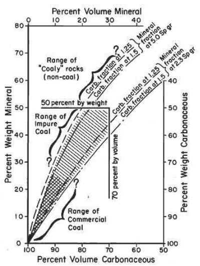
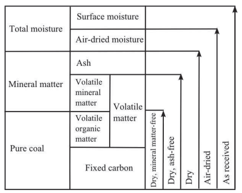
Outline

- Coal cleaning technology
- Acid mine drainage
- Spontaneous combustion
- CO_2 Geological storage

Coal

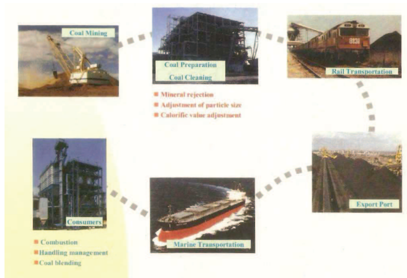


Relation of volume and weight of carbonaceous and mineral mixtures (Schopf, 1956)



Component of coal reporting to different bases (Ward, 1984)

Coal chain



Mineral frequently occurring in coals

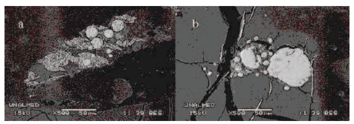
Minerals frequently occurring in coals, their stoichiometric compositions, relative abundances, and modes of occurrences

Mineral	Composition	Common minor and trace element associations	Frequency of occurrence in coal seams	Concentration in mineral matter	Physical chief occurrences [a]
Clay minerals					
Illite (sericite)	$KAl_2(AlSi_3O_{10})(OH)_2$	Na, Ca, Fe, Li, Ti, Mn, F and other lithophile elements	Common	Abundant	D, L
Smectite (incl. mixed layered)	$Al_2Si_4O_{10}(OH)_{2x}H_2O$		Common	Abundant	D, L
Kaolinite group	$Al_2Si_2O_5(OH)_4$		Common	Abundant	L, F
Chlorite	$Mg_5Al_2(AlSi_3O_{10})(OH)_8$		Rare	Moderate	L, F
Sulfides					
Pyrite	FeS_2 (isometric)	As, Co, Cu, and other chalcophile elements	Rare–common	Variable	D, N, F
Marcasite	FeS_2 (orthorhombic)		Rare–moderate	Trace	D(?)
Pyrrhotite	$Fe_{1-x}S$		Rare	Trace	D
Shalerite	ZnS		Rare	Minor–trace	F
Galena/chalcopyrite	$PbS/CuFeS_2$		Rare	Trace	F
Carbonates					
Calcite	$CaCO_3$		Rare–common	Abundant	N, F
Dolomite (ankerite)	$CaMg(CO_3)_2$	Mn, Zn, Sr	Moderate	Trace	N, L
Siderite	$FeCO_3$		Rare	Minor	N
Oxides					
Quartz	SiO_2	–	Common	Abundant	D, L, N
Magnetite/hematite	Fe_3O_4/Fe_2O_3	Mn, Ti	Common	Minor–trace	N
Rutile and anatase	TiO_2	–	Common	Trace	D
Others					
Goethite/limonite	FeOOH	Mn, Ti	Common	Trace	N
Feldspar	$KAlSi_3O_8$	Ca	Moderate	Trace	D, L
Zircon	$ZrSiO_4$	–	Moderate	Trace	D
Sulfates: gypsum	$CaSO_4 \cdot 2H_2O$	–	Moderate	Minor	D, F
Barite	$BaSO_4$	Na, Sr, Pb	Rare	Minor	F
Szomolnokite	$FeSO_4 \cdot H_2O$	–	Rare	Trace	D
Apatite	$Ca_5(PO_4)(f,Cl,OH)3$	Mn, Ce, Sr, U	Moderate	Trace	D
Halite	NaCl	K, Mg	Rare	Trace	D

[a] D = disseminated; L = layers (partings); N = nodules; F = fissures (cleat). First listed is the most common occurrence.

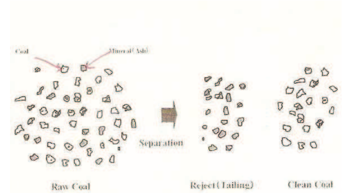
Sulfur

- The one constituent that most affect coal marketing (except ash and CV)
- Three type of sulfur:
  - Pyritic sulfur (iron sulfide-FeS, pyrite-FeS_2, isometric and marcasite-FeS_2, orthorombic)
  - Sulfate sulfur (H_2S)
  - Organic sulfur



Coal cleaning technologies

- A set of operation involved in processing raw coal into a form meeting market or consumer requirements
- Including 3 steps:
  a. Coal cleaning
  b. Sizing-crushing or screening
  c. Special treatment for commercialization (e.g. mixing or blending, briquetting or pelletizing, fluidization, as well as dewatering and upgrading of low rank coal)



Coal cleaning technologies

Table 4.1 The Properties Used in Coal Cleaning and Separation Technologies

Properties used	Separation technologies
Color Appearance	Hand picking, Color sorting
Specific gravity	Gravity separation
	(1) Dense medium separation ✓
	(2) Jigging ✓
	(3) Flowing-film concentration
	(4) Pneumatic separation
Surface wettability	Flotation
	Selective agglomeration
Magnetic property	Magnetic separation
Electric conductivity	Electrostatic separation
Miscellaneous	

Dense medium separation

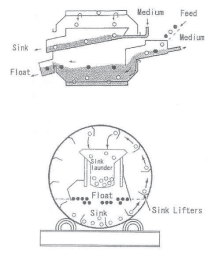
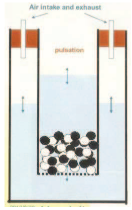


Figure 4.1 The Drum Dense-medium Separator

Jigging



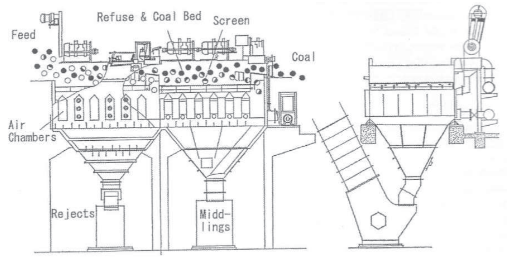


Figure 4.2 The Batac Jig (Tacub Jig)

Flowing-film concentration

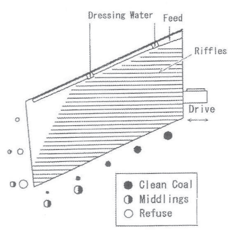
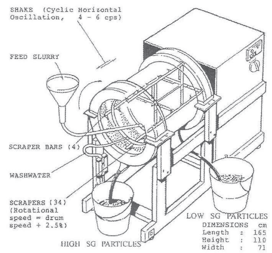


Figure 4.3 The Shaking Table

Multi gravity separator



Spiral concentrator

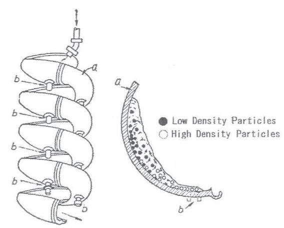


Figure 4.5 The Humphrey's Spiral Concentrator

Pneumatic separator

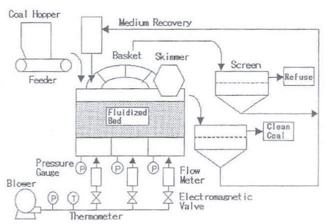
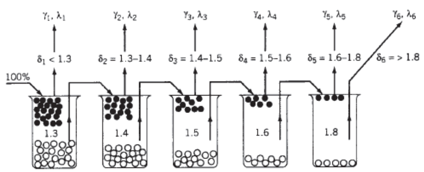


Figure 4.6 A Schematic Diagram of the Testing System

Floatation



Acid mine drainage (AMD)

- AMD is caused when water flows over or through sulfur-bearing materials forming solutions of net acidity.
- AMD comes mainly from abandoned coal mines and currently active mining.
- Mine drainage is metal-rich water formed from chemical reaction between water and rocks containing sulfur-bearing minerals
- Mine drainage is formed when pyrite, an iron sulfide, is exposed and reacts with air and water to form sulfuric acid and dissolved iron.
- Some or all of this iron can precipitate to form the red, orange, or yellow sediments in the bottom of streams containing mine drainage
- The acid runoff further dissolves heavy metals such as copper, lead, mercury into ground or surface water
- The rate and degree by which acid-mine drainage proceeds can be increased by the action of certain bacteria.

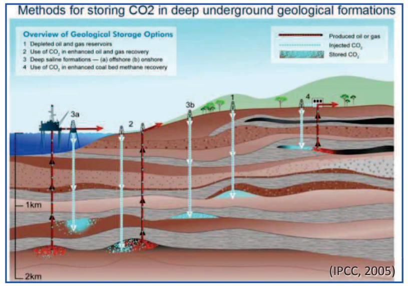
Problem associated with AMD

- Contaminated drinking water
- Disrupted growth and reproduction of aquatic plants and animals
- Corroding effects of acid on parts of infrastructure such as bridges
- $FeS_2 + 7/2\ O_2 + H_2O \rightarrow Fe^{2+} + 2SO_4^{2-} + 2H^+$

Spontaneous combustion

- Spontaneous combustion, or self heating, of coal is a naturally-occurring process caused by the oxidation of coal
- Natural oxidation is uncontrolled and can lead to emissions and spontaneous combustion
- Properties which influence the propensity of coal to self-heat include volatile content, coal particle size, rank, heat capacity, heat of reaction, the oxygen content of coal and pyrite content
- Tends to increase with decreasing rank
- Greenhouse gas emissions (CO2 and CH4) from low temperature oxidation and spontaneous combustion in coal mines

Geological storage

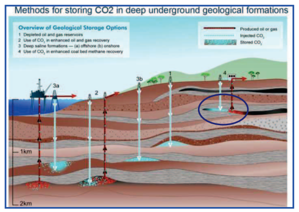


1. Geological CO_2 sequestrations (GS) offer potential for large scale, low-cost, and long-term sequestration
2. Four options for GS: (1) oil and gas reservoirs, (2) deep saline formations, (3) unminable coal beds and (4) mineral carbonation

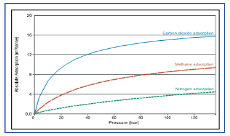
The benefits of Geological Storage

1. doesn't depend on climate condition
2. doesn't compete with agriculture, forestry, fishing, other industries and land use
3. the cost transporting is cheap
4. the technology is well developed and widely practiced,
5. no associated environmental problem and can be safely undertaken within national boundary.

Unminable Coal Seam

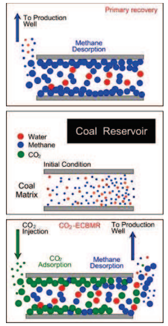


1. CO_2 injection into coal seams can displace methane, thereby enhancing CBM recovery ECBM).
2. ECBM increase produced methane to nearly 90% of the gas, (50% by conventional recovery)



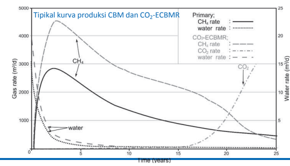
The main consideration:

- Coal swells as CO_2 absorbed which reduces permeability and injectivity
- Cap rock leakage caused by injection pressure

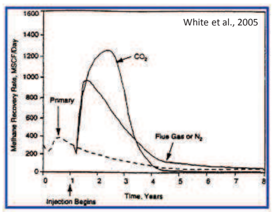


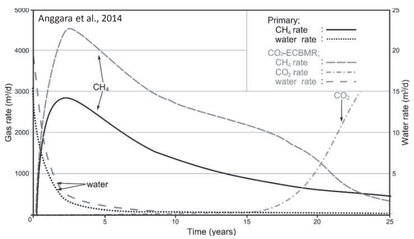
CBM Production

- **Proses *"dewatering"***
  → Prosedur standar yang dilakukan
- **Injeksi CO_2 ke reservoir CBM**
  - ✓ Meningkatkan produksi methane: CO_2 *enhanced coal bed methane recovery (CO_2-ECBMR)*
  - ✓ Sebagai salah satu opsi menyimpan CO_2 di formasi geologi: *CO_2-geological storage*



Tipikal kurva produksi CBM dan ECBM





Coal seams as CO_2 geological storage

- **Primary CBM production**
- **Injection of CO_2 into coal seams:**
  - ✓ Give added value of enhanced coal bed methane recovery (CO_2-ECBMR)
  - ✓ Safe and permanently storing CO_2 over geologic time
- **Geological storage** (GS): an option to store CO_2 storage in *large enough quantities over long geological periods of time*

Development of stable, affordable and environmentally friendly in term of natural resources

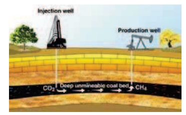
Potential of CO_2-ECBMR location

Feasibility study

Primary CBM
- suitable gas content
- adequate permeability
- ability to dewater the formation
- suitable coal geometry
- simple structure, homogeneous, laterally continuous and vertically isolated coal seam
- adequate depth
- coal rank

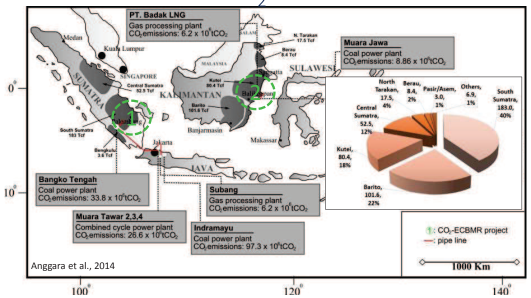
CO_2-ECBMR
- CO_2 emissions sources
- existing support facilities
- basin maturity
- seismic activity

Location

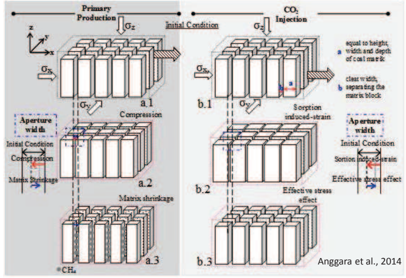


(IPCC, 2005; Anggara et al, 2010)

Potential of CO_2-ECBMR location

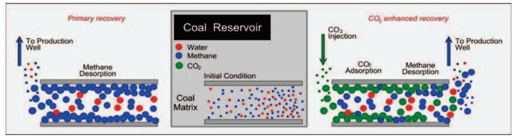


Matchstick geometry representation of a coal seam



a. CH_4 primary production scheme: a.1 initial condition; a.2 increasing effective stress caused by drawdown pressure and it's resulting decreasing aperture width thus permeability is decreasing; a.3 CH_4 is desorbed during drawdown pressure resulting matrix shrinkage and finally permeability is rebound at certain pressure. b. ECBMR by CO_2 injection scheme: b.1 initial condition; b.2 permeability reduction caused by CO_2 sorption induced-strain; b.3 when CO_2 is injected into coal reservoir, push back phenomenon is occurred and resulting rebound permeability (model was drawn based on Seidle et al. (1992); Shi and Durucan (2005).

Problem identification



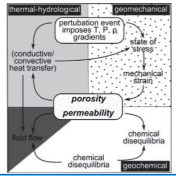
- CO_2 adsorption is higher compare to CH_4 at given pressure

--> to displace CH_4 (+++)

--> to induce coal swelling: permeability reduction

Changes in permeability

Johnson et al., 2004, Norton, 1984



End