Teknologi batubara

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		Maret				April					Mei				Juni			
		18/20	25/27	4/6	11/13	18/20	25/26	1/3	UTS	UTS	22/24	29/1	6/8	13/15	20/22	27/29	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	Pemanfaatan Batubara & Lingkungan															FA				
12	Teknologi Batubara																FA			
13	Ujian Akhir Semester																			

3 April Libur Wafat Isa Almasih
1 Mei Libur Hari Buruh

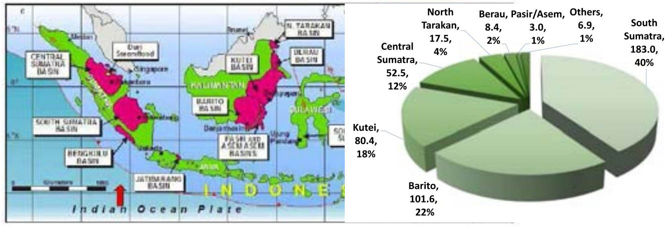
Outline

- Coal bed methane (CBM)
- Coal gasification
- Coal liquefaction
- Coal boiler and cooking coal

What is Coal Gas?

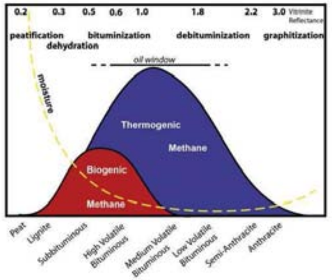
- This gas was considered one of the many hazards of coal mining
- Recently: unconventional resources
- Gas is generated during maturation of organic matter into coal and by microbes residing in a coal
- Coal deposits of all geologic ages have generated gas

Coal and CBM resources in Indonesia



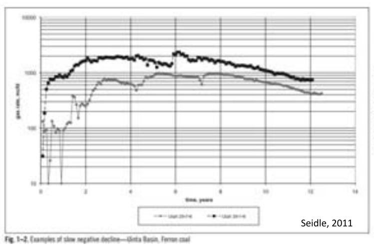
Coal bed methane (CBM):
337-453 Trillion cubic feet

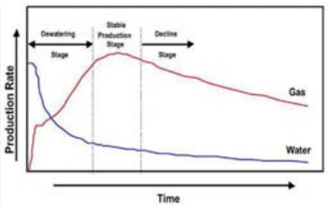
Schematic showing biogenic and thermogenic gas generation



Moore, 2012

Typical of CBM Production Curve





Seidle, 2011

Conventional Gas Vs. CBM

Conventional Gas	Coalbed
Darcy flow of gas to wellbore.	Diffusion through micropores by Fick's Law.
	Darcy flow through fractures.
Gas storage in macropores; real gas law.	Gas storage by adsorption on micropore surfaces.
Production schedule according to set decline curves.	Initial negative decline.
Gas content from logs.	Gas content from cores. Cannot get gas content from logs.
Gas to water ratio decreases with time.	Gas to water ratio increases with time in latter stages.
Inorganic reservoir rock.	Organic reservoir rock.
Hydraulic fracturing may be needed to enhance flow.	Hydraulic fracturing required in most of the basins except the eastern part of the Powder River basin where the permeability is very high. Permeability dependent on fractures.
Macropore size:[3] 1μ to 1 mm	Micropore size:[3] <5A° to 50A°
Reservoir and source rock independent.	Reservoir and source rock same.
Permeability not stress dependent.	Permeability highly stress dependent.
Well interference detrimental to production.	Well interference helps production. Must drill multiple wells to develop.

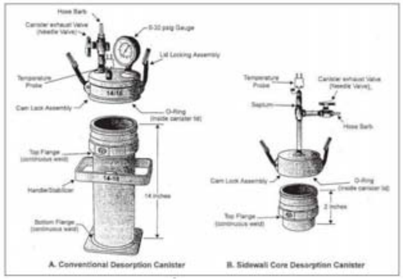
Levine, 1990

CBM-Outline

- Overview
- Adsorption (Gas content)
- Porosity
- Permeability (Cleat system)
- Gas Flow
- Reserve Analysis
- Dynamic reservoir
- Enhanced recovery

ADsorption vs ABsorption

Canister: Desorption test



Seidle, 2011

Sampling

Moore, 2012
Chiper coal, 2015

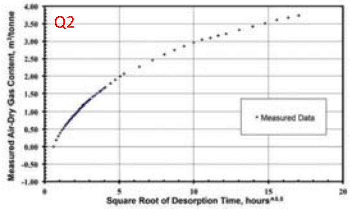
Gas desorption measurements

1. Lost gas (Q1)
   is the calculated amount of gas that has potentially been lost from the time the core leaves the reservoir at depth to when it is placed within a canister at the surface
2. Measured gas (Q2)
   the gas which is directly desorbed from the canister and measured using a manometer
3. Residual gas (Q3)
   - After a sample is either 'fully' desorbed or when the operator decides that enough has been measured to achieve the desired goals of the sampling, the coal is removed from the canister
   - Crushing coal to approximately 250 µm size particles, which has gas tight seals and a gas lead from which the gas evolved can be removed for measurement.

Total gas volume = Q1 + Q2 + Q3

Moore, 2012

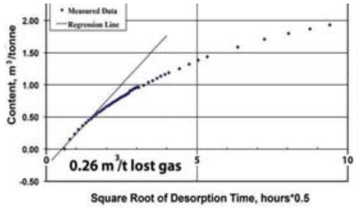
Q2& Q3 calculation



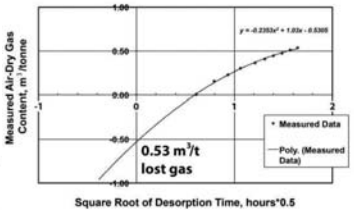
Moore, 2012

Q1 calculation

Linear regression



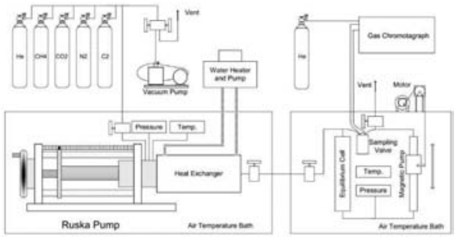
2nd order polynomial regression



Moore, 2012

Adsorption test

PVT Apparatus, Kyushu University-Japan



Gasem et al., 2009

Adsorption test

Client	Micah Global CBM
Sample Location	Brandon Basin Tonto Mine

Gas	Methane
Sample No	Rollo-20-7A
Formation	Jasper Fm
Depth (m)	410
Easting	N/A
Northing	N/A
Density (t/m³)	1.33

Adsorption Equation

$$V = \frac{a \cdot P}{P + b}$$

where
V - Gas content (m³/t)
P - Pressure (kPa)
a - Langmuir Volume (m³/t)
b - Langmuir Pressure (kPa)

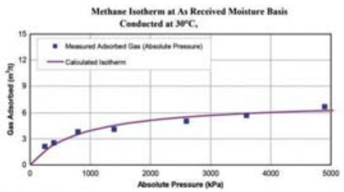
Proximate Analysis (%)	
Inherent Moisture	3.3
Ash	1.1
Volatile	32.8

Test Summary

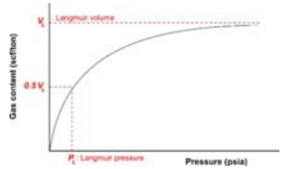
Absolute Pressure (kPa)	Gas Adsorbed (m³/t)	
	Measured	Calculated
101		0.77
251	2.09	1.65
401	2.50	2.32
801	3.78	3.53
1401	4.07	4.54
2601	5.01	5.51
3601	5.67	5.92
4901	6.67	6.25

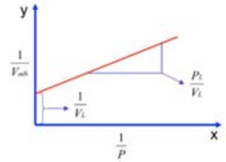
Isotherm Parameters

Parameter	At Gauge Pressure	At Absolute Pressure
a - Langmuir Volume (m³/t)	6.59	7.36
b - Langmuir Pressure (kPa)	971.72	870.40
Calculated gas content at 1 atm =	0.77	m³/t



Langmuir parameters





$$Vads = V_L \frac{p}{P_L + p} \qquad \frac{1}{V_{ads}} = \frac{P_L}{V_L}\left(\frac{1}{p}\right) + \frac{1}{V_L}$$

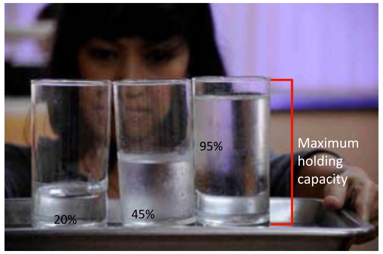
Gas saturation

1. **Desorption Isotherms**
   - “slow”, “fast” or “in between”
   - reservoir temperature
2. **Adsorption Isotherms**
   - reservoir temperature
   - fresh samples!

%g = 1-((a-d)/a)*100

where,
%g, is gas saturation
a, is maximum gas holding capacity [adsorption]
d, is total measured gas [desorption]

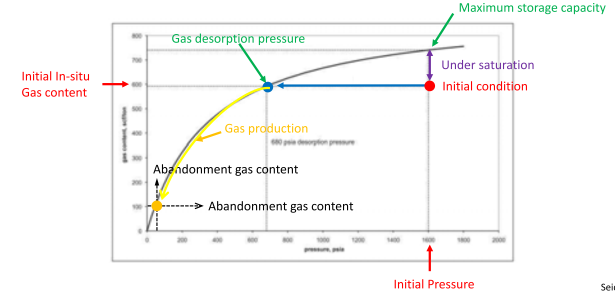
Moore, 2010



- But different types of coal can hold more or less gas (i.e. different coals have different holding capacities)

Moore, 2010

Gas saturation and desorption pressure



Seidle, 2011

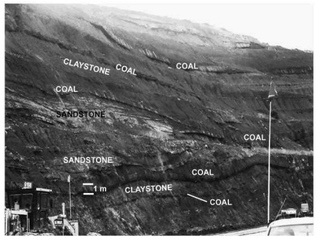
Which deposit would you pick?

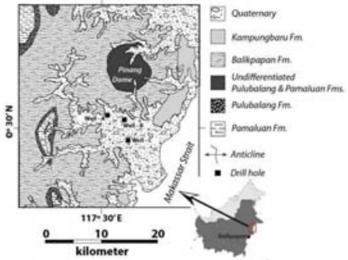
50% saturation

80% saturation

Moore, 2010

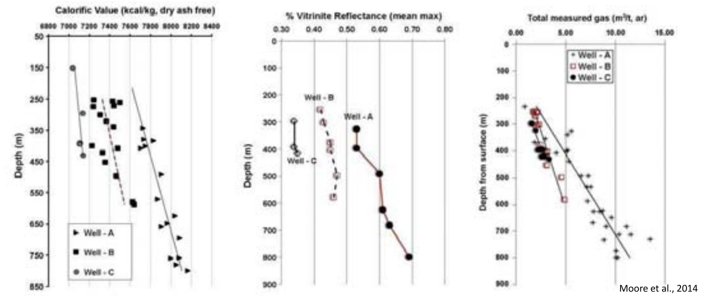
Coal properties & Gas content





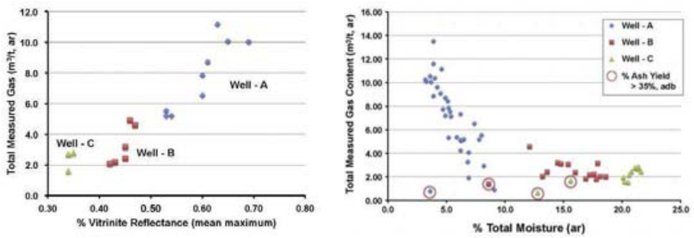
Moore et al., 2014

Coal properties & Gas content



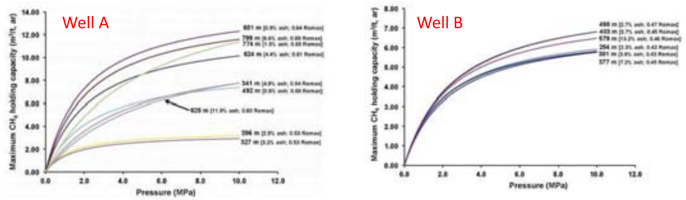
Moore et al., 2014

Coal properties & Gas content



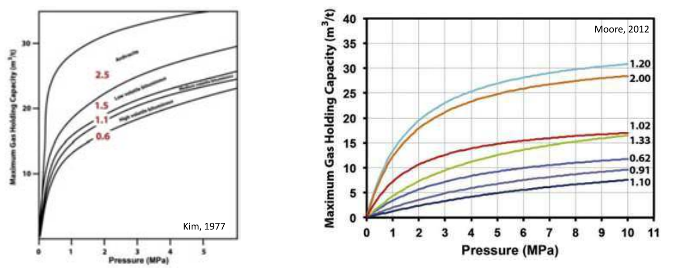
Moore et al., 2014

Adsorption isotherms



Moore et al., 2014

Adsorption isotherms related to rank



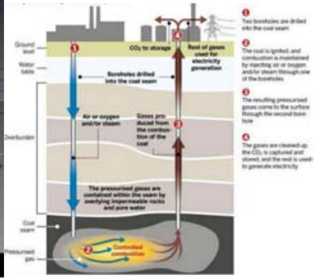
Rank–gas relationships shown are in general correct, they are far from universally observed

Gasification

- Proses pen-gas-an batubara (atau derivatifnya, mis. char) intinya adalah konversi bb menjadi gas yang *combustible* (dapat dibakar)
- Komposisi gas hasil gasifikasi: CO_2, H_2, CO_2, H_2O, CH_4, H_2S, H_2, CO (% vol.-nya bervariasi, tergantung macam2 faktor seperti peringkat bb, kandungan mineral, ukuran partikel pada saat diproses & kondisi reaksinya)
- Low Btu gas (150 – 300 Btu/scf), gasnya +- 50% nitrogen, sedikit H_2, CO, CO_2 & CH_4 -- umumnya produk insitu gasifikasi bb (tanpa ditambang dulu), bb hanya direaksikan dengan udara (oksidasi)
- Medium Btu gas (300 – 550 Btu/scf), gasnya terutama H_2 & CO, kadang CH_4 – prinsip sama dengan low btu, hanya oksidasinya dibuat dengan nitrogen barrier (mis. oksigen murni) supaya nitrogen tidak bercampur dalam sistem (nitrogen akan merendahkan nilai btu)
- High Btu gas (980 – 1080 Btu/scf), hampir semuanya CH_4 – pengasannya bisa dengan reaksi katalistik hidrogen & karbon monoksida ($3H_2+CO \rightarrow CH_4+H_2O$), tapi kurang efisien. Cara lain bisa dengan hidrogasifikasi ($C+2H_2 \rightarrow CH_4$).

Amijaya, 2015

Underground coal gasification



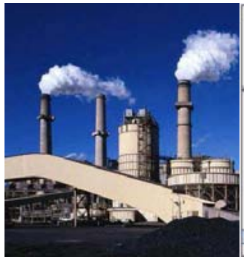
Liquifaction

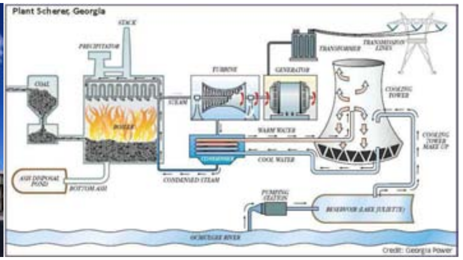
- Prinsipnya melalui dekomposisi thermal bb (biasanya 400-500°C bb sudah/mulai mengeluarkan liquid)
- Proses secara kimiawi pada prinsipnya:
  - struktur kimia bb dipecah menjadi kecil-kecil, ikatan-ikatan organik dipecah menjadi lebih kecil
  - rasio atom H/C ditingkatkan (supaya menjadi liquid)
- Kadang disebut karbonisasi atau destructive distillation, tapi istilah ini tidak tepat karena proses karbonisasi tidak ditujukan untuk menghasilkan liquid sebagai produk utama

  ($C_{organik}$ = Ccoke/char/carbon+liquid+gas)
- Metode: Pyrolysis, solvent extraction, catalytic liquefaction, indirect liquifaction

Amijaya, 2015

Coal boiler



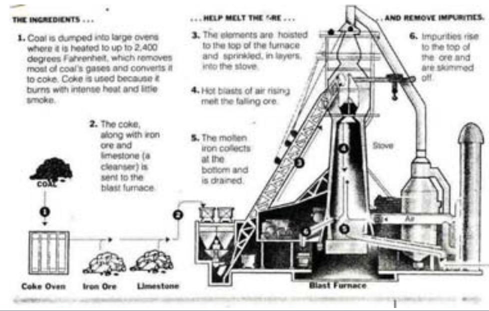


Coking Coals/Metallurgical Coals

- BB dengan karakteristik & diolah khusus yang dipakai dalam peleburan biji besi (dalam tanur).
- Hasil olahan BB ini disebut <u>coke</u> (residu solid karbon yang mengandung mineral).
- Dihasilkan dengan cara karbonisasi bb (dengan peringkat tertentu/hasil blending) dengan temperatur sd. 1400 K.
- Peran coke pada tanur:
  - Sebagai bahan bakar untuk reaksi kimia & peleburan slag & metal
  - Sebagai agen reduksi kimia karena menghasilkan gas untuk reduksi oksida besi
  - Sebagai penyangga (*permeable support*) biji besi, sehingga saat melebur, slag & besi dapat mengalir ke bawah dan gas dapat mengalir cerobong

Amijaya, 2015

Blast furnace



End