

Managing spontaneous combustion of coal

Johan de Korte



All coals have the potential to spontaneously combust.....

But no coal has to.....

MCJ van Vuuren

Overview

- Storage and stockpiling of coal
- Coal discards and dumps
- Transport of coal
- Mining of remnant pillar reserves
- Guidelines for controlling spontaneous heating

Storage of coal

- Coal is stored for different reasons:
- To provide a buffer between operations
- To blend coals
- For quality control purposes (targeting)

Coal storage as a buffer between operations

- Stockpiling of ROM coal allows mining to operate 6 days a week whilst the plant can operate for 7 days a week
- Storage bins between plant sections ensure that each section receives the required rate of coal
- Product coal is stockpiled before train loading to ensure correct tonnage of coal is available
- Coal is stockpiled at RBCT to control rail and shipping requirements

Coal storage for blending

- The quality of raw coal as mined can fluctuate significantly
- Variance in size consist and washability properties of raw coal has negative influence on performance of coal processing plants
- By blending the raw coal, a more even feed is provided to the processing plant
- Coals from different sources are blended before loading to ensure a homogenous product

Coal storage for quality control

- Quality of coal produced from a plant will vary over short time intervals due to variance in the size consist and properties of raw coal and also as a result of operational aspects
- By building a product stockpile, the quality of the product produced can be made more consistent
- The time period / tonnage targeted is important
- The quality of coal is monitored before the stockpile and a cumulative quality for the stockpile can be computed

Coal storage for quality control

- On-line quality monitoring is ideal but manual sampling and analysis also used
- When the stockpile is completed, the quality of the coal is known
- Enables a decision to be made regarding shipping of the coal
- Pre-qualified stockpiles of coal to Eskom

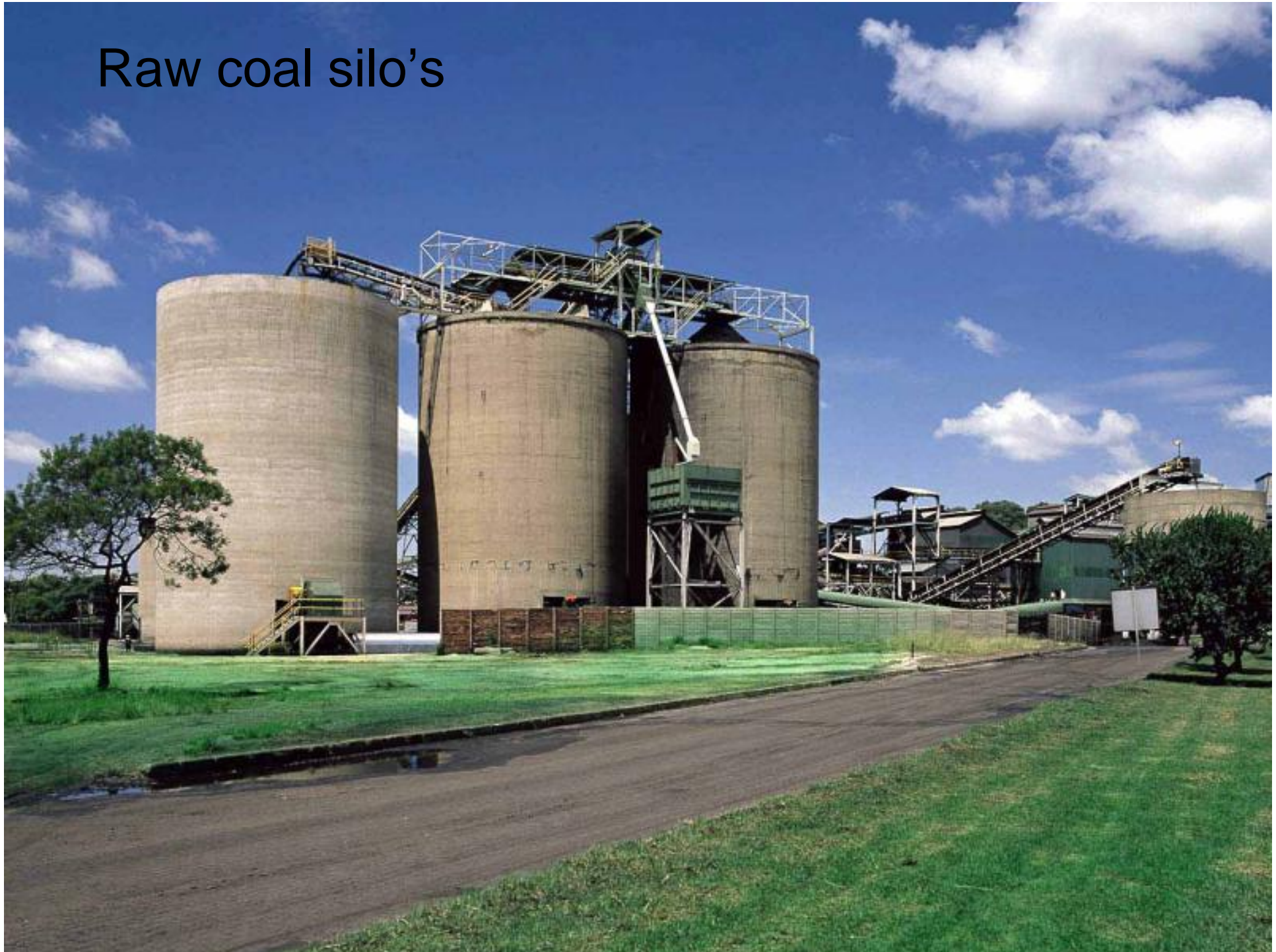
Coal storage

- Coal can be stored in bins, silo's, bunkers, staithes and stockpiles
- Bins and bunkers are normally used for smaller capacity storage
- Stockpiles have virtually unlimited capacity
- Stockpiles can be simple conical stockpiles
- Large stockpiles use stackers / reclaimers to place and reclaim coal

Product stockpiles at mine



Raw coal silo's



Raw coal stacker



Stacker / Reclaimer



“Emergency” stockpile at mine



Stockpiles of Eskom coal at mine



Discard coal

- A large proportion of South Africa's raw coal requires beneficiation in order to improve the quality of the coal so that it can be utilized in power generation, metallurgical applications and other industrial processes
- All of the coal exported through Richards Bay and other ports is beneficiated
- An unfortunate consequence of coal processing is the fact that large tonnages (about 65 mtpa) of discard coal arise and has to be disposed of
- The usual practice in South Africa is to dispose of this coal on discard dumps

Problems caused by discard coal

- Air pollution
- Ground water pollution due to water soluble oxidation products (acid mine drainage)
- Aesthetic effect on countryside
- Loss of a potentially recoverable asset
- DME – National Inventory of coal discards and slurry 2002

Stockpiling of coal

- Purpose – short term, long term or indefinite?
- Short term stockpiles / silos and bunkers – limit storage period (typically <30 days)
- First in -> first out
- Longer term stockpiles – special attention required

Long term stockpiling of coal

- Site selection and preparation
- Prevailing wind direction
- Limit height and segregation of sizes
- Stacking method (chevron, windrow or full length)
- Compaction
- Monitor temperature, gas emission (CO₂, CO)
- Grooteegeluk – 20 million tons of middling coal successfully stored for 11 years

Discard dumps and long-term stockpiles

- Storage time usually indefinite
- Need to prevent spontaneous combustion
- Need to control air and water pollution
- Placement of discards + compaction critical
- Monitor temperature, gas emission
- Maintain dump/stockpile in longer term

Construction of discard dump / long-term stockpile

- Thin layers (<500 mm) of discard placed on dump
- Individual layers compacted using impact rollers

Compactor



Placement and compaction of coal



Maintaining the integrity of a dump / long-term stockpile

- Maintain degree of compaction
- DCP (Dynamic Cone Penetrometer) tests
- Bulk density determination
- Control run-off water and repair damage
- Establish growth of grass
- Gas testing
- Temperature monitoring

Well managed discard dump



Rehabilitation of old discard dump



Rehabilitated discard dump



Transport of coal

- Coal transported by road / rail to inland users and RBCT
- Usually small tonnages per truck ~ 25 to 84 tons
- Basic rules applied:
 - Do not load hot coal into trucks
 - Trim coal to an even level
 - Do not mix wet and dry coal



Transport of coal

- Coal transported by ship to overseas users
- +- 70 million tons per annum via RBCT
- Large tonnages – Cape size vessel 70 000 to 120 000 tons in up to 11 hatches
- Hatches not air-tight
- Help is not a phone call away on the open seas

Richards Bay Coal Terminal



Ocean transport of coal

- Maritime safety regulated by IMO
- Code of safe practice for solid bulk cargoes
- Specific regulations apply to coal
- Information regarding cargo to be provided to master of vessel include moisture content, sulphur content, history of self-heating etc.
- Vessels required to have equipment to monitor oxygen, CO and methane levels as well as temperature
- No coal with temperature $> 55^{\circ}\text{C}$ may be loaded into a vessel
- Cargo to be trimmed as level as possible

IMSBC

International
Maritime
Solid Bulk
Cargoes Code

and supplement

2009 EDITION



Carrying solid bulk cargoes safely

Guidance for crews on the International
Maritime Solid Bulk Cargoes Code

Lloyd's
Register

LIFE MATTERS





Carefully to Carry

Coal cargoes

Since the publication of this article in *Carefully to Carry* No.13, issued in April 1989, there have been major changes in the recommendations for the safe carriage of coal cargoes.

Following a spate of coal cargo fires and explosions, a research project was sponsored by the UK Department of Trade and Industry. A working group comprised of:

British Coal
P&O Bulk Carriers
Souter Shipping
Minton, Treharne & Davies Ltd, instructed by the International Group of P&I Clubs and the Salvage Association

The main aim of the project was to validate the use of gas measurement to detect spontaneous heating of coal cargo at an early stage. Data was collected from a large number of voyages, some of which involved heated coal cargoes. Recommendations following this research were included in the revised entry for coal in the *IMO Code of Safe Practice for Solid Bulk Cargoes* (the IMO BC Code).

Properties and characteristics

The Categories A, B, C and D have now been excluded from the IMO BC Code and the properties and characteristics are shown under BC 010, at Appendix B, pages 61-66 of the Code as follows:

- Coals may emit methane, a flammable gas. A methane/air mixture containing between 5% and 16% methane constitutes an explosive atmosphere which can be ignited by sparks or naked flame, e.g. electrical or frictional sparks, a match or lighted cigarette. Methane is lighter than air and may, therefore, accumulate in the upper region of the cargo space or other enclosed spaces. If the cargo space boundaries are not tight, methane can seep through into spaces adjacent to the cargo space.
- Coals may be subject to oxidation, leading to depletion of oxygen and an increase in carbon dioxide in the cargo space.



"The carrier shall properly and carefully load, handle, stow, carry, keep, care for and discharge the goods carried."

Hague Rules,
Articles III, Rule 2

Carefully to Carry Advisory Committee

This report was produced by the Carefully to Carry Committee – the UK P&I Club's advisory committee on cargo matters. The aim of the Carefully to Carry Committee is to reduce claims through contemporaneous advice to the Club's Members through the most efficient means available.

The committee was established in 1961 and has produced many articles on cargoes that cause claims and other cargo related issues such as hold washing, cargo securing, and ventilation.

The quality of advice given has established Carefully to Carry as a key source of guidance for shipowners and ships' officers. In addition, the articles have frequently been the source of expertise in negotiations

UK P&I CLUB



Technical Bulletin

NUMBER 37 2011 (replaces Bulletin 14 2004)

Coal cargoes: self-heating and monitoring of evolved gas

Club inspectors still come across instances where ships' crew are not familiar with, or have little knowledge of, the recommendations of the IMO Code of Safe Practice for Solid Bulk cargoes (BC Code) 2005

This Code has now been completely reviewed with effect from January 2011 and is now called the

INTERNATIONAL MARITIME SOLID BULK CARGOES (IMSBC) CODE

As with the previous publication the BC Code, the IMSBC Code 2011 gives particular reference to monitoring and measurement of gases associated with the carriage of coal. These gases include Carbon Monoxide(CO), Methane (CH₄) and Oxygen (O₂).

In addition a complete new section has been added relating to self unloaders entitled:-

Measurement in cargo and self-unloading spaces of gravity fed self-unloading bulk carriers

1.2 All vessels engaged in the carriage of this cargo shall carry on board an instrument for measuring methane, oxygen and carbon monoxide gas concentrations, to enable the monitoring of the atmosphere within the cargo space. This instrument shall be regularly serviced and calibrated in accordance with the manufacturer's instructions. Care shall be exercised in interpreting methane measurements carried out in the low oxygen concentrations often found in unventilated cargo holds.

The catalytic sensors normally used for the detection of methane rely on the presence of sufficient oxygen for accurate measurement. This phenomenon does not affect the measurement of carbon monoxide, or measurement of methane by infra-red sensor.

Further guidance may be obtained from the instrument manufacturer.

Ship's hold prior to loading



Coal on fire in ship's hold



Re-mining of remnant pillar reserves

- Old underground workings sealed off for many years
- Re-mining disturbs pillars and generates new exposed area
- Spontaneous combustion can result and make mining difficult
- Research conducted by Coaltech / mining companies
- Guidelines compiled for use by coal mines
- Recent mining operations report successful control of spontaneous combustion through application of buffer blasting, use of sand to cover high-walls etc.

Mining operation recovering pillar coal



Dragline removing burning coal



Using sand cladding to control sponcom



PREVENTION AND CONTROL OF SPONTANEOUS COMBUSTION

Best Practice Guidelines for Surface Coal
Mines in South Africa



COALTECH Research Association



SPONTANEOUS COMBUSTION

THE DOS & DON'TS

prevention and
control of
spontaneous
combustion at
South African
Surface coal
mines



Guidelines for the prevention of spontaneous combustion of coal during storage and transport

- Compiled by the late MCJ van Vuuren
- Commissioned by the Dept. of Mineral and Energy Affairs
- Report number ES9307
- June 1995

Guidelines (1)

- All coals are liable to self-heating, some more than other
- The ingress of air into a storage pile must be restricted
- If the coal is well graded, ensure sufficient airflow to dissipate excess heat
- If coal in a bin self-heats, remove the coal and spread to cool
- Coals may emit explosive gases – ensure good ventilation in confined spaces such as bins and silos
- Coal must not be stored in bins and silos for long periods
- Avoid size segregation of large and small particles in live stockpiles

Guidelines (2)

- Do not mix coals of different rank, size, seam or areas
- Do not wet dry coal or add wet coal to a dry coal stockpile
- Repair wash-outs and gullies on discard dumps immediately
- Monitor the degree of compaction, temperature and gases emitted from long-term stockpiles
- Do not store coal adjacent to or on top of hot coal
- Do not load hot coal ($>55^{\circ}\text{C}$) into trains or ships
- If hot coal is detected – seek expert advice

Conclusion

- Most coals are likely to self-heat if not managed
- A few basic rules apply
- Minimize exposure to air
- Allow heat to dissipate
- Follow available guidelines