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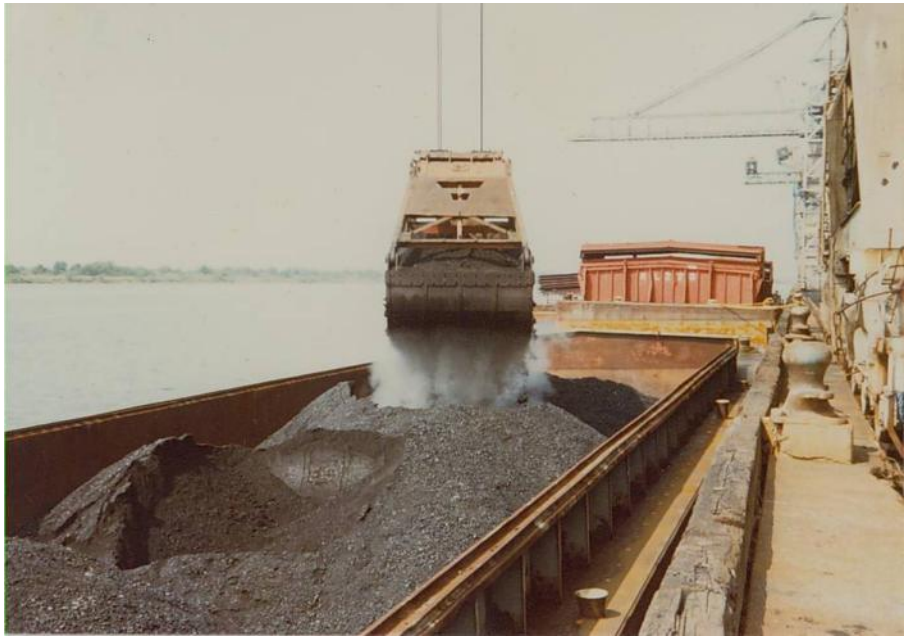

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MINTON, TREHARNE
& DAVIES LIMITED

Consulting Scientists, Mariners & Engineers
Analytical & Testing Laboratories
Public Analysts

RSC ENERGY SECTOR AND THE CRF ENVIRONMENT DIVISION

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As an independent laboratory we are frequently requested to sample and analyse fuels in respect of transportation and storage problems.

SEA TRANSPORTATION

For many years we sampled and analysed coals shipped from Southern Hemisphere Suppliers to the U.K. Calorific value was one of the important clauses in the contract documents. We were instructed to sample and analyse the coals as discharged at U.K. ports.

Following the initial shipments it was noted that the calorific value of the coal as discharged in the U.K. was generally of the order of 0.5% less than the calorific value of the coal as loaded. It was suggested

that there was possibly a problem with our methods of sampling and analyses. However we noted that as the hatch covers were opened prior to discharge water vapour escaped from the coal piles in the holds. Temperatures of the coal measured with a one metre probe indicated temperatures of the coal to be as high as 50ºC in some areas.

Ventilation of the holds had permitted the entry of air into the holds which assisted oxidation of the coal with attendant self heating effects. Hence the loss of calorific value of the coal as loaded. This explanation was not accepted by the supplier of the coal.

It was then agreed that at the next loading a representative sample of the coal as loaded was placed in a steel bomb and the space above the coal in the bomb was filled with nitrogen thus excluding air, and shipped on the vessel to the U.K. On arrival in the U.K. the coal in the holds was sampled and analysed, again showing a loss of 0.5%. However analysis of the coal in the steel bomb indicated the calorific value of the coal as loaded. This 0.5% reduction in calorific value as

a result of oxidation of the coal was accepted for future shipments to the U.K.

Spontaneous heating in the shipment of coals creates many problems. During the 1980's coal mines near the East Coast of America were shipping coals to Europe through the East Coast ports, rail journeys to the port from the mines approximately 2 – 3 days. However because of congestion at these ports it was decided to ship the coals from the Gulf area ports, New Orleans etc. Barges were used to carry the coals to these ports, journeys of possibly a few weeks.

Unfortunately at the mines the coal as loaded into the barges was not trimmed level, and appeared as a series of peaks of coal through the length of the barges. Thus as a result of passage through the warm air of the Mississippi air was free to enter the conical piles of coal. Oxidation of the coal resulted in a series of coal cargoes arriving at the coal ports in a heated condition.

Some of these coals were loaded in a heated condition into the holds of the ocean vessels and many of these vessels had to return to port to discharge burning cargoes.

We attended at one loading and rejected barges laden with coal because the temperature was in excess of 70ºC. The cargo was discharged and placed in a stockpile next to the loading berth. During the night there was a typical Mississippi Delta downpour of rain. Attendance next morning indicated drainage of a liquid from the stockpile and laboratory analysis of this indicated sulphuric and sulphurous acids with a pH of 1.

The Ship Owner was pleased that his cargo had been rejected, not simply because of the possibility of fire in the cargo holds but the effect of the acid on his hold structure. Soluble sulphur in the coal as carried and the solubility possibly increased by the elevated temperature of the coal.

INDONESIAN COALS

At the present time there is a great demand, world wide, for coals from Indonesia. These coals of low price and low rank readily oxidise and this oxidation process is assisted to some extent by the high inherent moisture content of the coals, of the order of 25 – 30%. Carriage of these coals demands extra sealing of cargo compartments to exclude the entry of air and daily monitoring of the hold space atmospheres to measure concentrations of methane, carbon monoxide and oxygen. Carbon monoxide levels will rise during the first few days of the voyage following oxidation of the coal. However at the same time the oxygen levels will fall, having been taken up in the oxidation process. Under ideal sealing conditions of the hold spaces oxygen levels will be so reduced as to produce an inert atmosphere in the cargo holds.

Inert conditions ensure no further oxidation or self heating of the coal and no danger of explosion of methane, evolved from the coal.

New problems have recently been presented, we have been instructed to advise in respect of two ships carrying Indonesian coal cargoes which have been seized by pirates off the coast of Somalia. Retention times have been of the order of 10 – 12 weeks and restriction of hold monitoring records caused some concern. However both ships were in good condition and the low oxygen contents in the holds were maintained whilst in captivity and later discharged cargoes with no claims.

COAL STORAGE

Storage of coal still creates problems, despite the research conducted and recommended methods of safe storage. The attached photograph shows the extent of fire in a stockpile in a coal loading terminal. Some of this heated coal had been loaded to an ocean going vessel. It was discharged again when the temperature of the cargo in the holds exceeded 50ºC.

Note the irregular structure of the stockpile, no level trim or compaction, breaks in the formation which permitted entry of air into

the body of the pile. Water monitors were directed to heated and burning areas of the stockpile, but these monitors created vertical faces which provided further easy access for air into stockpile. Hot air currents were rising up through the pile and drawing further into the bottom layers, the perfect “chimney effect”

Efforts to control the heating continued for several weeks, removing the heated coal with front end loaders, spreading in thin layers to cool and then creating a compacted pile, with sloping ends and edges “whale back” fashion. The coal was later shipped safely to discharge port. However the tonnage had been reduced, the calorific value had been reduced, and the ash content and moisture content had been increased.

There is a paper prepared in the 1960’s of a trial conducted by the CEGB related to the storage of coal. The stockpile was prepared in accordance with good practice, layering and compacting and sloping the ends and sides of the pile. The coal was sampled and analysed prior to stockpiling. After three and half years of storage samples

were taken from the stockpile and it was determined that there was a loss of only 0.65% of dry ash free calorific value. Obviously there had been very minor oxidation of the coal substance during that long period of storage, but the trial proved that coal can be safely stored and without significant loss of value.