Spectrum

Oil from coal, using water

Experiments in a CSIRO laboratory have shown promise in making oil from coal using that universal solvent, water.

A scientist at the Division of Applied Organic Chemistry has found that water can be used to turn more than half of a Victorian brown coal sample into synthetic crude oil (syncrude) and gas. Even higher yields can be achieved if the water is made alkaline with sodium hydroxide.

The trick Dr John Kershaw used was to pressure-cook the ground-up coal with water under such extreme conditions that the water behaved as a 'supercritical' fluid. In this state, at about 380°C and 22 MPa, the water greatly enhances the volatility of hydrocarbons in the coal.

Water reaches its 'critical point' at 374°C, and above this temperature water vapour cannot be liquified, no matter what the pressure. It exists as a supercritical fluid, a cross between a liquid and a vapour.

If we were to watch a sealed container of water during heating, the meniscus between the liquid and vapour phases would disappear when the critical temperature was reached. (The pressure would register 218 atmospheres, or 22 MPa, at this temperature.)

Dr Kershaw points to the special attractions of using supercritical water to produce liquid fuel. Apart from the low cost of the solvent, we don't have to pre-dry the coal, which is a significant factor when we consider the high water content of Victorian brown coal (50–70%).

Furthermore, extraction of the product is easy. After an hour's processing, the reactor is cooled and depressurised and most of the wanted liquids, being insoluble in water, simply precipitate out.

For these reasons, Dr Kershaw believes the method may well be more economical than alternative techniques. In particular, it appears to compare favourably with the approach of solvent-refining coal, which is presently being tried out in a pilot plant at Morwell by a Japanese company.

The Morwell process subjects brown coal to high pressure in the presence of solvent and hydrogen. It calls for plentiful hydrogen and dry coal. The mineral matter has to be separated out in a subsequent stage.

Using supercritical water as solvent avoids these drawbacks; and yields of 23–44% syncrude (expressed as a percentage of the dry starting material) have been achieved. Some 10% or more of coal is lost as gas, principally carbon dioxide, but the residue is a dry solid char that can be burnt for its energy.

At least one-third of the liquid product is classed as oil, with the remainder shared between heavier fractions known as asphaltene and pre-asphaltene.

The Yallourn open-cut brown-coal mine.

The ratio of hydrogen to carbon in the products is uniformly high, an attractive feature for refineries. However, because of the high oxygen content of brown coal, the product has a higher oxygen content than that in usual feedstocks, and this is a less favourable aspect.

Of course, the process has already removed a great deal of oxygen in the evolved carbon dioxide, and also some as water. The remaining oxygen can be taken out at a later stage by reaction with hydrogen to form water. (In fact, the Morwell operation removes considerably more of the oxygen this way, at considerable cost of hydrogen.)

When Dr Kershaw repeated his experiments with black coals, the same high yields could not be duplicated.

Nevertheless, for Victorian brown coal — an abundant resource — Dr Kershaw believes that pressure-cooking it fresh and wet straight from the mine may prove an economical way of deriving liquid fuels.

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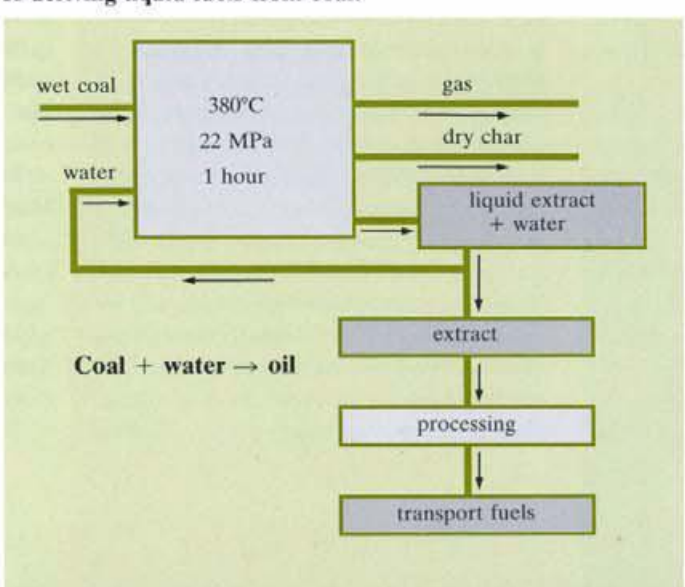
Extraction of Victorian brown coals with supercritical water. J.R. Kershaw. *Fuel Processing Technology*, 1986, **13**, 111–24.

Pressure-cooking Victorian brown coal may be an attractive way of deriving liquid fuels from coal.



Ants and plants — mutualism in action

Well known to biologists is the co-evolution of flowering plants and insects. The two groups of organisms developed during roughly the same period of geological time and together successfully spread over most of the planet's land surface.

During millions of years they have established a sort of partnership, coming to depend on each other. Most obviously, insects use plants for food and shelter, and many plants rely on insects for pollination.

Also, insects living on a plant may act to protect it from larger herbivores, such as mammals. Commonest in this protective role are ants.