The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Burning coal in place or in-situ gasification

Posted by Heading Out on March 5, 2006 - 1:01am
Topic: Supply/Production
Tags: australia, china, coal, gasification, tech talk, town gas, united kingdom, united states [list all tags]

Grin - well Yankee has suggested that we need more information on coal gasification and so, after threatening to do this a couple of times, today, having talked a little about surface gasification I thought I would move to the subject of in-situ gasification of coal. That would allow, if successful, that we would burn the coal in place, underground. This might have the advantages of not requiring the surface plant and impacts that a conventional coal mine would need, and it might also provide some useful way of getting to otherwise unavailable deposits such as those under the North Sea. Most particularly it would remove the need for all the grimy gas works that were dotted over Europe and North America until natural gas came along to clear the air. It is a subject that the Chinese are looking into

> The Chinese government has authorized an underground coal-gasification project in Lineng of Shandong Province recently. This is a model project combining in-sit-coal gasification and gas-fired power generation.

, as well as being of interest to the British, the Australians and ourselves, to name but a few.

This is another in the weekend technical talks that pop-up at frequent intervals on this site, It fits in with a series on coal technology that is listed at the end of the post, and more particularly is related to other ways of generating fuel from coal other than just burning it in a boiler to generate steam. As with a number of ideas that are getting more discussion (such as the injection of carbon dioxide back into the ground, and the use of pulverized coal in diesel engines) it is not particularly new, but since it is now getting more attention, the post will attempt, in a relatively simple manner, to explain what it is all about. For those more knowledgeable please do comment, as should those who find the explanation not totally clear.

My own first encounter with underground coal burning was when wandering into a mine that was something like a hundred years old, and being conscious of all the smells in the return air-way. I was told that an old part of the mine had spontaneously caught fire, could not be extinguished, but had been sealed off and left. The fire, in that case, was fed oxygen through the mined out passages around the place now on fire.

Which brings up the first point, which is that coal can, on its own, catch fire. The old pit heaps that dotted the landscape around mines were made up of old coal waste, including a fair amount of un-recovered coal. When they were later reclaimed it was often found that the tips had caught fire and burned the clay into a red-brick-like material. This self-ignition is known as spontaneous combustion and occurs because

> Coal reacts with atmospheric oxygen even at ambient temperatures and this reaction is exothermic. If the heat liberated during the process is allowed to accumulate, the rate of the above reaction increases exponentially and there is a further rise in temperature. When this temperature reaches the ignition temperature of coal, the coal starts to burn and the phenomena is described as spontaneous combustion.
>
> The temperature at which the coal oxidation reaction becomes self sustaining and at which spontaneous combustion occurs varies generally depending on the type (nature and rank) of coal and surrounding conditions of heat dissipation. In poor quality coal and where the heat retention is high the coal and carbonacous material may start burning at temperatures as low as 30-40° C.

Coal oxidation can occur in coal storage and, as I mentioned, undergound.

The fires are not always spontaneous, perhaps the most famous is the Centralia fire where the coal seam outcropped at the surface, where it ignited, and the fire then moved underground and beneath the town of Centralia, PA. Despite vast amounts of effort, money and time, the fires are still burning.

Which brings me to the second point. For a fire to continue to burn it has to have fuel (the coal) and air (oxygen). If the fire is totally cut-off all the air is consumed and the fire goes out. But if there are cracks through which air can reach the fire, then it will continue to burn. Thus, in Centralia, for example, as the coal burned in and under the town, it removed part of the rock holding the town where it was. The ground would then collapse into the burned out cavity, and a crack would run up to the surface along the edge of the opening, allowing air to flow back down to the fire and continue the progression. Having been once involved in fighting such an event, it is very difficult to tell where the fire front is, and the coal does not burn in a vertical front, but in a very jagged pattern, depending on air flow and relative composition of the different layers of the coal. The air generally flows through the cleat pictured here.

Having proved that coal seams can burn in place, we still have to work out how to make that useful. Short of running water pipes down, and using the steam that comes out for power surely there has to be a better way of getting the energy, and there is.

In the post last week I described how the old gas-from-coal plants worked in the UK to produce town gas. Simply put by heating the coal, and passing air and steam across it, one can generate "producer gas' and "The final composition of producer gas is about 12% hydrogen, 25% carbon monoxide, 7% carbon dioxide, and 56% nitrogen; the nitrogen comes from the air used in the producer gas reaction." So that if we can get the water and air to the coal fire underground in the right quantities then we can generate a gas that we can extract and it can be used as an energy source.

Sounds easy, right? It turns out that it is not quite that simple. Again from the DTI report on the Chinese work (pdf file)

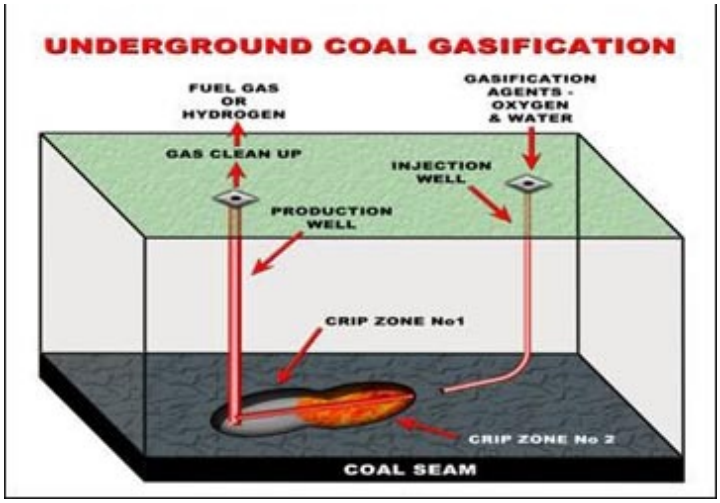
> Underground coal gasification (UCG) experiments have been carried out in many coal mining countries and industrial scale production has been achieved in the former Soviet Union. More than 15Mt of coal has been gasified by UCG and in excess of 50 billion m3 of gas has been produced from UCG projects around the world. Despite research and many trials in different countries, no truly commercially viable UCG project has yet

> been demonstrated. However, various technologies are now available which could change this situation. A shallow seam, commercial power generation project is currently under development in Australia.

The problems relate to a number of issues, but let me concentrate on two.

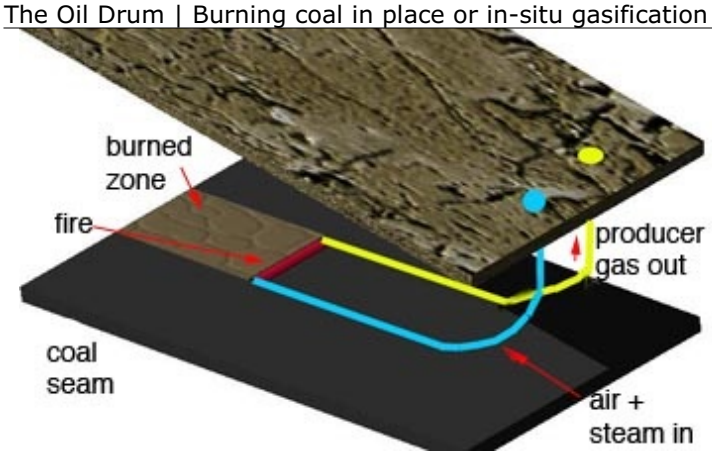
In the initial concept, it was proposed that two wells could be drilled from the surface to the coal seam. In one early US test of this idea, in Hannah WY, the seam was relatively close to the surface, and for the first test the wells were set 75 ft apart. After reaching the seam, it was intended that the connecting passage between the injection well and the extraction well would be created by starting a small fire at the bottom of the seam, at the first producing well, and then by blowing air down the injection well have the fire work back to that well along the cleats through which the air was passing. By restricting the flow it was intended that the passage would be small, and run along the bottom of the seam. Then, once a passage existed, more air and steam could be fed into the injection well, increasing the size of the fire, and creating the producer gas that could be extracted from the production well.

Unfortunately the fire would not "behave" and over-burned the coal, rather than burning in the lower section, and did not otherwise go as planned. The conclusion was that this passage had to be artificially created first. The need for a long hole in the coal requires a directional drilling tool, and in the 1970's when the earlier trials were made, those were not available, particularly ones that could turn ninety degrees within the 140 ft from the surface to the seam. One had to be invented (and was). Thus in recent experiments the UK planners have looked at directional drilling from the surface to the coal, as a way of creating the initial passage, and providing paths for the air and steam to the fire and for the producer gas to come out.



(Source UK Coal

Two different approaches are being looked at in China, one of which works by creating panels in existing mines from adjacent cross-cuts, while the second uses a pair of directionally drilled holes with the fire to be initiated between them. Although as I mentioned from the work done in the US, getting that initial connection may be rather difficult and long-term control of fire location gets to be rather tricky.



(Derived from the DTI report).

This is a part of a series of talks that has, most recently, dealt with coal mining.

Surface Mining

Longwall Mining

Room and Pillar Mining

Gas and gasoline from coal
As usual any concerns, corrections, or questions, should be addressed in comments.