The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Getting plowed also happens to coal

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As I mentioned in summarizing the Conference from last week, it seems as though, whether willingly or not, we are going to be seeing a lot of black coal in our energy future. I have written a couple of technical talks about coal mining in the past, and, if I can, I'll move references to them into The Book later on today, along with the petroleum ones. (The coal ones are in Chapter 10, the oil production ones in Chapter 3.2).

The Chinese have just bought another longwall mining system, but instead of the shearer that I had described in the earlier longwall piece these systems will use a plow system to mine the coal. So I thought I would explain what those machines are, why it is interesting to see the Chinese using them (and why) and then perhaps close with a little note on fires underground. And perhaps have a little comment on EROI thrown in along the way. The plow also featured in the recent Washington Post story on coal mining.

So let's drop down into my simplified mine model and see what it is I am talking about. And, since no-one answered my question about the modeling programs, the mine will be empty of workers, and you will have to use your imagination to sense their presence. Which may, fortuitously, be an indication of the future, since more and more pieces of mining equipment are being automated, or operated remotely, so that manpower is less, and less required. And this has some benefits beyond just removing people from areas of possible risk. I was fortunate enough to work with a couple of Dr Charles Hall's students over last summer who were looking into EROI issues relating to mining. The high energy cost to provide the support needed for personnel was particularly striking in some of the situations that they looked into. And from the EROI point of view, a plow is usually a lot less energy intensive.

Well my model isn't quite that forward looking, but let's start by presuming we have left the surface, and gone down in the cage to the level at which the coal seam lies in the ground. Since the coal, in general, is thick enough so that people can move around within the coal height, the mine is largely developed by driving parallel tunnels away from the shaft towards the boundaries of the property that is being mined. (Note that because coal seams can stretch for many miles) The tunnels run parallel to one another, so that air can be circulated down through some of the tunnels, across the working face, and then back out, through another tunnel, to the shaft that will carry it to the surface. The tunnels are driven in the same way as coal is mined by Room and Pillar mining.

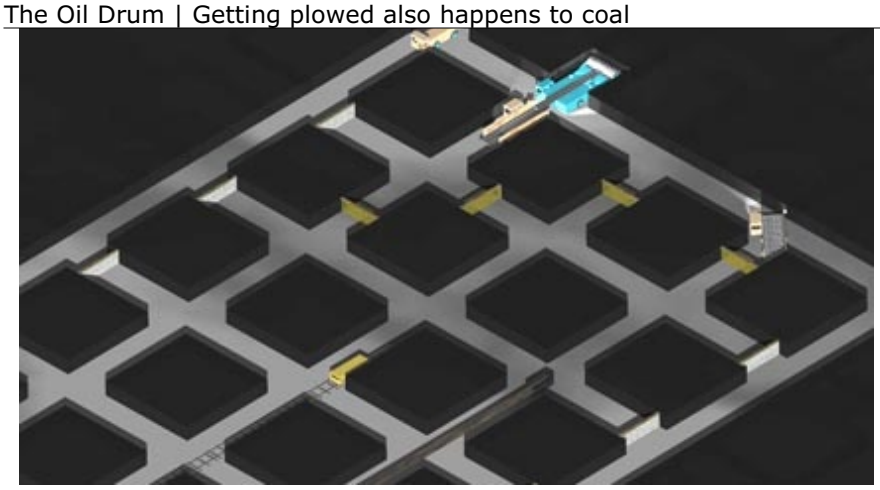

Figure 1 Overview showing the continuous mining machine (blue) loading into a shuttle car

Once the main tunnels have been driven out to the edge of the property, then the coal on either side of them can be recovered. To mine that coal, secondary sets of tunnels are now offset from what I will call the "mains."

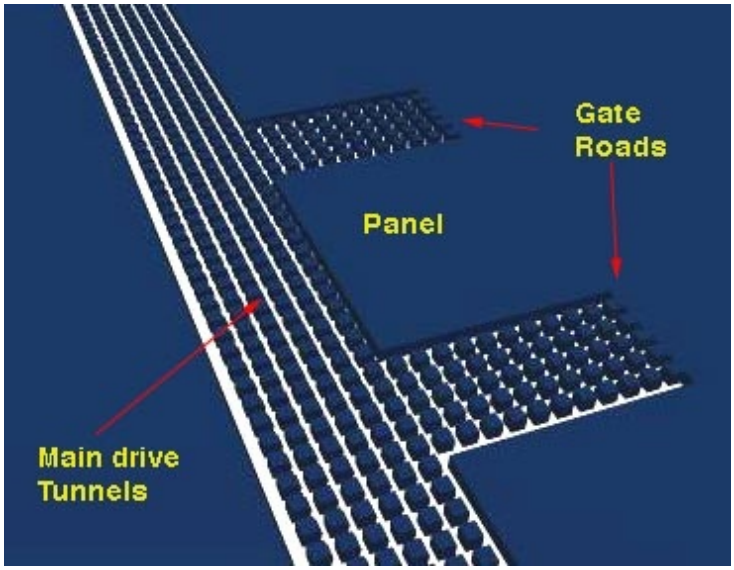

Figure 2 Overview showing how the two sets of side tunnels, forming the gate roads, develop from the main set of drive tunnels that contain the main conveyor belts that will cary the coal back to the shaft.

Once this gets to the edge of the area to be worked, a cross tunnel is driven between the two sets of advancing tunnels, which now form the gates to this cross-tunnel, which becomes the longwall face. It is into this tunnel that the roof supports are placed, and then a chain conveyor is installed along the tunnel, and the mining machine mounted to the conveyor.

In the previous post this machine was a shearer, with two rotating drums, one at each end, which had metal picks set into them to cut into the coal.. The drum rotation grinds the coal from the face, generally in pieces smaller than an inch, as the machine pulls itself down the face. In a plow face, that self-propelled machine is replaced with a machine called, not surprisingly, a plow (Hobel in German, since this is where the machines were invented).

Figure 3 Looking at the coal face with part of the shield canopy removed so that the different pieces of face machinery, including the plow and the face chain conveyor, can be seen.

In contrast with the shearer, the plow is pulled down the coal face by continuous chain attached to a winch mounted at the end of the face. The teeth of the plow are pushed into the coal by the thrust from the cylinders that are attached to the roof supporting chocks, on the other side of the conveyor. Every so often, as the plow cuts deeper into the coal, the supports lower the vertical rams, and reverse the action of the horizontal thrusting ram, so as to pull themselves forward into open space behind the plow. This keeps the immediate roof supported, while that behind the supports falls into the open space, as I have described before.

The plow is thus a much more inert piece of equipment (though if you have even seen one bash down a face that is not exactly horizontal you might doubt that word). But it has a significant advantage over the shearer, in that, with the body being segmented, individual layers can be removed. Thus the plow can, more easily, work in thinner coal seams than the shearer can easily be adapted for.

You should note, from the EROI perspective, that the plow does not, usually, break out all the coal by itself, but, as it pulls down the face, so it undercuts the top layer of coal. And in the type of brittle coal in which the plow works best, that top coal will collapse down onto the conveyor under its own weight.

So why is it interesting that the Chinese are buying more plows. Well, generally, when you find one coal seam, you will often find a number stacked, one above the other, in a sequence. Historically the mine owner would look to see which ones were thick enough to be worth mining and the rest would either be left, or would collapse into the waste, and be left as the thicker, underlying seams were mined.

However, by investing in plow systems, these thinner coals can be mined, and taken out before the thicker coal is removed. In this way more of the total resource is recovered and the thinner seams, which would otherwise be lost and abandoned, since their value will not justify the attempt to return later to recover them. It is indicative of the thoroughness with which the Chinese (and Mexicans) are addressing the different aspects of their need for energy supplies.

The second most scared I have been underground was when, many years ago in Germany, I watched a high-speed plow being pulled down a face that has a roll in it, so that the plow came up off the floor and gouged into the overlying rock roof, generating showers of sparks as it passed.

(Sparks in mines can ignite the methane that is being emitted from the coal, and which, in the right concentrations in the air, can then explode). The majority of the time it is the hot spot left in, usually a sandstone rock, as the cutting pick from a shearer rubs over it, that has both the temperature and the energy to ignite the gas. The plow can move at up to 3 m/sec, and thus the shoer of sparks can appear (and did) very dramatic, but fortunately the seam was not gassy, and they knew much more about what they were doing than I did. Even so, using machines to mine into rock along a coal face is not only wasteful of energy, but also increases wear, and thus operational costs, and can be a bit more dangerous, depending what that rock is.