CO_2 shortage

A MARKET MECHANISM IS NEEDED TO ROUTE CARBON EMISSIONS FROM POWER PLANTS TOWARDS ENHANCED OIL RECOVERY

That's right! The great irony is that amidst the everyday discussion of greenhouse gas mitigation and global warming, we have an acute shortage of CO_2. Go figure!

The application — of course — is Enhanced Oil Recovery (EOR) and the recent run-up in oil prices has triggered much greater interest in this tertiary recovery method (Figure 1). Not all reservoirs are amenable to CO_2 injection, but the productive life of those that are can be extended by as much as 25 years.

I'm learning some new terms here but conventional methods can extract 30% - 50% of the Original Oil In Place (OOIP). Effective CO_2 injection can deliver an additional 8% - 15% of the OOIP. (Figure 2 shows the projection for the Weyburn, Canada, project and illustrates the impact).

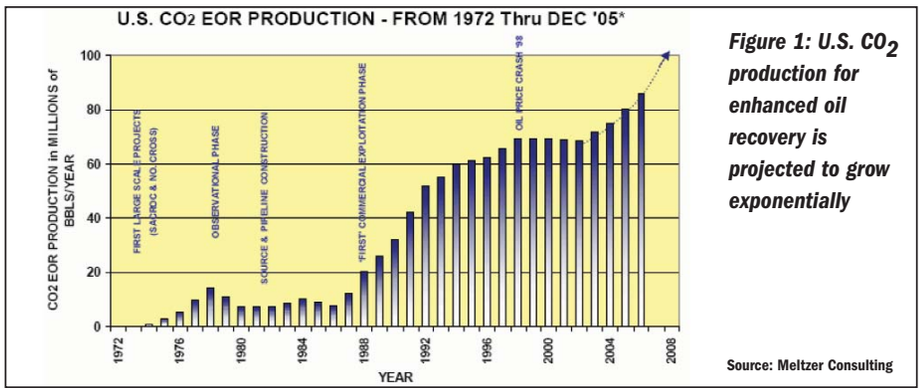

Figure 1: U.S. CO_2 production for enhanced oil recovery is projected to grow exponentially

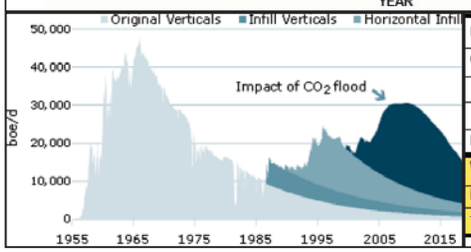

Figure 2: Carbon sequestration could boost production in the Weyburn, Canada, oil field to 30,000 bbl/day

United States	
Carbon Dioxide use for EOR	8 Mt/yr
• Naturally occurring	7.2 Mt/yr
• Anthropogenic	0.8 Mt/yr
Estimated CO_2 sequestered from EOR operations	0.6 Mt/yr
Worldwide	
Potential CO_2 EOR sequestration	130 Gt C
Total CO_2 accumulated in atmosphere	3-4 Gt C/yr

Table: In the U.S., 90% of CO_2 used for enhanced oil recovery comes from naturally occurring sources

Carbon abundance

The U.S. Department of Energy (DOE) published an EOR program fact sheet in July 2004, which indicated the levels of CO_2 used for EOR at approximately 8 Mt/yr. I have seen other reports that indicate values closer to 30 Mt/yr. The relationship of mass fractions suggests that the 8 Mt/yr value may be just the carbon portion.

Almost all of this comes from naturally occurring sources, either as CO_2 itself or as CO_2-natural gas mix. These are mega-tons, defined as 10^6 tons, and refer to the U.S.-based 2,000 lb tons, not 2,200 lb metric tonnes. Fifty to seventy-five percent of what is injected remains sequestered, depending on who you talk with, while the balance is captured and re-injected.

An extract from a DOE report (Table) shows that only 10% of this comes from anthropogenic sources, defined as those effects or processes that are derived from human activities, as opposed to effects or processes that occur in the natural environment without human influences.

According to the Intergovernmental Panel on Climate Change (IPCC), global CO_2 emissions produced by large power plant point sources are 10,539 Mt/yr. The EOR consumption is a tiny fraction of existing supply, but an interesting one, as it can jump start the development of tools and infrastructure, while adding to oil reserves. And, there are important new initiatives to deploy CO_2 methods in similar ways for enhanced coal-bed methane, as well as a method to moderate the in-situ combustion as an oil shale recovery technology.

The oil producers are interested in CO_2 at 98% - 99% purity, delivered at a nominal 2,000 psia pressure for a price between $0.30 to $1.00 per mcf, or $6.00 to $20.00 per ton.

Flue gas has approximately 15% CO_2 at either atmospheric pressure or 50 psia, depending on the type of power plant and the specifics of the Carbon Capture & Storage (CC&S) process. Current estimates suggest that CO_2 using today's CC&S methods would range from $20 to $70 per ton. This would be at the point source, but delivered at pressure to a pipeline system.

The cost of laying pipelines is estimated at $30,000 per inch of diameter, per mile. I don't know a lot about pipelines, but at these prices, you can't go very far.

A single 1,000 MW power plant burning sub-bituminous coal will produce almost 0.8 Mt/yr. One 1,000 MW power plant can produce all of today's anthropogenic requirements. Ten such power plants at the 8 Mt/yr level would produce enough CO_2 to supplant the use of naturally occurring CO_2 that is tapped for this purpose today. Forty-four power plants could supply the 30 Mt/day requirement. Associated Melzer Consulting data support a 29 Mt/day projection.

Long term, the market seems to have significant upside demand potential moderated by price and availability. Locational factors will certainly become the basis of competition, and marginal cost pricing will eventually result from CO_2 commoditization. But early movers have the opportunity to establish a favorable position, if supported with long term contracts.

What we have now is a logistics problem that lacks the market mechanism to narrow the differences and to correct itself. The mechanism — of course — is some form of cap-and-trade program that would encourage the markets to seek solutions. TI

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