Betsy Mills
03 | 31 | 04
L330

Innovations in Crude Oil Production: A Wolf In Sheep's Clothing

The first oil well was drilled in 1859 by Edwin Drake. It burned to the ground several months later, but had it survived it would only have yielded around 20 barrels of oil per day, hardly a drop in today's market.("Story") At the time however, it was considered a success and it began a revolution in oil production. Crude oil production in the world skyrocketed from a few hundred barrels of oil per day to 76 million today. ("International") Of course, in the long term, this is not sustainable. In the near future however, it is the goal of the oil industry to continue this growth in order to continue to meet the world demand.

Unlike the rest of the world, crude oil production in the US has gone down, from a high of 9.6 million barrels per day in the 1970's to only 5.7 million barrels of oil per day now. But like the world, demand for oil has gone up. Looking at statistics for estimated US oil supply("Environmental" : A History of Innovation, p. 9) :

- 162 billion barrels have already been produced
- 22 billion barrels make up our proven reserves
- 37 billion barrels are proven, but currently unrecoverable
- 50 billion barrels are estimated undiscovered and recoverable
- 351 billion barrels are estimated undiscovered and unrecoverable

With an estimate of around 460 billion barrels of oil remaining, recent production declines are not due to the US running out of crude completely. However, 388 billion barrels of this country's crude oil are technologically unrecoverable. What this means is that technology may exist to recover this oil, but that with today's crude prices, it is not economical to do so. This problem faces oil producing countries all over the world. Thus, world production is likely to eventually undergo the same decrease as the US unless new and emerging technologies are employed to cheaply access the 'unrecoverable' oil. Examining the technological leaps made from early means of oil production to present day emerging technology shows a trend of increasing efficiency that suggests efforts to access this unrecoverable oil will succeed.

Traditionally, oil production is a very inefficient process. To see this, examine a conventional oil well, which lacks most modern innovations. Means used to locate this well, such as 2D seismic imaging, were imprecise, so developing this well probably involved drilling and abandoning several so-called 'dry holes' where no oil was struck. The well itself consists of one vertically drilled hole. The structure and equipment surrounding the well take up a great deal of space. Only around 10% of the oil in the reservoir the well taps will be recovered. ("Enhanced") Obviously, there is room for improvement in the efficiency of the well and in its environmental impact.

The first major area of improvement is in the process used to locate sites for oil wells. The first really accurate way to do this was by employing 2D seismic technology. This still resulted in many dry holes. Using Shell and Amoco's Foenhaven Oil Field as an example, only around 25-30% of the oil was recovered from wells located using the 2D technology. With the advent of 3D seismic locating technology, the depth of an oil

pocket could be determined, and as a result far fewer dry holes were made, which drastically decreases the environmental impact of drilling, as less land is disturbed to get the same amount of oil. The recovery rate at Foenhaven field improved to 40-50%. The most recent advance is 4D seismic technology which not only locates oil pockets, but can analyze how these pockets change over time. This advance has increased the recovery rate at Foenhaven field to around 65-70% by ensuring that the oil reservoir is drilled at the best spot to ensure maximum output. ("Environmental" : Exploration, p. 7) The overall high recovery rate is also due to other technology used for oil recovery, which will be described later.

Improvements have also been made in the "footprints" of wells, or the area an oil drilling pad takes up on the surface. Most new oil wells take up far less area than their predecessors—if technology had not advanced beyond 1985 levels, oil drilling pads in the US would cover an additional area the size of 12,900 football fields: 17,000 acres. (source) Many oil rigs are also built to be temporary. Light modular rigs are designed for surface drilling. They are built out of lightweight material, in pieces which can be easily assembled and disassembled on site. Because they weigh less and take up less space, they have a lesser environmental impact on the site. Some rigs for deep underwater drilling are even based on boats, making it even easier to disassemble equipment when the drilling has stopped. ("Environmental" : Exploration, p. 7 and Drilling, p. 9)

One important advancement not only for efficiency but also for safety is the development of Measurement While Drilling (MWD) technology. This technology allows readings to be taken at the bottom of the drill hole as drilling is in progress. It allows drilling operators to keep track of the hole pressure while drilling and guard

against dangerous blowouts, where oil in combination with natural gas explodes out of the drill hole. Such blowouts can be dangerous for workers, and also spill crude oil in the surrounding environment. This technology also allows for more accuracy while drilling, as the direction of drilling can be adjusted according to the readings from the bottom of the hole. It means that drilling can be completed more quickly, and also that resulting well is likely to be more successful. ("Environmental" : Drilling, p. 9)

Being able to control the direction of drilling is another major advancement in oil production. From only being able to drill a straight vertical hole, technology has progressed to offer many more possibilities. The first big innovation was directional drilling, which employs special motors to control the path of the drill and MWD technology to keep track of the drill's position. This allows for a surface well to reach oil pockets that are not directly below it, which is useful in such situation as drilling for oil underneath a lake or other sensitive environmental area where a well could not be placed. A specialization of this method is horizontal drilling. By approaching an oil pocket from the side, this method proves more effective than vertical drill holes for exploiting pockets of oil which are much wider than they are deep. ("Environmental" : Drilling, p. 6)

Other new drilling advancements methods involve using existing wells so that new surface drill holes do not have to be constructed. One such option is multilateral drilling, which drills a well deeper in order to reach a lower pocket of oil. Another is sidetrack drilling which adds a directional extension to a well in order to reach a pocket of oil to the side of the current well. ("Environmental" : Drilling, p. 7)

One last drilling innovation is slim hole drilling. As a drill hole is made, shavings of rock called cuttings are produced. These are contaminated with the drilling fluid used

to lubricate the drill, and disposing of these cuttings in an environmentally sound manner can be expensive, and consume both time and space. Slim hole drilling allows a drill hole of smaller diameter to be made, which reduces cuttings by one third. ("Environmental" : Drilling, p. 8)

As mentioned before, typical oil wells have low efficiencies. Even with the aforementioned technology, the primary recovery rate of crude oil in a well is typically around 10%. This is because, as the oil is extracted from its reservoir, the pressure in the reservoir decreases and the oil no longer is forced up into the drill hole where it can be pumped out. Several secondary means have been found to increase the recovery rate. The simplest is water flooding, in which the oil reservoir is filled with water. This displaces the oil, forcing it the top of the reservoir, and the pressure caused by the water's presence then allows that oil to be more fully recovered.

Water recovery is typically the first step used to recover more oil from a well. Further methods tend to be more involved. One such means is thermal recovery, in which steam is injected into a well to reduce the viscosity of the oil and allow it to be more easily pumped. Chemicals, such as detergent–like surfactants can also be injected into an oil well. These break down the surface tension in the oil and also allow it to flow and be pumped more easily. Other means involve flooding the well with gasses such as carbon dioxide. Depending on the gas used, this either increases the pressure in the reservoir and forces the oil out, or the gas combines with the oil to lower its viscosity and make it flow more easily. These methods allow the amount of oil recovered in a well to be increased to anywhere from 30% to 60% of the total. ("Enhanced")

The environmental impact of new technology is much less disruptive than previous oil recovery methods. There are fewer dry holes. The footprints of oil wells are smaller. Individual wells are more efficient, requiring fewer new wells to be drilled. Wells can be drilled more quickly, and fewer cuttings are produced. The risk of blowouts and fires has substantially decreased. All of these things have a positive impact on the environment.

Technology used in oil production can also be used in other environmentally friendly ways. Directional and horizontal oil wells can be used to clean up subsurface oil contamination, especially in hard to reach areas such as below buildings. Chemicals used to enhance oil recovery can also be used to enhance oil recovery from oil spills. And finally, flooding oil wells with CO2 is one way to sequester CO2, keeping it out of the atmosphere and helping to fight global warming. These are all examples of environmentally beneficial uses that technology used to advance oil production can have. (source)

All of these advancements in oil production show that the capacity exists for technology to continue to expand oil production. Technology has increased efficiency in locating sites for successful oil wells, and increased efficiency in recovering the oil form those wells. As these technologies are further developed, it is quite possible that more sources of oil will become economically recoverable. However, technology can only do so much.

In the US in particular, many of these advances in drilling have been around for decades, and US crude production has still gone down. It is unlikely that future technological developments will help the situation substantially. However, this will likely

not slow the increase in US demand for crude, and the US will remain a large consumer in the world oil market.

The general attitude of the US and the world crude market as a whole is that cheap, plentiful oil will continue to be available into the indefinite future. Technological advances have allowed this to be the case so far, and there is a certain belief that technology will continue to keep oil flowing cheaply. But this is simply not the case. Technology cannot change the fact that the world's oil supplies are finite. Eventually, technological advancement will no be able to keep up with the pace of demand for crude oil, prices will go up and supply will have to go down. Just comparing the price of crude oil (~$15/barrel) to such things as milk (~$126/barrel) and orange juice(~$250/barrel) shows how unrealistically low the price of this resource is. ("Environmental" : Oil and Gas, p. 5) It will eventually be completely and irreversibly gone, but now it is cheaper than such renewable items as orange juice.

Technology allows the price of crude oil to stay that low, and it is a mixed blessing at best. Because crude oil is so cheap, demand continues to increase and there is no thought to conserving it. None of the big crude oil consumers are trying to reduce their demand for crude oil. The US, for example, is trying to increase domestic production, and to make democratic allies out of countries like Iraq, which coincidentally has the world's second largest crude oil reserves. This is not behavior to increase conservation. There is no thought to even trying to use the crude oil more efficiently. The US invests money in technologies of questionable merit, such as Hydrogen cars, but stalls on useful efforts like increasing fuel efficiency or mass transit. There is no though to curtailing crude oil consumption because countries economies depend on it, for plastics and for

transportation. Countries see no reason to prepare for a day when oil is gone because it is so cheap and accessible now.

These new technologies that increase oil production may seem good on the surface, but they do more harm than good. Even their environmental benefits are only good in comparison to worse ways of obtaining oil. The most environmentally beneficial thing would be not to drill for oil at all. Equal money should be put into developing technologies that will help in a fossil fuel-less future that this technology is bringing closer every day. If money is continued to be put into technology to increase oil production, equal money at least ought to be put into developing renewable energy technologies that will prepare for a fossil fuel-less future that this technology is bringing closer every day.

A very nice paper with a good mix of fact and authoritative opinion and personal opinion at the end. By chance, I happened to get in touch recently with my best boyhood friend and next door neighbor, who grew up to be a petroleum geologist. He has a Ph.D. in geology from the University of Wisconsin, worked for Shell Oil Co. and other oil companies for many years, was president of the American Association of Petroleum Geologists in 1999-2000, and presently is president of Thomasson Partner Associates, Inc., an international oil and natural gas exploration company based in Denver. I'm going to send him your paper to see if he will comment on it.

Works Cited

"The Story of Oil in Pennsylvania." Paleontological Research Institution Official Home Page . 2004.
http://www.priweb.org/ed/pgws/history/pennsylvania/pennsylvania2.html

"International Energy Annual" 2001 edition, released in March 2003. Energy Information Administration (DOE) Official Home Page.
http://www.eia.doe.gov/emeu/iea/tableg1.html

US Department of Energy. "Environmental Benefits of Advanced Oil and Gas Exploration and Production Technology". Washington: 1999.
http://www.fossil.energy.gov./programs/oilgas/publications/environmentalbenefits/

"Enhanced Oil Recovery/ CO2 Injection" Office of Fossil Energy (DOE) Official Home Page. 2004.
http://www.fossil.energy.gov/programs/oilgas/eor/