

Unconventional sources are next on E&P radar

OIL AND NATURAL gas prices are presently at levels that make the exploration and development of unconventional hydrocarbon sources economical. Some unconventional hydrocarbon sources are already being developed, including gas shales, tight gas sands, heavy oil (or oil sands) and coalbed methane. These resources are near the bottom of the resource triangle, which depicts the world's oil and natural gas sources from the easiest to find and exploit to the most difficult, which requires a certain commodity price and necessary technology, some of which is yet to be developed.

"The thing about the resource triangle is that you are going to have all of these different kinds of deposits in most geologic basins," said **Dr. Stephen A. Holditch**, Samuel Roberts Noble Foundation Chair and Head of the Harold Vance Department of Petroleum Engineering at **Texas A&M University**.

The US discovered its better reservoirs in the 1940s, '50s and '60s and those reservoirs have been developed, according to Dr. Holditch. "Now we are dipping down in the resource triangle to discover and develop what is left. There is still plenty of development left to do."

One of the problems, however, is the lack of technology necessary to tap into these unconventional hydrocarbon sources such as oil shale and hydrates, and it could be as long as a couple of decades away until the industry has mastered the required technology.

GAS SHALES

About 30% of the natural gas produced in the US comes from tight gas, coalbed methane and gas shales, according to Dr. Holditch. Two of the largest natural gas plays in the US were discovered and developed just within the past few years. The most active area in the US, according to Dr. Holditch, is the Barnett shale play between Fort Worth and Wichita Falls, a gas play with huge reserves that is presently being developed.

Other areas with significant gas shales include the Devonian shale in the

Appalachian basin, which has been producing for the past 60-70 years, according to Dr. Holditch. There are also gas shales being produced in Illinois and Michigan and in the San Juan basin.

These resources are at the lower part of the resource triangle where the industry needs higher prices and better technology in order to develop and produce those

While the world has been producing light oil for the past 120 years, he said, the industry is just now becoming serious about producing the heavy oil.

"There is twice as much heavy oil in the world as light oil," Dr. Holditch, noted, "so there is an enormous resource of heavy oil that is economic right now.

"In fact," Dr. Holditch continued, "heavy oil is economic at prices around \$20 per barrel, which is a breakeven price, perhaps even less, so when the price gets to \$40 or \$50 per barrel it is very economical."

Heavy oil is being produced in several parts of the world, including the US, mainly in California; Canada, Venezuela; and Indonesia. Several areas that could emerge as heavy oil producers include China, with heavy oil resources in

Bohai Bay, Brazil and Russia.

"There are probably heavy oil resources in the Middle East," Dr. Holditch noted, "but there is so much light oil left to be produced there that they are not presently paying attention to those kinds of resources."

OIL SHALE

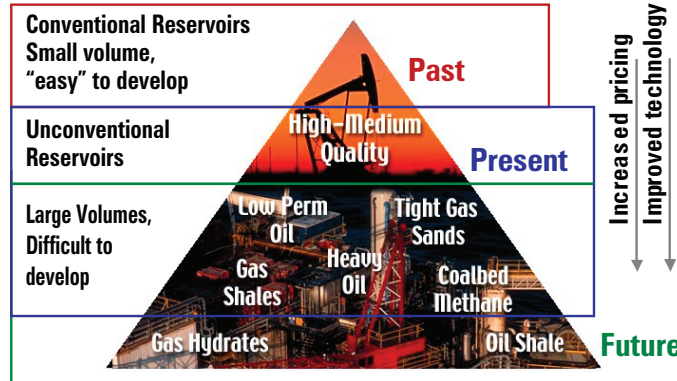
Similar to gas shales, oil shales are rocks that are not very permeable. There is no other way to produce oil shale presently other than to mine it, crush the rock and heat it to remove the oil. There are several issues that make oil shales unattractive presently, including numerous environmental issues.

HYDRATES

Gas hydrates are a mixture of gas and water in low temperature and under pressure that forms an ice. Hydrates are usually found in areas close to the freezing point; however, pressure must be present to form the hydrate.

Areas where gas hydrates are found include the Arctic, Alaska, Canada and Russia in depths from 100 ft to several thousand feet below the surface. Hydrates are also found in deep ocean

Resource Triangle



reserves. "We are already at the higher price aspect of development. What we have been doing is developing better technology that allows us to get this gas out of the ground in the form of horizontal drilling, multilateral drilling and better stimulation methods."

GAS SANDS

The same technology used on high quality reservoirs is used for developing and producing tight gas sands. The primary difference is that more wells have to be drilled in the field to get this gas out of the ground because each well produces less volume than a high permeable well produces. Tight gas sand formations are low porosity, low permeability rocks, and the quality of the reservoir is generally low due to the low permeability.

One of the largest gas plays in the US is the Bossier sand play, a tight gas sand play between Dallas and Houston.

HEAVY OIL

The worldwide oil endowment is generally estimated to contain about 30% light oil, which is being produced today, and about 70% heavy oil, according to Dr. Holditch.

areas including the Gulf of Mexico, the Atlantic and Pacific coasts of the US, and in many other areas of the world such as Japan, India and off South America. They generally exist in water depths of 3,000-4,000 ft.

"The industry is spending a lot of money on research trying to understand where the hydrates exist and how much gas is trapped in the hydrates," Dr Holditch said. "We may produce gas from hydrate deposits but this is something that is maybe 15, 20 or 25 years away."

Rather than mining to produce tight oil sands or gas shale deposits, hydrates will be produced through the wellbore. As the pressure is released from the hydrates, the methane turns back into a gas. If the hydrates were mined, the pressure would decrease and the gas would escape into the atmosphere.

"One of the problems with hydrates is that no one is certain yet how to produce them," Dr Holditch explained. "We don't understand the rocks or the formations that hold the hydrates."

R & D

The US Department of Energy and several US and foreign oil companies have begun research into better understanding the properties of formations that contain gas hydrates.

There are essentially three ways to release the gas from the hydrate. One is to reduce the pressure; second, it can be heated; and third is to use some type of solvent. Any of the three can cause the hydrates to melt.

What the research is aiming at is to determine the proper way to produce the hydrates. "Most people believe that the only way to produce gas hydrates economically is to heat the reservoir," Dr Holditch said. "But we are going to have to figure out how to add the heat to the reservoir."

One possible way is to add steam downhole, similar to how the industry produces heavy oil. In a heavy oil field, steam is injected in the reservoir to reduce the oil's viscosity to a point where it will begin to flow.

With gas hydrates, however, one has to keep in mind the pressure and temperature in the reservoir and what the pressure could be when production begins.

In many cases, according to Dr Holditch, it is physically impossible to reduce the downhole pressure enough for the hydrates to begin melting.

"The only alternative is to use chemicals or heat," Dr Holditch explained. "Logically, although we don't know for certain, heat probably will be the most economic way to achieve this."

Industry research is examining the injection of hot water or steam to heat the reservoir and melt the hydrates. One company is developing downhole catalytic burners that would burn some of the gas downhole to generate heat to melt the hydrates.

"We are still 20 years away from knowing how to do this," Dr Holditch said, "but there is so much gas hydrate in the world that it is really something that has caught a lot of people's attention, including the US government.

"They're asking how the industry can supply our country with energy over the next 20, 30 or 50 years," he continued. "Hydrates may prove to be a source of energy two decades from now that will

be very important to the country."

THE FUTURE

As noted earlier, today's commodity prices, and even prices significantly lower than today's in some cases, make much of the new resources feasible to produce. Prices were high enough in 2003 but many of the oil and gas companies were using their cash and income to shore up their balance sheets and/or to buy back their stock.

"This year, the high prices have continued and the companies have actually dusted off their checkbooks and are beginning to drill more wells," Dr Holditch said.

In addition to oil and gas companies conducting their own research, they have also approached Texas A&M about the research being conducted there.

"I am seeing a lot of companies that are eager to talk with us about the work we do here that might be of benefit to them," Dr Holditch said. "We have a strong effort to increase the amount of research being conducted here." ■