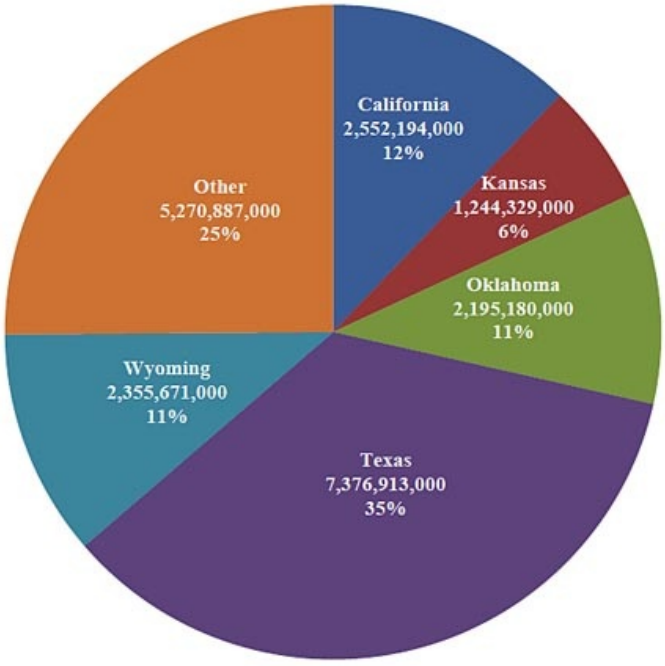
The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Produced Water, GOSPs and Saudi Arabia

Posted by Heading Out on December 20, 2009 - 11:04am
Topic: Supply/Production
Tags: crude oil, gas, tech talk, water [list all tags]

To the uninitiated the thought of a gas or oil well is one where a pipe goes down into the ground, and out of it flows either a steady stream of oil or natural gas, that is fed straight into a pipeline and then delivered to them (often at what they consider to be an outrageous price) with no further treatment. Or the crude oil that comes out runs straight over to a refinery where (with minimum effort and maximum profit) it is transformed into the gasoline or diesel fuel that they must then again buy at great cost in order to drive in to the liquor store to buy some beer.*

The reality of oil and gas production is considerably different, and fluid that comes out of the well is not the ideal that the uninitiated imagines. So today's topic will deal with the initial separation of a couple of the parts. This is a part of a series of tech talks that I write on Sundays about various aspects of fossil fuel production. It is a relatively simplistic explanation which seems to fit most folks needs, though it also has considerable help from those with more technical knowledge who add comments.



Total produced water generated by wells in the United States in 2007 (with top 5 state producers identified) Source Argonne National Labs

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There are three major fluids that come out of a well, and these are gas, crude oil and water. If the well is a natural gas one, the oil component will not be the heavier fractions that we associate with

an oil well, but rather the higher end liquids such as propane and these are referred to as the natural gas liquids (NGL). NGLs include ethane, propane, butane, iso-butane, and natural gasoline. But today I am going to talk about the water.

Back when I first started writing about this separation oilcanboyd was kind enough to point me to the Produced Water Society.

> The Produced Water Society is a collection of engineers and industry professionals with the common purpose to study and improve the separation, treatment, and analysis of Offshore and Onshore Produced Water with the goal to meet the discharge and reinjection requirements of the industry and the environment.

And just to be clear about what Produced Water is:

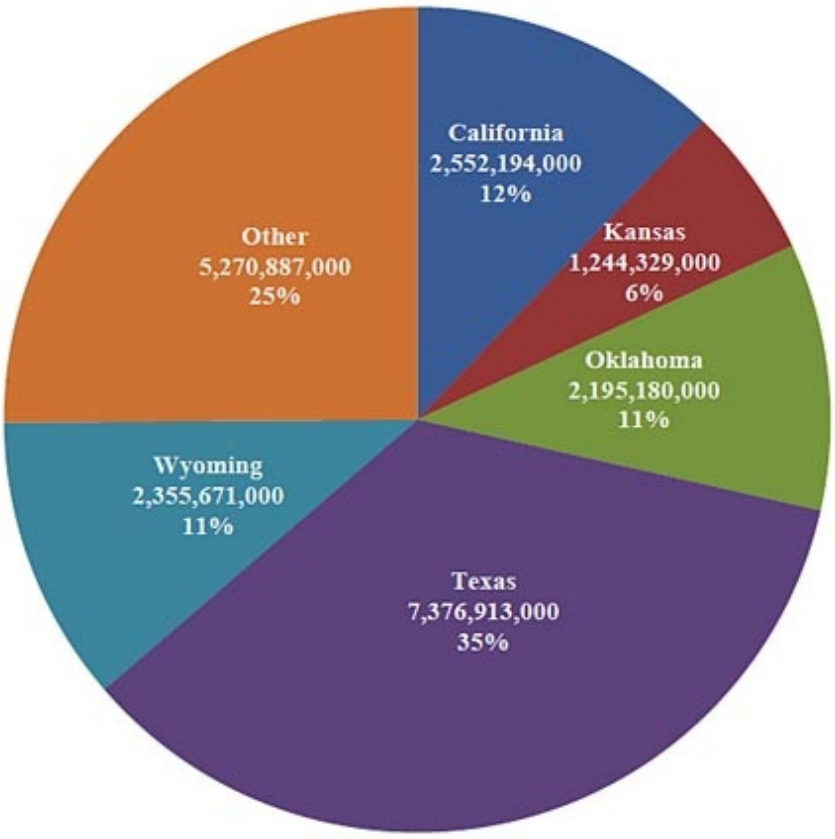
> Produced water is mainly salty water trapped in the reservoir rock and brought up along with oil or gas during production. It can contain very minor amounts of chemicals added downhole during production. These waters exist under high pressures and temperatures, and usually contain oil and metals. . . . . The treatment of produced water is a major component of the cost of producing oil and gas. Wells may start out producing little water but sooner or later all oil wells produce a much larger volume of water than oil. The ability to efficiently and economically dispose of this water is critical to the success in the oil production business.

Back in April 2007, oilcanboyd quoted volume flows for the lower 48 US States as being 4.8 mbd of oil, 128 mbd of brine (the typical term for produced water). His number was considerably higher for the water than that offered by the Argonne report given below, though they admit that their count could be significantly under true values.

The changes in pressure, temperature, and the possible access to oxygen when the water reaches the surface, means that the water can precipitate out dissolved minerals and hydrocarbons such as paraffin, which can plug wells that are being used for disposal,

> 65% of the produced water generated in the US is injected back into the producing formation, 30% into deep saline formations and 5% is discharged to surface waters.

Argonne National Labs recently reviewed the status of this brine, providing not only a review of the process, but also the summary of conditions for each state. They show the relative volumes of water produced, in 2007, by the five largest producing states:



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To try and give some sense of the scale of these numbers they point out that Washington DC and its local communities collectively use some 300 million gallons a day, which is only 13% of the amount of produced water that must be dealt with. The water comes from the roughly 1 million oil and natural gas wells that are still producing in the United States. Texas, while the largest producer of natural gas (6.9 tcf in 2007) lagged offshore in the amount of crude that it produced. The national average amount of water produced per barrel of oil was 7.6 barrels of brine, which produced about 87% of all the produced water developed. The average gas well production was around 270 barrels of water per mcf of natural gas. Some 59% of this is reinjected into the producing formations in onshore facilities (only about 9% offshore) in order to enhance production. These relatively large volumes that must be processed and disposed of can control the economics and life of the operation. As the Argonne report notes:

> early in the life of an oil well, oil production is high and water production is low. As the production age of the well increases, the oil production decreases and the water production increases. When the cost of managing produced water exceeds the profit from selling oil, production is terminated and the well is closed. This is contrary to the typical production cycle of a coal bed methane (CBM) well. Initially CBM wells produce large volumes of water, which decline over time. Methane production is initially low, increases over time to a peak, and then decreases.

Because the US fields are, in the main, much older from a production point of view, than the average well in the total world, the average water flow is higher, and the report estimates that the global value is around 3 barrels of water per barrel of oil.

Because of the high salinity (generally greater than that of seawater) the amount of sodium and salt in the water make it difficult to use for agriculture (which has a very large demand for water in its own right). However in states where the water is reinjected to maintain reservoir pressure even the volumes available may not be enough, and thus one finds, for example in Alaska, that the 842 wells using this EOR used about 1 billion barrels of water in 2007. Given the recent controversy over the disposal of water from the development of the Marcellus shale in New York, it is perhaps interesting to quote the numbers for that state.

> The most recent available report is for 2007. According to the 2007 data, 13,113 wells were reported to the division. Of the total, 7,387 were natural gas wells, 4,874 were oil wells, and the remaining wells were gas storage, dry holes, and solution salt wells. The database provided production volumes of 55,001 Mmcf for natural gas and 377,514 bbl for oil. The state-produced water volume was 649,333 bbl from active wells for 2007, which included 215,050 bbl that were associated with water injection wells.

Handling the water from these wells is thus not a small matter, especially in the larger production fields around the world such as Saudi Arabia. When Aramco decide to increase production from a field, or to add another field to their supply network, they cannot just drill another well, hook it into the line and see their exports increase. Because of the nature of the fluid that actually comes out of the hole, it has to be run, first through a Gas Oil Separation Plant or GOSP. Here the oil, formation water and gas that come out of the well together are separated, so that they can be piped to the different treatment plants. (And as a side point readers might want to look at some of the articles on oil production from Saudi Aramco World since they are written more for a family audience than a technical one.)

These plants are generally rather large--the one in the article treats 450,000 bd of oil--and they take considerable time to build, install and connect up. Thus when new production is planned one has to wait for the plant to be in operation before the wells themselves can be productive. The new addition at Khurais, for example, required a new central processing plant, and when Haradh Stage 3 began, it had to first have the new GOSP in place and running by the second quarter of 2006. Thus the production increments in the country are controlled by the rate at which these can be brought on line. In addition the older ones had to be upgraded, particularly in the controls for the system. (Side comment, though the KSA centralize their GOSPs, they don't have to be that big. We have had an individual well unit hauled through our yard behind an SUV). But we'll talk about them a little more another time.

Putting this all together the oil and gas industry have been handling, without significant public complaint, relatively large volumes of water for a considerable time. The processes are handled through the state agencies (which is where Argonne got much of their information) in a set of processes that seem to be under control.

* across the street, last week.