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Kern River Production Estimates versus What is Economic

Posted by Gail the Actuary on February 12, 2009 - 6:41pm
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I wrote a post a few days ago about my visit to Chevron's Kern River Heavy Oil facility.

This morning, I received an e-mail from Jean Laherrère of ASPO-France with some graphs of historical production and forecasts that he had prepared for Kern River. The e-mail gave permission to post these graphs, if I "found them of value". I thought a separate short post on the subject might be worthwhile, since most readers are no longer looking back at late comments on my original post.

When I compare Laherrère's forecast with what I learned in my visit, it seems to me that the production forecasts developed using linearization are not tied in well with what is actually economic. Unless one makes careful adjustment for economics, it seems to me that this approach could significantly over-state the amount of oil that will ultimately be produced.

Kern River Historical Production, Number of Wells, and Water Cut

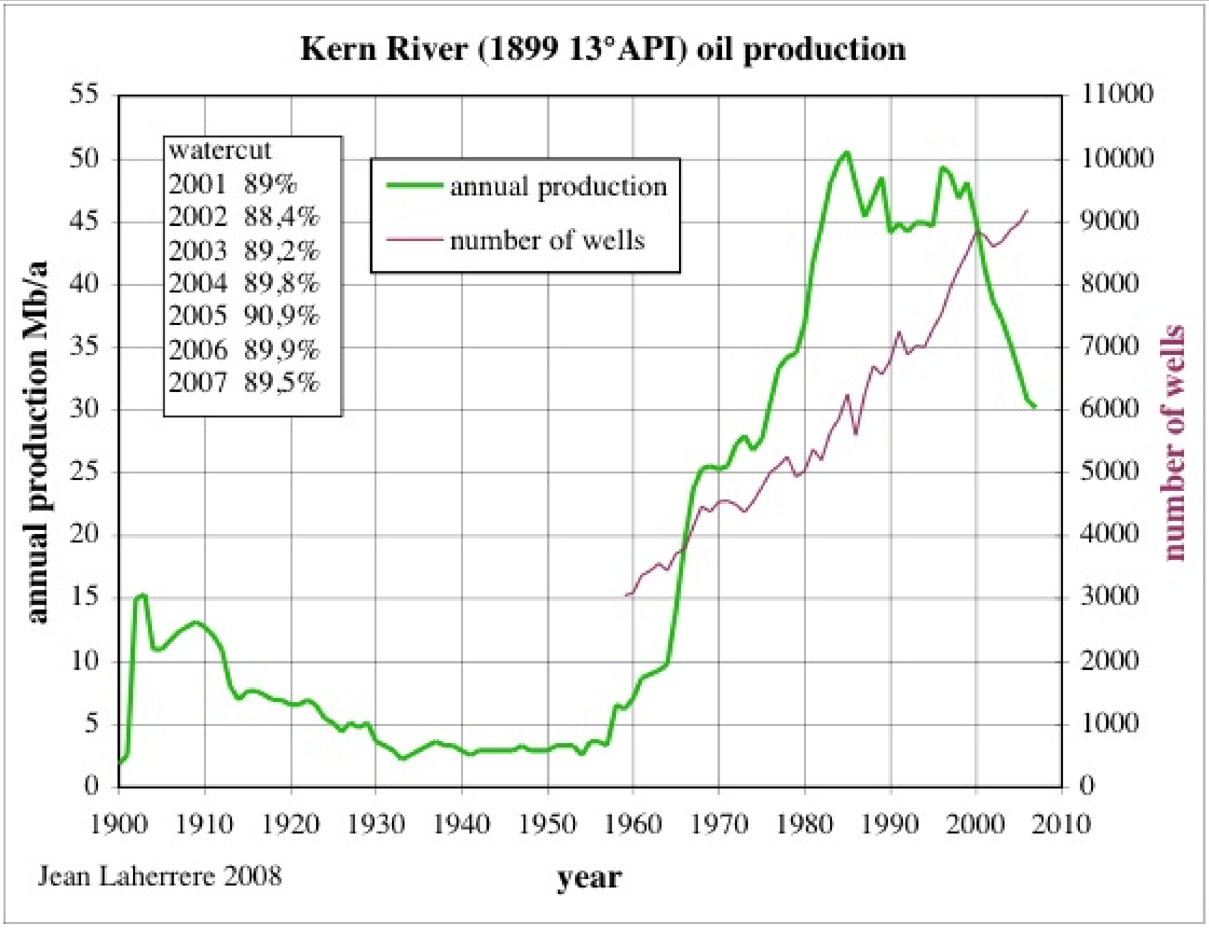

Figure 1. Kern River production, number of wells, and water cut, historical data

In Figure 1, Laherrère displays historical data. Based on the information I was provided on my visit, initial production was done using gravity drainage only. It began to decline almost immediately after production began about 1900.

In the late 1950s, owners began trying to use heat to get more out--first with "bottom hole heaters" and "hot waterflood," and eventually with "steam flood," which produced the burst in production. Since about 1999, production has been declining at about 6% per year. The number of wells in use keeps rising, and the watercut remains fairly constant at about 90%. Laherrère notes that the decline in production is symmetrical with the increase.

Kern River, Annual Production vs Cumulative Production Forecast

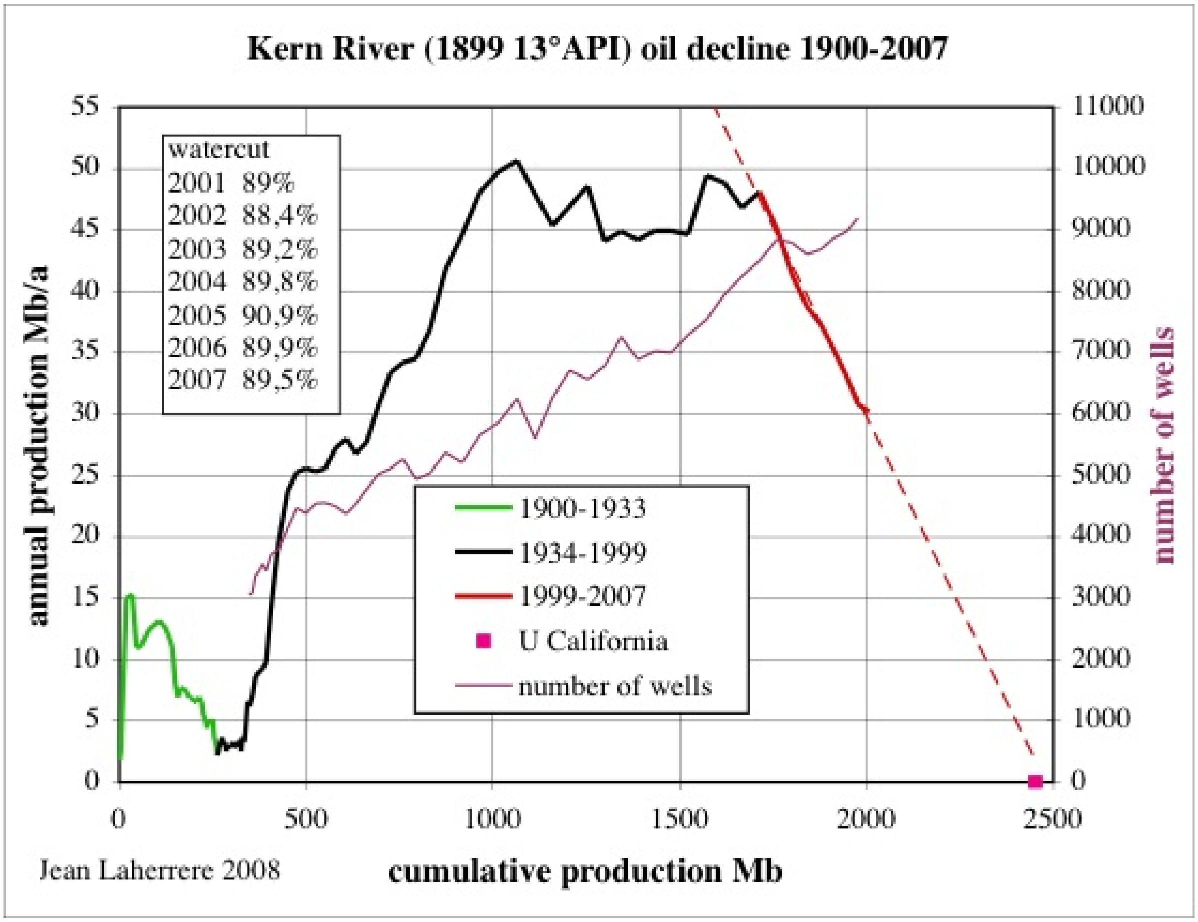

Figure 2. Kern River graph of annual production versus cumulative production with fitted projection of ultimate production

This curve fitting approach shown in Figure 2 is based on the assumption that the logistic curve fits production data. Based on this approach, Laherrère estimates future production will be 450 million barrels (difference between production to date and the point where the fitted line crosses the x-axis), which is in good agreement with a forecast made by the University of California.

Kern River, Expected Future Production by Year

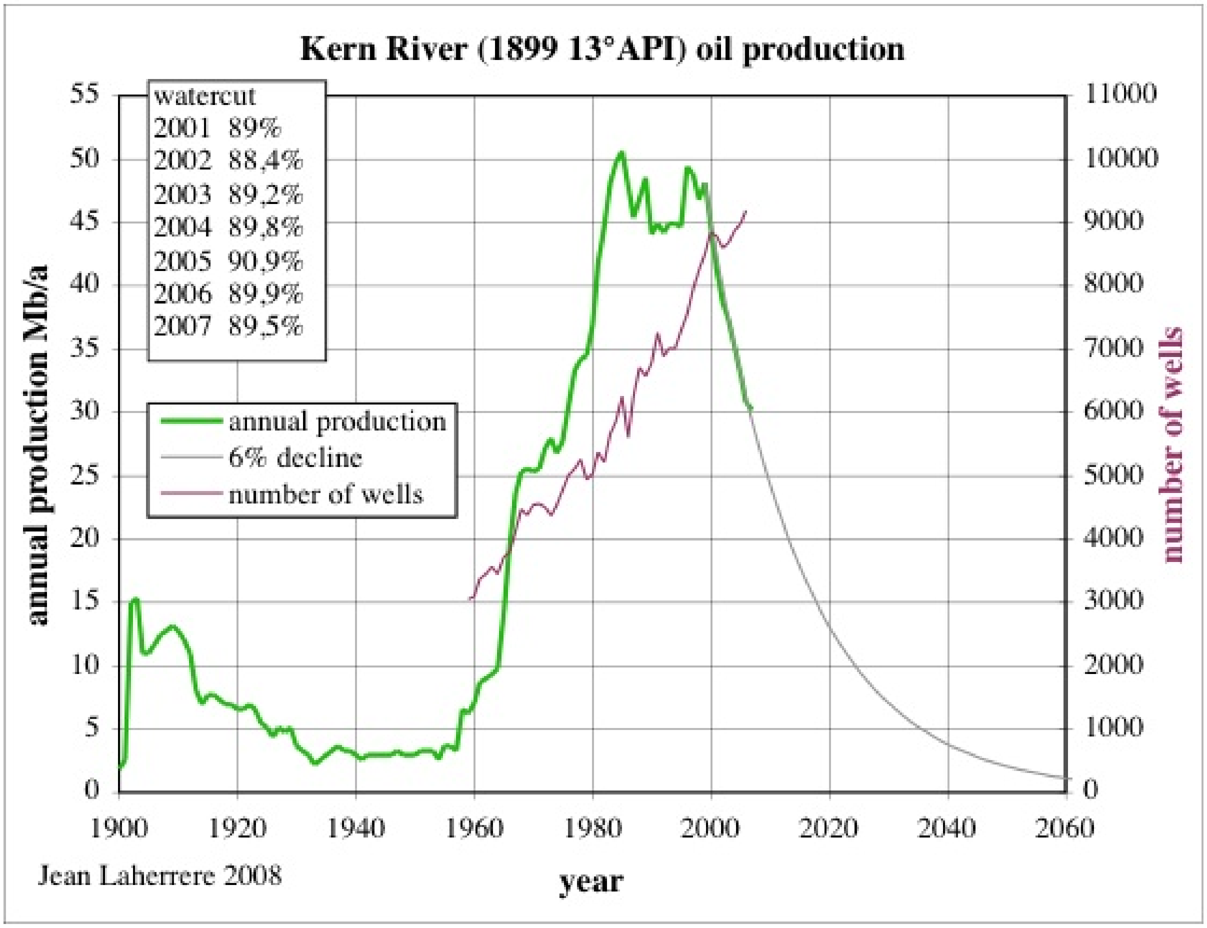

Figure 3. Forecast of future Kern River oil production, based on fitted data

In Laherrère's e-mail to me, he says, "The decline since 1999 is about 6%/a and the remaining 450 Mb can be produced up to 2100 (0,1 Mb/a) but likely economically stopped around 2060 (1 Mb/a)."

My View--Future Production

My view is that if production is declining by 6% per year, it is likely to be economically stopped far sooner than 2060. According to Laherrère, production in 2060 is expected to be 1,000,000 barrels for the entire year, or 2,740 barrels per day. If the number of wells continues to increase by about 200 per year, by 2060 the total number of wells will be about 19,500, and the average production per day per well will be about .14 barrel, or 6 gallons. The number of steam injector wells will need to increase proportionately, since Chevron adds these near groups of about five producer wells, also driving up costs.

It seems to me that Chevron is likely to reach cost constraints relatively soon, if production is dropping at 6% a year, since we saw in my previous post that the cost of producing this kind of heavy oil seems to be quite high relative to the current price available. Even if the price bounces higher again, the recent price drop will make companies less willing to believe the higher prices will last.

I also think at some point Chevron will start hitting bottlenecks. For example, if more and more steam injector wells are placed, one would theoretically need more and more natural gas to produce the steam. How does one talk a natural gas pipeline company into building a bigger pipeline to what is obviously a declining field? How does one justify adding new boilers, if they are fairly expensive?

One consideration Rockman and other readers mentioned in the comments to my previous post was the need to clean-up the site and cap the wells, before the site can be abandoned. This may help to keep the site open longer than otherwise will be the case, but one cannot count on this being the case indefinitely.

In the case of Kern River, I don't see that the forecast using linearization gives much insight as to how much additional production will actually be economic. Has anyone looked at this issue in general? With declining Energy Return on Energy Invested (EROEI), one would expect that at some point there would be a cut off, since it does not make sense to use more energy to produce oil than can be obtained in return.

Cost constraints are likely to limit production in a similar manner to EROEI. Recently, cost constraints may not have been as apparent, because they were masked by the rapidly rising price of oil. Now that the price of oil is lower, and capital is more scarce, we may find that economics play a greater role. Linearization likely produces accurate estimates as long as economics are favorable, but does not seem to give insight as to when economics (and EROEI) will cause production to stop. If we truly want to estimate future production, we may need to overlay linearization estimates with an economic analysis indicating how long production is likely to remain cost-effective.