**Wells Proposal-Oil and Gas Production in California**

Introduction

Oil and gas production in California began in the 1800s. The Geologic Energy Management Division (CalGEM) was created in 1915 by the Legislature to ensure that the development and recovery of energy sources in the region are made safely. According to the organization's information, there are 242,000 wells in the area, with 101,300 classified as active. The organization protects public health, safety, and the environment. It has the power to regulate drilling operations and completely close an oil, gas, or geothermal well. Despite California being one of the top ten producing states in the U.S, the wells' production rates have been declining. This paper will discuss the production rates of various wells in the country and model plans to increase their productivity.

Production Rates

Well, #31 was opened for operations in January 1981. It produced both oil and gas. In the first year, oil and gas extraction ran for 224 days, making 4989 Bbi for oil, 5953 for water, and 1297 Mcf for gas. The production rate lowered with time. In 1990, 447 bbi of oil was produced, which was the lowest since its' opening. The production rose in the years that followed, reaching around 1000 bbi for oil in the late 90s. The rate then went down and increased in 2016 and 2017, where it produced 949 and 658, respectively. The excellent production rate for gas went extremely low in the early 90s. In the year 1995, it made a total of 78 Mcf and gas extraction processes were stopped. The preceding five years produced 116 in 1990, 89 in 1991, 111 in 1992, 51 in 1993, and 54 in 1994. The production rate had spontaneously gone down from an average of 1000 Mcf in the early 80s.

Well, #30 began producing oil and gas in July 1979. It had 4331 bbi of fat and 303 Mcf of gas within 148 days in the first year. In 1987, the annual production rate for gas fell to 6 Mcf, and gas extraction was stopped. The rate came as a declining trend in the gas production rate for the preceding five years. All attention was directed to oil production, which also started to decline from the year 1987. Improvements done on the wells improved the rate until they fell again in 1993, producing an annual production rate of 13 bbi in 1994. The output picked up also until 2011 when the wells seemed to stop making any significant well. For instance, the oil production rate for 2011 stood at 39 bbi. 2012 and 2013 also had low production rates of 12 bbi each. However, the wells improved in the years that followed; by the end of 2017, the production rate stood at 151 bbi. Therefore, the production can be said to have been rising in the most recent years.

Well #43, located in area code 9, ceased producing oil and gas in August 2003. Oil exploration activities on the well began in November 1996, where it had 140 bbi. The years that followed saw a decline in oil production rates that led to its closure. In the five years leading to its closure, it produced 1097 bbi in 1999, 482 bbi in 2000, 1194 bbi in 2001, 348 bbi in 2002, 210 bbi in 2003. The data show a significant drop in oil production rates.

Well # 63 began operations in 1997 as an oil-only source. It produced 596 bbi within 75 days of the first year. The well was temporarily closed in 2003 when the annual production rate had fallen to 266. It was reopened in April 2005, and the production rate rose to 672 bbi within 248 days of extraction. The last five years from 2013 saw a consistent fall in the annual production rates. In 2013, the annual rate was 243 bbi. The rate fell to 1038 bbi in 2013, 876 bbi in 2014, 135 bbiin 2015, 92bbi in 2016, and 95bbi in 2017. Plotting the rates on a graph shows that the production rates of the well are continually dropping.

Well #59 began operations as an oil well in 1997. In the first year, it produced 2306 bbiof oil in 99 days. For the five consecutive years from 2013, the oil production rate was 332bbi in 2013,226 bbi in 2014, 227 bbi in 2015, 190 bbi in 2016, and 71 bbi in 2017. By using the graph, the production rate is dropping. However, the significant drop in the production rate occurred in 2007 when it fell from 1311 bbi in 2006 to 895 in 2007. It never went above 1000 bbi again.

Oil exploration on well #57 began in 1997 and was closed in 2007 when the production rate went extremely low. The fuel produced from the well was oil only. Exploration began with a high oil production rate of 1683 bbi in the first year in 77 days. The well had large oil reservoirs, which saw it produce 7012 bbi in the year 1998. Just like other wells, the production rate started declining. In 2004, the oil production rate went down drastically from 1126 bbi in 2004 to 674 bbi in 2005, 178bbi in 2006, and hit rock bottom in 2007 when the annual production rate became 46 bbi. The well was instantly closed as it only made losses as the cost of production exceeded the revenues. Graphically, the production rate kept going down without a single instance of rising rates.

Well #40 began operations in 1996 as an oil-only source. The annual production rate in the first year was 585bbi, which was achieved in 33 days. The well maintained average production rates until 2006 when it had its first significant drop. The rate dropped from 1038 bbi in 2005 to 564 bbi in 2006. Data available for the last five years leading to 2017 show a decline in the oil production rates. In 2017, the production rate stood at 693 bbi, a rise from 679 in the previous year. Generally, the wells rates were dropping, beginning with a 1089 bbi in 2013, to 715 in 2014 to 802 bbi in 2015.

Well # 66 began operations in 1997, producing 2392 bbi of oil in 188 days.

\well #43 started its operations in 1997 and closed in 2003. It was an oil only well. In the first year, it was produced in 33 days. The rate rose to 4009 bbi in 1997, to 3726bbi in 1998, to 1097 in 1999, 482 bbi in 2000, 1194 bbi in 2001, 348 bbi in 2002, and 210 bbi in 2003. Throughout its production life, the well's rate kept dropping until it was closed when the product could not sustain its operational costs.

Well #38 began oil and gas production in 1982. It hit the highest production rates in its first years in operation. For instance, in the first three years, the rates were 3897 bbi in 1982, 3302 bbi in 1983, and 1138 bbi in 1984. The production rates for both oil and gas kept dropping to insufficient numbers as per the recently available data. In the recent five years, the oil production rates were for 2013, for 2014, for 2015, 2016, and 2017. Gas production rates were

Well # 64 began operations in September 1997 as an oil-producing well. It produced a total of 1942 bbi in the first year. The production rates were high in the following years, too, with the highest being in 1998 when it produced 3153 bbi. The rates declined, and in the last five years, the well has been performing dismally. The production rate for 2013 was 641 bbi, 736 bbi in 2014, 674 bbi in 2015, 566 bbi in 2016, and 575 bbi in 2017. The data shows a drop in production rates each year.

Operations in well #33 kicked off in March 1981, producing both oil and gas. In the first year, the oil production rate was 9530 bbi, while gas was 2479 Mfg. The production rates began declining, notably for gas. The 1995 annual production rate was meager, which prompted its stoppage. It hit the lowest level at 86 Mfg. The oil production rates were also declining even though the well remained still active. The recent five years have seen the production rates go to the lowest levels, with the annual production rate for the year 2017 standing at 224 bbi. It was in the dropping trend with the previous year having 220 bbi, 267 bbi for 2015, 257 bbifor 2014, and 490 bbi for 2013. The rates signify a drop in production rates when plotted in a graph.

Cyclic Steam Injection

Cyclic [*steam injection*](https://www.sciencedirect.com/topics/engineering/steam-injection) is an oil and gas recovery process whereby steam is injected into the wells and oil produced in condensed steam. Extraction is done in a vertical wall process whereby wells are alternatively injected with steam, and large condensates of oil and steam brought to the surface. In essence, steam is injected to create a pressure exceeding the one used in the fracturing process. A soak period follows, after which the fuel production starts. Heated steam functions to warm the heavy oil deposits lowering its viscosity. A heated zone is created through which the heated heavy oil flows back into the well. The process has the advantage that less than 30% can be recovered.

The process can be used in the wells' recovery process in their initial production stages, especially when they contain heavy reservoirs. When used in such extraction, the heated steam functions to thin the oil to easily move through the formation into the production wells (Dong et al. 2019). The cyclic steam stimulation is done at a minimum depth of 1000 feet even though the depth is determinant of overlying formations' type and structure.

The process begins with the injection of high pressure and temperature steams, which are approximately 350 degrees Celsius, into wells. The high pressure is used to fracture the oil sand. The heated steam, on the other side, melts the bitumen. The phase is followed by the soaking period stage whereby the wells are closed to allow steam to heat the producing formation around the wall. As the soaking process is ongoing, the melted material flows into the producing well and is pumped to the surface. While steam soaks into the deposit, the heated material flows to a producing well and is pumped to the surface.

The wells will be given adequate time for heating. The time given may add up to one year. After the heating is done, the wells will be returned into production wells. It will go on until all the heat has been eliminated alongside the produced fluids. The process of soaking and producing will be done continuously until the response becomes marginal as the reservoir will be losing pressure and getting and be producing more water (Kokal& Al-Kaabi, 2010). As this is happening, a continuous flow of steam flood will be initiated to ensure production continuity. When the flooding process starts, some original injection wells will be used for production. More wells may also be drilled to produce more fuel. The process is repeated several cycles in a formation. It takes a maximum of two years to complete one steam stimulation cycle

successfully.

The steam injection technique will be employed to increase the production rates of the wells. As explained above, the process will be done in a cycle. The entire process will be divided into three phases. The first phase will include injecting a high temperature, high-pressure steam into the wells. The second phase will involve leaving the formation to soak. The third phase will include pumping out the well. Artificial lifts will be used to bring heavy oil to the surface.

Other conditions of the plan include the surface measuring of the fluids produced, including water, oil, and gas, to optimize production through artificial lifts and steam injection rates adjustments. Measurements for the downhole fluid-flow requirements will be used in determining the zones in the producing wells that are rich in oil and gas. Observation wells will also be drilled at five hundred meters apart and fitted with sensors for monitoring purposes. Optic-fiber sensors will be the most appropriate for monitoring pressure and temperature in the wells.

Nuclear spectroscopy logs will measure water and steam saturation outside the casing, while electrical imaging will identify oil zones between the observation wells. Cross-well seismic and surface seismic measurements will be used in identifying and monitoring steam fonts. High-temperature equipment withstands up to 300 degrees will also be used (Alvarez & Han, 2013). Some of them include artificial lifts, cement, valves, sensors, and pumps. The only technical challenge during the production will be the high-solution needed for the formation.

The first phase, which includes pumping high temperature and pressure into the wells, will be done for one month. The steam will be heated up to 350 degrees Celsius to warm the heavy and dense crude oil deposits.

The second phase will include soaking where the good wells will be left for two weeks. The phase's significance is to allow heat to diffuse and lower the oil's viscosity to a level that can be pumped.

The third phase includes the pumping of the contents out of the well. The stage will take a duration of up to one year. Pumping of the heavy oil will be done until production exceeds the revenue where the rate will have fallen below economic rates. The whole cycle will have to be repeated for about 15 times to a level where production cannot be recovered.

**Challenges.**

The technique is faced with several challenges. The major technical challenge is concerned with reducing the cost of steam, which is mostly generated using natural gas. Alternative energy sources such as coal and coke will be used to reduce the cost of steam generation. Waste heat will also be used for cogeneration. Moreover, the steam front will be keenly monitored and controlled to ensure that heated steam is concentrated mostly on zones where heavy oil deposits have not been warmed hence economic usage. Likewise, steams directed towards zones that have already been swept will be turned off to reduce energy wastage and save on costs.

The other challenge associated with the technique is gravity override. The challenge affects almost every steam-flood whereby steam breaks through the producing wells and starts a drainage process. A steam chest on the top of the formation expands downward, and the viscous heavy oil begins draining by gravity into the producing wells.

Additionally, there is the risk that the ultimate recovery may be lower than the oil in place in the reservoir. Steam drives will follow the steam injection technique. The combination of the two techniques is effective in raising recovery. Crude oil will be accelerated very quickly, making recovery very high.

Conclusion

In summary, California is one of the leading oils and gas-producing states in the country. It has 101,300 active wells. The production rates for the wells have, however, been declining since the mid-1980s. There are several geological and engineering techniques to increase production rates for oil and gas wells. One of the widely used methods is the steam injection method. The process starts with the injection of steam at high pressure and temperature into the wells. The steam warms up the heavy oil deposits. The wells are left to soak as the hot steam warms the crude oil to make it dense. The heavy oil is then pumped to the surface for refining processes.

References

Alvarez, J., & Han, S. (2013). Current overview of the cyclic steam injection process. *Journal of Petroleum Science Research*, *2*(3).

CalGEM website. Retrieved from: https://www.conservation.ca.gov/calgem/Pages/Oil-and-Gas.aspx

Dong, X., Liu, H., Chen, Z., Wu, K., Lu, N., & Zhang, Q. (2019). Enhanced oil recovery techniques for heavy oil and oil sands reservoirs after steam injection. *Applied Energy*, *239*, 1190-1211.

Kokal, S., & Al-Kaabi, A. (2010). Enhanced oil recovery: challenges & opportunities. *World Petroleum Council: Official Publication*, *64*.