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15/ENG07/029

PETROLEUM ENGINEERING

PTE 512

Thermal Enhanced Oil Recovery

Steam injection is an increasingly common method of extracting heavy crude oil. It is considered an enhanced oil recovery (EOR) method and is the main type of thermal stimulation of oil reservoirs. There are several different forms of the technology, with the two main ones being Cyclic Steam Stimulation and Steam Flooding. Both are most commonly applied to oil reservoirs, which are relatively shallow and which contain crude oils which are very viscous at the temperature of the native underground formation.

Heavy oils are rated below 22.3 API gravity and do not flow easily. Extra-heavy oil and bitumen is rated below 10 API gravity and is heavier than water. To extract this type of oil, an enhanced oil recovery (EOR) method is needed. In this case, a thermal EOR will be sufficient for extracting the hydrocarbons.

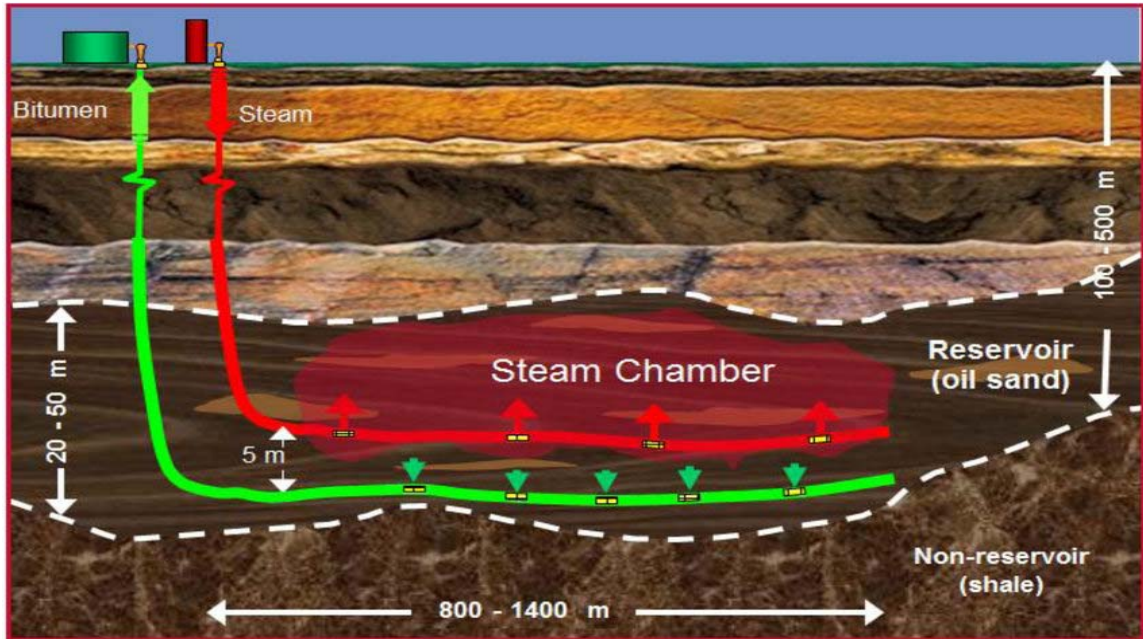
METHODS

1. Steam Assisted Gravity Drainage (SAGD)

This is an enhanced oil recovery technology for producing heavy crude oil and bitumen. It is an advanced form of steam stimulation in which a pair of horizontal wells is drilled into the oil reservoir, one a few metres above the other. High pressure steam is continuously injected into the upper wellbore to heat the oil and reduce its viscosity, causing the heated oil to drain into the lower wellbore, where it is pumped out.

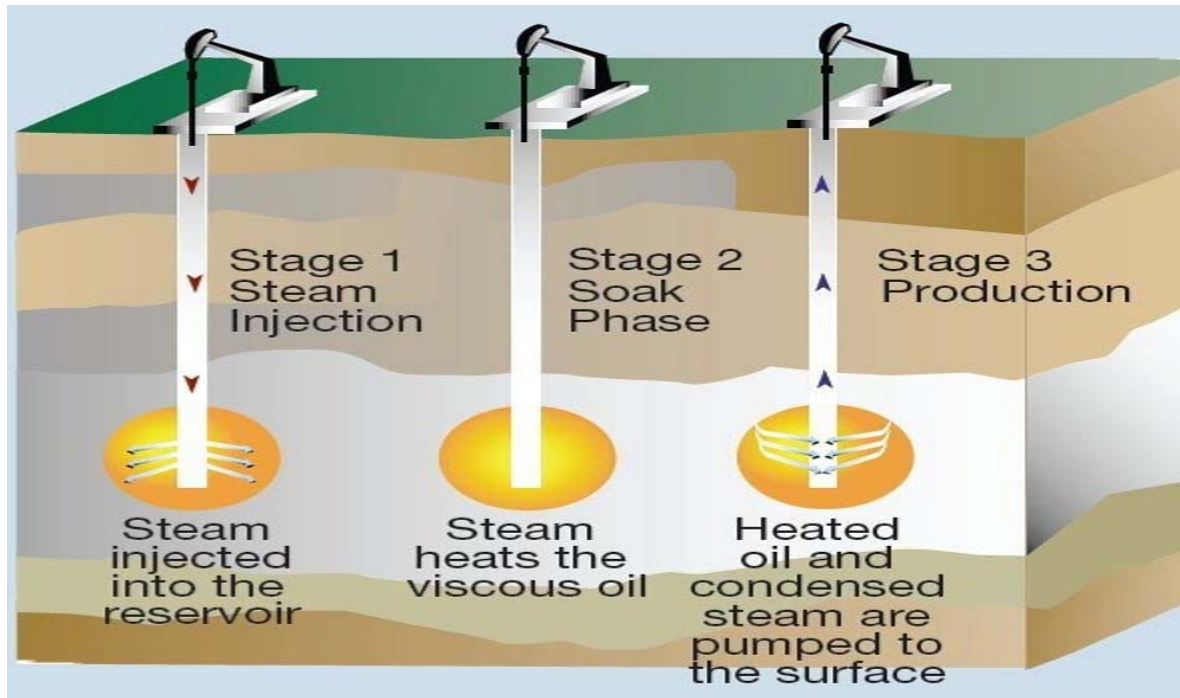
SAGD is also an emerging technology but geared toward bitumen reservoirs. It is more effective than regular steam-flooding methods (15% recovery rate), which are inefficient because they do not permit the bitumen to be exposed long enough to the steam. SAGD, with a recovery rates as high as 70%, uses two wells: one introduces steam into the bitumen, and the other is used for extraction. The injection and production wells are in close proximity to one another and are located at the bottom of the reservoir. With this setup, the

steam chamber expands above the injection well and covers a large area of the reservoir. This allows the temperature inside the steam chamber to remain constant and equal. The desired effect is that the bitumen remains hot as it flows toward the production well. This technique provides longer exposure to the steam and keeps the bitumen flowing, unlike the steam-flooding method.



2. Cyclic Steam Stimulation (CSS)

A method of thermal recovery in which a well is injected with steam and then subsequently put back on production. A cyclic steam-injection process includes three stages. The first stage is injection, during which a slug of steam is introduced into the reservoir. The second stage, or soak phase, requires that the well be shut in for several days to allow uniform heat distribution to thin the oil. Finally, during the third stage, the thinned oil is produced through the same well. The cycle is repeated as long as oil production is profitable. Cyclic steam injection is used extensively in heavy-oil reservoirs, tar sands, and in some cases to improve injectivity prior to steam flood or in situ combustion operations. Cyclic steam injection is also called steam soak or the huff 'n puff (slang) method. The CSS method has the advantage that recovery factors are around 20 to 25% and the disadvantage that the cost to inject steam is high.



3. Hot water flooding

Hot Water Flooding, also known as hot water injection is a technique of increasing crude oil production from a producing well by injecting hot water into the reservoir. The hot water is injected through an injection well which is drilled parallel to the primary producing well. The heat from the hot water acts as a way of reducing the viscosity of crude oil, making it to flow toward the producing well with ease. Hot water flooding is generally used to extract crude oil which has an API degree of less than 20.

Hot water flooding is considered as one of the techniques of increasing crude oil production under Enhanced Oil Recovery Technique (EOR) and thermal recovery. It is less effective than steam injection process, due to the fact that hot water has a lower heat content as compared to steam.

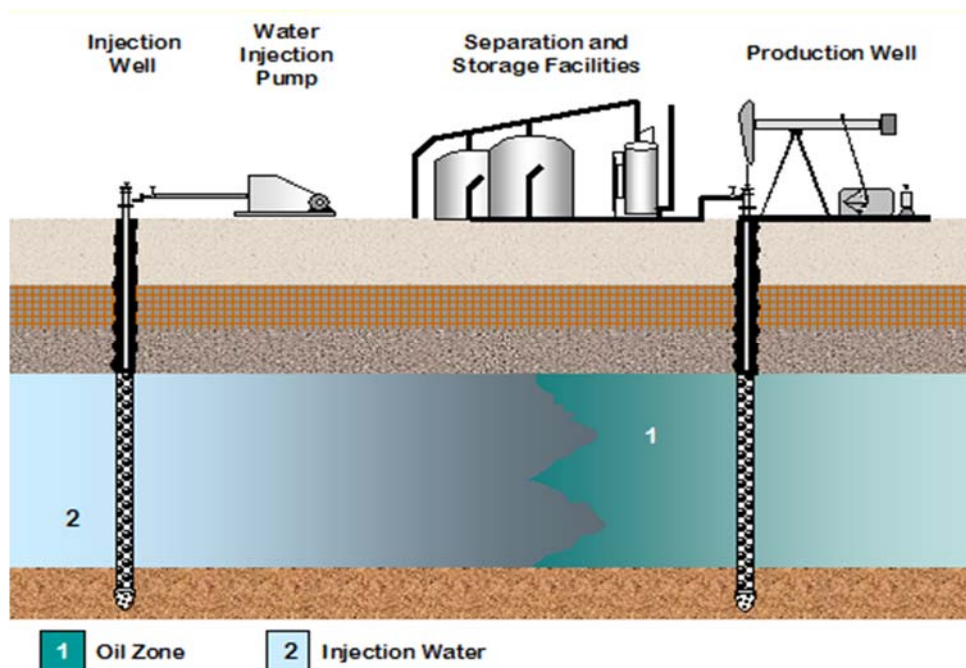
Over time the pressure in an oil reservoir slowly and steadily decreases and as a result the production rate decreases. This is one of the techniques used by E&P organizations to enhance the production of heavy to medium category crude oil from a reservoir. To use this technique, an injection well is drilled parallel to the primary producing well through

which hot water is injected forcefully into the reservoir in the direction of the producing well.

The benefits of injecting water into the reservoir are:

- It supports the reservoir pressure, also known as voidage replacement.
- As oil is lighter than water hence it floats on top of the water. Also, the heat content of the water reduces the viscosity of heavy crude oil, making it not to stick on the edges of the reservoir and move quickly toward the producing well. Thus, water helps in displacing oil from its location in the reservoir and pushes it toward the producing well.

With this technique, oil recovery factor can be increased and well production rate can be maintained for a longer period.



REFERENCES

1. <https://www.petropedia.com/definition/6773/hot-water-flooding>
2. https://www.glossary.oilfield.slb.com/en/Terms/c/cyclic_steam_injection.aspx
3. [https://en.wikipedia.org/wiki/Steam_injection_\(oil_industry\)](https://en.wikipedia.org/wiki/Steam_injection_(oil_industry))
4. https://en.wikipedia.org/wiki/Steam-assisted_gravity_drainage