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Plasma Pulse Technology: An uprising EOR technique

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ABSTRACT

Conventionally oil recovery factor is too low, which leaves great prospects for application of Enhanced Oil Recovery (EOR) methods to increase recovery factor. EOR methods are capital intensive and few are environmentally hazardous. So the paper discusses on the alternate enhanced oil recovery technique which has tremendous potential to curb the challenges of conventional EOR methods. Plasma Pulse Technology (PPT) aided EOR treatment is administered with an electric wireline conveyed Plasma Pulse Generator Tool that is run in the well and positioned alongside the perforations. Using energy stored in the generator's capacitors, a plasma arc is created that emits a tremendous amount of heat and pressure for a fraction of a second. This in turn creates a broad band of hydraulic impulse acoustic waves that are powerful enough to clean perforations and near wellbore damage. These waves continue to resonate deep into the reservoir, exciting the fluid molecules and increasing the reservoirs natural resonance to the degree that it can break larger hydrocarbon molecules to smaller one and simultaneously reducing adhesion tension which results in increased mobility of hydrocarbons. Plasma Pulse Technology has been successfully used on production as well as injection wells. It has been used often as a remedial procedure to increase well's productivity that has been on production for a period of time. This paper throws light on fundamentals of this advancing Plasma Pulse technology, contrasting it with recent EOR techniques. Effectiveness of treatment in increasing oil recovery, it's applicability to different reservoir types and results achieved so far have also been covered in the paper.

1. Introduction

The main reason for "being so wrong" about oil's future availability is the over-reliance on analytical techniques that fail to appreciate petroleum as an economic commodity powered by the constant advance of technology. There is no approximate date of "running out of oil" since there are a lot of factors to take into consideration when it comes to estimating the reserves. By general definition of reserves, they are the discovered accumulations of hydrocarbon which can be legally, economically and technically extractable. It has been observed that prediction models on peak oil production (including Hubbert's theory) do not stand with increasing giant field discoveries adding on to total world reserves. Any forecasts can be done on basis of future production profile, consumption rates and implied ultimate recoverable reserves. All the parameters into consideration are highly variable, so prediction or approximation of running out of oil is very sensitive subject to assumptions considered and still it has extremely high chance of variation (Sorrell et al., 2010). Most important factors that define reserves are: economics and technology. For example consider a field with recovery factor of 30%. Other 70% is not economically profitable or technologically not possible to recover. So when a field is abandoned there is still a lot of oil that can be recovered with more investment and advanced technology. And we have no estimate on how far these two factors can take us in future. Average worldwide recovery factor of conventional oil reserves is somewhere in between 20 and 40% (Muggeridge et al., 2014), although this number is an inference rather than anything particularly evidence-based. Recovery factor can even be as high as 80% depending on type of reservoir, drive mechanism, crude properties technological development and economical investments (Thakur and Rajput, 2011). As graphically summarized in Fig. 1 secondary recovery takes the recovery factor in between 30 and 50% and tertiary or Enhanced Oil Recovery methods raises the number varyingly in range of 50–80% depending on type of method used and reservoir characteristics and compatibility with that method can increase the factor significantly (Stosur et al., 2003). But still for unconventional and horizontal wells effective EOR technology has still not been devised (Goswami et al., 2017). Because if the injection well is vertical, then the effective area will be very small (i.e. the size of well bore diameter) for the displaced/swept hydrocarbon to be produced in case of gas injection, chemical flooding, steam injection or other flooding EOR methods as shown in Fig. 2. Moreover, movement of subsurface fluid because of injection well will be perpendicular to the movement of fluid caused due to drainage by production well. This may lead to displace the fluid parallel to well bore instead of their movement towards the well bore. Hence, the flooding EOR methods are relatively ineffective in horizontal wells as compared to vertical wells. While PPT will make it possible to uniformly decolmatate the entire producing interval of the horizontal well without large expense and time allowing drainage of more reservoir fluids.

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