Feasibility of Reservoir Heating by Electromagnetic Irradiation

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Introduction

Conventional thermal EOR methods, such as fireflooding and steamflooding,are commercially viable when properly applied. Every conventional method hasone or more limitations. If the reservoir is shallow, the reservoir pressuremay be too low to maintain a steam drive. If a reservoir is too deep, wellboreheat losses become excessive. Fireflooding does not have the same depthconstraints as steamflooding, but fireflood success depends on crudecomposition. Each of the conventional thermal methods requires sufficientreservoir transmissibility to achieve fluid injection. EMH has the potentialfor overcoming some of the limitations of conventional thermal methods. Reviewsof EMH techniques have been presented by Baker-Jarvis and Inguva, and Kim.Especially noteworthy as background for derivations presented in later sectionsof this paper was the work by Abernethy. Abernethy coupled paper was the workby Abernethy. Abernethy coupled electromagnetic absorption and fluid flow in aone dimensional radial model of wellbore behavior. He made the simplifyingassumption that heat losses to adjacent formations could be neglected at hislevel of approximation. Later work by McPherson, et al., Hiebert, et al., andKim accounts for more physical effects, but has a corresponding increase incomplexity. Our goal is to present a simple algorithm for estimating thetemperature profile of an irradiated reservoir. The algorithm includes heatlosses to adjacent formations, and is designed to be a tool for determining thefeasibility of heating a reservoir with electromagnetic energy. The EMH processrelies on preferential absorption of electromagnetic energy as the means forincreasing the temperature of a material. Different materials have differentelectromagnetic absorption properties. The ability of an electromagnetic waveto transfer energy to a medium depends on the molecular composition of themedium. Suppose a medium contains mobile molecules with a molecular dipolemoment (such as water). The passing electromagnetic wave will exert a torque onthe polar molecules as their dipole moments try to align with the oscillatingelectric field of the electromagnetic wave. Interaction of an oscillating polarmolecule with its neighbors generates frictional heat and raises thetemperature of the medium. The magnitude of temperature increase of a materialdepends on the amount of electromagnetic energy absorbed by the irradiatedmaterial. Electromagnetic Power attenuation in a porous medium is discussed inSection II. A simple algorithm for estimating the temperature increaseassociated with reservoir irradiation is given in Section III. Applications ofthe algorithm in Section IV illustrate typical sources of input data andalgorithm results. Some hardware considerations are provided in Section V, andnear-wellbore applications arc discussed in Section Vi. Conclusions arepresented in Section VII.

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The electromagnetic heating for oil recovery is based on the transformation of electric energy into thermal energy. It happens through a direct interaction between the electromagnetic field and the electrically sensitive particles of the medium. There are different types of electromagnetic heating and the choice of the heating type depends on factors such as reservoir depth, geological [Show full abstract] heterogeneities, and electrical characteristics of the reservoir constituents. This study was based on reservoirs with characteristics similar to those found in the sedimentary basins of Electromagnetic heating targets part of the reservoir instead of heating the bulk of the reservoir, which means that the targeted area can be heated up more effectively and with lower heat losses than with other thermal methods. Electromagnetic heating is still relatively new and is not widely used as an alternate or addition to traditional thermal recovery methods. Volume 2013

|Article ID 476519 | https://doi.org/10.1155/2013/476519. Albina Mukhametshina, Elena Martynova, "Electromagnetic Heating of Heavy Oil and Bitumen: A Review of Experimental Studies and Field Applications", Journal of Petroleum Engineering, vol. 2013, Article ID 476519, 7 pages, 2013. https://doi.org/10.1155/2013/476519. Show citation. Electromagnetic heating (EMH) can be used instead. This study presents an oil-gas two-phase linear flow EMH model by COMSOL. The model uses the variation in temperature to update the EM absorption coefficient. Special attention is focused on reservoirs with characteristics for which steam injection is not feasible such as low permeability, thin-zone, and extra-heavy oil reservoirs. In the case of reservoir heating there is a wide range of available frequencies in the electrical spectrum that can be used in diverse heating schemes. In ERH, also known as low frequency heating, the heat source is assumed to be inside the production well using a hot pipe, a constant temperature is assumed at the boundary of the well. Electromagnetic Heating of Heavy Oil and Bitumen: A Review of Experimental Studies and Field Applications. For these types of reservoirs, electromagnetic heating is the recommended solution. Electromagnetic heating targets part of the reservoir instead of heating the bulk of the reservoir, which means that the targeted area can be heated up more effectively and with lower heat losses than with other thermal methods. 1. Introduction High-frequency electromagnetic radiation is a relatively new technique for use in enhanced oil recovery methods. It has been tested by theoretic, laboratories and field trial research in Russia [110], the United States [1117], Canada [1821], and other countries [2234]. publisher:"Publisher Name" author:(Smith OR Jones). Feasibility of Reservoir Heating by Electromagnetic Irradiation. He made the simplifyingassumption that heat losses to adjacent formations could be neglected at hislevel of approximation. Later work by McPherson, et al., Hiebert, et al., andKim accounts for more physical effects, but has a corresponding increase incomplexity. Our goal is to present a simple algorithm for estimating thetemperature profile of an irradiated reservoir. The algorithm includes heatlosses to adjacent formations, and is designed to be a tool for determining thefeasibility of heating a reservoir with electromagnetic energy.