Pakistan Journal of Hydrocarbon Research
Vol.5, No.1&2 (January & July 1993), P.77-80, 3 Figs.

Electromagnetic EOR for Heavy Oil Wells of Potwar Region, Pakistan

M. A. Qureshi[1] and Mozaffer Ali Khan[1]

ABSTRACT

Presently Pakistan is producing about sixty five thousand barrels of crude oil per day mostly from reservoirs of Potwar and Badin/Sanghar areas which contribute to nearly one third of our energy needs. Therefore, there is a need to produce as much oil as possible from the known reservoirs. This paper suggests application of Electromagnetic technique for improved recovery from some heavy oil fields in Potwar area.

INTRODUCTION

Heavy crude oil is highly sensitive to temperature. The Electromagnetic technique involves induction of Electromagnetic fields in the zones near the well bore by the action of antenna whereby heating of reservoir fluids occurs through a combination of ohmic and dielectric mechanisms. This technique is feasible for a number of heavy crude oil wells in Potwar area which have either not produced and abandoned or are producing below economic limits.

DISCUSSION

Henry Dracy enunciated that flow rate in porous medium is directly proportional to permeability and inversely proportional to the fluid viscosity. This provides a lead to increase the fluid flow if viscosity of the fluid can be further reduced.

The crude oil viscosity and specific gravity varies significantly from reservoir to reservoir and even from well to well, temperature is by far the most important variable affecting viscosity. Pressure also affects viscosity but in the study area it has minor influence as the dissolved gases are minimum in the wells under study, however, generally at higher pressure viscosity increases and gas oil ratio also plays an important part.

[1] Oil and Gas Development Corporation, Islamabad.

The curve in Figure 1 shows temperature vs. viscosity for two wells of Chakwal Area, in which the change in viscosity is manifold in the order of magnitude over the temperature range. Substituting the value in flow equation, if the viscosity reduces to half the production will be doubled. This requires some more lab. evaluation to avoid any uncertainty in this pertinent data.

The standard way to plot viscosity vs. temperature is on ASTM viscosity vs. temperature chart for liquid petroleum products, which for Newtonian fluid generally yield a straight line. An example of such a plot for free-gas oils at atmospheric pressure is shown at Figure 2, when comparing it to the oil from Chak Naurang Area it comes close to Gulf Coast crude oil and Mid Continent red oil (Braden, 1966). The density is not a strong function of temperature but it is important to mention here that for heavy crude oil the rise in temperature cause density reduction, this is not being discussed in this paper as a thermal simulator computer model can help to study the affects at higher temperatures.

From the above it is concluded that the viscosity reduction by increasing temperature can contribute considerable rise in oil production for the wells like Chak Naurang, Nuryal, Hayal, Turkwal, Dhermond, etc. Most of the geological work has already been done for the wells drilled but there is a need for some geological / reservoir studies of heavy oil bearing formations.

RECOVERY METHODS

Recovery practice in Chak Naurang well no. 1A where sucker rod pumping system is installed has shown considerable increase in oil production. In Chak Naurang well no. 2 surface heating systems are successfully operating. Other methods of lift systems like hydraulic pumping are also in practice in the same area. Sucker rod pumping system is the oldest and widely used method of artificial lift system which can operate over a wide range of wells producing moderate to small quantity from intermediate depths. The sucker rod string and parts of down hole pump and tubing are continuously subjected to fatigue and paraffin scale/sediments from the formation often interrupt the efficient pump operating system. Hydrogen sulfide gas is also a limitation for above option (Clegg, 1981).

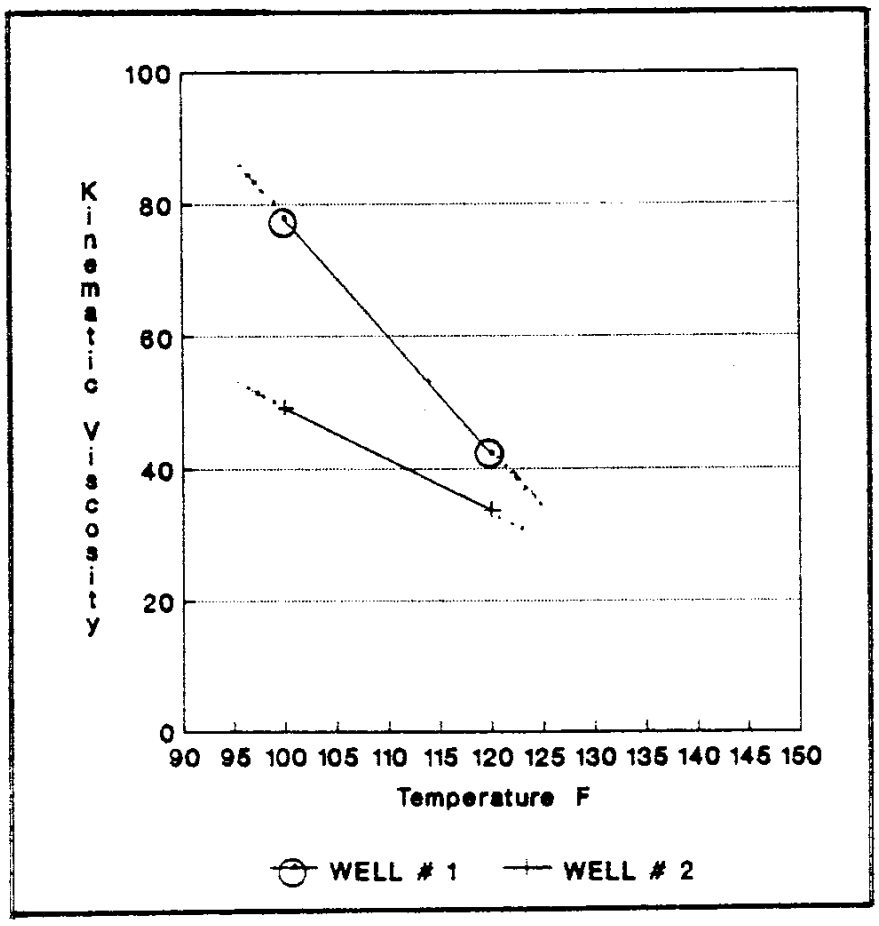

Figure 1– Viscosity vs. temperature for two wells in Chakwal area.

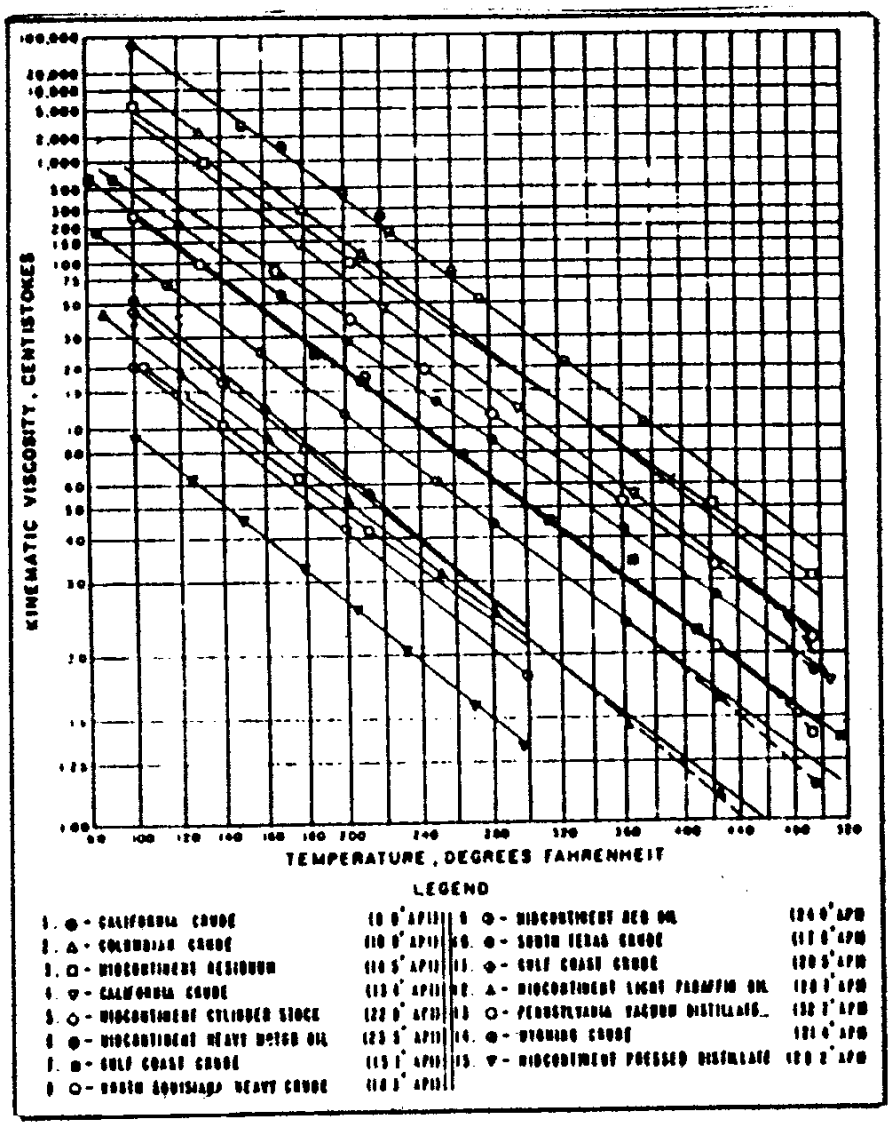

Figure 2– Viscosity of gas-free oils vs. temperature.

Hydraulic pumping system technology is in practice in the area, this is comparatively a new technology to lift fluid from low potential wells or for the production of viscous oils, The system works with the power fluid which is pumped from surface at a higher pressure. To supplement the efficiency of the pump the power fluid can be heated or diluted before pumping depending upon the pump (Jet or Piston) used in the well for lifting oil.

After studying the use of above technologies which are already in practice it is recommended to introduce the technology of down hole electromagnetic heating system which can be applied both at well bore or near well bore region and to the pay zone for the removal of temperature sensitive skin, viscosity reduction and elimination of paraffin deposition in oil wells and hydrate formation in gas wells.

ELECTROMAGNETIC HEATING (RF PROCESS)

The principal application of RF process is to enhance recovery from a single borehole conventional heavy oil well (Spencer, 1987) and assist the fluid flow when it enters the borehole (the flow is impeded by high viscosity or other constituent of the produced fluid). The main area of application is production from those heavy oil wells which otherwise have no attraction of steam stimulation methods (huff & puff).

Figure 3 is a schematic representation of the electromagnetic oil well stimulation process. It is a thermal stimulation process which is analogous to cyclic steam injection, except that the process is continuous instead of cyclic and electromagnetic energy is used instead of steam as the agent to transfer energy from the surface to the reservoir conditions and in which sufficient pressure exists to push the reservoir fluids to the well.

The process is applied by designing the completion of the well in such a way that the production casing and tubing can act as an antenna powered from the surface. It is exactly analogous to a commercial radio antenna tower powered by a surface transmitter with its energy discharge point at the top of the tower. With the process, the antenna is turned upside-down, inserted into a well, and designed such that the energy discharge point transmits the power into the pay zone or pay zones. Multiple pay zones can be heated simultaneously. Electromagnetic fields are induced in the zones near the wellbore by the action of antenna, and heating of the reservoir fluids occurs through a combination of mechanisms (ohmic & dielectric).

Heavy crude oil is sensitive to temperature as discussed earlier and typically a modest increase in the temperature above its neutral occurring reservoir state greatly increases its mobility. If there is a pressure in the

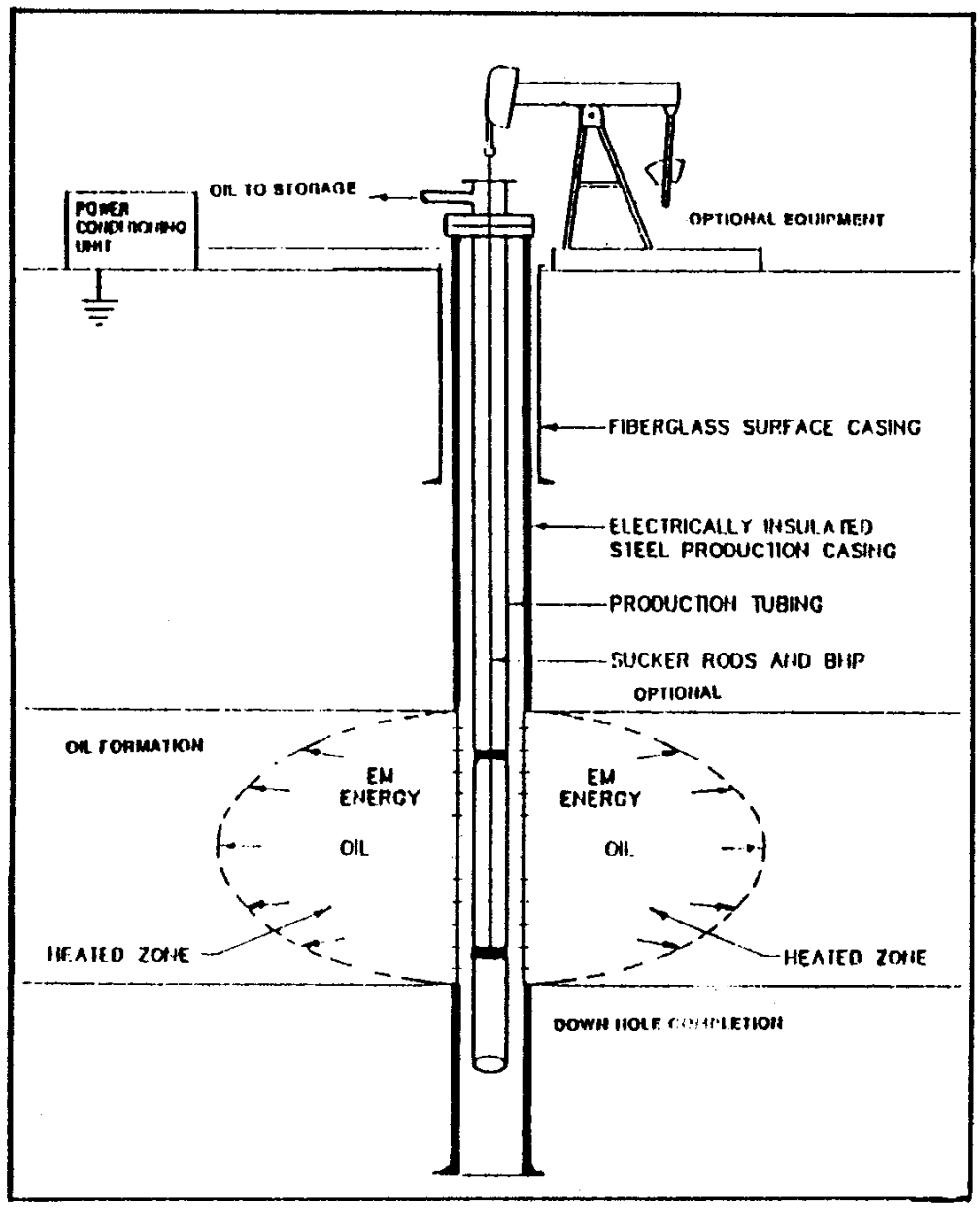

Figure 3– Electromagnetic stimulation for heavy oil wells.

reservoir, localized application of heat near well bore reduces the steep pressure drop around the well bore which also affects other parameters resulting in an overall increase in oil production, this increase can be from 2 to 10 percent depending upon the reservoir characteristics.

The downhole electromagnetic heating system consist of the following major elements.

1. The antenna like applicator or Electromagnetic exciter system.
2. The power delivery system.
3. The wellhead which allows both Em-power delivery and product recovery system.
4. Electromagnetic power source.
5. Surface facilities.

Electromagnetic energy is radiated away from the exciter into the pay zone or as desired in vertical lift system, which radically advances outward with time. This process has many advantages over steam stimulation process in view of clay swelling, thief zones/fault or high permeability loses and above all it is more efficient than cyclic steam stimulation in terms of cost per barrel of recovery. This process can also be used on wells or reservoirs having paraffin problems, in which oil is not necessarily heavy but contains waxy compounds which precipitate around the well bore and restrict the fluid flow. This application is effectively in use in North America.

Another version of the process is the heat production tubing for the elimination of the paraffin deposition during vertical flow in waxy oil wells and hydrate formation in gas wells. Installation of the RF single well stimulation system removes the paraffin deposition by heating as it flows towards the well from the reservoir by maintaining the oil temperature above its saturation point. The RF well stimulation process provides a fundamental and economical solution.

CONCLUSIONS

1. Heavy oil wells in Potwar area which are producing below their economic limits can be the candidates for the electromagnetic methods of recovery. Similarly, those wells which encountered heavy oil shows but did

not produce could be reviewed for application of electromagnetic methods.

2. In case of very old wells the application of electromagnetic methods might be difficult as the re-entry in such wells is generally uneconomical.

REFERENCES

Braden, W.B., 1966 (Nov.), A viscosity-temperature correlation at atmospheric pressure for gas free oils: JPT. AIME-237, p.1487-1490.

Clegg, J., 1981, Selection of Artificial Lift Method: SPE-10337, Dallas, Texas.

Spencer Jr., H.L., 1987, Solution of paraffin deposition problems in oil wells by utilization of the RF single well stimulation process: A publication of Electromagnetic Oil Recovery Ltd., Calgary.