A Study of the Effect of Rock Properties on Oil Recovery by Solution Gas Drive

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Relative permeability characteristics of core samples from twenty sandstone reservoirs were studied in our laboratory. In practically all cases, a trend was observed toward more favorable relative permeability curves (from the point of view of solution gas drive recoveries) with increasing permeability. This trend has also been reported by others in the literature, (1, 2).

An effect of porosity on relative permeability data was also noted in our laroratory studies. Such an effect has not yet been reported in the literature. Although the role of porosity is not generally discernible in a study of relative permeability data for a given reservoir, it becomes apparent when data for sandstone reservoirs of similar lithology but differing average porosity are compared. For instance, in a comparison of argillaceous and/or calcareous sandstones from eleven reservoirs, ranging in average porosities from 13 to 28%, a definite trend was noted indicating that for a given permeability, relative permeability curves become less favorable as porosity increases. A similar trend was observed for a group of relatively clean sandstones from five reservoirs, ranging in average porosities from 15 to 21%.

For a given permeability and porosity, argillaceous and/or calcareous sandstones possess less favorable relative permeability characteristics than comparatively clean sandstones. The laboratory studies also indicated that least favorable relative permeability characteristics are exhibited by shaly sandstone, conglomerate and sandstone containing carbon inclusions.

An explanation was sought why sandstones of differing lithology but identical permeability and porosity exhibit divergent relative permeability curves. To clarify this point, pore size tests were performed by a mercury injection technique (3). It was found that in the relatively clean sandstones, the larger pores were grouped in a narrow range, giving a sharp peak in the pore size distribution curve. This sharp peak was generally absent in the types of sandstones exhibiting less favorable relative permeability characteristics.

The probable effect of pore size distribution in solution gas drive recoveries may be explained as follows: Solution gas tends to sweep oil first from the largest pores. This is followed by oil removal from progressively smaller pores. Resistance to flow, however, increases exponentially with decreasing pore size. While the smaller pores are being swept, much of the gas still prefers to travel the path of least resistance, i. e., through the depleted larger pore channels, thereby leading to a gross inefficiency in the oil recovery mechanism. This inefficiency becomes minimized if the larger pores are grouped in a narrow range.

It is concluded that lithology, permeability and porosity play important roles in oil recovery by solution gas drive. Closely interrelated with these factors is the distribution of pore sizes in the reservoir rock. A study of pore size distributions will, in many cases, contribute greatly to a better understanding of oil recovery mechanisms.

LITERATURE CITED

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