RESERVOIR EVALUATION AND REPORTS

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Introduction
Oil is where you find it, and after you have found it you must bring it to market—success of the “factory”—the reservoir—which you cannot touch or even see. Furthermore, the operator will have to manage his “factory” by remote control, using to best advantage the limited information gained by analysis of currently available reservoir data. If the operator, with his engineer and geologist, takes advantage of technical knowledge and modern production methods, he is often rewarded richly by a higher than average recovery of the oil originally in place under his property.

The work of the valuation engineer or valuation geologist includes that of a technologist and an economist since he is concerned not only with the application of science but also with the economic success of technical operations. If he is to serve management well or look forward to assuming an executive position it behooves him to be alert to the economics of his recommendations.

After discovering oil the operator is immediately confronted with at least two problems, (1) estimating the amount of producible oil and its value so plans can be made for further development and perhaps necessary financing, and (2) deciding on the best method of producing his oil so he may obtain the highest net return. This means determining as promptly as possible the characteristics of the reservoir, the primary source of reservoir energy, the extent of the reservoir and the kind of trap in which the oil has accumulated. Other considerations include the advisability of certain spacing patterns, unitization and pressure maintenance instead of a period of “primary” production followed by “secondary” production.

The operator who makes an effort to obtain as much data as possible regarding his wells at the time of completion and periodically thereafter, is in a much better position to evaluate his leases than is the operator who ignores technical data.

Gas-oil ratio tests, bottom-hole pressure tests and determination of the productivity index (PI), in addition to core analyses and the various electrical logs, are useful in reservoir evaluation. If taken periodically for comparison, tests permit continuing close examination of reservoir performance.

Reservoir Mechanics
Oil and gas deposits occur in the pore spaces between the grains or particles of various kinds of rock as does water that has been poured into a jar or pan when it was first completely filled with marbles, crushed rock or sand. The problem is to recover as much of this oil and gas as possible.

Since oil has no inherent energy some natural or artificial source of energy is required for moving it to the well bore and helping it up to the surface of the ground. There are a number of sources of reservoir energy which move oil into the well, (1) gas dissolved in the oil, (2) free gas-cap, (3) water pressure, (4) gravity and (5) the elastically compressed rock in which the oil is trapped.

Reservoirs may be broadly classified to reflect the principal source of their energy as (1) solution-gas expansion reservoirs; (2) combination solution-gas expansion, gas-cap expansion and gravity-drainage reservoirs; and (3) water-drive reservoirs. Several kinds of energy may be available in the same pool and often it is difficult to separate them, especially in the early stages of development. Amount of ultimate recovery depends largely upon early recognition of the source of energy, proper well completions, restrictions of gas-oil and water-oil ratios and efficient rates of production.

Competitive production, with resulting loss of gas and reservoir energy, instead of unit operations with pressure maintenance, has been responsible for leaving much oil in the ground. Some of it will be recovered through secondary recovery operations which provide new energy for pushing the oil to the well bore. The trend toward unit operations and pressure maintenance is a scientifically well founded effort towards reducing expenses resulting from producing a pool through long years of stripper production and then belatedly incurring the expense of secondary operations. By beginning secondary recovery methods during primary production the original reservoir energy may be maintained at a relatively high level; also, gravity separation and the formation of a secondary gas cap may be minimized. In view of increasing production costs and the continuing threat of price cuts because of imports, it appears that conservation of reservoir energy by pressure maintenance offers a real opportunity for reducing costs and increasing ultimate recovery. The production of oil from high gas-oil ratio wells and the wasteful flaring of gas is a glaring economic waste the industry can ill afford to continue. There are, of course, other less obvious wastes which also increase the cost of delivering a barrel of oil to market.

If imports continue to place a ceiling on the price of oil while costs go up, operators will become increasingly aware of their narrowing profit margin and the low-cost producer will be in the most favorable financial position. Early evaluation of a reservoir and planning of the most efficient method of operation is indeed a challenge to the engineer and geologist.

Methods of Estimating Oil Reserves
Estimating oil and gas reserves and periodically checking and revising them is an accepted practice in the oil and gas business and is comparable to the periodic accounting of other assets in any well-managed organization.

There are a number of methods of estimating oil reserves, including one which indicates the probable rate of future production. Estimates are made (1) by volumetric determinations in which the pore-volume is calculated and a factor of recovery is assumed, (2) by extrapolation of various curves, (3) by comparison with an older supposedly similar pool or property and (4) by the “material-balance” method. Volumetric calculations and the rate vs. time decline curve are the two methods in general use.

The volumetric method is probably as old as the oil business, however, its accuracy has undoubtedly improved with the development of better techniques for determining reservoir characteristics. The standard volumetric formula, while generally accepted, leaves much to be desired and the appraiser must use judgment in applying it to a given pool or property. A formula can at best be only as good as the data used and the assumptions made. If the data are correct the estimate of reserves in place will be fairly accurate, however, the estimated recovery factor may be wrong because recovery is dependent upon many conditions beyond the control of the appraiser. For example, the degree of reservoir energy conservation practiced by the operators and the price of oil may have a direct bearing on the amount that will be recovered.

Other assumptions involved in the volumetric method are the uniformity