

6751
Memorandum M-1121

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SUBJECT: BI-WEEKLY REPORT, Project 6751, October 30, 1950

To: J. W. Forrester

1.0 GENERAL
(J. D. Porter)

While awaiting Dr. J. von Neumann's more recent report (May, 1950) on the oil production problem, I have been studying the one he wrote as his second report in July-August, 1948. The equations involved in the 1948 report (and presumably also in the 1950 report) may conveniently be considered as a set of four, two of which apply to the liquid phase and two to the gas phase. In each pair, one equation expresses Darcy's law (a sort of Ohm's law for fluid dynamics) and the other the material balance (the conservation of matter).

These equations describe the so-called IP (linear production) case which describes those cases where a dominant direction of flow through the entire oil field can be defined. If we let x be the coordinate along this dominant direction and let t denote the time, then the four equations can be combined to give two quasilinear partial differential equations of the second order in the independent variables x and t with two dependent variables p (the reservoir pressure) and s (the saturation of the pore-volume with the liquid phase). By setting up a lattice (integration net) in the x, t -plane, Dr. von Neumann is then able to describe a procedure for obtaining solutions of these equations under suitable boundary conditions. From these solutions the flow velocities (expressed in volume units per unit time per unit cross-sectional area) can then be determined for the liquid and gas phases. A count of the number of operations involved in the numerical procedure is given assuming the use of the SSCC. If a 25×120 net is assumed, an estimated 13.3 hours computing time would be required.

The procedure given in the 1948 report determines the "leading" $(\frac{\partial}{\partial x})$ terms "implicitly" (i. e. by interpolation) and treats the other terms "explicitly" (i. e. by extrapolation). According to F. E. Swain's report (referred to previously in M-1115), Dr. von Neumann's new analysis differs from that given in his second report by replacing the implicit steps by explicit ones.