

AN INVESTIGATION OF PRODUCTIVITY AND PRESSURE DECLINE TRENDS IN GEOTHERMAL STEAM RESERVOIRS

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ABSTRACT

This paper derives the relation between productivity and pressure decline trends in a geothermal steam reservoir. At all stages of a geothermal project, the economics is affected by the rate of productivity decline. The rate of pressure decline becomes a critical issue when the reservoir pressure declines to the point that wells have to be flowed wide open to supply the turbine; at that stage, maintaining reservoir pressure and well productivity by redistribution and/or augmentation of injection becomes a strategic issue in field management. Therefore, the issues considered in this paper have significant practical implications.

The decline rate (D) in the productivity of a steam well (normalized for a constant flowing wellhead pressure) and the decline rate in static wellhead pressure is shown to be related by a simple equation derived from standard the gas deliverability equation. The application of this equation is verified against the productivity and pressure decline data from wells at The Geysers steam field in California. Wells in steam reservoirs usually show harmonic decline in productivity (that is, the decline rate in productivity declines with time).

Another simple equation has been derived relating the initial harmonic decline rate of a steam well and the decline rate in static wellhead pressure at any time. It is further shown that if the productivity decline rate is constant over a period, a plot of the difference between the squares of the static wellhead pressure and the normalizing pressure on log scale versus time yields a linear trend over the period, the slope of the trend being equal to D/n , where n is the "turbulence factor" of the well (between 0.5 and 1.0). This equation is verified against data from steam wells at The Geysers.

Estimating the productivity decline rate from the static wellhead pressure decline rate using the above approach avoids the need for normalizing the production history of the well and is independent of the productivity index of the well or wells involved.

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