AN INVESTIGATION OF SCREENING GEOTHERMAL PRODUCTION WELLS FROM EFFECTS OF REINJECTION

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Reinjection of used geothermal liquids into the producing reservoir has been proposed by several investigators as an effective way to avoid disposal problems and to reduce the possibility of land subsidence in the reservoir area.

However, after a length of time, the reinjectoon water will break through at the production well, which will no longer be able to maintain its original temperature. Gringarten and Sauty[1] have developed a simple steady-state model to study such a system of many production and injection wells, capable of calculating the temperature decrease as functions of time. The present paper describes a possibility of retarding the breakthrough time and reducing the temperature drop by means of screening wells.

The basic physical idea is as follows. Consider a doublet of one production and one injection well. Streamlines will go from the injection to the production well. The earliest streamlines that reach the production well will correspond to those close to the straight line leading from the injection to the production well. Now if we have an extra screening well on this line in between the two wells, which extracts fluid and puts it back into the injection well, then these earliest streamlines will be "picked up" by the screening well and prevented from arriving at the production well. In this way, not only is the breakthrough time increased, but also the rate of temperature drop is reduced. Besides the temperature difference of the reinjected water and the reservoir, two dimensionless parameters enter into the problem, the rate of extraction of the screening well relative to that of the production well, y, and the position of the screening well, CY, defined as the distance of screening well from the production well divided by the separation of the doublet. It is easy to see that the screening effect will' increased with an increase of γ and a decrease of *a*.

We have calculated the breakthrough time as a function of a and y, with α ranging from 0.1 to 0.9 and y from 0 to 1.5, and we found that it is possible to increase the breakthrough time by as much as a factor of 2 in certain cases. Hence, given a case of a doublet whose breakthrough time is 20 years, it is possible to place a screening well of appropriate flow rate such that the production temperature is not affected at all for 40 years.

It is easy to extend the problem to include effects of the natural areal flow in the reservoir. We consider a case that Gringarten and Sauty studied, in which they looked at the possibility of siting a doublet in a heavily-built area for space heating and cooling. There is a strong areal flow and by placing the injection well downstream, they found that there will be no interflow (i.e., infinite breakthrough time) if the two wells are placed 965 meters apart. But the maximum practical separation is only 300 meters in the direction of areal flow. Thus they have to employ other techniques. However, by our calculations with a separation of 300 meters, we found that it is possible to obtain zero interflow with the production well by placing a screening well 90 meters from the producing well with a flow rate 1.4 times the producing rate.

Further calculations are made on the steady-state flow model of Gringarten and Sauty to study the temperature decrease rate for systems with screening wells. Not only are we able to calculate the streamlines and thermal fronts, but the temperatures at the wells as a function of time are calculated. Figure 1 illustrates a simple example of a doublet with and without the screening well. It can be seen from the top half of the figure that the effect of the screening well is to intercept the streamlines, thus pulling the thermal fronts toward it. The lower half of the figure illustrates the temperature curves. The energy extracted is proportional to the flow-rate times the area under these curves above a certain given temperature below which the water will not be useful. To make a comparison which is somewhat meaningful, we take a case of a doublet without screening in which the production and reinjection rates are each 2Q, to be comparedl with a case with screening in which the production and screening wells are each at a flow-rate Q and the injection at 2Q. It is found that the accumulative extracted energy of the system with the screening well (for $\gamma = 1$ and $\alpha = 0.1$) after 50, 100 and ∞ years are respectively 1.6, 2.0, and 4.8 times larger than that for the unscreened system.

We have also made calculations on the same model for a system of many production and reinjection wells with screening wells in between. A gain in the energy extracted is also obtained, but the amount depends on the distribution of wells in each given case.

In conclusion, we believe that a retardation of breakthrough time and a reduct on of the rate of temperature drop at the production well can be obtained by means of an (extraction) screening well. In our calculations, we found that a very significant factor in energy gained can be realized. However, we have not yet made a detailed economic feasibility study taking into consideration the expenses of digging the extra screening well. Initial discussions indicate that with certain arrangements and parameters, such screened systems may have significant economic advantages.

Reference

[1] A. C. Gringarten, J. T. Sauty, to be published in the Journal of Geophysical Research (1975).

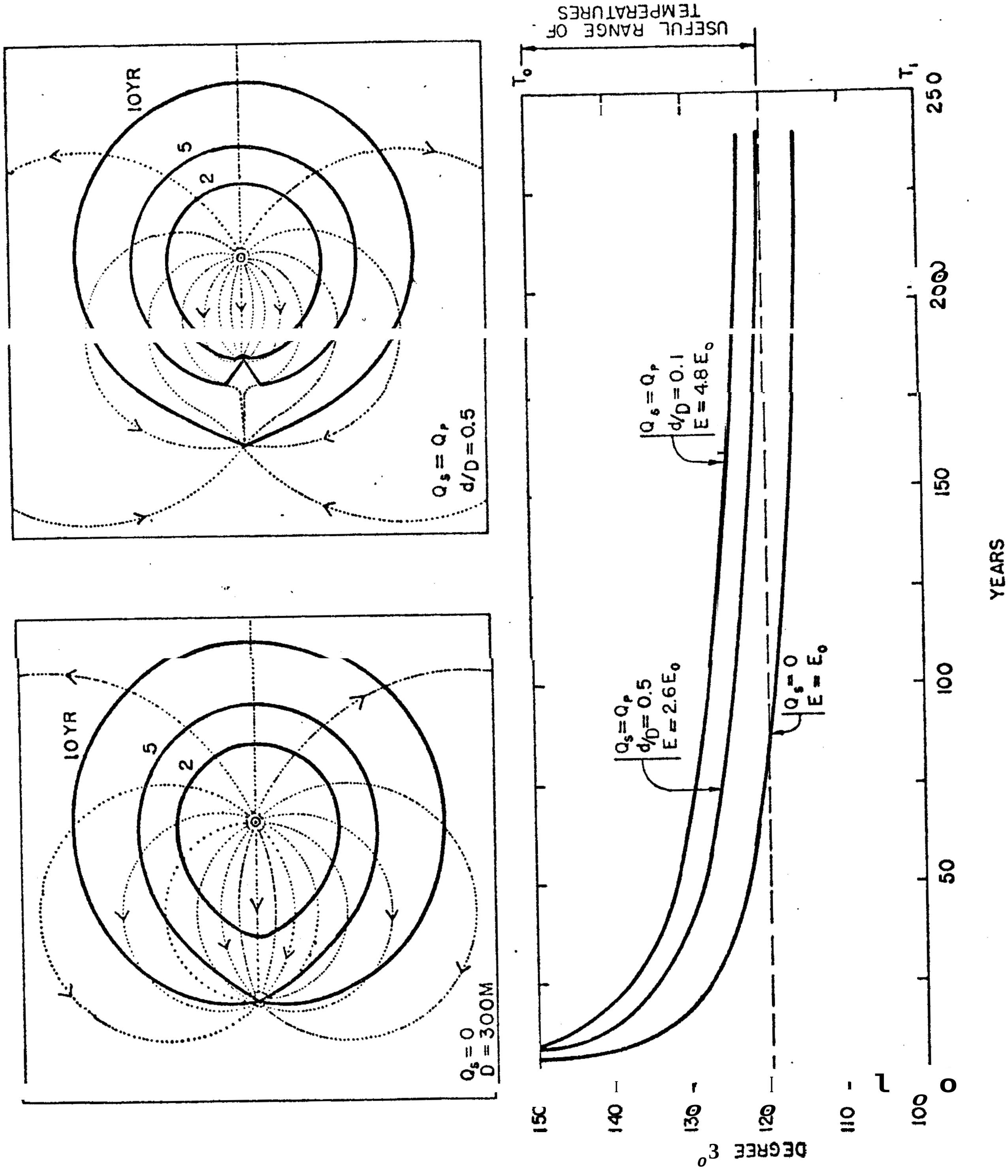

Figure 1. The top half of the figure indicates the streamlines (dotted lines) and the thermal fronts (solid lines) of the doublet system with and without screening. The lower half shows the temperature at the production well as a function of time in three cases, (a) no screening well, (b) screening well half-way between production and injection wells at a flow rate equal to production, and (c) same as (b) but with screening well at 1/10 the separation distance from the production well.