ГЕОЛОГИЯ, ГОРНОЕ И НЕФТЕГАЗОВОЕ ДЕЛО (ДОКЛАДЫ НА АНГЛИЙСКОМ И НЕМЕЦКОМ ЯЗЫКАХ)

THE USE OF MODIFIED DYKSTRA-PARSONS COEFFICIENT TO ALLOW THE INFLUENCE OF NATURAL FRACTURING IN SIMULATION MODELS FOR THE OPTIMAL DEVELOPMENT STRATEGY SELECTION

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Since oil production is declining in West-Siberian sedimentary basin what brings the most important contribution to oil production from clastic reservoirs in the Russian Federation. Other oil and gas provinces with prevalent portion of reserves in carbonate reservoirs seem to be attractive. They are Volga-Ural, Timano-Pechora, Precaspian and East-Siberian provinces. Now companies are aimed to develop untouched parts of these provinces what leads to the necessity of detailed estimation of fields with carbonate reservoirs. [1]

The decent modelling of such objects requires the implementation of more complex relationships in models to allow the double-permeability medium, what is labor-intensive. That is why the requirement of simple methods of double-filtering modelling arises when analytical techniques may be valuable. [2]

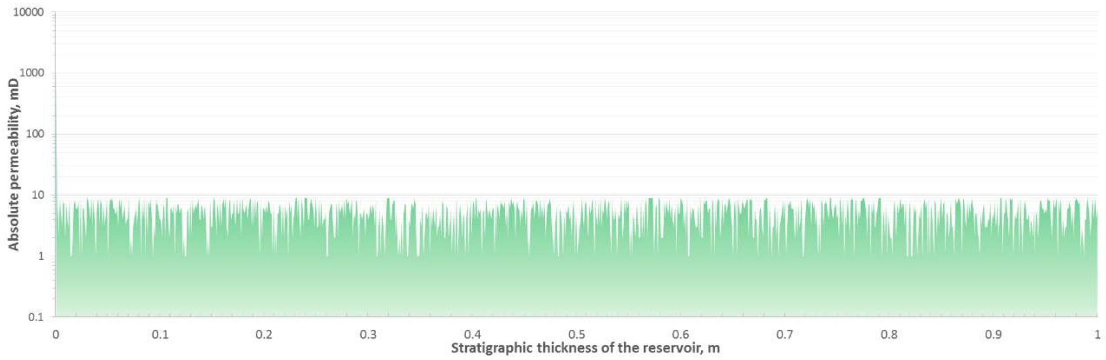
The applicability of modified Dykstra-Parsons coefficient was estimated in the work if it may help to allow the influence of fractures in two-dimensional simulation of a synthetic development element of 5-spot well template.

First, it is necessary to obtain the modified coefficient (Vdp) which may be obtained by calculation on permeability profile with open fractures. Thus, it is necessary to assess the density of natural fractures per thickness unit (Dn). If a real field is analyzed, density may be found from the image log. However, for the synthetic medium used in the work density is equal to 50 fractures per meter with 0.001m fracture opening (δ). The linear velocity of filtration in a fracture may be calculated with the use of Boussinesq equation, which gives the ability to calculate the absolute permeability of a fracture if combined with Darcy's equation:

$$k_f = \frac{\emptyset_f \cdot \delta^2}{12} = \frac{Dn \cdot \delta^3}{12} = 4.17\ D, \qquad where\ \emptyset_f = 0.05$$

Therefore, permeability profile per meter with and without fractures looks like in the Figure 1.

a) permeability profile of porous medium



b) integral permeability profile with fractures

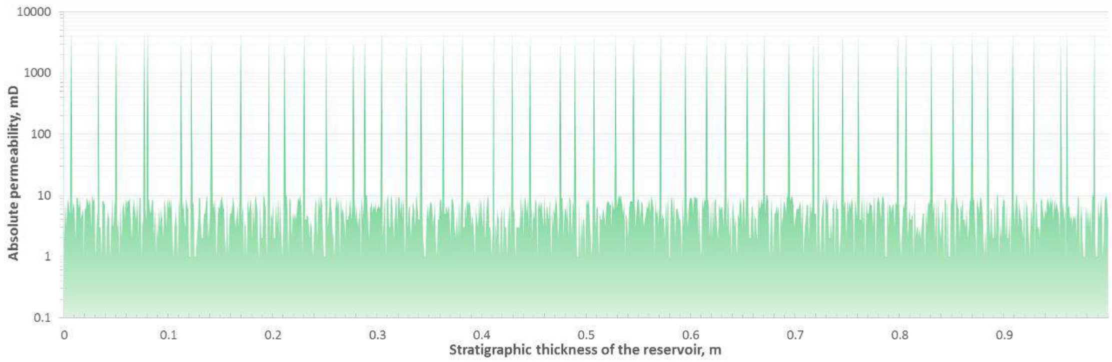


Fig.1 Permeability profile per meter

The permeability profiles are used to obtain the Dykstra-Parsons coefficients as:

$$V_{dp} = \frac{k_{0.5} - k_{0.841}}{k_{0.5}} = 0.6$$

$$V_{dp\_M} = \frac{k_{0.5\_M} - k_{0.841\_M}}{k_{0.5\_M}} = 0.667$$

Constructed relative permeability by natural and modified Dykstra-Parsons coefficients normalized by phase permeability is shown in Figure 2. End-points are set as typical for the carbonate oil-wet rock (Swc = 0.1, Sor = 0.15, krw' = 1 and kwo'=0.9).

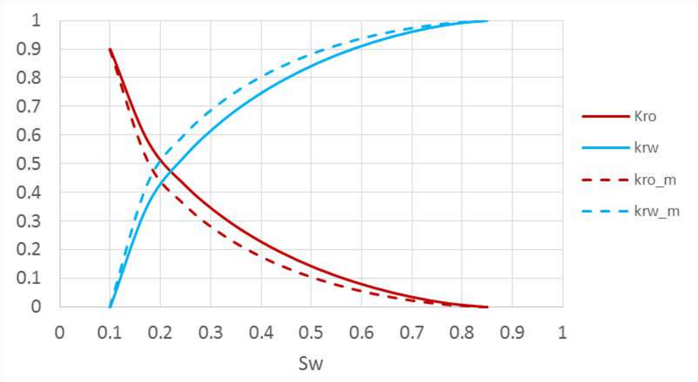
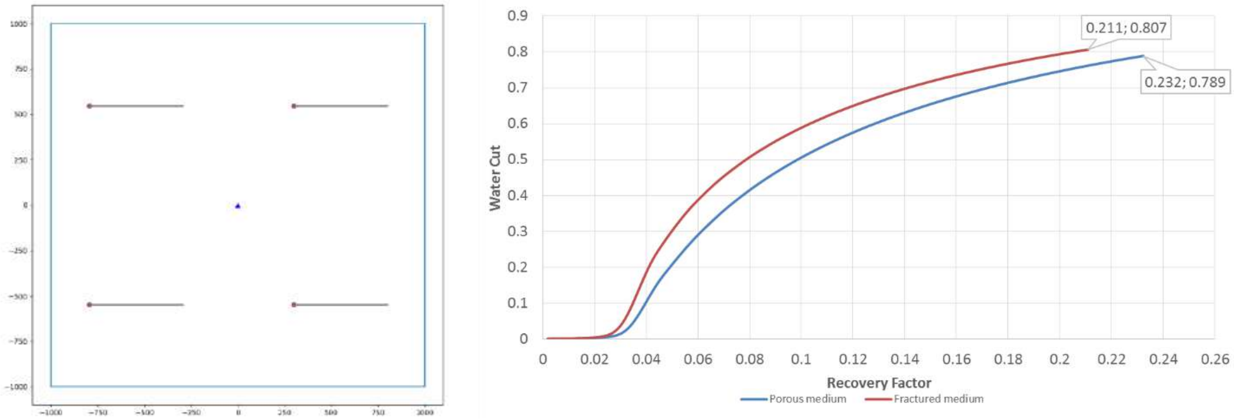


Fig. 2 Relative permeability plot

To compare the results a development element of 5-spot well template with horizontal producers was modeled because carbonate reservoirs are usually characterized by massive structural trap with bottom water aquifers where horizontal wells seem to be actual due to the low required drawdown for water coning reduction. [3]



a) Development element b) Displacement characteristic

Fig.3 Simulation modeling

The results of simulation with constructed relative permeability are in the Figure 3b. It is obvious that model with modified Dykstra-Parsons coefficient looks more conservative and for the simulation period (25 years) the RF reached the value of 0.211 while it is 0.232 for the conventional model with non-modified relative permeability. Moreover, faster breakthrough from the injector occurs with modified phase permeability what changes the NPV.

Thus, the method may be used in simple models with relatively high uncertainty degree. For example, if probabilities are applied in the calculation. Nevertheless, sufficient assumptions are applied in the method and it should be used with high caution. The best case is to compare the achieved results to real data to understand how applicable it is in the current task.

References

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