Calculation Method of Production Log Holdup using CAT Instrument

Wen Guang Song

Abstract - **This paper researches a set of interpretation for capacitance array tool (CAT) production logging data interpretation. It devises the water-holding rate of the CAT data and verified that this method can produce the horizontal well logging data interpretation. So it has some research value.**

Keywords - **Production Log Well; Capacitance Array Tool; Water-Holding Rate**

I. The Design of Algorithm

The main purpose of the production log interpretation is to identify the productivity of the output layer [1]. And we can determine the produced water layer. So we will be to block the water layer, it provides the basis for increased oil production. The liquid flow rate can be measured with tracer flow velocity in the horizontal wells. And the tube constant Pc can be concluded by the formula 1.

$$Pc = \frac{1}{4} p (D^2 - D_t^2) \times 3600 \times 24 \times 10^{-6} \quad (1)$$

The total flow of the explain level is marked Q. The Q is the Vm multiply Pc. This Vm is the tube cross-section of average speed. The Pc is the tube constant. The Dt is the diameter of the external tube, and the D is the outside diameter of the internal pipe .That is shown as the Fig. 1.

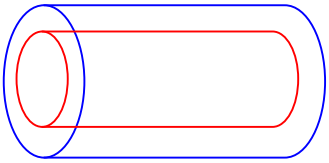

Fig. 1 Liquid flow in the annular space

We can calculate the flow of each phase as Qw=YwQ, Qo=YoQ. The Qw is the water flow. The Yw is the water-holding rate. The Qo is the oil flow rate. The Yo is the oil-holding rate. The Q is the total oil-water two-phase flow.

Therefore, the focus is that how to calculate the Yw of each phase. The paper proposes a split shaft cross-section calculation of holdup CAT production logging methods. The measuring instrument is made of twelve sensors [2]. There twelve sensors on the one single radius as shown in the Fig. 2.

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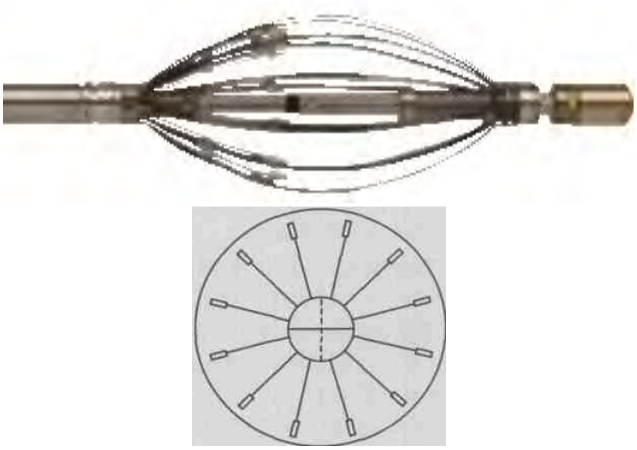

Fig. 2 Capacitor combination meter-CAT

It is from the differential point of view. The CAT is a production logging measurement instruments of the holdup.

II. CAT to Determine the Holdup

The design idea is shown in Figure 3.The holdup is the Yw.

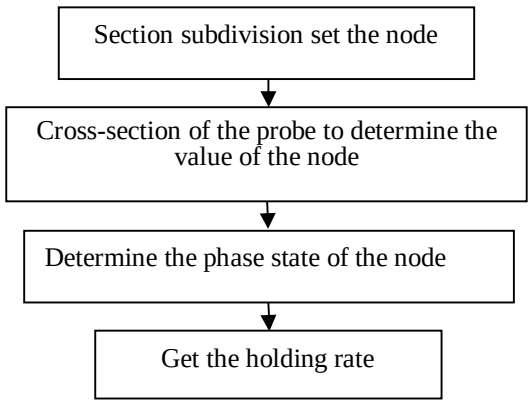

Fig. 3 Calculate the Yw of CAT

A. Setting the Probe Shaft Cross-section of Split Nodes

The idea is that it divides the cross section area into the n circle along the radius direction in the counterclockwise direction with respectively 12, 24… 12n equal. So there have 12, 24… 12n nodes are in the equal portions circle that is from the inside to the outside of each ring. The CAT is distributed as the Fig. 4.

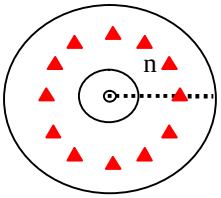

Fig. 4 Shaft cross-section Picture

B. Section Probes the Node Value

We calculate the cross section at other nodes response predictive value as formula 2.

$$w_i = \sum_{j=1}^{12} k_j \times D_{ij} \times T_j \qquad (2)$$

The W_i is the i node response predictive value in the formula 2. The K_j is the correction factor the j probe. The D_{ij} is the weight value of the j probe to the i node. The T_j is the measured response value of the j probe in the CAT. The D_{ij} is concluded from the formula 3.

$$D_{i,j} = \exp(-(\frac{x-a}{m})^2 - (\frac{y-b}{n})^2) \qquad (3)$$

Which, the m is the horizontal direction, and it is decreases control coefficient. The n is the perpendicular to the direction of reducing control coefficient. The (a,b) is the coordinate of the j probe. The (x,y) is the coordinate of the i node.

We hope that the results is very accurate and can be applicable. So the value calculated must have certain self-adaptive, and it is approximately equal with the true value. But only using the formula 3 to calculate the result $D_{i,j}$, it is not meet the requirements. Therefore, we pull in the weights k_j (j=1,2,3,4,5,6,7,8,9,10,11,12).

The weights can ensure that the probe at the nodes of the calculated and measured values are equal or only minimal differences. Accordingly, in order to determine the correction factor, establish the target function is as formula 4.

$$\sum_{j=1}^{12} (k_j D_{i,j} - T_j) \Rightarrow 0 \qquad (4)$$

Among them, the formula 4 is based on the formula 2 which it is as a probe type node. It is calculated, and it is a probe measurement.

C. Identified CAT Probe Node Phase and the Phase Node Number

If the value of W_i is 1, that the probe is all in the water. If the value of W_i is 0.2, that the probe is all in the oil. If the value of W_i is 0, that the probe is all in the gas. In practical production, the oil-water two-phase horizontal well production logging measurements, here we set probe response values greater than or equal to 0.8, and then the probe region is the whole aquifer. The probe response value is less than or equal to 0.4 for the whole reservoir. There was no measurement values ranged from 0.4 to 0.8, because the productivity is very low in out horizontal wells. Therefore, we only statistical probe measuring value and the corresponding node number to know in the oil in the node number and the number of the nodes in the water. Then the oil holdup rate is the oil phase section node divided the all nodes, and the water holdup rate of aqueous is the water node divided the total number of nodes.

III. Conclusion

This paper proposes a method of calculating the water-holding rate. We use the idea to calculate the Yw. It can accurately calculate the holdup in the low production log well. So it can be use to the production log interpretation.

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