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INFLUENCE OF CURVINESS OF THE ELECTRODE PAD SURFACE ON ELECTRIC WELL-LOGGING MICRO-SYSTEMS

Abstract

The surface of the electrode pad for Microlog or for other focused micro-methods of well-logging is curved. It is cylindrical surface. The curvature of the pad surface is not to affect calculation of the electrode constant, because the above calculation is made for the plane into which the contours of electrodes are projected. Aim of this paper is the proof of previous contention.

Key words: the electrode pad, curvature of the pad, focused micro-methods, Microlog, Microlaterolog, calculation of constant, well-logging

Introduction

The last, but not insignificant, problem of electric well-logging micro-systems is curviness of the electrode pad surface and its effect on the voltage registration. The question sounds whether the above curviness has or has not an influence. Let's prove it.

Curviness of the electrode pad and its effect on

You can work on assumption of fig.1 and suppose that the oblong electrode has dimensions remarked as a* × b. Dimension b is laid in the only line being parallel to axis of cylinder, whereas, dimension a* is the part of the curve of cylindrical surface.

If you project both sides on the straight surface, it will hold the following formulas:

$$a = 2r \times \sin\left(\frac{\varphi}{2}\right) = 2r \times \left(\frac{a}{2r}\right), \text{ and} \tag{1}$$

$$b = b^{*}, \tag{2}$$

Where φ = central angle of the part of the cylindrical surface curve, and

r = radius of the cylindrical surface of the electrode pad.

For the part of the cylindrical surface curve forming the side a* it holds that:

$$a^{*} = r \times \varphi = 2r \times \arcsin\left(\frac{a}{2r}\right). \tag{3}$$

The voltage element remarked as dU* being on the cylindrical surface of the oblong potential electrode is defined as follows:

$$dU^{*} = \frac{R \times I}{k} \times \frac{dS^{*}}{S^{*}}, \text{ and} \tag{4}$$

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$$S^* = a^* \times b^* = 2r \times b \times \arcsin\left(\frac{a}{2r}\right), \tag{5}$$

where k = constant of the electric well-logging micro-system [m],

R = resistivity of surroundings [Ωm], and

I = electric current flowing through the current electrode [mA].

The voltage element remarked as dU being on the straight surface where the electrode is projected from the cylindrical surface is determined with the help of this formula:

$$dU = \frac{R \times I}{k} \times \frac{dS}{S}, \text{ and} \tag{6}$$

$$S = a \times b = 2r \times b \times \left(\frac{a}{2r}\right). \tag{7}$$

The ratio between S* and S is constant and has this form:

$$m = \frac{S^*}{S} = \frac{a^*}{a} = \frac{\arcsin\left(\frac{a}{2r}\right)}{\left(\frac{a}{2r}\right)}. \tag{8}$$

As it is valid that r > a/2 therefore there holds this inequality:

$$0 < \left(\frac{a}{2r}\right) < 1. \tag{9}$$

The inequality (9) results in the next inequality for m:

$$1 < m < \frac{\pi}{2}. \tag{10}$$

From equation (8) it is evident that it holds:

$$S^* = m \times S, \text{ and} \tag{11}$$

$$dS^* = m \times dS. \tag{12}$$

Due to relations (11) and (12) you are able to write:

$$\frac{dS^*}{S^*} = \frac{m \times dS}{m \times S} = \frac{dS}{S}. \tag{13}$$

This is very important relation entitled without any doubts that equations (4) and (6) are identical:

$$dU^* = dU. \tag{14}$$

For the electrode formed like circle the formula (14) holds, as well. We ought to remember that the contour curve on the cylindrical surface facing like circle is in fact ellipse.

$$S^* = \pi \times \frac{a^*}{2} \times \frac{a}{2} \text{ , and} \tag{15}$$

$$S = \pi \times \frac{a^2}{4} \quad . \tag{16}$$

Formulas (13) and (14) are again valid, because there hold formulas from (8) up to (12). That is identical process as it was for the oblong electrode.

This all confirms that curviness of the electrode pad surface has no influence on registration of voltage. You are allowed to do all counting for voltage being on the incurvate plane having cylindrical surface as if the contours of electrode were projected into plane.

Conclusions

If you summarize the results of analysis, you will state that:

Curviness of the electrode pad does not affect calculation of constant remarked ask.

For calculation of the above constant we are allowed to take the distances between electrodes and their dimensions measured out the plane where the electrodes were projected.

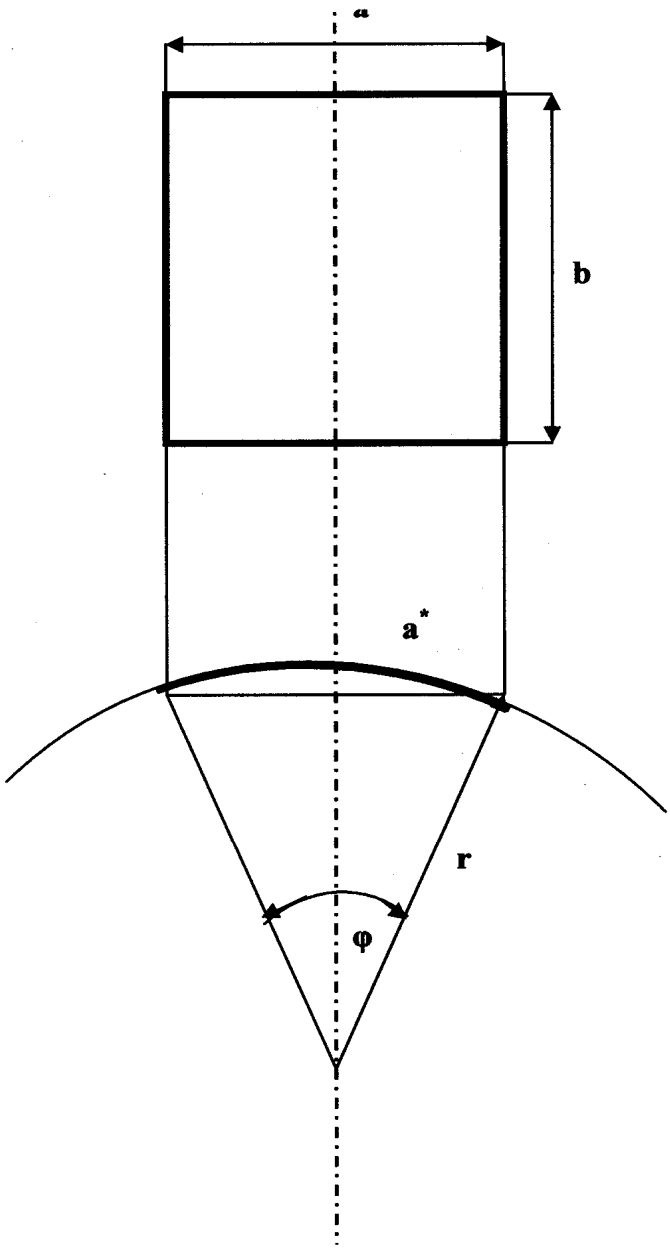

Fig.1 Schema of derivation of formulas for incurvate surface of pad

References

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