Electrical contacts impact on the DC resistance measurement of metallic conductors: Application on an industrial measurement device

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ABSTRACT

In most industrial devices used to measure electrical conductor resistance, the supplying current is applied using clamping jaws. One of the stumbling blocks is the existence of contact phenomenon. The contacts between wires and the clamps present a crucial challenge for measurements. The electrical characteristics of the contacts between wires on the one hand, and the mechanical stresses they face on the other hand, influence the distribution of current along the conductor. The distance from current entry points to the position where current may be considered uniform along the conductor and recommended position of voltage taps from current taps have been established.

KEYWORDS

Contact resistance, mechanical stresses, FEM, conductor resistance, measurement device, current distribution.

INTRODUCTION

In most industrial devices used for measuring electrical resistance of conductors, the supplying current is applied using clamping jaws. One of the stumbling blocks of this type of device is the existence of contact phenomenon between wires. Indeed, the contact areas between the components of the conductor present a crucial challenge when measuring conductor's resistance. The electrical characteristics of the contact between wires on the one hand, and the mechanical stresses they face on the other hand, influence the distribution of current paths within the conductor cross section.

It is well known that the contact resistance depends on the shape and dimension of contacts spots and on the magnitude of contact pressure. In this paper we suggest a series of measurements coupled with a wide range of numerical simulations to establish the relationship between the contact resistivity and conductor design parameters, under different conditions, including variable mechanical pressure and contacts shapes. The purpose is finding out how the current passes from one conductor to another. The effect of the intermediate layer in the contact region on the current density distribution has been also examined. It was deduced that an intermediate layer with conductivity lower than copper was present. Through extensive simulations and supporting measurements the effects of various design parameters on the conductor resistance were also established. It was found that the current density is not uniform through the conductor cross-section. The current density distribution is also heavily influenced by the structure of the contact interfaces and the resistance of the transient layers.

Our work present a method by which the contact interfaces can be identified and their electrical contact resistance precisely measured. The distance (**L**) from the current entry point (the clamps) to the position where current density may be considered uniform along the conductor will be established (Fig. 1). This will facilitate estimating recommended positions of voltage taps from current taps. Original relationships will be proposed showing the dependency between contact resistance, conductor design parameters and mechanical contact conditions.

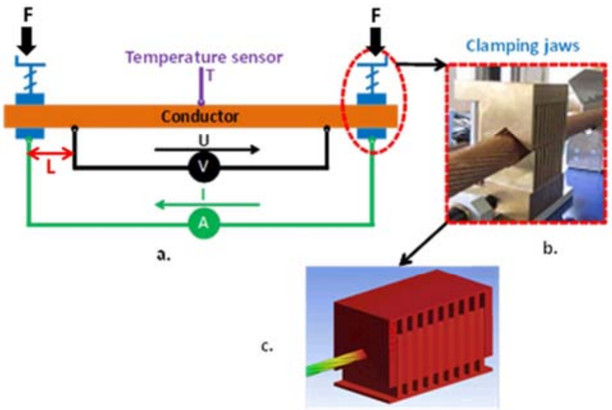

Fig. 1: Industrial conductor resistance testing method (a), Current injection system "Clamping jaws" (b) and DC finite element model (c)

ELECTRICAL CONTACT MEASUREMENT

There are many unknowns relevant to optimization of the electrical contact resistance and experimental techniques to measure the resistance and its dependence on various parameters, such as temperature, pressure and the contact angle [4], [5], [6]. The two main questions requiring an answer concern the value of the contact resistance between the strands of a conductor at a given force, created by the stranding process or due to subsequent application of compression, and ways to reduce contact resistance by considering the shape, size and distribution of contact interface sand current paths.

It is necessary to use the theory of mechanical contact in the analysis of the electrical contact. For this purpose a dedicated experimental device has been developed. This device is used to evaluate the electrical contact resistance