Electrical Resistivity Measurement of Carbon Anodes Using Van Der Pauw Method

Geoffroy Rouget¹, Hicham Chaouki², Donald Picard³, Donald Ziegler⁴, Houshang Alamdari⁵
1. PhD Student
5. Professor
Department of Mining, Metallurgical and Materials Engineering,
Université Laval, Québec, Canada
1. PhD Student
2. Research professional
3. Research professional
5. Professor
NSERC/Alcoa Industrial Research Chair MACE⁵ and Aluminum Research Centre – REGAL
Université Laval, Québec, Canada
4. Program manager / Modelling
Alcoa Primary Metals, Alcoa Technical Center, PA, USA
Corresponding author: Houshang.Alamdari@gmn.ulaval.ca

Abstract

Electrical resistivity of carbon anodes is an important parameter in the overall efficiency of aluminium smelting process. In order to characterize their electrical resistivity, a cylindrical core is extracted from the top of the anodes. The electrical resistivity of the core samples is measured according to ISO 11713 standard. This method consists of applying a 1A current along the revolution axis of the sample, and measuring the voltage drop on its side, along the same direction. Theoretically, this technique appears to be satisfying, but cracks in the sample, either generated during the anode production, or while coring the sample may induce high variations in the measured signal. Van der Pauw method, as presented in 1958 by L.J. van der Pauw, allows measuring the electrical resistivity of any plain sample with arbitrary shape and low thickness even in the presence of cracks. In this work, measurements were performed using both standard and van der Pauw method, on both flawless and cracked samples. Results provided by van der Pauw method appeared to be more reliable and repeatable.

Keywords: Carbon anodes; aluminum smelters; electrical resistivity; van der Pauw.

1. Introduction:

Carbon anodes, used in Hall-Héroult process to produce aluminium, are characterized to control the quality of produced anodes along the process. Usually, core samples are extracted from the top of the anodes, beside the stud holes. This location may lead core samples to have some structural flaws, especially at their bottom [1,3]. Core sampling itself may also induce flaws such as cracks in the samples [⁴]. The characterization of anode cores is achieved using ISO11713 standard method. This standard is merely an adaptation of ASTM B193-02, used as test method for resistivity of electrical conductors materials. Though, this latter method requires a sample with no cracks or visible defects. Cracks located in the radial axis may most probably induce overestimated values on the measured electrical resistivity, which would not necessarily be representative of the electrical resistivity of the anodic block.

Van der Pauw (VdP) method [⁵,⁶] for measuring electrical resistivity of samples of various shapes was presented 60 years ago. More recently, Kasl and Hoch [⁷] proposed a study using VdP method on circular and cylindrical samples. This study shows that samples with a thickness smaller than