

# **The Data Fusion Between Acousto Ultrasonic-Echo (AU-E) and Thermal Measurements for Determining Refractory Thickness and Condition in Operating Furnaces – The AU-E Measurements (Part I)**

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The remaining campaign life of a smelting furnace depends largely on the thickness and condition of the refractory lining. A common practice for evaluating the refractory lining is to monitor refractory temperatures and use information from the refractory material data sheets to calculate the remaining refractory thicknesses using a thermal resistance calculation. Predominantly temperatures are collected continuously through thermocouples, fiberoptic and thermal cameras and simple or complex computational models are used to calculate the remaining refractory thickness and estimate the condition of the lining. Another common method of measuring refractory thickness is by using the acousto ultrasonic-echo (AU-E) method. AU-E is a non-destructive testing (NDT) technique based on the stress wave propagation principles that has been used for the past 26 years to determine refractory thicknesses and quality in the operating furnaces. Both these methods have been successfully used in the past to determine the refractory thickness in operating smelting furnaces. However, like any indirect assessment methods, both thermal and AU-E refractory calculations have their inherent limitations. Due to the complex nature of smelting furnaces, the results of each technique, when used alone, can result in an increased uncertainty in the assessment of the refractory lining condition. A data fusion process was developed to combine the results of thermal and AU-E systems. The cross correlation of the data collected from different techniques based on different physics principles reduces interpretation uncertainties and increases confidence and reliability of results. Our field results have shown that the combination of both techniques can ensure the reliability of the refractory lining assessment. In this paper, the authors provide further detail into the refractory issues, principals of the AU-E and thermal measurements and the benefits of conducting and fusing the results of both sets of testing systems. This is done by a scientific approach to the problem, as well as providing case studies.