PROTOTYPE FOR DETECTION OF DELAMINATIONS IN THE SHEATH SYSTEMS OF HIGH VOLTAGE POWER CABLES USING ULTRASONIC DIAGNOSIS

Dipl.-Ing. Gregor **BRAMMER**, Prof. Dr. Armin **SCHNETTLER** Institute for high voltage technology – RWTH Aachen University, (Germany), brammer@ifht.rwth-aachen.de

ABSTRACT

In high voltage power cables the screen system is a fundamental part concerning electrical and chemical aspects. During production of welded screen systems there is a risk of defects in the glue layer between screen and polymer sheath. As a consequence, during operation water can diffuse to the screen and accumulates in the areas of missing glue which causes corrosion of the metallic screen. In order to detect missing glue during production, this article describes a method and the realization of a prototype which detects areas of missing glue automatically and to safe the quality of the sheath system.

KEYWORDS

Delamination, polymer interfaces, sheath system, HV power cables, ultrasonic testing, reflection coefficients, signal correlation.

INTRODUCTION

In the last production step of a power cable for high voltage (HV) and extra high voltage (EHV) an aluminium screen is bent around the cable core and both ends are welded together. After welding, the screen is led into the extruder head. Inside the head the hot screen is covered with a thin glue layer and a PE-sheath is extruded on top. During this extrusion there is a risk that gas inclusions can occur between PE and aluminium caused by missing glue. Due to those inclusions water can permeate into this delamination and could cause corrosion of the aluminium screen, which leads to reduced life time of the cable.

With the ultrasonic diagnosis it is possible to identify gas inclusions (delamination) at interfaces in principle. In this special case it is possible to do a non-destructive online test of the interface between the aluminium and the PE for detection and location of defects. The positive aspect about this monitoring is the knowledge of the defect's position. So the area of the defect can be marked and treated at the end of the cable production. Moreover it gives the chance to correct production parameters during the running of the sheathing line.

BASICS OF ULTRASONIC TECHNIQUE

Acoustical waves with frequencies above 22 kHz are classified as ultrasonic waves (ultrasound). Those mechanical waves can propagate in materials due to the mechanical coupling of the molecules. There are two different types of waves: transversal and longitudinal waves. Transversal waves are not considered anymore because only longitudinal waves propagate in water, which is used as coupling liquid between ultrasonic transducer and test sample. Ultrasonic waves are generated by using a piezo ceramic which is triggered by a voltage impulse in the range of usual 100 to 400 Volts.

Figure 1 shows a typical ultrasonic impulse.

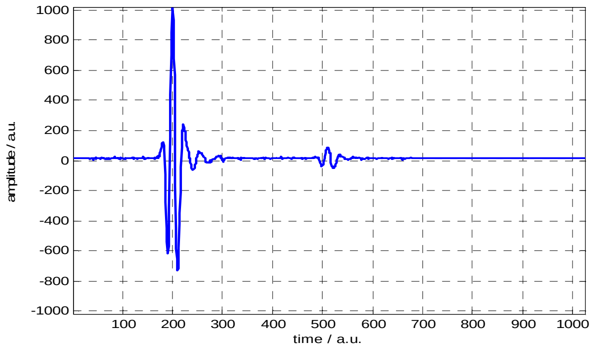

Fig. 1: typical ultrasonic impulse

This generated wave is propagating in materials with a certain sound velocity *c* which can be calculated by

$$c = \frac{2s}{t} \qquad [1]$$

where *s* is the propagation distance inside the material and *t* the time of flight (TOF) which is needed by the impulse to propagate through the material {1}. Factor *2* results from reflection and the way back to the transducer. So, distance *d* is passed twice. Figure 2 points up the principle.

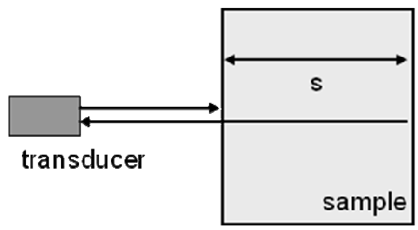

Fig.2: Principle of ultrasonic wave propagation

Sound impulses propagating from the transducer through the sample to the backwall (right side) are reflected and propagate back to the transducer which receives the impulse. A reflection of waves occurs generally at interfaces between two materials with different sound impedances *Z* which is defined as product of density *ρ* and sound velocity *c* of the material:

$$Z = c\rho \qquad [2]$$

Similar to traveling waves on transmission lines for example the reflection of ultrasonic waves is described as follows