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A device for measuring the heat flux on the cylinder outer surface in a cross-flow.

Artur Cebula*

Institute of Thermal Power Engineering, Cracow University of Technology, Al. Jana Pawla II 37, 31-864 Cracow, Poland

Abstract

The paper presents heat transfer measurements results concerning a cylindrical element. The cylindrical rod that is the object of interest that is surrounded by a mixing region of hot and cold flows and, as a consequence, is subjected to thermal device for determining heat flux on the outer surface of fluctuations. The paper describes an experimental he rod, the method is based on the solution of the inverse heat conduction problem (IHCP). A heat flux measuring instrument is described together with its construction and tests performed at a special design stand.

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Keywords: heat flux, inverse method, measurements, temperature fluctuations, heat flux measurements

1. Introduction

The paper presents an instrument for measuring heat flux on the outer surface of cylindrical element. The work is a follow up of works that were performed to analyze and determine heat transfer phenomena occurring to a control rod of nuclear power plant [1-4,7]. The designed measuring instrument is able to measure heat flux and heat transfer coefficient on the outer surface of cylindrical element. The element could be immersed in fluid and subjected to rapid thermal fluctuations resulting from a jet impingement.

The determination of the unknown surface heat flux does not require any knowledge of temperature field in fluid and can base on measurements of the temperatures in some discrete points beneath the surface. These temperatures can be used to solve the inverse heat conduction problem (IHCP) [5, 6]. The IHCP can be defined as the estimation

* Corresponding author. Tel.: +48 126283578; fax: +48 126283560.
E-mail address: acebula@pk.edu.pl

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of the boundary conditions (here heat flux and temperature on the surface) from transient temperature histories at one or more interior locations. In order to test the IHCP-method a numerical test was performed [4]. In the test the transient temperatures calculated by CFD at some interior locations inside the stem were used as input data in IHCP-analysis [4] and surface heat fluxes and temperatures were calculated. The heat fluxes were then compared with respective calculated directly by CFD. The comparison shows good agreement between CFD and IHCP calculated surface heat fluxes and temperatures [7]. Based on these experiences the heat flux measuring instrument (MI) was designed, manufactured, armed with thermocouples and tested

2. Measuring instrument

Measuring instrument (MI) measures solid temperature at some discrete points, then by utilization the algorithm, which is described in [5, 6 and 7], heat flux and temperature are determined on the outer surface of the MI. The algorithm is incorporated in the software, and the software together with MI composes a unit. The construction is based on a metal pad (stainless steel) which covers a 94^o cylindrical sector. Figure 1 presents the geometry and dimensions of the pad. The pad represents ¼ of the full cylinder. The 94^o sector is equipped with 14 thermocouples equally spaced every 15^o on two radii R1 = 60.50 mm and R2 = 69.50 mm. Thermocouples are installed 0.50 mm from the inner and outer surface. As it is depicted in Fig. 2, thermocouples 1-7 are placed at the distance of 0.5 mm from the outer pad surface and thermocouples 8-14 at the distance of 0.5 mm from the inner pad surface. There are two measuring levels located 50.00 mm from the bottom and top of the MI. They are marked by thick red lines in

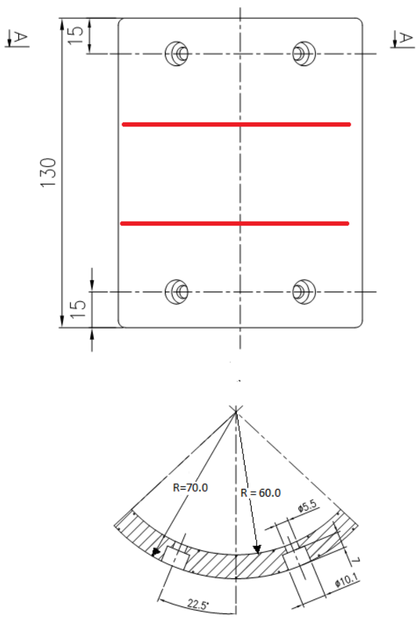

Fig. 1. The measuring pad: scheme and dimensions, the red lines show measuring level

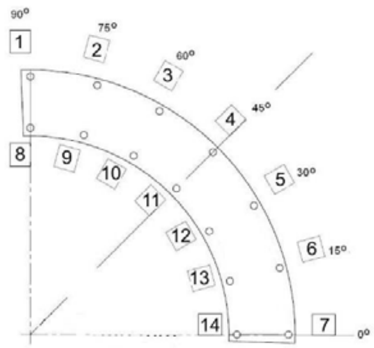

Fig. 2. Location of thermocouples in MI