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О ВОЗМОЖНОСТИ ИСПОЛЬЗОВАНИЯ ИНФРАКРАСНОЙ ТЕРМОГРАФИИ ДЛЯ НЕИНВАЗИВНОГО ИЗМЕРЕНИЯ РАСПРЕДЕЛЕНИЯ ТЕМПЕРАТУРЫ ПОВЕРХНОСТИ ШАРОВОГО ЭЛЕМЕНТА

В настоящей работе исследован и экспериментально подтвержден новый подход к определению распределения температуры по поверхности шарового элемента. Средний коэффициент теплопередачи определен по данным поверхностной температуры, полученным с использованием инфракрасной теплометрии поверхности одиночного шара-калориметра, расположенного внутри цилиндрического канала при постоянным тепловым потоке в стационарных условиях, используя воздух в качестве охлаждающей среды.

Ключевые слова: *шаровой элемент, инфракрасная теплометрия, коэффициент теплопередачи.*

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APPLICABILITY OF USING INFRARED THERMOGRAPHIC AS A NON-INVASIVE MEASUREMENT OF SURFACE TEMPERATURE DISTRIBUTION OF SPHERICAL ELEMENT

In the present paper, a new approach for detecting the temperature distribution on the spherical element surface was examined and experimentally validated. The average heat transfer coefficient was evaluated from surface temperature data obtained using infrared spectrum for a single sphere located inside cylindrical channel with constant heat flux under steady state conditions by using air as working fluid.
Keyword: *Spherical element, Infrared spectrum, heat transfer coefficient*.

Surface temperature of the heated objects is one of the important key factors which need to be precisely determined in order to estimate the thermal stability and surface heat transfer process in many significant engineering applications. During steady as well as unsteady heat transfer process, real time and precise measurement of the temperature filed, especially the surface temperature distribution is an efficient way to ensure that the heat transfer processes was correctly performed [1]. The average heat transfer coefficient measurements in spherical element were initially evaluated by Williams [2–7]. They have presented correlations in which the heat transfer coefficient in the form of Nusselt number is dependent upon Reynolds number. Despite all these studies have made a great contribution to improvement and development of temperature measurements and evaluate heat transfer process, but these techniques are hard to meet the requirements of engineering practice due to the idealization of measurement conditions. All the experimental studies till date are based on thermocouples as one of the conventional technique that used to measure the temperature profile.

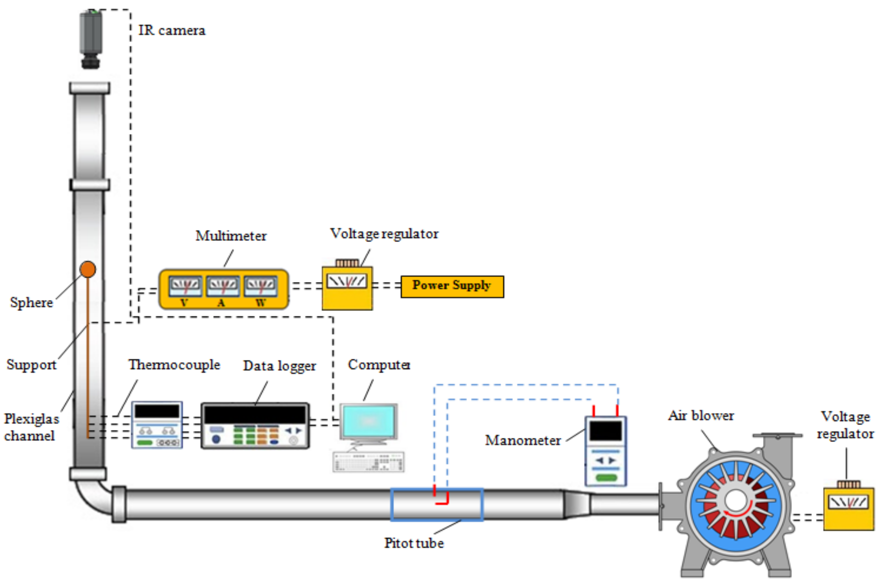

Fig. 1. Schematic diagram of the experimental test bench

Although that thermocouples can be accurately determine the temperature, but it is only a local point measurement, i.e., it is not capable of mapping temperature distribution at object surface. So, in the present work, a contactless technique has been proposed to measure the surface temperature distribution and determine the heat transfer coefficient of spherical element inside cylindrical tube using Infrared (IR) thermographic technique which have being used in more and more engineering applications in recent years. In addition, direct surface temperatures were measured using K-type thermocouples installed inside element for comparison to the Infrared (IR) thermographic.

Herein, the surface heat transfer coefficient is estimated for range of Reynolds number range of 10000< Re < 55000. The schematic diagram of the experimental set-up is presented in Fig. 1. In order to verify the accuracy of heated surface temperature measurement, the following experiment is performed.

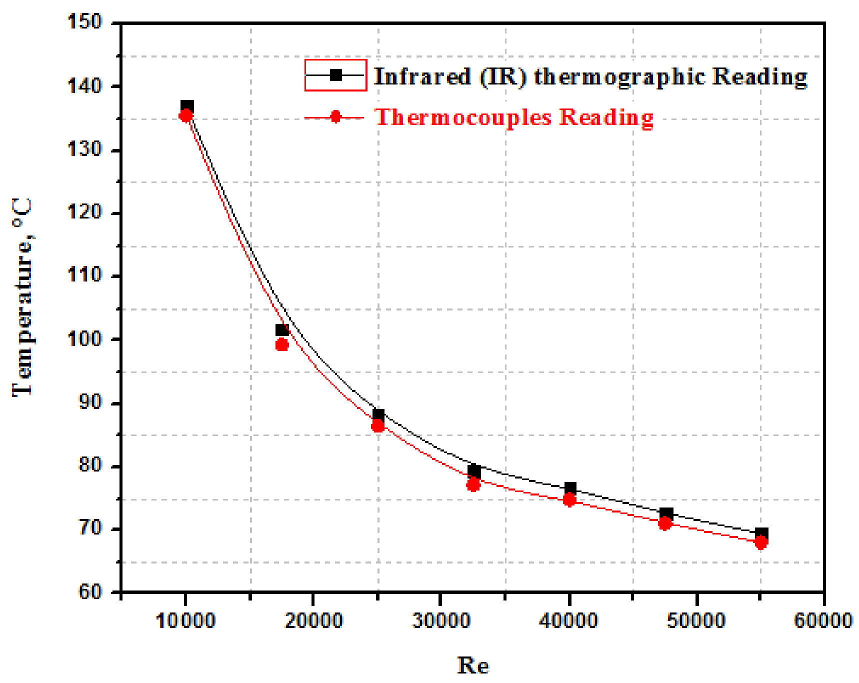

Fig. 2. Comparison of surface temperature measured by infrared (IR) thermography and that measured from thermocouples during verification tests

The test sphere is being heated under constant heat flux (7800 W/m^2), when the steady-state condition was achieved; the surface temperature distribution is recorded by infrared (IR) system. At the same time, the sphere temperature was directly measured by using two K-type thermocouples. Then, the average temperature of the test sphere is extracted to compare with the data obtained by thermocouples.

Repeating all the above process in the measurement of other range of Reynolds number, the final result of the heat transfer coefficient is depicted in Fig. 2. The results obtained from the related experiments showed that the thermal (IR) imaging appears to be powerful tool and an accurate technique to determine the temperature profile of heated elements. If we considered that thermocouple readings as true values and take it as a reference temperature of sphere being measured, then Accordingly, the experimental data: the average error of infrared (IR) temperature measurement method is 2.94 %. We hope that the technique can be applied in future for temperature measuring in several engineering applications

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