RESEARCH OF CONTACT HEAT CONDUCTIVITY OF POROUS STRUCTURES FOR HEAT PIPES WITH THE HELIOTHICKENER HELP

Shapoval A.A., Kostornov A.G., Shapoval Art. A. (1)
Institute for Problems of Material Science, NAS of Ukraine,
3, Krzhyzhanovsky Str., Kiev, 03142 Ukraine; otd5@ipms.kiev.ua
(1) National technical university of Ukraine «Kiev polytechnic institute» 37,
Peremogy Pr., 03056 Kiev

Introduction

The problems with calculations of sizes of thermal resistance R_{cont} in places of contact of porous structures (CS) with surfaces of heating there are creation of new heat-exchange equipment for hydrogen power in which heat pipes – superhigh-heat-conductivity devices are used. The data for calculations of characteristics of contact heat conductivity, in particular, influences of conditions of contact and characteristics CS on size R_{cont}, in the literature are absent. The research problems, allowing to receive the authentic results necessary for practice of designing, it is possible to solve with the help of the experimental stand created with use heliothickeners of a solar energy. The design of the stand and some results of experiments received in IPMS Heliocentre of Ukraine are submitted.

Results and discussion

The heat pipes (HP) developed, in particular, in IPMS of Ukraine since 70th years, are superhigh heat conductivity devices, capable to decide a number of complex thermophysical problems which arising at design of new heat-exchange devices and the equipment, including, hydrogen power. Capillary-porous structures of heat pipes (CPS) are the major HP details, which qualities of manufacturing essentially depend on the HP basic thermophysical characteristics, in particular - heat-transmitting ability Q_{max} and total thermal resistance R_{cont} . Calculations of contact thermal resistance R_{cont} in places of connection CPS to case HP should be based on the authentic skilled data received, basically, experimental methods.

The size of contact thermal resistance R_{cont} in places of connection of capillary structures to cases HP depends on lines of factors. Except conditions of connection, R_{cont} have an influence of CPS physical characteristics (porosity, heat conductivity, etc).

As the experimental test bench has used solar parabolic mirror heliothickener of Institute for problems of material science of Ukraine. It is possible to attribute a number of advantages of its application: an
opportunity of reception of high values of density of a thermal stream, speed of carrying out of experiment, minimal heat loss. For carrying out of experiments by definition of thermal resistance in places of contact CPS with smooth bearing surfaces (heat pipes) the working site (fig.1) into which structure enter is created: 1) researched pre-production model CPS; 2) measuring cylinders from stainless steel into which thermocouples are preliminary inserted; 3) gauges of a thermal stream; 4) a bearing holder; 5) radiator-heat-conducting path; 6) the cooling fan. Pre-production models CPS were located between corrosion-proof cylinders and were heated up due to the concentrated stream of a solar energy. Thermal stream gauges and the located differentially thermocouples preliminary calibrated; also thermal resistance in a place of contact of cylinders is predefined at absence CPS.

The technique of experiments was: 1) established CPS-sample with the certain physical characteristics; 2) heated up a sample concentrated solar radiation which density determined by means of heat-gauges (developed in Institute of thermal physics of Ukraine); 3) measured values of temperatures in control points of metal cylinders by thermocouples. Also previous experiences without CPS are carried out. Application of cylinders-heat-conducting paths with replaceable weight has allowed to obtain the data on influence of various efforts of pressing CPS to a heating surface on value R_{cont} .

The received results enable to establish character of influence on R_{cont} parameters of metal powder and fibrous capillary structures HP in the following ranges of change of their physical characteristics: porosity Θ_{ps} = 30...90 %; heat conductivity λ_{ps} = 0,1...70 W/mK; thickness δ_{ps} = 0,3...3 mm; PS-material - copper and corrosion-resistant steel (9X18H10T).

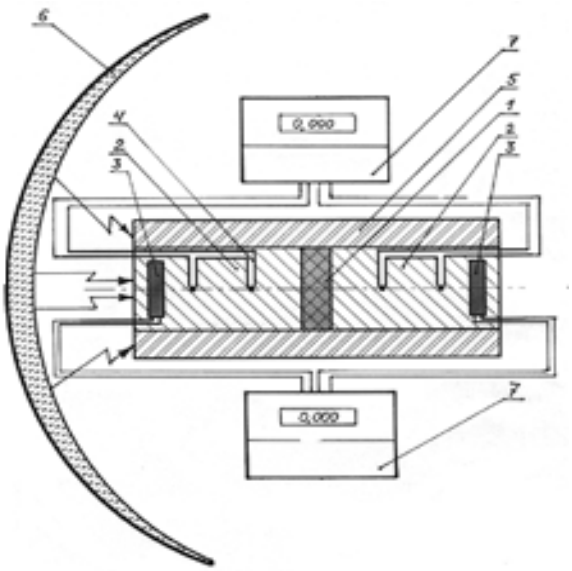

Fig. 1. The circuit of a research section of the experimental stand for contact heat conductivity researches of porous structures in a place of connection to a hea-ting surfaces

1 - porous material; 2 - measuring cylinder; 3 - gauge-calori-meter; 4 - thermocouples; 5 - bearing pulley (chuck); 6 - pump mirror of heliothickener; 7 - measuring devices

On fig.2 some results of experiments received as dependence of temperature in control points of corrosion-proof cylinders from time of heating of a metal-fibrous PS-sample (material - 9X18H9T) are submitted. Since 3-rd minute of heating, the difference of temperatures between control points is practically constant, that allows to use it as initial size for calculations R_{cont}. Subtract from the received value of a difference of temperatures for given sample CPS value of the similar difference ΔT, received in experiences at absence of sample CPS, is easy to receive experimental value of $R_{cont.}$

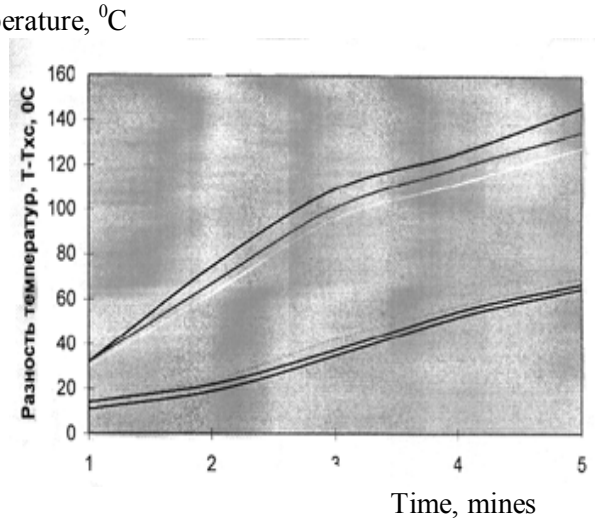

Fig. 2. Experimental data of measurements of temperatures at pre-production heating model capillary-porous structures the concentrated stream of a solar energy

The top curves - indications of the thermocouples located on a direction of a thermal stream up to sample CPS; bottom - after a sample

Conclusions

Some scientific and technical problems of definition of contact thermal resistance in junctions of capillary-porous structures with cases of heat pipes – superhigh-heat-conductivity devices, perspective for heat-exchange equipments of hydrogen power are considered. The developed method of definition of contact thermal resistance CPS with the heating surfaces, using solar heliothickeners, has a number of technical advantages and allows to receive authentic experimental data about influence of physical characteristics CPS on sizes $R_{cont.}$

Research work is executed at support of the State Fund basic researches of the Education and Science Ministry of Ukraine (contract № Ф7/569).