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Letters to the Editors

Comments on "Process intensification: heat and mass transfer characteristics of liquid films on rotating discs", A. Aoune and C. Ramshaw

[International Journal of Heat and Mass Transfer 42 (1998) 2543–2556]

Bearing in mind that the International Journal of Heat and Mass Transfer gives highest priority to those contributions which increase our basic understanding of transfer processes, and of their application to engineering problems, I think that these guidelines have been omitted in the case of the above-mentioned paper. Let me quickly introduce you to the merit of my comments.

The work presented in the paper is primarily an experimental work and shows a series of experimental runs for some specified conditions. A great disadvantage of these data is that it does not provide very useful information, which could be of invaluable importance to the researchers working in the same field. Such presentation of the experiment by the authors discards all its scientific value and makes it practically useless to those who would like to compare them with similar experiments or models. For example, no indication of what was the exact material type of the disc apart from calling it brass was given, neither the wall heat flux was quoted. Another indication of poor quality of presentation of the experimental data in the paper was that none of the figures presented in the paper are reproducible without knowledge of additional parameters. For example, in Fig. 7 data such as angular velocity and volumetric flow rate are missing. In Figs. 10–17 nobody is capable of using such data for fundamental research as the values of wall heat flux are missing.

Anyway, having some expertise in the above-mentioned area, I tried to conduct some analysis of the experiments, bearing in mind that the authors conclude the paper with some breakthrough observations.

I took the "typical" values of experimentally measured disc temperature, presented in the paper in Fig. 7, from the two locations (1 and 9 mm from the disc surface) and in such a way calculated the wall heat flux, based on a constant thermal conductivity of 80 W/(mK), using a 1-D conduction model. The error of such approach can be estimated and in this case it was less than about 15%. This provided me with a non-uniform wall heat flux distribution, the details of which, together with a linear approximation of such data and a constant value, are presented in Fig. 1. The linear approximation and a constant value are here for the sake of comparisons. Non-uniform distribution of wall heat flux was also mentioned by the authors. Further parameters missing from the same Fig. 7 were the volumetric flow rate of water as well as rotational velocity. These values had to be assumed according to other figures in the paper.

Using the three above-mentioned cases of heat flux distribution and also the distributions of film and wall temperature (same as in Fig. 7), one can determine the distribution of local heat transfer coefficient for this case. In the first case, corresponding to the experimental distribution of wall heat flux, similar trend is obtained as by Aoune and Ramshaw. However, if any of the two remaining approximations are used, a monotonic distribution of heat transfer coefficient is

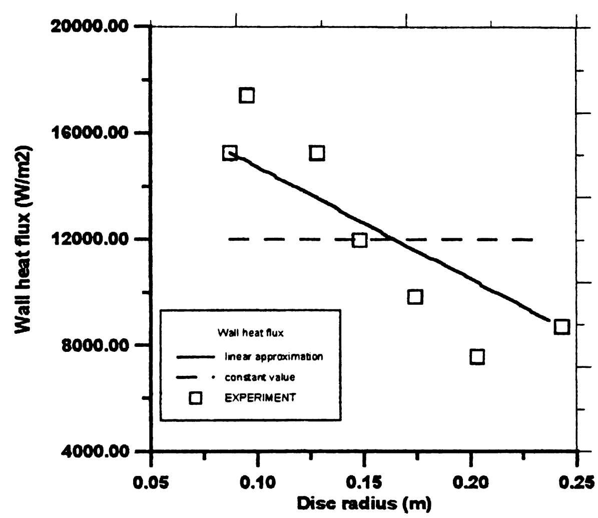

Fig. 1. Various approximations of experimental distribution of wall heat flux.

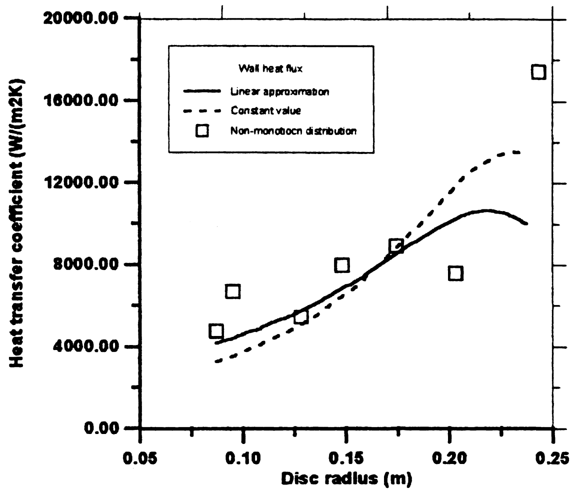

Fig. 2. Comparison of the model calculations against Aoune and Ramshaw data using various distributions of wall heat flux assuming $Q = 35$ cm^3/s, $\omega = 30$ s^{-1}.

obtained as in theories presented in the paper (Fig. 2). Therefore, the non-monotonic distribution of heat transfer coefficient is only due to the non-monotonic wall heat flux distribution and not due to specifics of liquid film spreading on the surface of the disc as the authors are trying to claim. One can draw a conclusion that using a more conductant material of the disc the authors will not encounter such unusual behaviour. I also suspect that such unusual distribution of experimental heat flux could be a result of the end effects existing in the experimental rig.

Therefore, it would be recommended that the experiment was repeated on a disc made of copper rather than brass, which would alleviate the problems with non-uniformity of the wall heat flux and probably will show only monotonic distributions of heat transfer coefficient.

I would be delighted to change my view on the authors contribution if I had some more details on the experiment. I believe that other readers would have similar feelings having a deficiency of information about the experiment.

I look forward to the authors' comments.

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Reply to Prof. Mikielewicz

The work reported in the paper represents some of the smooth disc experimental results which were obtained during a programme to develop a multi-disc absorption heat pump. It was recognised at the outset, that the generation of reliable heat transfer data would be facilitated if a uniform disc temperature could have been ensured. Because of this, a copper disc was considered in view of its relatively high thermal conductivity compared with that of the brass which was eventually selected (70% Cu, 30% Zn "CZ 108" grade). The reason for this choice was that previous work had shown that various surface profiles were capable of generating significant performance enhancements and these would ultimately require extensive machining of the smooth disc surface. It is well known that the machining characteristics of pure copper are very poor while those of brass are excellent. Results from the profiled disc were not reported for reasons of commercial confidentiality.

Fig. 7 was included in the paper only to indicate the typical relative temperature profiles of disc and liquid film. It was not intended to be a general basis for computing heat fluxes and hence heat transfer coefficients. The principal message to be conveyed by Fig. 7 was that the disc temperature was far from uniform, varying typically by 12 K and that the liquid/surface temperature difference varied from about 2 K at the inner radius and 0.5 K at the periphery. Even if copper had been used it was unlikely to ensure a uniform disc temperature which would generate a heat flux normal to the disc surface for transfer to the fluid flowing over the disc. In addition the close temperature approach at the periphery emphasised the accuracy needed for temperature measurement. As pointed out in the paper the accuracy of the disc temperature measurements was only ± 0.1 K while that of the liquid film (thermistor