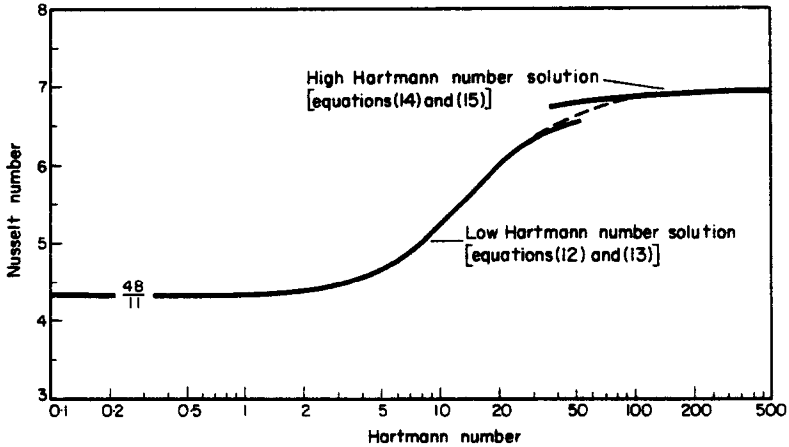

FIG. 4. Average Nusselt number as a function of the Hartmann number. Dashed line indicates suggested interpolation between the high and low Hartmann number solutions.

becomes laminar. The local and average Nusselt numbers obtained here for the case of high Hartmann numbers should also describe the heat transfer of such a flow.

ACKNOWLEDGEMENTS

The author would like to express his appreciation to Professor Paul S. Lykoudis of Purdue University for his helpful comments and discussions, and to Dr. R. R. Gold of Hughes Aircraft Company for providing details of the velocity profile, equation (2), and to the National Science Foundation for financial assistance under Grant GK 181.

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Int. J. Heat Mass Transfer. Vol. 11, pp. 1081–1083. Pergamon Press 1968. Printed in Great Britain

DEVICE FOR PRODUCTION OF GAS-FREE LIQUIDS OR VAPORS

GEORGE W. PRECKSHOT

Chemical Engineering Department, University of Missouri, Columbia, Missouri 65201, U.S.A.

(*Received* 26 *October* 1966 *and in revised form* 1 *January* 1968)

SEVERAL years ago at the University of Minnesota it was necessary to produce gas-free liquids for use in nucleate boiling experiments. Using Taylor's [1] idea of fractionation we produced a degassing unit shown in Fig. 1 which operates continuously without back diffusion and without hazardous bumping. Organic chemists will find it helpful in distilling carefully purified liquids where boiling chips are of no use. Gas-free liquids can be produced easily for experimental verification of theory of liquids, for cavitation or nucleation studies or for liquid tension studies.

Gas is removed by fractional distillation at almost total reflux for a period of hours to days with the overhead gas and some vapor being removed through a sonic orifice which prevents back diffusion. If the period of fractionation is long enough, gases trapped in dead-ended parts of the apparatus and physically adsorbed on the walls are removed. The device can be operated at any pressure if suitable condenser cooling fluid temperatures can be provided.

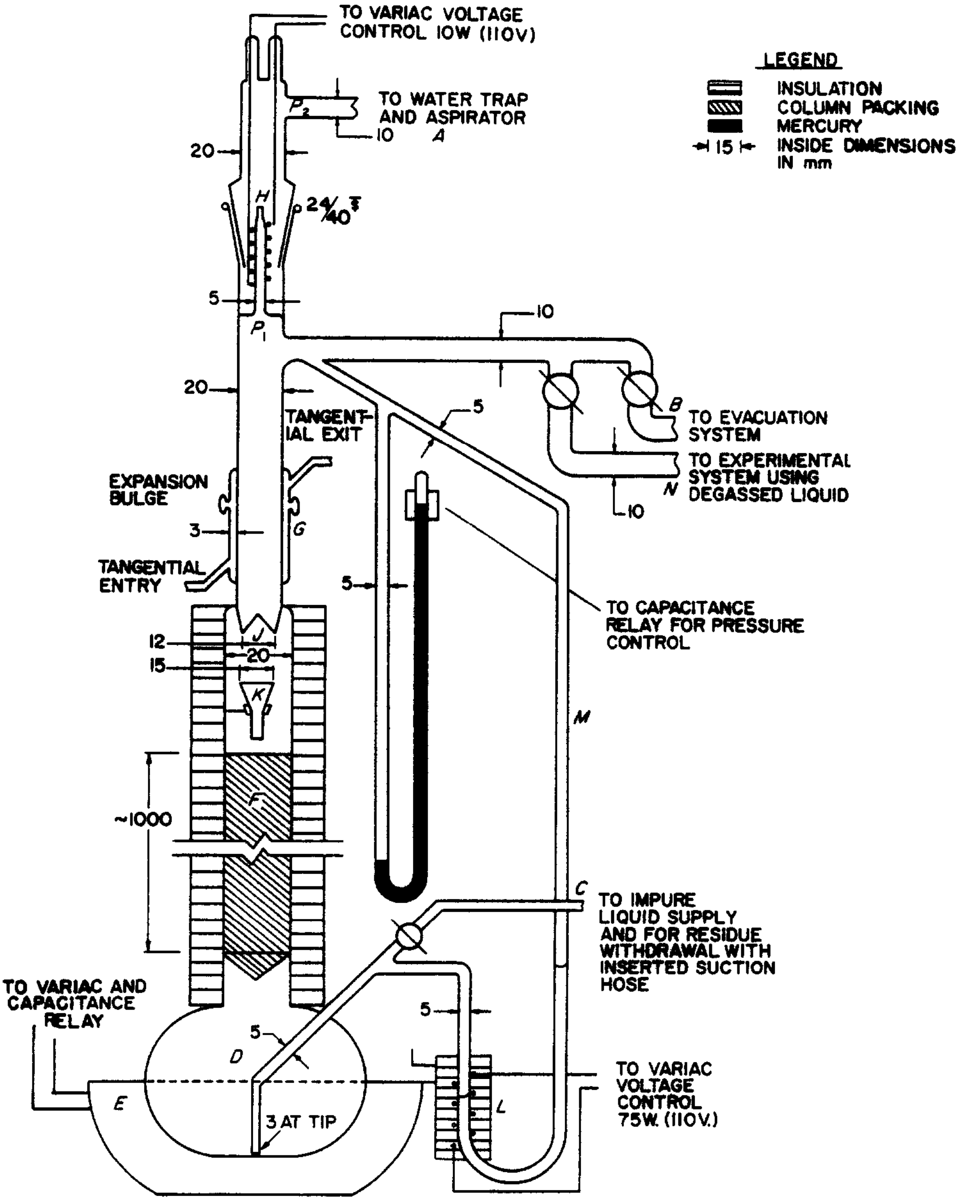

FIG. 1. Liquid degassing device.

After the aspirator is attached at *A* and turned on, the system is evacuated roughly through *B* so that the impure liquid may be drawn in through *C* to fill the 4-l flask *D*. The closures at *B* (*C* and *N*) are Teflon stop cocks or Teflon seated ball valves, bellows valves or glass capillary liquid freeze valves. The liquid in *D* is brought quickly to the desired boiling temperature through adjusting the power to the Glass-Col heater *E*. As the vapor boil-up time increases, the fractionating column *F* packed with $\frac{1}{4}$ in dia. stainless steel wire (20 ga.) helical segments gets warm allowing the vapor to reach the condenser *G*. The non-condensable gases collect above the condenser and pass through the heated sonic orifice *H* (0·001 in dia.) to the aspirator. The ratio P_2/P_1 for most gases must be maintained below 0·5. The 10 W–110 V heating element insures that there is no condensation in the orifice.

The amount of condensate produced in *G* is adjusted through the choice of coolant (air, water, refrigerant) its rate, and the size of the condenser surface provided. It is directed from dropping points *J* in a funnel *K* so that the reflux is distributed from the center rather than running down the walls of the fractionator. The funnel *K* is supported in a ring fastened at three points to the fractionator wall allowing the vapor unobstructed passage around the funnel. Weep holes above the dropping tips *J* prevent the trapping of non-condensable gases there. The reflux ultimately returns to *D*.

As the dissolved and absorbed gases are removed, the boiling would proceed in a chaotic and disruptive fashion were it not for the vapor introduced under the liquid in *D*. When the heat input to heater *L* (75 W–110 V) is adjusted to give 3–10 vapor bubbles/s, the distillation proceeds uniformly and well. Wide fluctuations in system pressure may momentarily interupt this flow of vapor. With large increases in system pressure a larger heat input to *L* may be required or the feed line *M* should be insulated to reduce the condensation rate there.

When all the non-condensable gases have been removed, the system pressure may be increased by increasing the boil-up rate, and by reducing the condensation rate. The vapor is removed through *N*. A condenser may be introduced here if the product is desired as a liquid. The residual liquid in *D* may be removed by inserting a small diameter Teflon tube to the bottom of *D*.

This system has been used to produce gas-free water, CCl_4, and other organic solvents. In producing gas-free water, the water in *D* will become increasingly cloudy due to the precipitation of SiO_2 and other silicates dissolved from the fractionating column and condenser walls. Small amounts of organic impurities can be removed by destructive oxidation by putting in basic $KMnO_4$ in *D*.

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Int. J. Heat Mass Transfer. Vol. 11, pp. 1083–1085. Pergamon Press 1968. Printed in Great Britain

LAMINAR FLOW OVER RECTANGULAR CAVITIES†

THOMAS C. REIMAN‡ and ROLF. H. SABERSKY§

(*Received* 2 *November* 1967 *and in revised form* 16 *February* 1968)

INTRODUCTION

THE INTEREST in flows over rough surfaces stems originally from the desire to interpret more completely heat-transfer results for forced convection over rough surfaces [1]. In this connection a series of flow experiments were initiated. In a previous paper which appeared in this Journal [3], the results of a study on the flow over a set of transverse rectangular slots were reported. In those experiments the slots were exposed to a turbulent outer boundary layer and the slot depth was from three to thirty times that of the laminar sublayer (defined as $y^* = 5$). This size relationship is typical for rough surfaces and the purpose of the investigation was to obtain a better understanding of the flow conditions. It was found that when the slot size was less

† The work on which this paper is based has enjoyed the support of the National Science Foundation under Grant No. GK 572.

‡ Development Engineer, Battelle Memorial Institute, Richland, Washington.

§ Professor, California Institute of Technology, Pasadena, California 91109, U.S.A.