FLOW BOILING OF R-22 IN PLAIN AND WIRE SCREEN FITTED TUBES

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by

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CERTIFICATE

This is to certify that the Thesis entitled 'Flow Boiling of R22 in Plain and Wire Screen Fitted Tubes' being submitted by Mr. Narayan Ji Dembi to the Indian Institute of Technology, Delhi, for the award of the Degree of Doctor of Philosophy in Mechanical Engineering, is a record of bonafide research work carried out by him. He has worked under our guidance and supervision and has fulfilled the requirements for the submission of this Thesis, which in our opinion has reached the requisite standard.

The results contained in this Thesis have not been submitted in part or in full, to any other University or Institute for the award of any degree or diploma.

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N.J. Dembi

ABSTRACT

The phenomenon of boiling being fundamentally microscopic in nature, the difficulties associated with the theoretical estimation of the heat transfer coefficient seem to be of principal nature. Consequently, a more pragmatic approach of collecting and analysing reliable and systematic data has been followed in this study.

A fairly broad based data file on the flow boiling of refrigerants in horizontal tubes has been compiled. This file has been used to carry out a comprehensive evaluation of the existing correlations. Two new correlations, one for forced convection vaporisation and the other for nucleate flow boiling, have been developed using parameters derived from basic flow boiling mechanism. A new dimensionless parameter significant in horizontal flow has been derived. The validity of the parameters derived is substantiated by the results obtained. Both the correlations developed give a much better prediction of the heat transfer coefficient values in their respective zones, than any of the existing correlations.

The test facility constructed to investigate the local heat transfer and pressure drop for evaporating refrigerants in plain and wire screen fitted tubes has been described. This test rig has been subject to adequate proofing to build

confidence in and obtain reliable measurements from it. Data on local values of heat transfer coefficient and pressure drop are presented for Refrigerant 22 evaporating at $0^{o}C$ saturation temperature in a 30 cm. long, 12.3 mm. i.d. straight horizontal copper tube. Data have been taken for the plain tube, and the same tube fitted with wire screens of 30, 100 and 150 mesh respectively keeping the parametric variation almost identical. Pressure drop and wall temperature fluctuations, in general, and near the dryout, in particular, have been recorded and reported with adequate explanations.

A distinguishing feature of the plain tube data is the presentation of and interpretation from the linear scale plotting which has been shown to be more instructive than logarithmic scale plotting, resorted hitherto.

Compared to the plain tube, the results on wire screen fitted tubes indicate a more even wall temperature distribution. The pressure drop and wall temperature fluctuations, in general, and near the dryout region, in particular, are appreciably reduced. Heat transfer coefficient variation with quality is smoother. There is an appreciable improvement in heat transfer though pressure drops are also higher. All these features are a result of the change in flow dynamics brought about by the use of wire screen which increases the tube wetted area. This is borne out by a visible drainage of the

liquid along the circumference in the glass section provided for flow pattern visualisation. Based on this observation, a mechanism of action of the wire screen is suggested which satisfactorily explains the results obtained.

The performance of the screened tubes is evaluated on the basis of the results of heat transfer coefficient and pressure drop using an efficiency parameter derived from single phase studies. The application of wire screens in DX-chillers for optimum performance is suggested.

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TABLE OF CONTENTS

TABLE OF CONTENTS (Contd.)

TABLE OF CONTENTS (Contd.)

TABLE OF CONTENTS (Contd.)

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