

# **THERMODYNAMIC PROPERTIES OF DIMETHYL FORMAMIDE AND REFRIGERANT 22 FOR VAPOUR ABSORPTION REFRIGERATION SYSTEM**

A thesis submitted to the  
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By  
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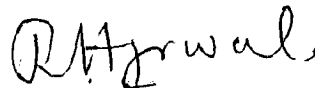
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CERTIFICATE

This is to certify that the thesis entitled,  
'Thermodynamic Properties of Dimethyl Formamide and  
Refrigerant 22 for Vapour Absorption Refrigeration System'  
being submitted by Mr. S.L. Bapat 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 under my  
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the standard fulfilling the requirements of the regulations  
relating to the degree.

The matter embodied in this thesis has not been  
submitted, in part or full, elsewhere for the award of any  
other degree.



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## ABSTRACT

With growing emphasis on the use of low grade energy such as the solar, geothermal, waste steam etc., the interest in vapour-absorption systems has rejuvenated. This has also engendered the need to evolve better refrigerant-absorbent combinations. The present work is concerned with the investigation of one such combination, viz., R22-DMF system. R22 (Monochloro-Difluoro-Methane) appears to be a good refrigerant because of its properties and also chemical stability in the normally used working temperature range. It also overcomes the problems inherent to conventional systems such as  $H_2O-LiBr$ ;  $NH_3-H_2O$  etc. Further, DMF (Dimethyl Formamide) shows very good solubility for R22 (by weight) and hence it is selected as the absorbent.

The method presently used for the computation of the thermodynamic properties for the above mixture assumes the reference state at  $0^\circ C$  in the liquid phase. The vapour phase nonideality has been described by the virial equation of state truncated at second virial coefficient. The P-v-T data has been measured by using Burnett's method and processed by least squares fitting procedure to obtain second virial coefficients and the interaction coefficients for mixtures as well as pure components.

Barker's method has been used to establish vapour-liquid equilibrium, vapour phase composition and the activity coefficients. The method needs pure component liquid volumes, second virial coefficients and vapour pressure data. Vapour pressure data have been measured by using static still method from  $-25^{\circ}\text{C}$  to  $150^{\circ}\text{C}$  for the complete composition range. The activity coefficients are correlated to liquid composition by the two-constant Redlich-Kister expansion. Thus, the liquid phase nonideality given by heat of mixing is calculated from the temperature derivatives of the activity coefficients.

The vapour pressure data have been plotted as  $\ln P-1/T$  diagram and solubility characteristics. The mixture shows strong negative deviation from Raoult's law. The temperature-composition and enthalpy-composition diagrams are obtained from 1 bar to 20 bar covering the complete range of absorption systems. Thermodynamic design and analysis has been carried out for the above system using the enthalpy composition diagram and is compared with  $\text{NH}_3\text{-H}_2\text{O}$  system under the same working conditions. The C.O.P. of R22-DMF system is higher than that of  $\text{NH}_3\text{-H}_2\text{O}$  system which indicates the superiority of the former.

A computer program has been developed for the thermodynamic design and analysis of the system. It has been used to investigate the effect of various working parameters on

the performance of the system. The parameters varied are generator temperature ( $60^{\circ}\text{C}$  to  $130^{\circ}\text{C}$ ), evaporator temperature ( $-20^{\circ}\text{C}$  to  $15^{\circ}\text{C}$ ) and condenser/absorber temperature ( $20^{\circ}\text{C}$  to  $40^{\circ}\text{C}$ ). Detailed performance characteristics have been given which are helpful in the design of such a system for any specific application.

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AUTHOR'S BIO-DATA