PART - B.

CHAPTER - 4

C O N C L U S I O N

Chapter - 4.

C O N C L U S I O N.

4.1. The following conclusions can be drawn relating to part B of the thesis:-

(A) A fluorocarbon power plant has the following advantages:-

(a) Though the Rankine cycle efficiency of a plant with a fluorocarbon refrigerant as working medium is lower than that of a steam operated plant, the overall efficiency of the former plant becomes higher than the latter plant because of better reversibility of the former due to the adoption of super-critical cycle.

(b) There is less turbine blade erosion as the expansion of the fluid takes place only in the dry region. Besides, fluorocarbon refrigerants do not have any corrosive action on the usual turbine blade materials.

(c) In case of a steam plant, moisture and super saturation losses take place in the steam turbine. These losses will not occur in fluorocarbon turbines, as the fluid will not be wet after expansion.

(d) It is seen that the size of a fluorocarbon turbine and condenser is much smaller than a steam turbine and condenser for the same output.

(e) There will not be any necessity of installing reheaters in a fluorocarbon power plant.

(f) As the enthalpy drop of a fluorocarbon turbine is small, the number of expansion stages is much less than that of a steam turbine. Another advantage of this is that the former can be directly coupled to an electric generator whereas the latter usually requires a gear box between the turbine and the generator.

(g) A fluorocarbon power plant can run most economically by taking heat from the exhaust gases of internal combustion engines, open-cycle gas turbines and steam power stations.

(B) A fluorocarbon power plant, in comparison with a sub-critical steam power plant operating between the same temperature limits and having the same output, has the following disadvantages:-

(a) High initial cost of liquid and make up fluid.

(b) Higher strength required for a supercritical Freon boiler as compared to a sub-critical steam boiler.

(c) Slightly higher cost of liquid pipe lines.

(C) It is possible to produce about 20 percent of additional power from the exhaust gases of a medium sized gas turbine (about 10,000 h.p) with the help of a Freon turbine. If the exhaust gases of such a gas turbine are utilised to operate a steam operated waste heat recovery plant instead of a Freon plant, the thermal efficiency of the former (i.e. steam plant) will be about 6% lower than the latter.

(D) A refrigerant power plant can also work in the lower stage of a dual cycle plant in a gas cooled reactor.

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PART - B.

CHAPTER - 5

FUTURE SCOPE OF WORK

Chapter - 5.

FUTURE SCOPE OF WORK.

As this thesis contains two parts it is natural that the future scopes will also have to be discussed in two parts. (PART- A)

5.1. Theoretical estimation of thermodynamic properties:

(A) Under this item we shall have to discuss the future scopes of theoretical estimation of many properties. In part A of this thesis the following thermodynamic properties relating to pure components have been estimated:- Critical pressure, Critical Temperature, Critical Volume, Ideal gas heat Capacity, Saturation Pressures, Latent heat of ~~xpx~~ vaporisation, Enthalpy and Entropy.

Except for the ideal gas heat Capacity and Critical properties, which have been estimated for about fifteen different refrigerants, other properties have been estimated only for R 12 and R 11. These properties can also be evaluated for other refrigerants.

(B) Only in case of ideal gas heat capacity, some calculations have been made for one azeotrope. All the above properties can also be theoretically estimated for other mixtures of refrigerants and azeotropes and the most reliable method on the basis of experimental results can be determined.

(C) The normal boiling points can be estimated and a relation between the normal boiling point and the number of chlorine or Fluorine atoms in a refrigerant can be established.

5.2. Theoretical estimation of transport properties:

In addition to the thermodynamic properties mentioned above, transport properties like viscosity, thermal conductivity and diffusion co-efficients can also be predicted. The predicted values can be compared with the available experimental values and accurate theoretical methods can be established.

Under this heading some more derived properties like condensing heat transfer co-efficient, boiling heat transfer co-efficient, and Prandtl number etc. can also be predicted.

For example, the Nusselt's equation for condensation on horizontal tubes is given below:-

$$h_m = 0.725 \left(\frac{K_f^3 \rho_f^2 g \lambda}{N D_o \mu_f \Delta t} \right)^{\frac{1}{4}}$$

where

h_m	=	mean local heat transfer coefficient
K_f	=	thermal conductivity of condensate at t°F,
ρ_f	=	density of condensate film at t°F
λ	=	latent heat of condensation at t°F
N	=	No. of horizontal tubes in condenser
D_o	=	outside dia of water tubes
μ_f	=	absolute viscosity of condensate film, at t°F
Δt	=	temp. diff. between tube wall and t°F
g	=	accln. due to gravity.

If K_f, λ and μ_f can be estimated accurately, h_m can be calculated from the above equation and a condenser can thus be designed, at least for preliminary investigations.

Some other properties like heat of mixing, free energy and parachor which are more useful for Chemical Engineers and for the solution of problems on mixed refrigerants, can also be predicted. A few references on this subject have been given in the Bibliography.

5.3. Estimation of properties of mixed refrigerants:

All thermodynamic and transport properties relating to mixed refrigerants can also be predicted and thus the performances of refrigeration plants using mixed refrigerants can be predicted. In this connection the works of Bijlani[49], Arora[50] and Gupta[51,52] are worth mentioning. The existence of azeotropy can also be pre-determined by theoretical methods.

Some references have been given in Bibliography on the theoretical methods of estimations of the above mentioned properties.

5.4. Experimental enthalpy measurements:

As described in section 2.11 of Part A of this thesis, direct experimental determination of enthalpy may be done and the results may be compared with theoretical values and with the values obtained from P-V-T relations.

(PART-B)

5.5. Experiments on Freon Turbines:

Part B of this thesis contains only the theoretical calculations relating to the performance of Freon Turbines. Experiments should be carried out on Freon turbines to verify the theoretical results. The irregular variation of efficiency of a Freon super-critical power plant with temperature requires further investigation.

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