Reduction in Size of Vars by using Different Materials in Generator

Prof. Animesh Kumar¹, Om Singh Patel², Nishi Yadav², Pooja Shakya², Muzzafar Ayub Khan²

¹Assistant Professor, ²Student

¹,²Department of Mechanical Engineering, ABES Engineering College, Ghaziabad, Uttar Pradesh, India

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ABSTRACT

In present scenario to achieve refrigeration effect, we have to supply high grade energy which take from shaft which decreases the millage of automobile and increase in cost of fuel. It is not economical to produce refrigeration effect by VCRS. In VARS system we use wasteful energy from exhaust gases of automobile to produce refrigeration effect hence saving cost of fuel.

Optimization of length of tubes of heat exchanger (generator) is done for different material like stainless steel, aluminium, copper to achieve 1TR Refrigeration effect. Inlet temperature of generator is 25°C and COP of refrigerator is 0.7.

KEYWORDS: COP (coefficient of performance), VARS (vapour absorption refrigeration system), VCRS (vapour compression refrigeration system), TR (Tonne of refrigeration)

INTRODUCTION

Comparison between VCRS and VARS

| VCRS | VARS |
|---|---|
| 1. In VCRS we use compressor that uses hybrid energy in the form of work. | 1. In VARS we use generator, Absorber and pump that uses low grade energy, in form energy |
| 2. The refrigerating effect or refrigerating capacity decreases with lower evaporator pressure | 2. Very little effect is seen in the refrigerating capacity with lowering evaporator pressure |
| 3. VCRS doesn’t work at partial load | 3. Varying load doesn’t affect performance of VCRS |
| 4. Refrigerant and Hydrocarbons CFCs hydrochlorofluorocarbon’s | 4. Ammonia or water can be used as Refrigerant with proper absorber. |

Simple vapour absorption system

The continuous increase in the cost and demand for energy has lead to more research and development to utilize available energy resources efficiently by minimizing waste energy with reference to [1] Replacing the electrical energy with solar energy will reduce the consumption of high grade electrical energy also the replacement of compression system with absorption system eliminates the energy consumption by compressors [2] In the context, diesel engine exhaust heat utilization has the potential to reduce the consumption of fossil fuels and reduce the release of greenhouse gases, significant waste heat recovery technologies have been developed to recover exhaust heat and turn it into useful energysuch as electricity[5] To reduce...
the Ozone depletion many refrigerant has been banned and due to increase in global warming it is necessary to have an alternate source which will be reliable and meet the future requirements in cars [7]

**Engine specification of Toyota Innova Crysta**
Fuel type: Diesel
Engine Displacement: 2393 cc
Torque: 343 Nm @ 1400 rpm
Power: 148 BHP @ 3400 rpm

**System Description**

| Concentration | kg of NH3/Kg of solution | Enthaply |
|---------------|--------------------------|----------|
| Strong solution leaving absorber | .421 | 30 |
| Weak solution leaving generator (x2') | .375 | 340 |
| Vapour leaving generator | .945 | 1870 |
| Liquid leaving condenser | .945 | 470 |
| Vapour leaving evaporator (x1) | .945 | 1388 |

For Aqua-Ammonia

\[ \mu = \text{Dynamic viscosity of aqua ammonia} \]
\[ k = \text{Thermal conductivity of aqua ammonia} \]
\[ Pr = \frac{\mu C_P}{k} = \text{Prandtl number} \]
\[ Re = \frac{m \times D g}{\mu} \]
\[ Nu = 0.06 \left( \frac{\rho_i}{\rho_f} \right)^{0.85} (Re)^{0.87} (Pr)^{0.4} \]

\[ hi = \text{convective heat transfer coefficient for inner tube} \]

\[ \frac{1}{U_o} = \frac{1}{h_i} + \frac{dx}{dx} + \frac{dx}{dx} \ln \left( \frac{d_i}{d_o} \right) \]

**Thermodynamic Analysis**

\[ m_1 = m_2 + m_1' \]
\[ m_1' * (\text{Latent heat}) = 1TR \]
\[ m_1 = 0.0424 \text{ kg / s} \]
\[ m_2 = 0.0483 \text{ kg / s} \]
\[ m_1 = 0.052539 \text{ kg / s} \]
\[ C_p = 3.8927 + 95.779 / (133 - T) \]
\[ T_e = \frac{C_p}{J / g \circ C} \]
\[ T_{ce} = 42 \circ C \]
\[ T_{ci} = 25 \circ C \]
\[ T_{avg} = 33.5 \circ C \]
\[ C_p = 4.8553 \text{ kJ / Kg } \circ C \]
\[ \Delta T = 17 \circ C \]
\[ m_a = \rho \ast V \ast \eta \ast (N / 2) \]
\[ = 0.2505977 \text{ Kg / s} \]
\[ \text{AirFuelrat } i o = 14 \text{ to } 20 \]
\[ \frac{\dot{m}_a}{\dot{m}_f} = 15 \]
\[ \dot{m}_f = 1.737318 \times 10^{-3} \text{ kg / sec} \]
\[ m_{ex} = 0.0277971 \text{ kg / sec} \]
\[ m_a \times C_p \times \Delta T = m_{ex} \times C_{pex} \times \Delta T_{ex} \]
\[ T_{bu} - T_{he} = \Delta T_{ex} = 141.82 \]
\[ T_{he} = 1442.78 \circ C \]

**Results and discussion**

\[ di = 28 \text{ mm} \]
\[ LMDT = 174 \]
\[ T_{avg} = 488.69 \text{ k} \]
\[ \mu g = 2.6577 \times 10^{-5} \text{ Ns/m}^2 \]
Kg =0.36314W/mk  
Pr =.80805  
Ug =5.36248m/s  
Re =14646.8  
Nu =123.17  
ho =149.092634W/m
µ =900µPa.sec=9×10⁻⁴Pa.sec  
K =.504W/mk  
Pr =8.0922  
Re =2654.553  
Nu =892.08  
hi =17204.4W/m
\[ QG = UO \times A \times LMTD \]
A =.168m²  
A =ΠDL  
L =1.783m

**ON THE BASIS OF THERMAL CONDUCTIVITY**

| S. no. | Materials       | Temp(⁰C) | Thermal Conductivity(w/mk) |
|-------|-----------------|----------|-----------------------------|
| 1     | Aluminium       | 124.595  | 239.92                      |
| 2     | Stainless Steel | 124.595  | 15.53                       |
| 3     | Beryllium       | 124.595  | 162.1                       |
| 4     | Chromium        | 124.595  | 87.44                       |

**CONCLUSION**

In present times stainless steel tubes are used for Aqua Ammonia refrigerant (NH3-H2O) for heat transfer in case of steel length of tube is more compared other materials like as Aluminium, Beryllium and chromium which have the same heat transfer capacity.

For low temperature we use Aluminium, and for the high temperature we use chromium to replace the stainless steel which has high melting point up to 1907oC-

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