Q - Refrigerant R_{22} enters a well-insulated compressor at 3.5 bar, -5^0C and exits at 14 bar. Determine the work input in kJ/kg it the outlet temperature 75^0C.
(γ = Cp/Cv for R_{22} is 1.562 at -5^0C and 1.348 at 75^0C)

Given γ = Cp/Cv at -5^0C = 23^0 F= 1.526
Hence Cp $_{(-5^0 C)}$ = $\frac{\gamma R}{\gamma-1} = 2.90 * R = 2.90 * 8.31 = \mathbf{24.11}\ \frac{J}{mol.K}$

And γ = Cp/Cv at 75^0C= 167^0 F= 1.348
Hence Cp $_{(75^0 C)}$ = $\frac{\gamma R}{\gamma-1} = 3.87 * R = 3.87 * 8.31 = \mathbf{32.19}\ \frac{J}{mol.K}$

If we consider a controlled volume of air in the compressor, and the steady state then the total change of internal energy inside the compressor will be zero and we can writer

$H_{in} - H_{out} + W_{in} = 0$ ----------------- (1)

Here
Hin = Enthalpy (or heat content) entering the compressor with input air.
Hout = Enthalpy coming out of the compressor with output air.
Win = Work going in as the power input.

Let n mol of R_{22} flows through the compressor per second.

As the enthalpy is given by

H = U + PV = n*Cv*T + n RT [PV = n RT]

Or H = n (Cv + R) T = n Cp T

Here Cv and Cp are the molar specific heats of R_{22} at constant volume and constant pressure respectively

Thus the input and output enthalpy is given by

Hin = n Cp T_1 = n*(24.11 $J.mol^{-1}.K^{-1}$)*(273-5)K = n*6.46 KJ
Hout = nCp T_2 =n*(32.19 $J.g^{-1}.K^{-1}$)*(273+75) K =n*11.20 KJ

Substituting above in equation (1) we get

$H_{in} - H_{out} + W_{in} = 0$

Or n*6.46 – n*11.20 + W_{in} = 0

Or Win = n*4.74 KJ

As the molecular weight of $CHClF_2$ is 86.48 g/mol, 1 kg of R22 will have

1000/ 86.48 = 11.56 mol and hence we get
Win = 11.56*4.74 = 54.8 KJ/Kg