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Effect of Pressure on Thermo Physical Properties of MixedRefrigerantR-290andR-600afor High Capacity Vapour Compression Refrigeration System (VCRS)

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Abstract

Theconceptofmixedrefrigerantfluidshasemergedduringthepastfewdecadesfrom16thcentury thermo physical propertiesas compared tobasefluids. ascoolantsinheattransferequipmentsuch asheatexchangers,electroniccoolingsystemandradiators.Inthepresentinvestigation,analyze physical properties,variousparametersbyconsidering10gmsof mixedrefrigerant of butaneatdifferent compositions.Resultsarepresentedforsimulationscarried outatatemperatu 350Kandapressure rangeo isconcludedfromtheresultsthatasthetemperatureincreases,specificheat refrigerantdecreases.Similarly,thermal conductivityincreasewithan increaseintemperat refrigerant atdiffere Further,asthepressureisvariedfrom3MPato7MPawhilekeepingthetemperature at350K,thespecificheatdecreaseby 5.2%aswell as thermal conductivityfollowsthe opp increasedby 6.9%.

Keywords:

Refrigerants, Thermophysical, Base fluids, heat transfer, Coolants, Heat exchangers.

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1. Introduction

Inpresentscenariostudieson mixedrefrigerantshas becomeversatileall overtheuniverse,sofortheserereasons vaporcompressionrefrigerationsystems(VCRS)areusedforcoolingpurposes.Ingeneral,Figure1represents VCRS cycleconsistsoffourmajorpartssuchascompressor,condenser,expansionvalveandevaporator.Thecompressor istheprocesswherethelowtemperatureand lowpressuregaseousrefrigerantiscompressedisentropicallyto obtainhigh pressuresuper-heated

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vaporregion this processis alsopredominatelyknownas 'Win'process. From process1-2Figure1,Figure2,Figure 3representsthework givenbythecompressor[1]–[3].Fromtheprocess2-3 condenserprocesstakesplace incondenserthehighpressureandhightemperaturesuperheatedvaporis converted tohighpressureandhigh temperatureliquidrefrigerantthisprocesstakesatconstantpressure(P=C) andwithinthedometherewillbeoccurrenceofconstanttemperatureprocess(T=C).Inthisprocessheatr ejection will takeplace 'Q out' in theFigure 1, Figure2,andFigure3representsprocess2-3[4]–[6].Expansionvalveis the process takes place at takesplacefrom3-4inthis neitherheatinputnor rejectionofheat occurorneithersupply ofworkornorrejectionofworktakesitistheprocessenthalpyistheprocesswherenarrowcutjunctionwill occur tosupplytheliquid fromhigh pressureand temperatureliquid tolowpressureand temperatureliquid and vapor region[7]–[9]Figure1,Figure2,Figure3representsprocess 3-4.Evaporatoristheprocesswherethe objectgets cooledthisprocessgenerallytakesplacefrom3-4istheprocessrepresentsInFigure1,Figure2,Figure3 where lowpressureand lowtemperatureliquid and vaporrefrigerantisconverted to Vaporrefrigerant.This processis alsowidelyknown asheatsupplyprocess(Qin)[5],[6],and[8].

2.Materials and Methods

Gow[10].Investigatedwiththeelementarymaterialsofcryogenicsand39purerefrigerantsareusedt odesignthe vaporpressurevstemperaturerelationshipbyusingdifferenttype'shydrocarbonrefrigerantsandthecry ogenic compoundstheequationhasdeveloped.Richardson*etal*[11] conductedexperimentallywithoutpassageofairthe performanceofrefrigerantsandconcludedthatpropaneandISO-butanegivesthebetterperformanceofCoefficient ofperformance(COP).Lorentzen [12]. Consideredthermodynamicandheattransfer propertiesasan importantfactor. Naturalsubstancessuchaspropane,ammoniaandcarbondioxideareusedashalocarbons. Scalabarin*etal*inthis work,purefluidsandmixturesarepredictedfluidfamiliessuchasalkanesandhalogenatedalkaneswithhi ghaccuracy ofdedicated equations of state(DEOS) havebeen proposed thermodynamically.LatraBoumaraf*etal*[13] havebeen proposedsimulationresultsfortheperformanceandcharacteristicsoftheoperatingcycleofrefrigeratio nsystem.This simulationresultsincludesco-relationoftheejectorentertainmenttheconservationof1-Dmodel.Dalkilic*etal*[14] inthisstudyexperimentalresultsofpressuredropcondensationweredeterminedbychoosingtworefrig erantssuchas R600a1mlonghorizontalandsmoothwithinnerdiameter4mmadouterdiameter6mmandR134inaverti cal 0.5mmsmooth coppertubewithinnerdiameter 8.1mmand outerand9.52mm. Mohan raj*etal*[15]performedan experimentalwork,withsingleevaporatordomestic refrigeratorusinghydrocarbonsmixturewhich meanamixed refrigerant ofpropane(R290) andISO-butane (R600a)itpresentsthat hydrocarbonshavelowerconsumptionof energy.However,itleadstohighervalue ofcoefficientofperformance(COP).Ardhapukar*etal*[16].Inthepresent investigation tocalculatetheoverall heattransfercoefficientsalong with thelengthofheatexchangersforvarious mixtureshasbeendeterminedfortheseexperimentaldataandempiricalco-relationshavebeendetermined.Yan*et* *al*[17] .InvestigatedwithzeotropicrefrigerantmixturesuchasR290andR600afordomesticfreezerinaninternal auto cascaderefrigerationcycle(IARC)performance oftheseIARCa mathematicalmodelisusedtodevelopthe performance.Theresults arediscussedaboutthe pressureratioof compressor, COPperformance volumetric compressor.Yan*etal* [18]. Studyreportsusingzoetrope mixturesuch as R290andR600a forthe modified ejector expansioncycleinthisconventionalejectorexpansioncycleandthrottlingcycleiscarried out.Resultsare presented thatrefrigeranteffectofCOP,volumetric efficiencyetc.Chen[19].Toenhancetheoverallsystemperformancean internalsub-coolerwithadditionalbypassisused.Inthisstudymodifiedvaporcompressionrefrigerationcycle(MVRC) usingzeotropicmixtureswithadditionofhydrocarbonsofrefrigerantssuchaspropane(R290)andISO-butane(R600a) is used.

3.ResultsandDiscussion

3.1. Pressureeffect onspecificwithrespectto temperatureofarefrigerantmixture atdifferentcompositions such as 10%-90%,20%-80%,30%-70%,and40%-60% forpropane(R290)andISO-butane(R600a)

To evaluate thethermo physical propertiesrefrigerantmixturesuchasspecificandthermal conductivityare evaluated forthepropaneandISO-butane (R290andR600a) areconsidered.Refrigerantmixtureoperates ata pressureof3MPato7MPaandtemperature of300-350K. Specificheatandthermal conductivityof therefrigerant mixtureisevaluated fromFigure1toFigure4

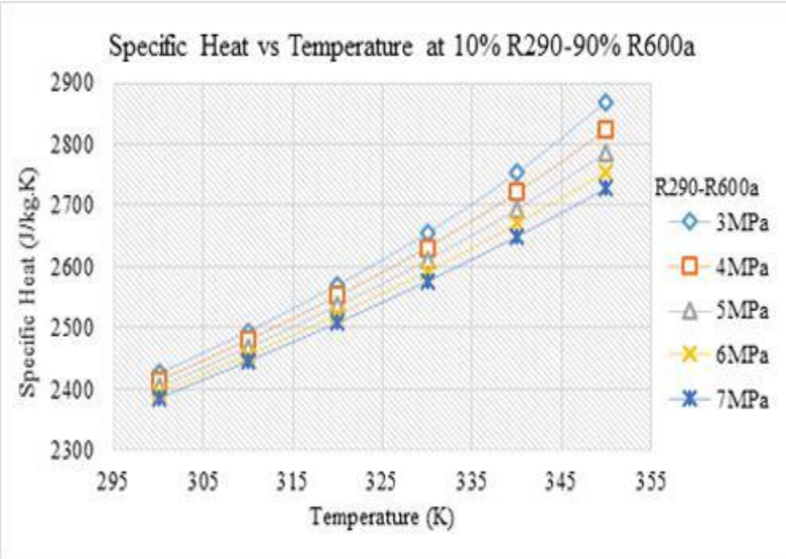

Figure1.Specificheatvs.temperatureatdifferent compositions

Figure1revealsthatvariationofspecificheatasafunctionoftemperatureatacompositionof10%-90%ofamixed refrigerantR290and R600a.Moreover,astheincreaseintemperature,effectofpressure onspecificheatofamixed refrigerantisdecreases.

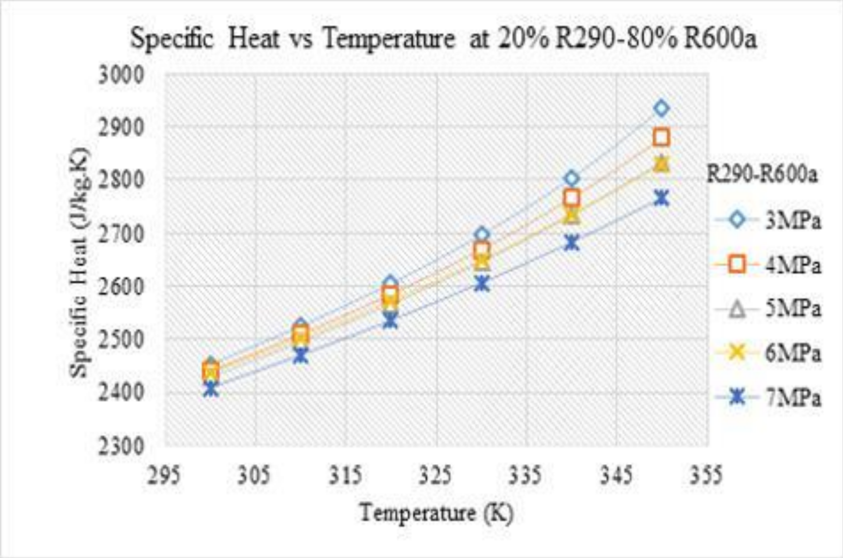

Figure2.specificheatvs.temperatureatdifferent compositions

Figure2showsthevariationofspecificheatwith respecttotemperatureatacompositionof 20%-80%ofamixed refrigerantR290and R600a.Moreover,astheincreaseintemperature,effectofpressure onspecificheatofamixed refrigerantis decreases.

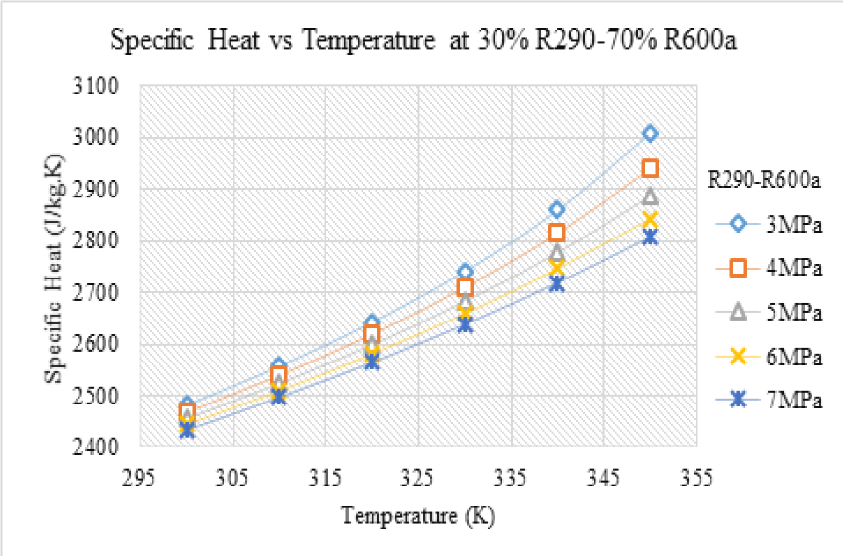

Figure3.specificheatvs.temperatureatdifferent compositions

Figure3showsthevariationofspecificheatasoffunctionoftemperatureatacompositionof30%-70%ofamixed refrigerantR290and R600a.However,astheincreaseintemperature,effect of pressure onspecificheat ofa mixed refrigerantisdecreases

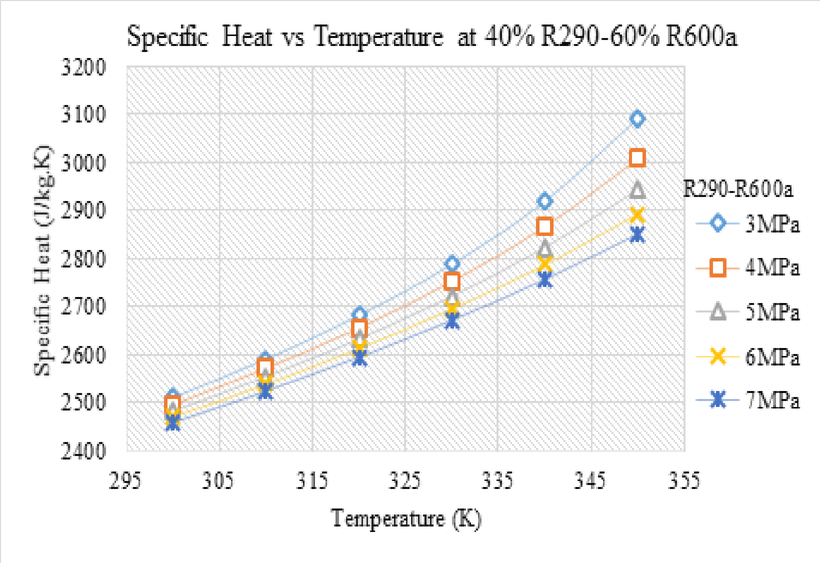

Figure4.specificheatvs.temperatureatdifferent composition

Figure4representsthat variationof specificheatasa functionoftemperatureatacompositionof 40%-60%ofa mixedrefrigerantR290andR600a.However,as theincreasein temperature,effect ofpressure onspecificheat ofa mixedrefrigerantisdecreases.

3.2.Pressureeffectonthermalconductivitywithrespecttotemperatureofarefrigerantmixtureatdifferent compositions suchas10%-90%,20%-80%,30%-70%,and40%-60% forpropane(R290)andISO-butane (R600a).

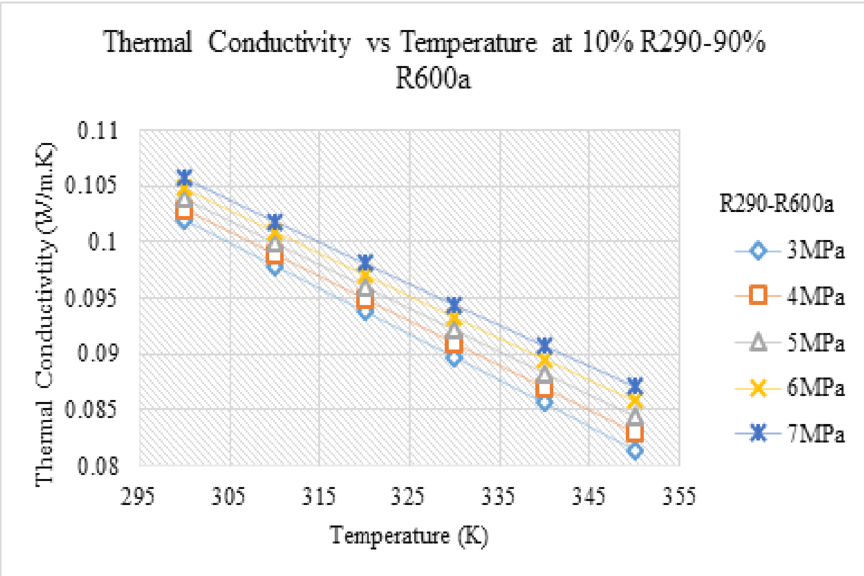

Figure5.Thermalconductivityvs.temperatureatdifferent compositions

Figure5shows the variation of thermal conductivitywith respectto temperatureata compositionof10%-90%of amixedrefrigerantR290andR600a.Moreover,as theincreaseintemperaturethermalconductivityofamixed refrigerantisalsoincreases

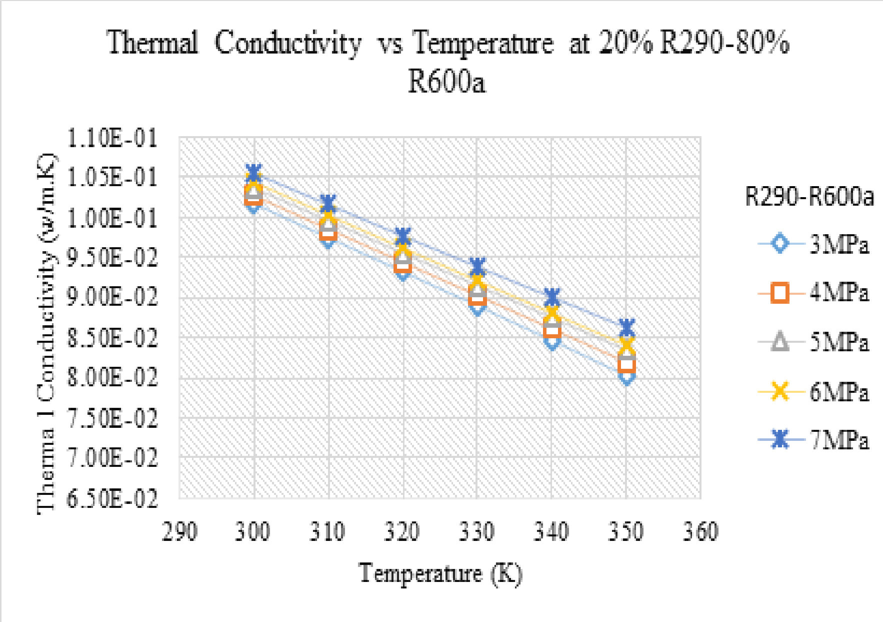

Figure6Thermalconductivityvs.temperatureatdifferent compositions

Figure6shows the variationof thermal conductivity with respecttotemperatureata compositionof 20%-80%of amixedrefrigerantR290andR600a.However,as theincreaseintemperaturethermal conductivityof amixed refrigerantisalsoincreases.

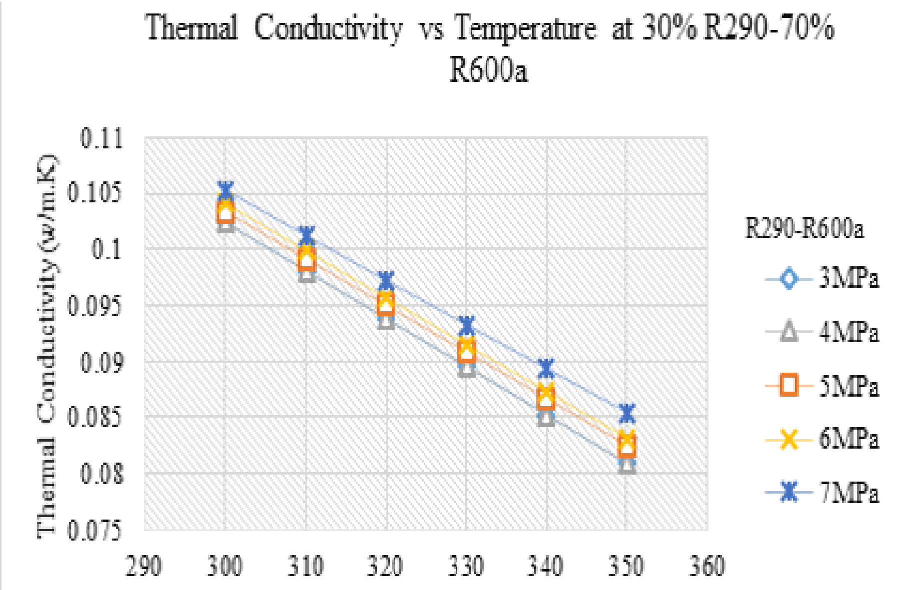

Figure7.Thermalconductivityvs.temperatureatdifferent compositions

Figure7representsthevariationofthermalconductivitywithrespecttotemperatureatacomposition of30%-70%of amixedrefrigerantR290andR600a.However,asthe increaseintemperaturethermal conductivity of amixed refrigerantisalsoincreases.

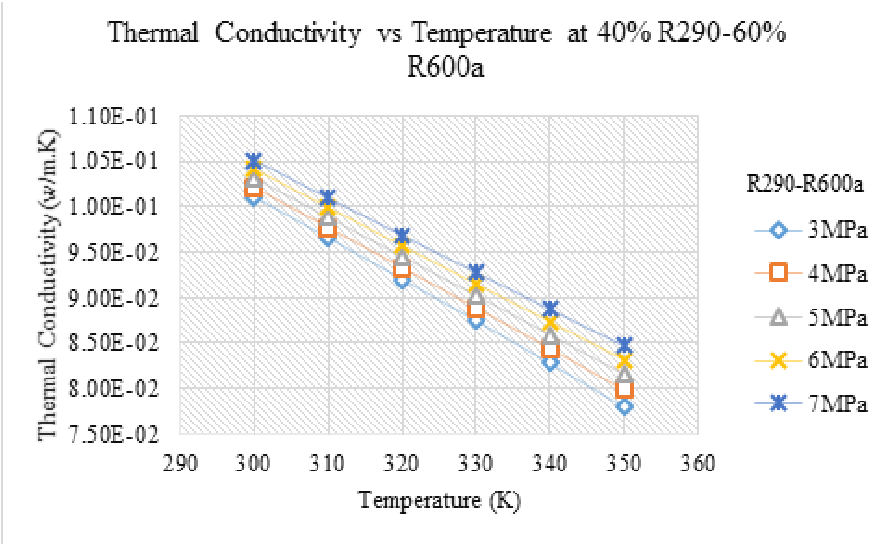

Figure8.Thermalconductivityvs.temperatureatdifferent compositions

Figure8shows the variationof thermal conductivity with respectto temperatureata compositionof 40%-60%of amixedrefrigerantR290andR600a.However,as theincreaseintemperaturethermal conductivityof amixed refrigerantisalsoincreases.

4.Conclusion

Inthepresentresearchwork,investigationonpressureeffectofmixedrefrigerantssuchaspropaneandISO-butaneareevaluatedatdifferentcomposition.Itwasconcludedthatasthatastheincreaseinthermalconductivity by 6.9%atconstanttemperature350K.Meanwhile,oppositetrendwasfollowedbythespecificheatdecreasefrom temperaturerangeof300-350Kanditreducesby5.2%reductionatconstanttemperature350Kinthe liquidregion.

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