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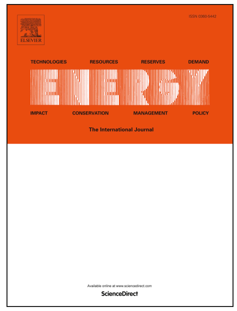

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Numerical investigation of heat transfer in a CO_2 two-phase ejector

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Abstract

In this paper, the influence of heat transfer in the walls of an R744 two-phase ejector on ejector performance was investigated. A numerical investigation was performed using a computational fluid dynamic (CFD) model of the R744 two-phase flow coupled with the heat transfer inside the ejector. An ejector equipped with thermocouple channels was designed and manufactured to investigate temperature distribution in the inner walls under boundary conditions typical for a refrigeration and air-conditioning application in a supermarket. The ejector was installed on the test rig to perform a test series that evaluated the outer walls of the ejector with and without insulation. The experimental results were used to validate the proposed CFD model, and a numerical investigation was performed to analyse the influence of heat transfer on ejector performance. The motive nozzle and suction nozzle mass flow rates accuracies were within ±7% and ±15%, respectively. In addition, the proposed CFD model predicted the wall temperatures with ±5 K accuracy for most of the validated points. The heat transfer coefficient of the R744 two-phase flow inside the ejector is presented. The non-adiabatic inner walls degraded ejector performance. The maximum reduction of the mass entrainment ratio reached approximately 13%.

Keywords: carbon dioxide, heat transfer, CFD model, two-phase ejector, heat transfer coefficient, experimental investigation

Nomenclature

c specific heat, J/(kg·K)

E total enthalpy, J/kg

GCI grid convergence index, -

h total specific enthalpy, J/kg

HTC heat transfer coefficient, W/(m^2·K)

k thermal conductivity, W/(m·K)

$\dot{m}$ mass flow rate, kg/s

p pressure, Pa

T temperature, K

$\mathbf{u}$ velocity vector, m/s

q heat flux, W/m^2

$\dot{W}$ expansion work rate, W

x vapour quality, -

Greek Symbols

α void fraction

χ mass entrainment ratio

Δ absolute difference

δ relative difference, %

η ejector efficiency, %

μ dynamic viscosity, Pa·s

ϕ non dimensional pressure difference, -

ρ density, kg/m^3

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