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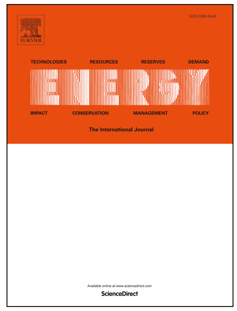

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A novel CFD approach for the computation of R744 flashing nozzles in compressible and metastable conditions

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ABSTRACT

The present paper describes a novel CFD approach for the flashing of CO_2 through nozzles and ejectors. The novelty of the method is represented by the possibility of defining both the liquid and vapor phases as compressible materials. The properties of each phase are obtained via look-up tables calibrated against standard fluid libraries and are valid in the whole domain of interest, including the supercritical, subcritical and metastable regions.

The model has been implemented within a commercial CFD solver and is completely general, i.e., it can be applied to any type of compressible multiphase flow. In the present study, the proposed approach has been validated against an experimental test-case available in literature.

Keywords: R744, flashing Nozzle, CFD, look-up tables, metastable properties

Nomenclature		Greek letters	
a	Speed of sound (m s^{-1})	α	Volume fraction
E	Energy	β	Mass fraction of the phase
f, g	Functions in Eq. 9	Γ	Source term
h	Enthalpy (kJ kg^{-1})	ε	Rate of turbulence dissipation
k	Turbulence kinetic energy	θ	Angle of diverging nozzle (°)
p	Pressure (Pa)	ρ	Density (kg m^{-3})
q	Conductive heat transfer	ς	Mass-specific thermodynamic property
T	Temperature (K)	τ	Shear stress (Pa)
t	Time (s)	χ	Volume-specific thermodynamic property
x	Coordinate (m)		
Y	Mass fraction of the species		
Superscripts/subscripts		Acronyms	
c	Condensation	CFD	Computational Fluid Dynamics
e	Evaporation	EOS	Equation Of State
eff	Effective	EXP	Experimental
l	Liquid	HEM	Homogeneous Equilibrium Model
m	Mixture	HFO	Hydro-Fluoro-Olefin
sat	Saturation	SST	Shear Stress Transport
v	Vapor	UDF	User Defined Function
		UDRGM	User Defined Real Gas Model

1. INTRODUCTION

The use of ejectors to improve the efficiency and capacity of vapor compression chillers has seen a renewed interest from both industry and academy in recent years. One of the fluids that benefits the most from the