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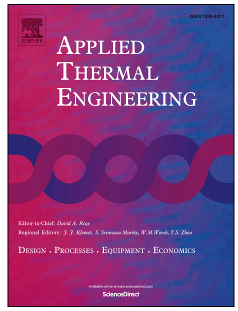

Ejector Primary Nozzle Steam Condensation: Area Ratio Effects and Mixing Layer Development

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Ejector Primary Nozzle Steam Condensation: Area Ratio Effects and Mixing Layer Development [this is the new, preferred title]
Effect of Area Ratio on Simulated Performance of Wet Steam Primary Nozzles for Ejector Applications

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Abstract

Recent ejector simulations based on wet steam modeling give significantly different performance figures relative to ideal gas modeling, but the origins of such differences are not clear. This paper presents a numerical investigation of flow in the primary nozzle of a steam ejector to further explore the differences between ideal gas and wet steam analysis of ejector flows. The wet steam modeling was first validated using primary nozzle surface pressure data from three experiments reported in the literature. Ejector primary nozzles with area ratios (AR) of 11, 18 and 25 were then simulated using wet steam and ideal gas models. The wet steam simulations show that nozzle static pressures are higher than those for ideal gas model, and in the AR = 25 case, the static pressure is larger by a factor of approximately 1.7. In contrast, no significant difference exists between the nozzle momentum flux for both ideal gas and wet steam models, except the vicinity of the nozzle throat where nucleation occurs. Enhanced mixing between primary and secondary streams, which arises because primary stream condensation reduces compressibility in the mixing layer, is proposed as an explanation of the increased entrainment ratio observed in recent wet steam ejector simulations.

Keywords: steam ejector, nozzle, steam condensation, nucleation, CFD, mixing

Nomenclature

Latin letters

A	stream-wise cross-sectional area of the nozzle, m^2
A_t	cross-sectional area of the nozzle throat, m^2
a	speed of sound, m/s
B	virial coefficients, m^3/kg
b	nozzle throat diameter, m
C	virial coefficients, m^6/kg^2
C_μ	viscosity related constant
c_p	isobaric heat capacity, J/kg.K
E	total energy, J
h_{lv}	specific enthalpy of vaporization, J/kg
I	nucleation rate, # droplets/m^3.s
K_b	Boltzmann constant 1.3807*10^{-23}, J/K
k	turbulent kinetic energy, J/kg
M	molecular mass, kg/mol