Condensation of multicomponent mixtures

Citation for published version (APA):

Document status and date:
Published: 01/01/1996

Document Version:
Accepted manuscript including changes made at the peer-review stage

Please check the document version of this publication:

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Download date: 02. May. 2019
Introduction

If condensation occurs in air-steam mixtures the transferred heat is high because of the release of latent heat. The presence of inert gases causes temperature differences at the condensate interface which affects the surface tension. When a second volatile component is added to the gas mixture, the induced Marangoni flows are even higher. Addition of ethanol, \( x = 0.002 \), yields internal drop flows that are at least three times higher in magnitude.

Aims research

- quantifying the heat transfer enhancement by addition of surface active species
- measuring drainage, drop coalescence and interface and surface temperatures for various mixture conditions

Experimental

Heat exchanger

- Multicomponent mixtures are condensed under well defined conditions in the presence of inert gases in a plastic (PVDF) heat exchanger. Condensation is always dropwise on a polymer.
- Heat transfer is measured in two identical compartments, one with a volatile component.
- In-situ measuring of the interface is achieved with an infrared camera. Drainage and wetting behaviour are measured.

Peltier element

- Visualization of flows in a single droplet, which is a mixture of water and a volatile species (low concentration).

Results

Adding ethanol to air-steam mixture yields

- an increase of heat transfer by \( \pm 5\% \)
- the expected decrease of the interface temperature
- 30\% decrease of the average droplet diameter
- an increase of wetted area by 15\%

Conclusions

Addition of ethanol in low concentrations influences the wetting and the heat resistance of the condensate. The heat flow rate is increased because the drop heat resistance is decreased and the average interface temperature is lowered.

References: