Challenges of Process Condenser Design

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Overview

- Current design practices
  - Pure components
  - Mixtures
- Current HTRI research initiatives
- Improving future air cooled condenser designs
  - Optimizing fin and bundle designs
  - Improving fan efficiencies
  - Augmenting heat transfer on hot summer days

Condenser Design Practices
Pure components

- Minimize pressure drop
  - Maximize mean temperature difference
- Drain condensate
  - Avoid excessive condensate loading
  - Facilitates removal of non-condensables
- Remove non-condensables
  - Vent located at coldest temperature location

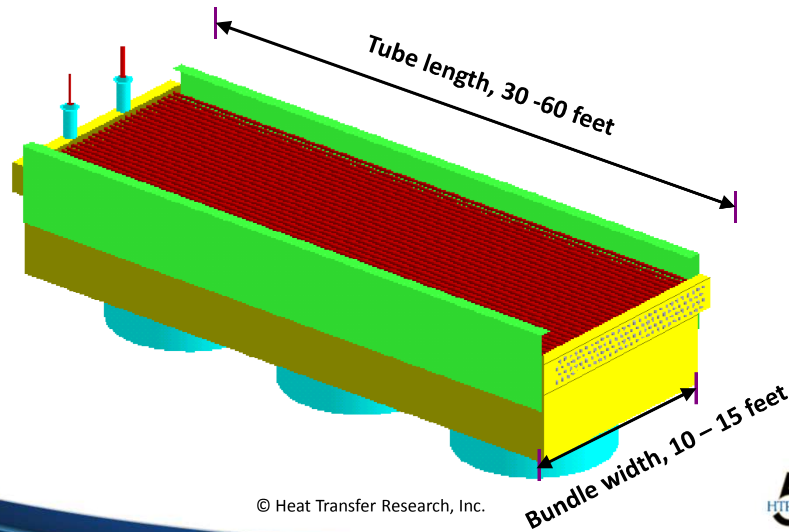
Typical steam cycle condenser applications

Condenser Design Practices
Mixtures

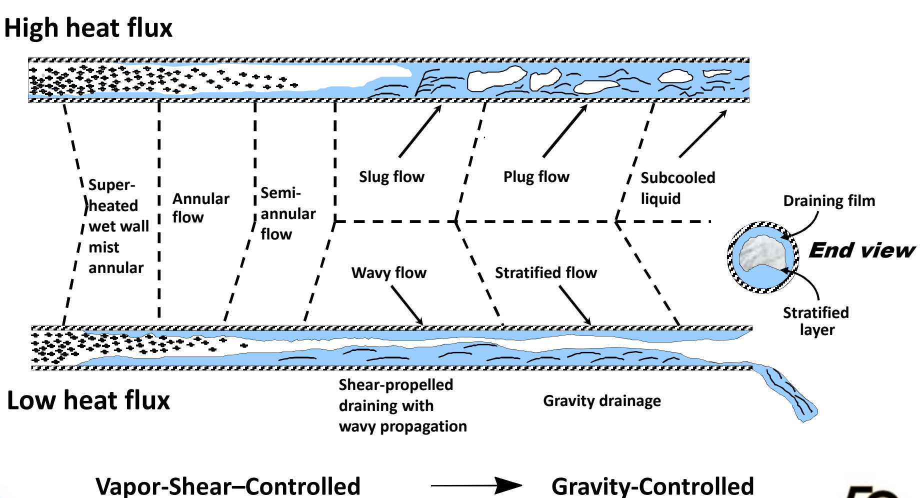
- Use all allowable pressure drop
  - Maximize heat transfer coefficient
  - Vapor phase resistance may dominate
- Maintain adequate velocities
  - Vapor/liquid swept from exchanger

Binary hydrocarbon and Kalina cycles

API Air Cooler Geometry

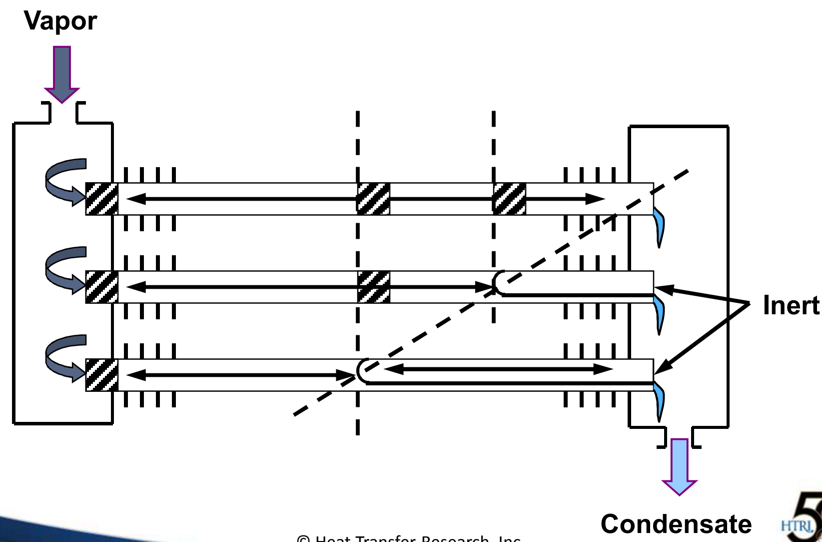


Horizontal Intube Condensation



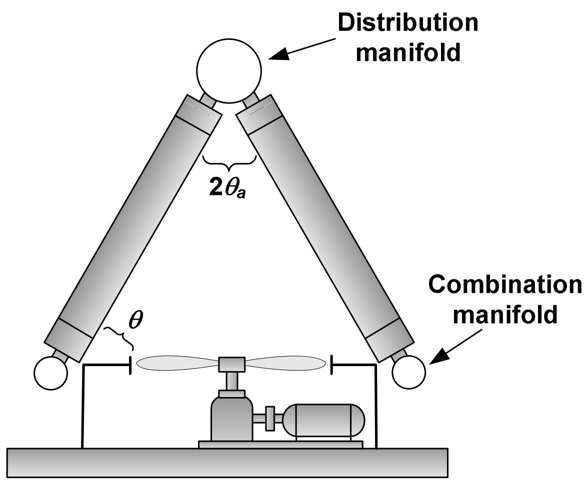
Condensing Backflow

Inert Accumulation in API Air Coolers

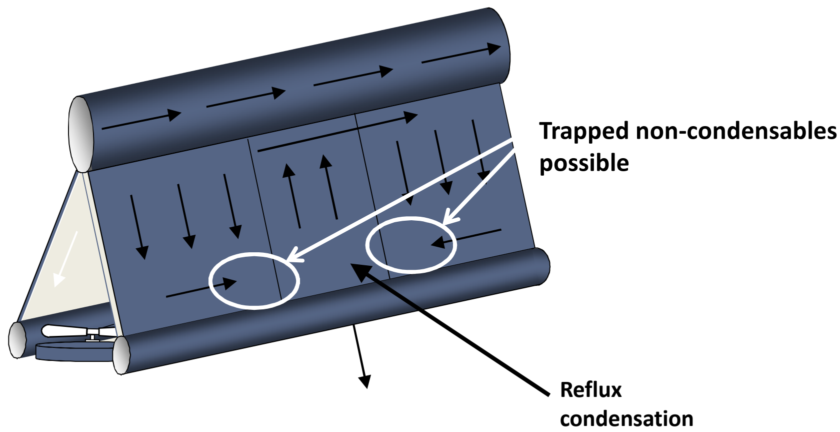


A-frame Condensers

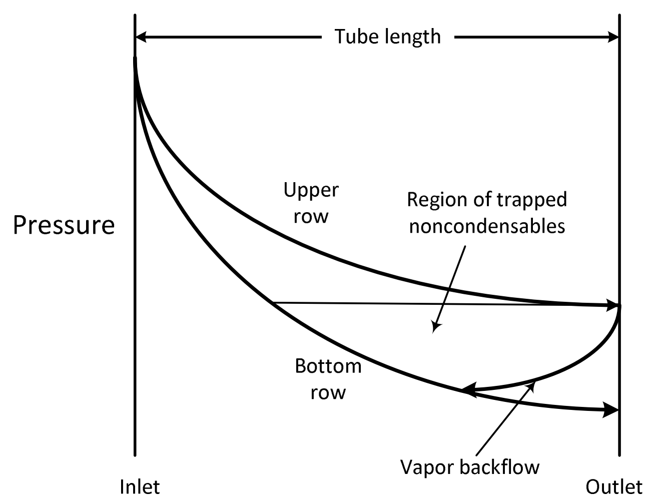
Geometry



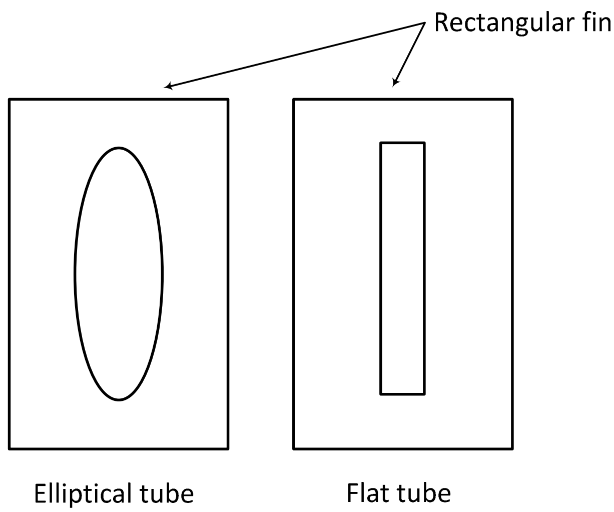
Tubeside Flow Path with Reflux



Trapped Non-condensables



A-frame condenser tubes

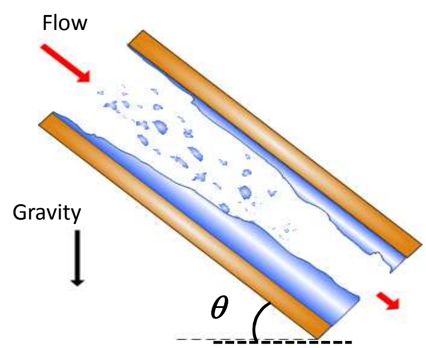


Fewer tube rows needed than for circular tubes

Current HTRI research

Performance in inclined tubes

- Inclined circular and elliptical tube condensation
  - What is the performance with higher condensate loading?



Current HTRI research

Vacuum condensation pressure drop

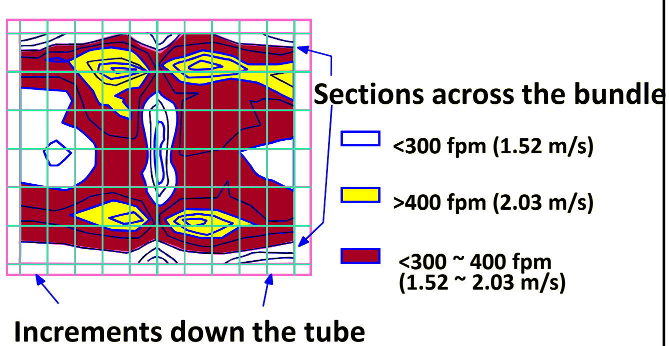
$$\Delta P = \Delta P_s + \Delta P_f + \Delta P_m$$

- Friction pressure drop and momentum recovery are comparable in vacuum
  - Better estimates of momentum recovery needed
- Static pressure drop neglected for downflow
  - Included in the reflux region

Current HTRI research

Airside maldistribution

- What design changes can reduce airside maldistribution and improve performance?
  - Plenums
  - Fan rings
  - Wind walls



Improving future air cooled condenser designs

- Optimizing fin and bundle design
  - Fin heights, downflow tubes versus reflux tubes, tube size
  - Minimize plot area
  - Reduce fan power
- Improving fan efficiencies
  - Reduce noise and required power
- Augmenting performance on summer days
  - Fin surface texture enhancements
  - Other strategies?