Atypical Fluid Behavior on the Liquid Side of the Saturation Line of CO2 With Implications for Compressor Design

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- sCO2 turbomachinery design requires a complicated equation of state
  - NIST REFPROP is “gold standard” for accuracy
    - Computational costs are very high
  - Table interpolation method often used
    - Method used in Concepts NREC’s product line is locally refined cells near the saturation line
      - Accurate, robust, fast
- Properties of CO2 are highly non-linear near the critical point
- Properties on liquid side of saturation dome are also super non-linear
  - Speed of sound is the dominate non-linear effect on the liquid side
- One dimensional nozzle studies used to determine flow behavior
- CFD results show choking can occur as Mach numbers well below 1.0
- Shock like behavior occurs at Mach numbers far below 1.0
- Effects confirmed with 1D calculations using REFPROP
- Nonlinear effects on the liquid side of the saturation dome can pose significant risks for sCO2 compressor designs