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A Mathematical Model for the Simulation of Two-phase Compression in Thermal Non-equilibrium

REGEN by 2

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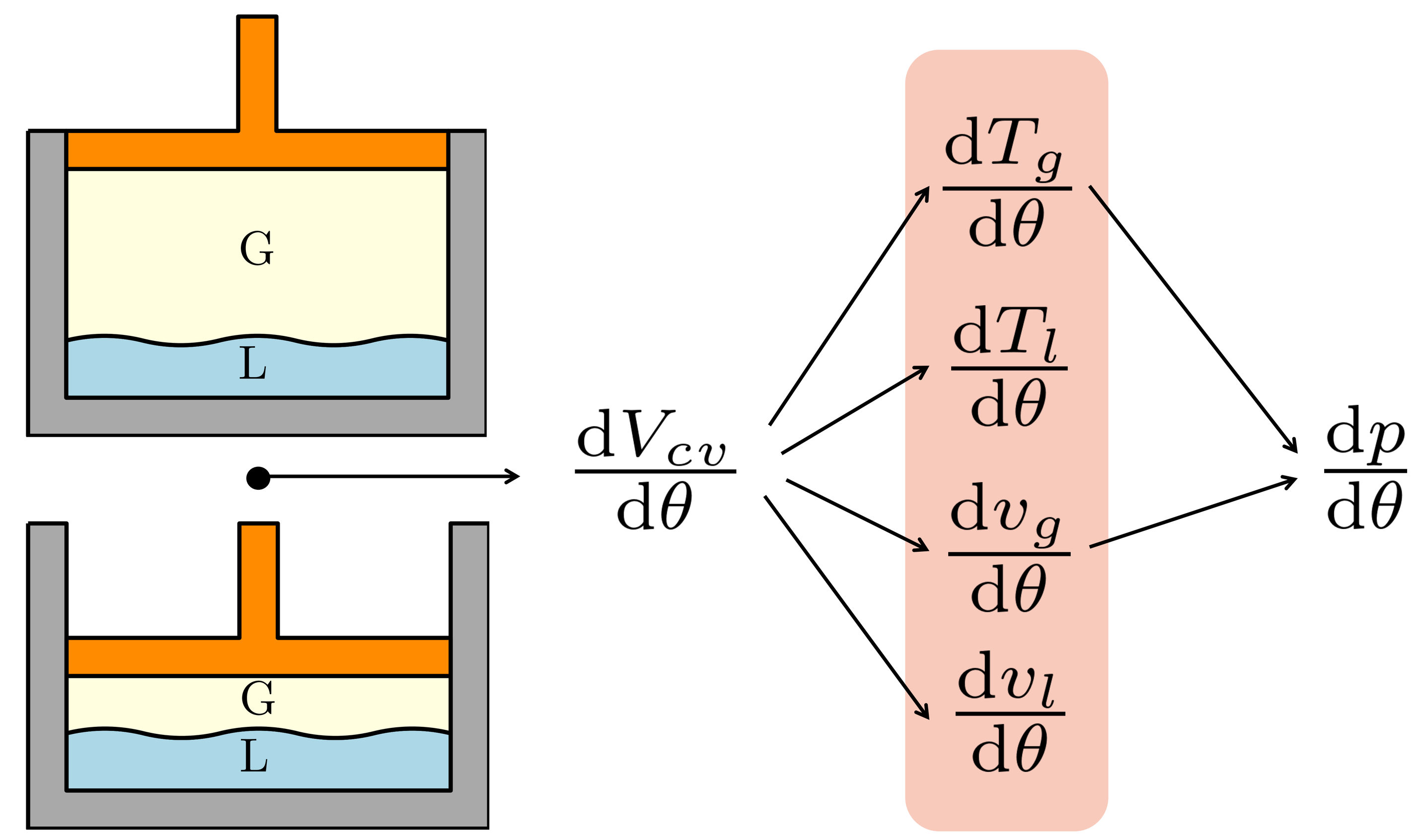
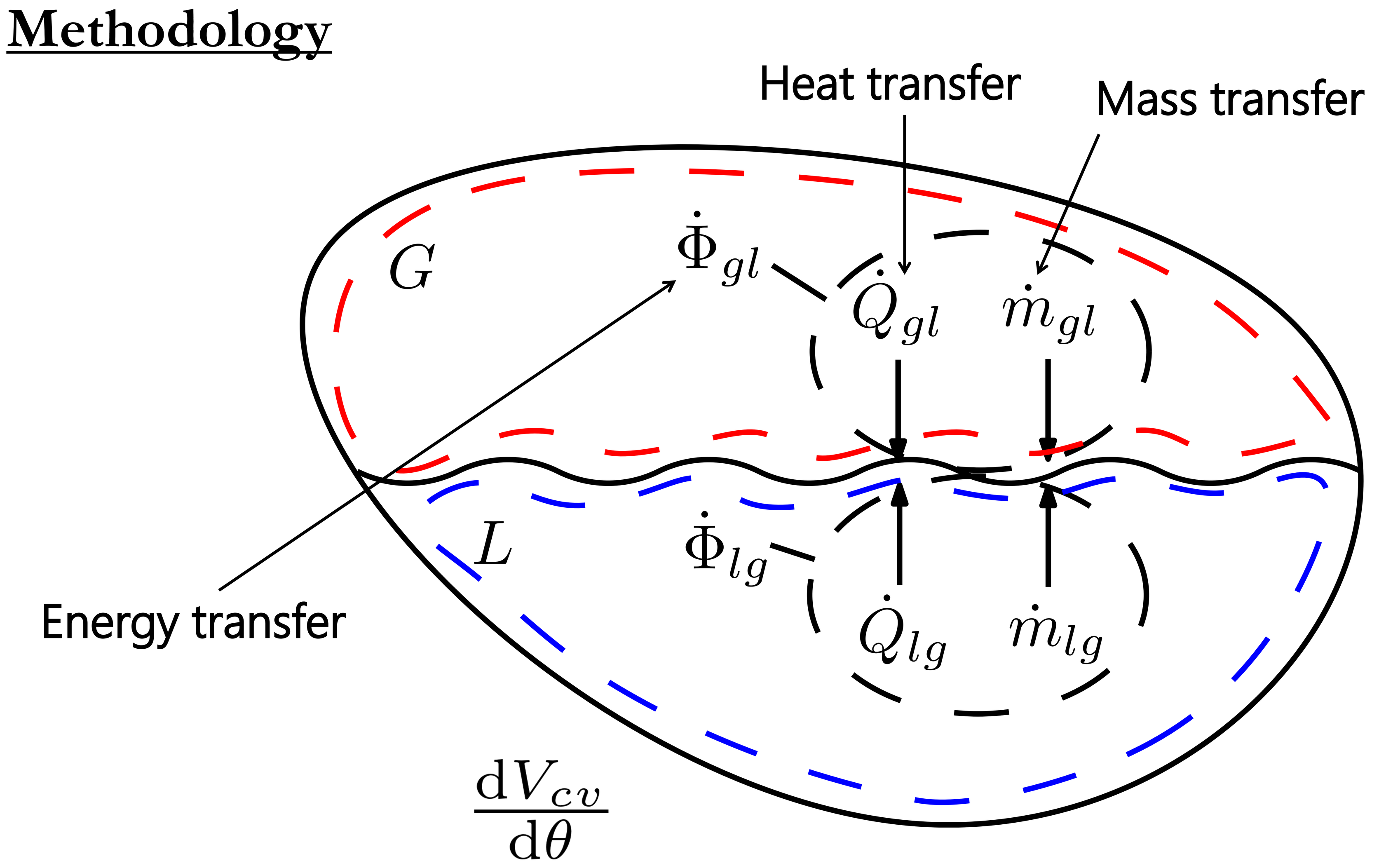
Context

- **Core model** describing a two-phase pure-refrigerant compression with the shaft angle of any displacement machine (θ)
- **Input**: variation rate of the control volume (cv)
- **Outputs**: evolution of the pressure and vapour (G) / liquid (L) phases temperatures
- **Thermal non-equilibrium** between the liquid and vapour phases (different temperatures) but same pressure



Methodology



- Increase of the vapour phase temperature due to the compression **creates a thermal non-equilibrium** between both phases
- **Heat transfer** generated
- Induces **mass transfer**
- **Energy and mass balances** applied in the extended control volumes of each phase and at the interface
- **Backward Euler** method applied to obtain the new state after each angle step ($d\theta$)

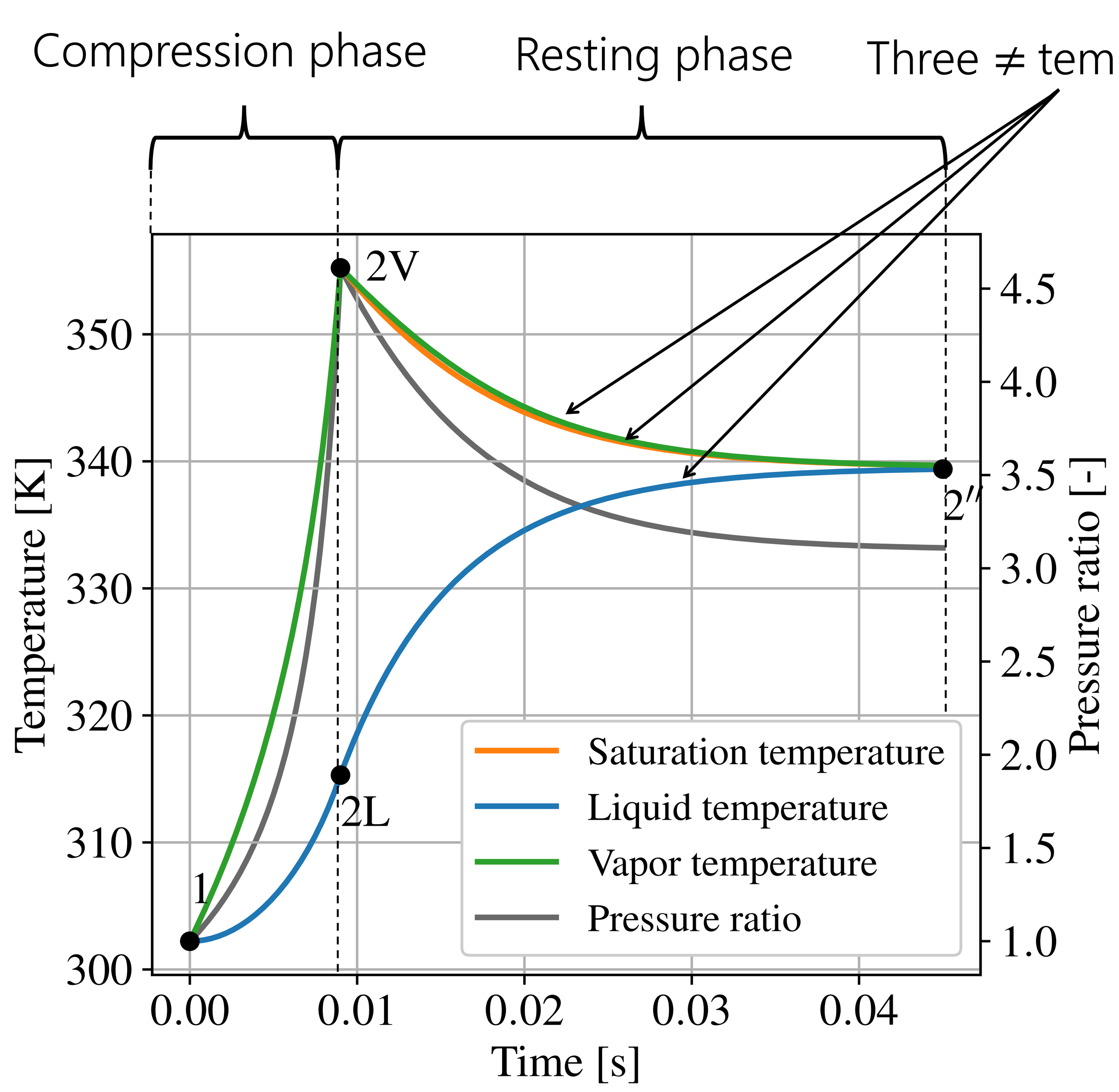
$$\rho_g(\theta), T_g(\theta) \qquad \rho_l(\theta), T_l(\theta)$$

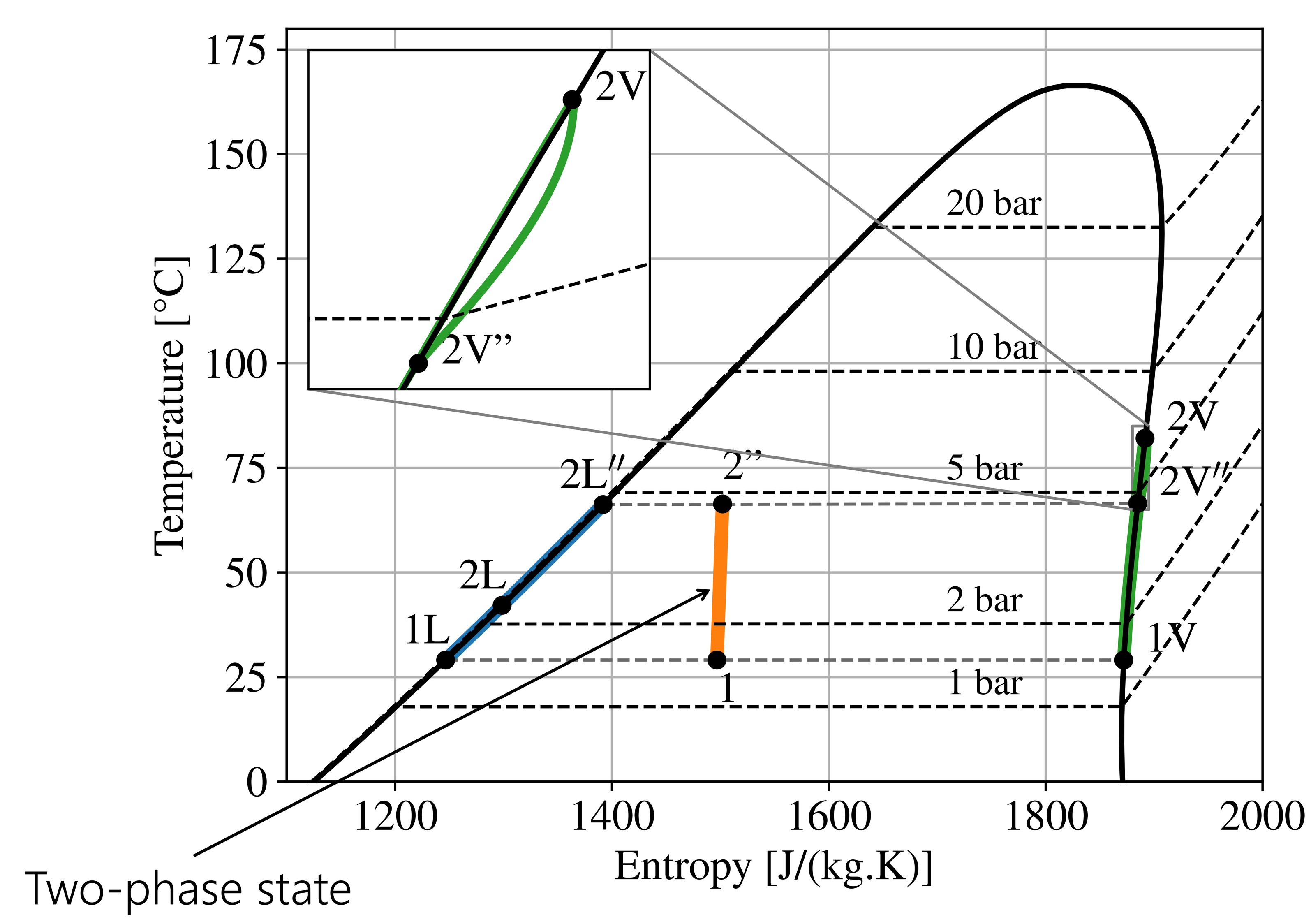
Results

Three ≠ temperatures → Co-existence of a superheated vapour phase with a subcooled liquid phase during the resting phase

Case study

- Fluid: R1233zd(E)
- Initial vapour quality: 0.4
- Initial pressure: 1.5 bar
- Volume ratio: 5





Conclusion

- The results strongly **rely on the heat transfer coefficient** between the two phases
- The studied case shows an **isentropic efficiency** of 86.45%, even if the compression is adiabatic → **irreversibilities** created with the non-equilibrium

Future work

- Integration into a **deterministic model** of scroll compressor, accounting for leakages, friction losses, pressure losses, heat transfer
- **Validation** with experimental data on the isentropic/volumetric efficiencies + internal dynamic pressure measurements

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