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Investigations of Efficiency Losses Due to Control of Variable Displacement Compressors

Axel Müller[#], Norbert Stulgies*, Sven Försterling°, Wilhelm Tegethoff*, Jürgen Köhler*

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[#] Thomas Magnete GmbH, * TU Braunschweig, ° TLK-Thermo GmbH

Outline

1. Model and boundary conditions
2. Control concepts and simulation results
3. Conclusion

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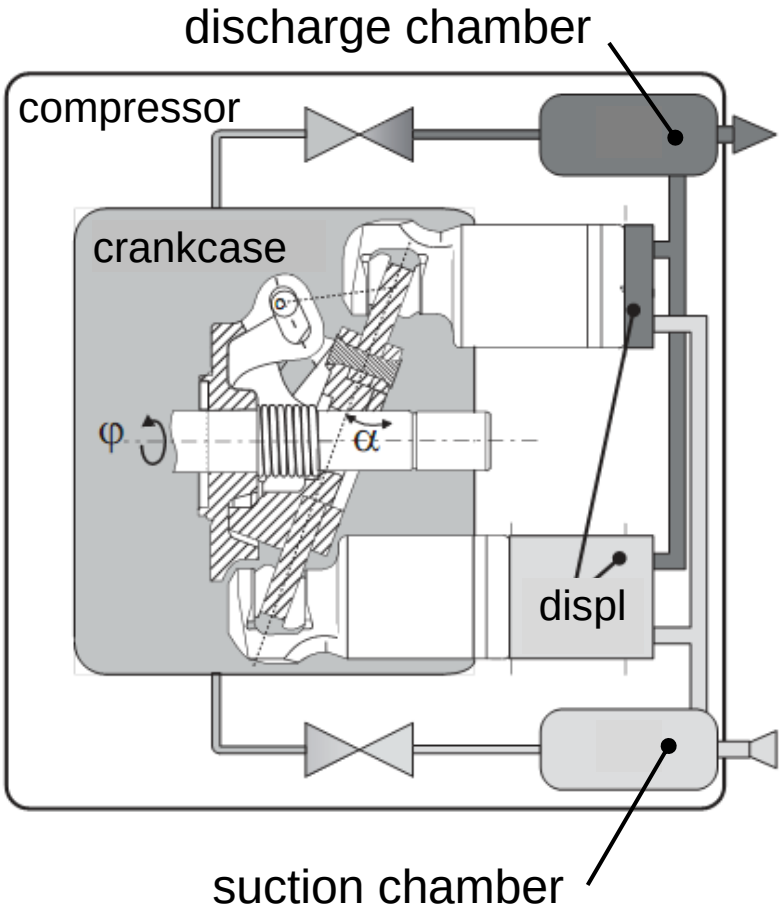
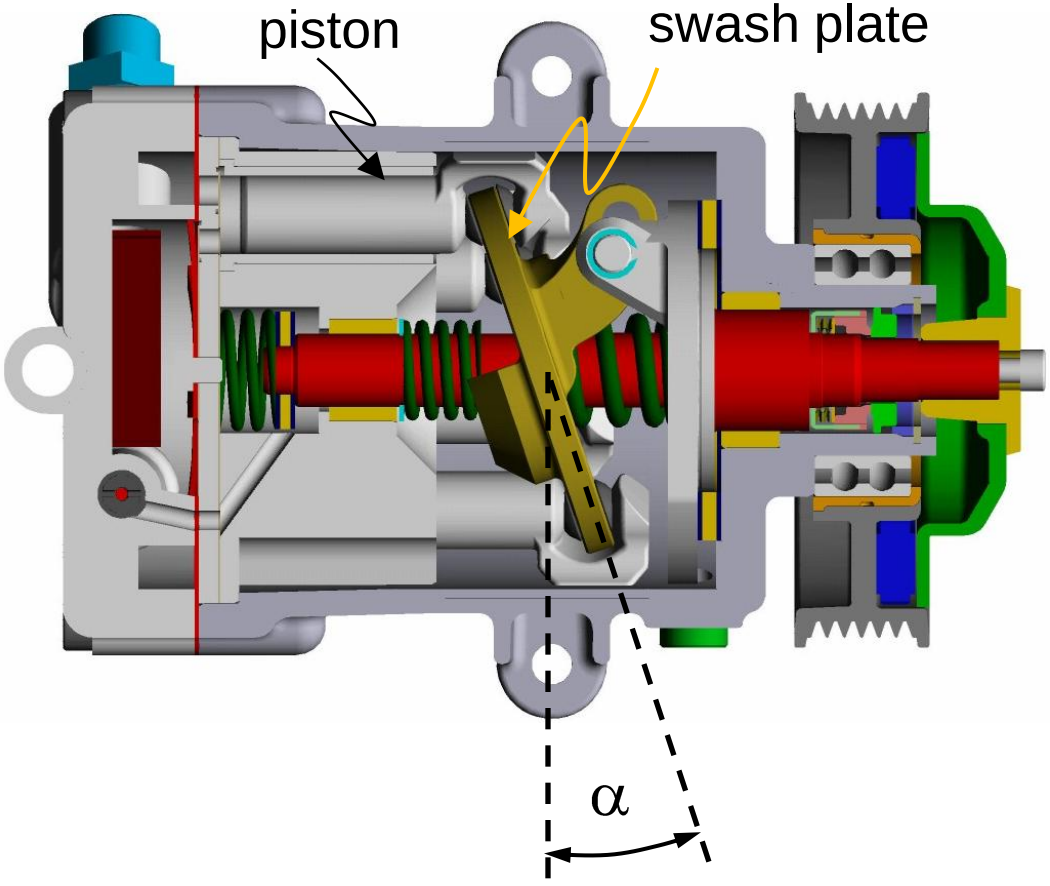
Functional sketch / cross section of an axial piston compressor





Source: [Magzalci 05]

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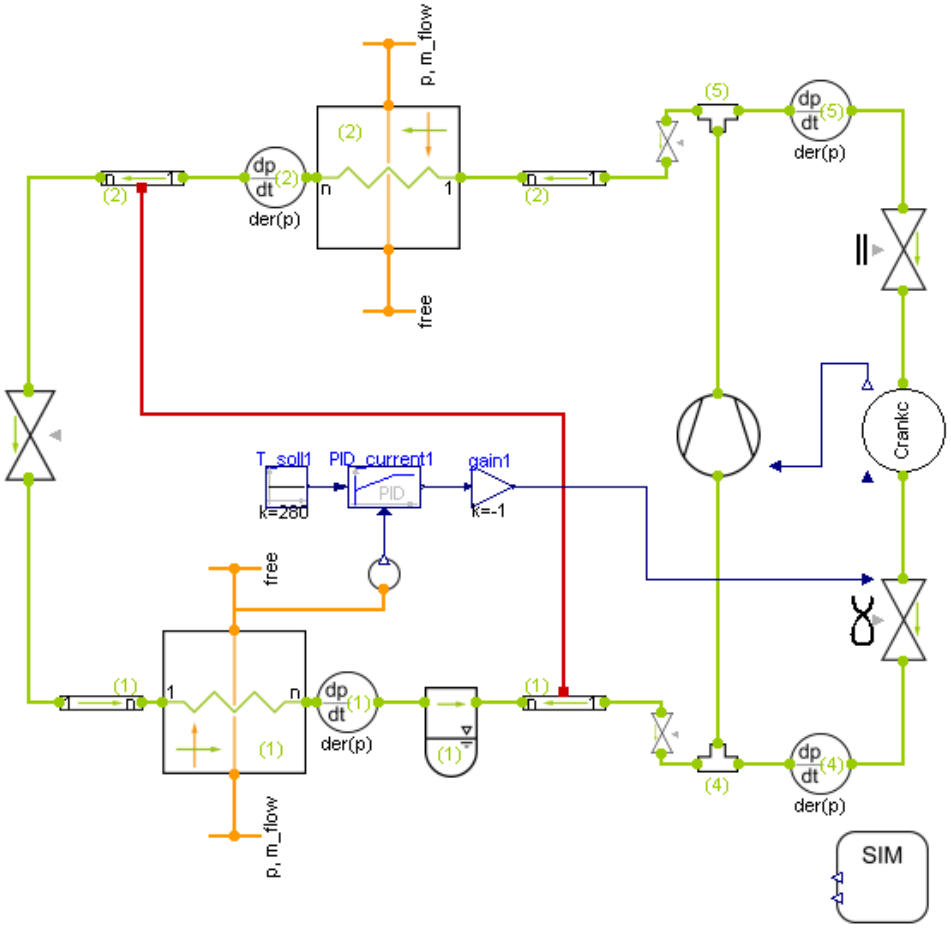
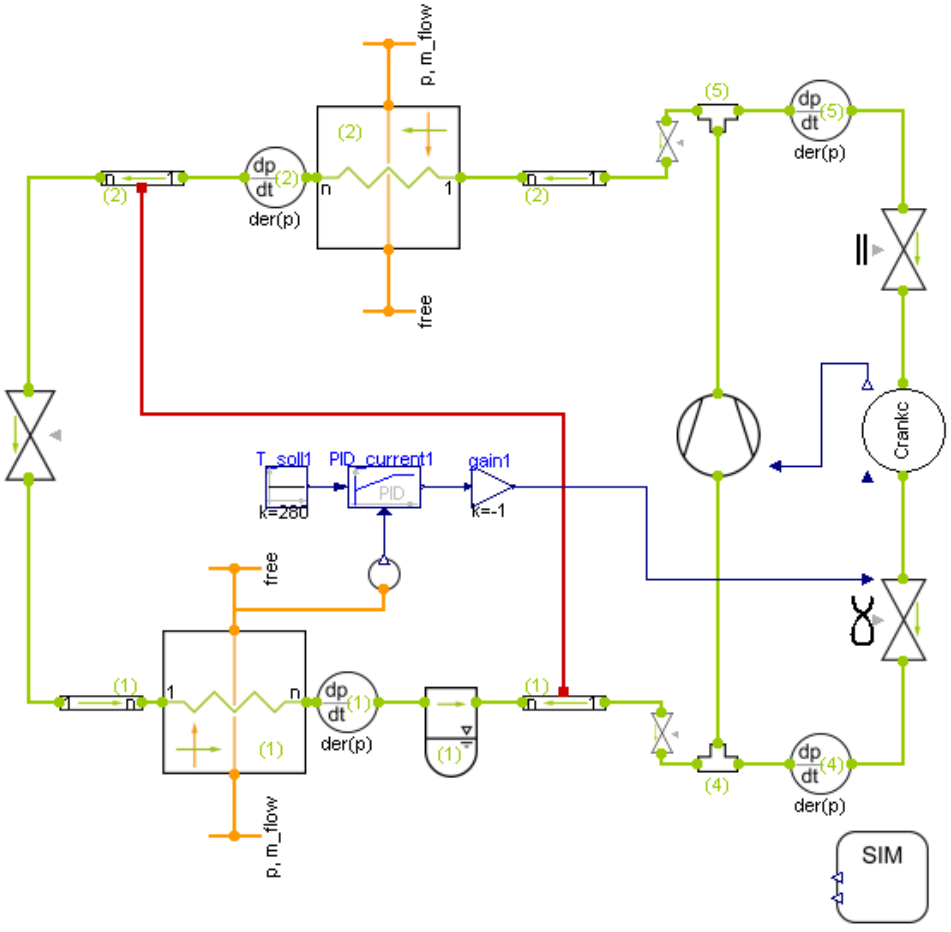
Refrigerant Cycle in Modelica



Model written in Modelica

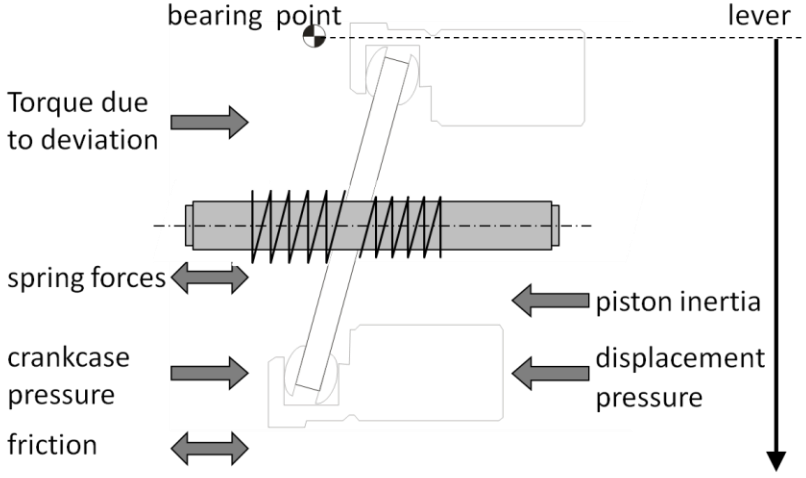
Thermal component TIL library

Refrigerant Cycle in Modelica



Model written in Modelica

Thermal component TIL library



Boundary Conditions

Boundary conditions for simulation in order to investigate power input:

- transient compressor speed according to Common Artemis Driving Cycle (CADC, total cycle time 3141s)
- two steps of power reducing
    1) decreasing evaporator air mass flow rate: ramp from 8 kg/min (17.6 lbs/min) at 150s to 5 kg/min (11 lbs/min) at 250s,
    2) increasing evaporator air set point temperature: ramp from 2°C (35.6°F) at 250s to 11°C (51.8°F) at 350s
- ambient temperature 28°C (82.4 °F)

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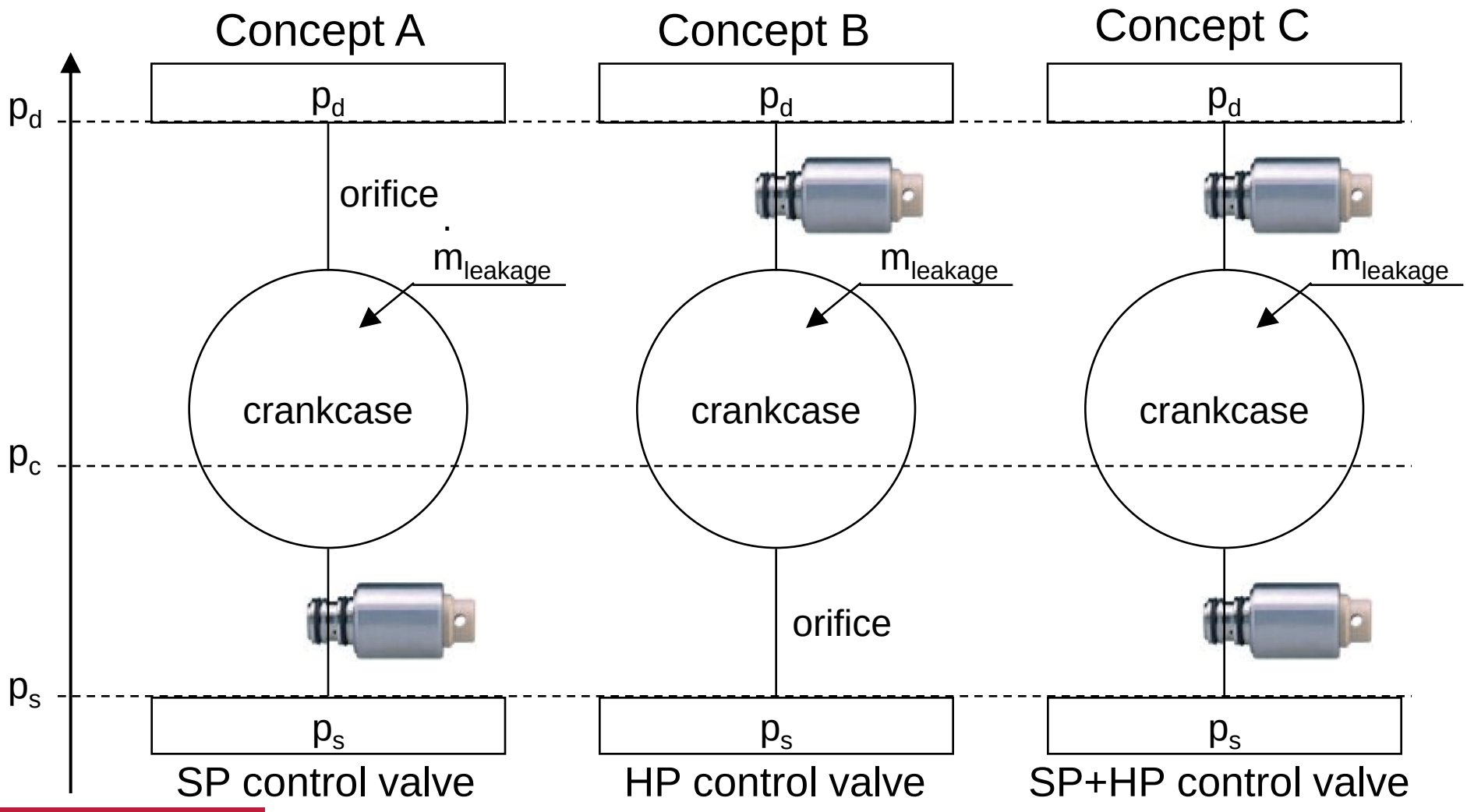
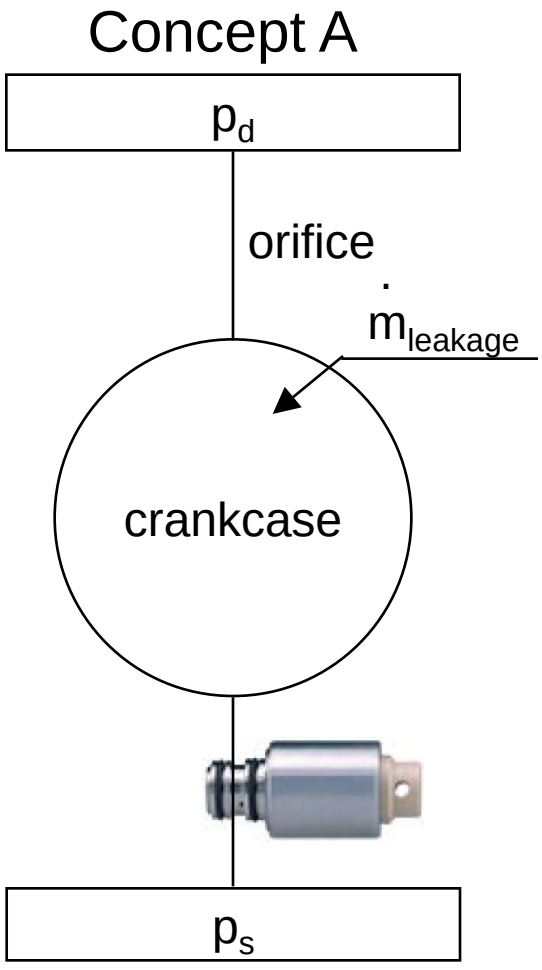
Concepts of control strategy



SP control valve

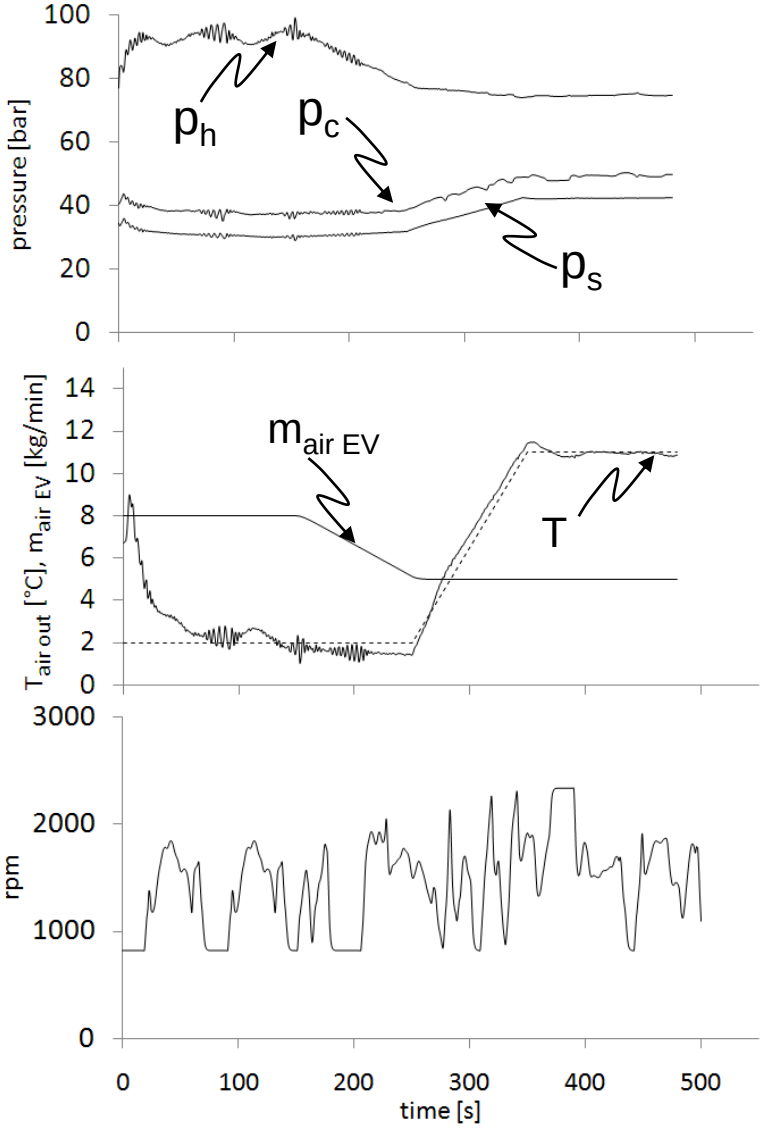
The limiting orifice design factor is the filling time of the crankcase

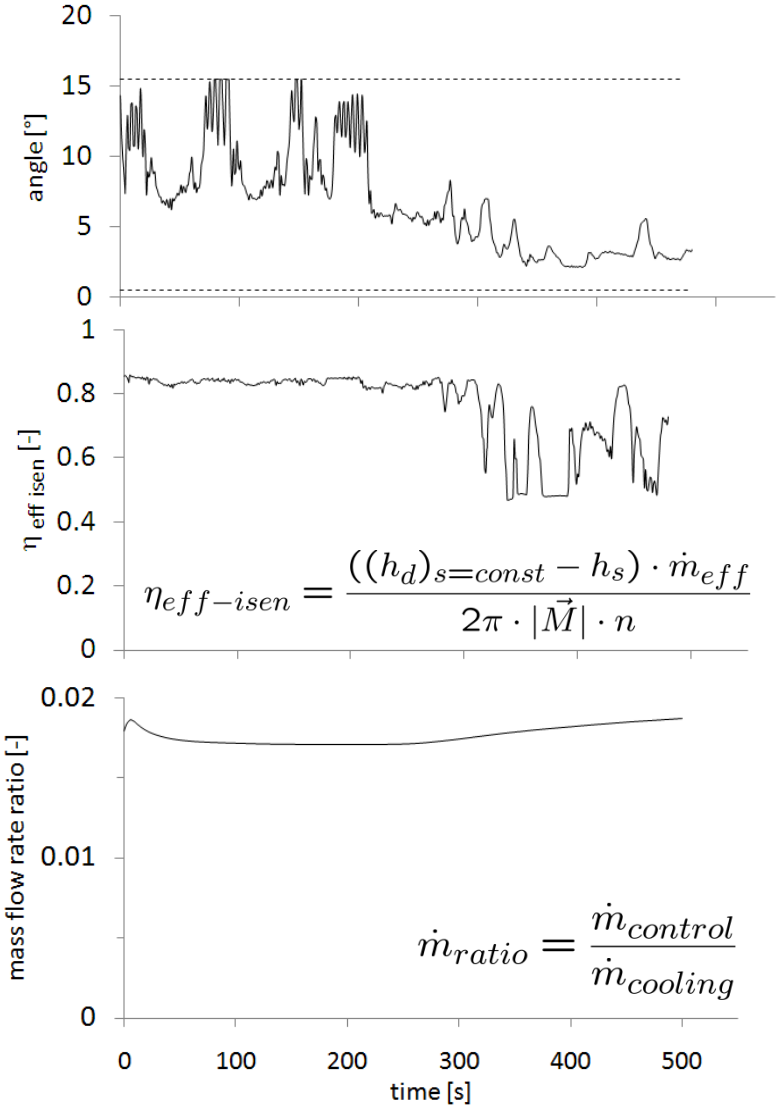
Control valve can be totally closed



SP control valve

Simulation and results - SP

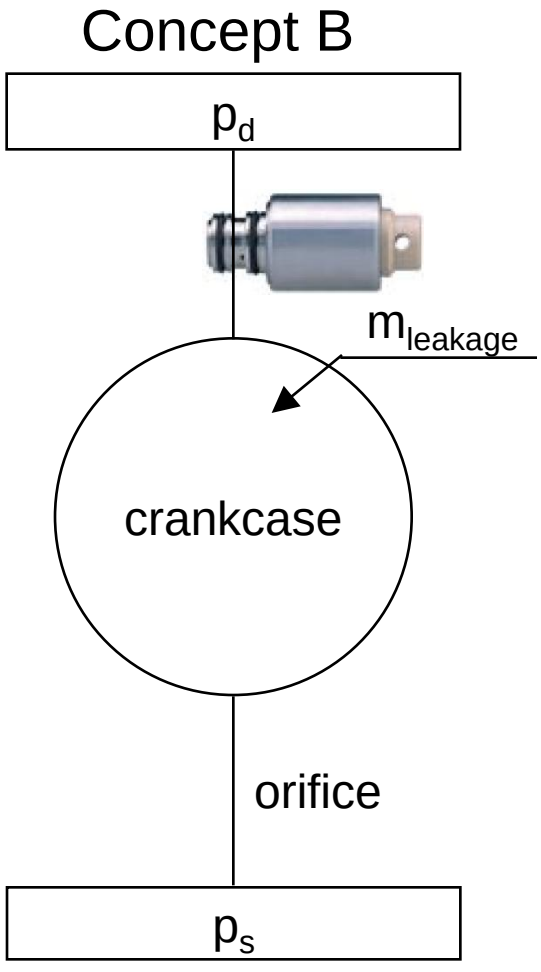




HP control valve

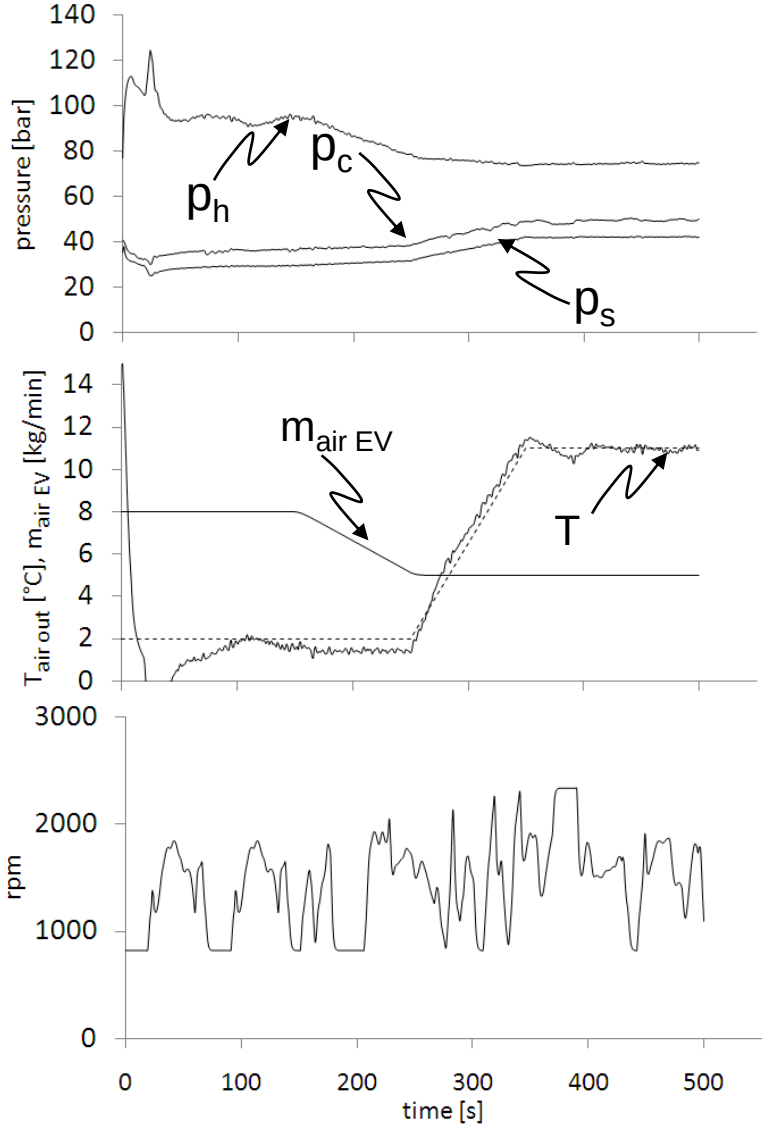
The limiting orifice design factor is the emptying time of the crankcase

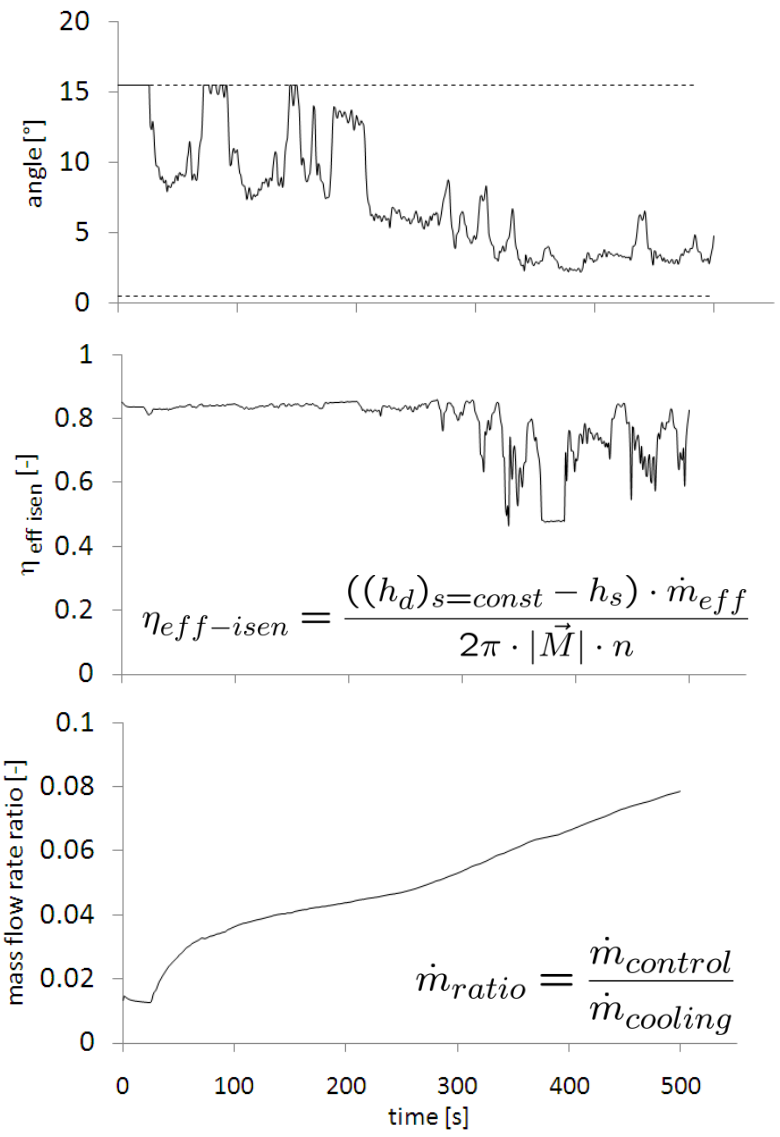
The mass inflow due to internal oil recirculation and piston leakage is taken into account



HP control valve

Simulation and results - HP

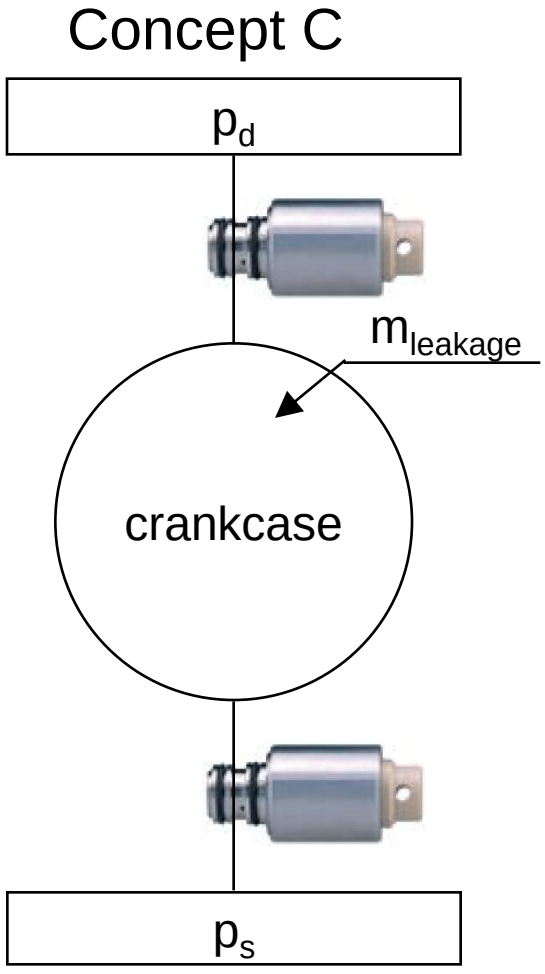




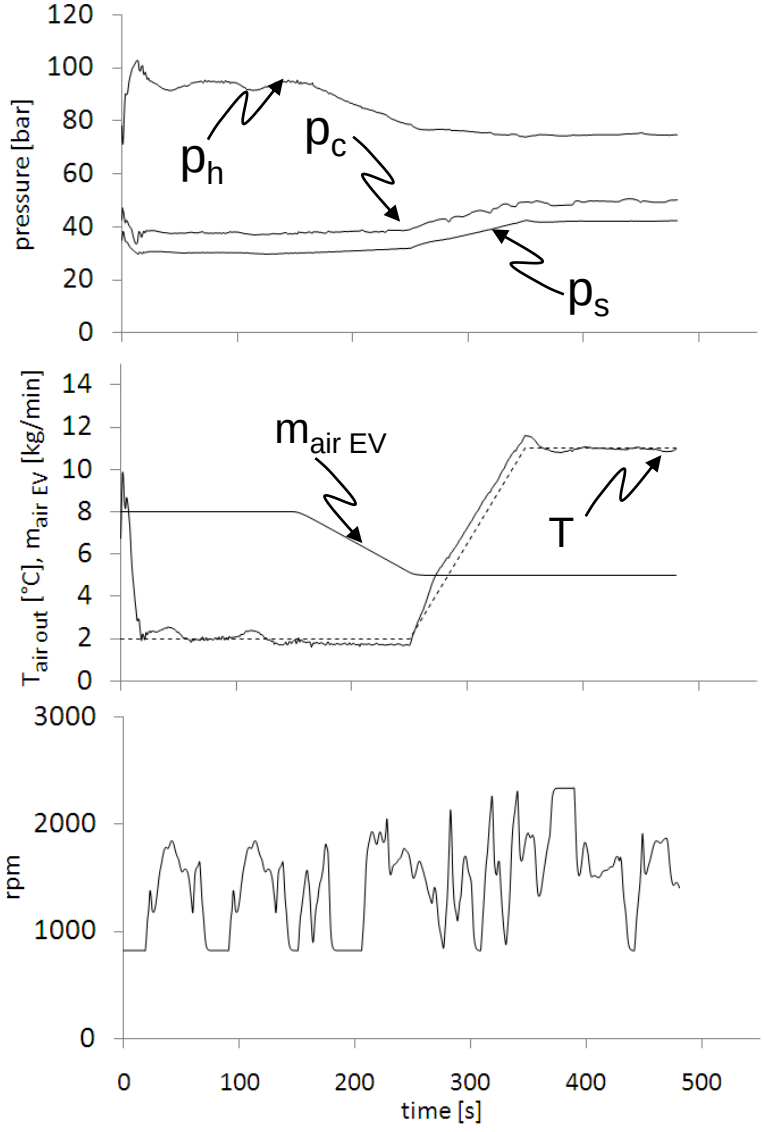
SP+HP control valve

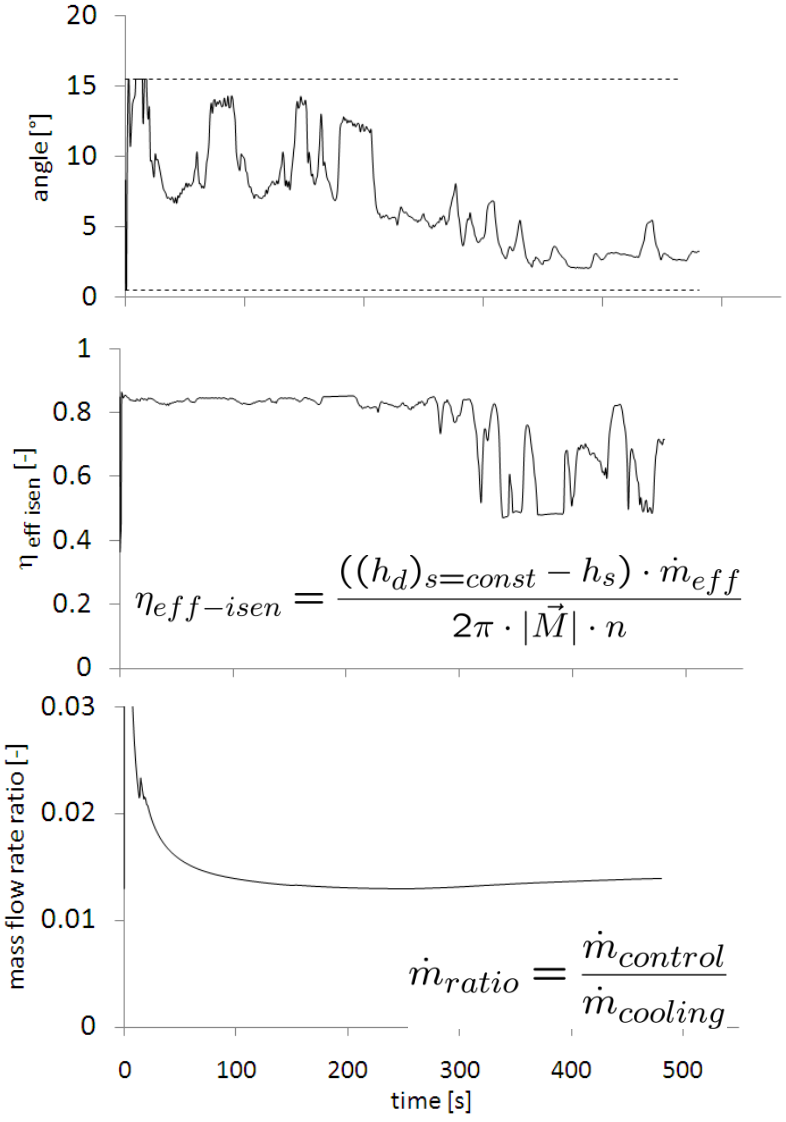
Discharge side:
The mass inflow due to internal oil recirculation and piston leakage is taken Into account

Suction side:
Control valve can be totally closed



Simulation and results - HP+SP





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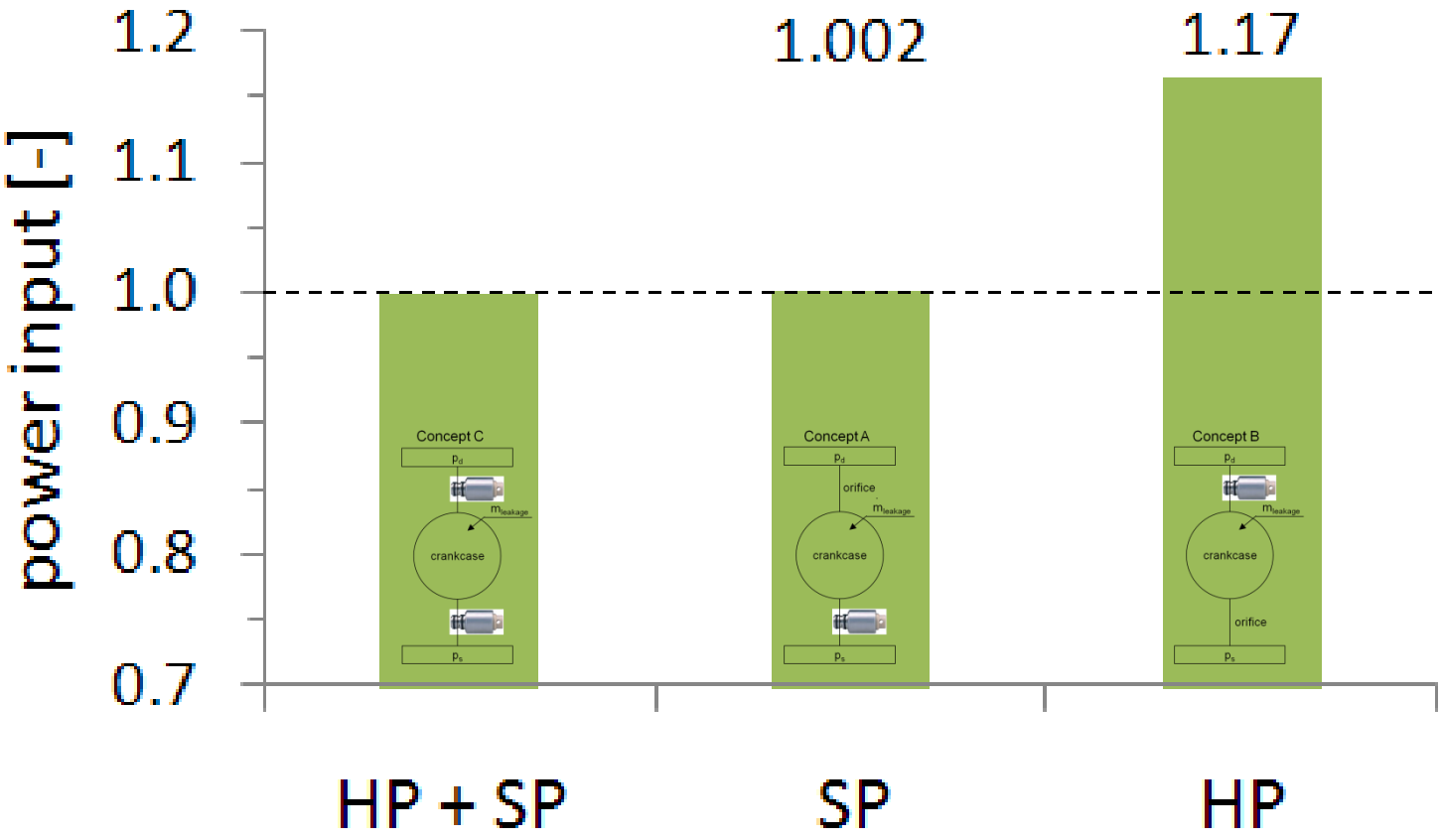
Integrated power input for the three concepts



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Conclusion

- A refrigerant cycle including a detailed swash plate compressor was modeled.
- Three concepts were investigated: control valve on suction side, control valve on high pressure side and control valves on both sides.
- Transient investigations were done by using Artemis driving cycle.
- The different control concepts were compared. SP concept needs 0.2% and HP concept needs 17% more power input than the concept with two valves.

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Thank you!

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