TECHNISCHE UNIVERSITÄT DRESDEN

Faculty of Mechanical Science and Engineering Bitzer Chair of Refrigeration, Cryogenics and Compressor Technology

The Scroll Machine

A Design for Compression and Expansion

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Principle of Operation

The main component of a scroll machine is its displacement device. It consists of two parallel scroll contours, each attached to a base plate.

The moving scroll is not rotating but it orbits on a circular path. The shape of the scrolls results in a crescentic working chamber. During compression mode the working chamber moves to the center of the scroll while being reduced in size and thus the working fluid is compressed.

By reversing the movement of the orbiting scroll, the working chamber moves to the outside of the scroll while being enlarged. The working fluid is expanded.

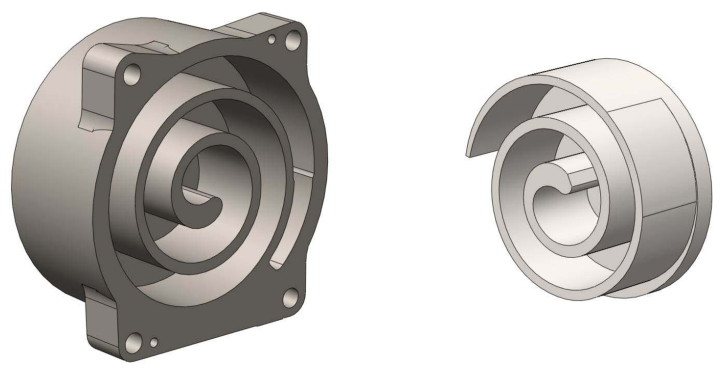

Fig. 1: Scroll set – fixed (left) and orbiting (right) scroll

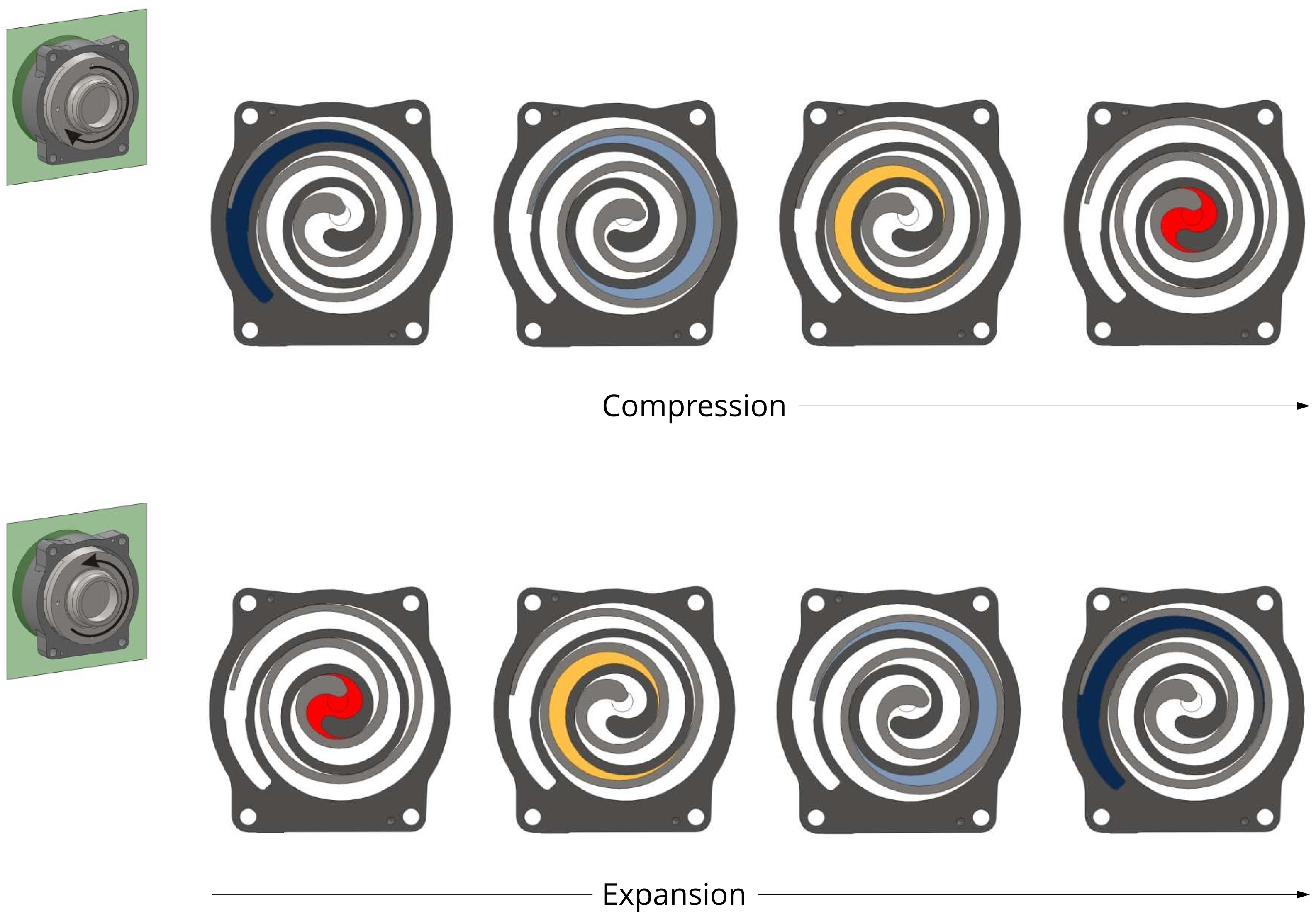

Fig. 2: Cross-sectional view of the compression process (upper) and expansion process (lower)

Advantages and Challenges

Scroll machines have a reduced number of moving parts. The continuous compression / expansion of its multiple chambers leads to a reduced pulsation, an even torque characteristic and favorable noise and vibration behavior. Scroll machines do not need any valves since the inlet and outlet is controlled by the scroll geometry. Both oil and refrigerant injection are possible for scroll machines.

Long gaps along the tip seals of scroll machines increase their internal leakage losses. Small production tolerances are required to reduce these losses. The built-in volume ratio of scroll machines leads to over-/under-compression (-expansion) losses for off-design pressure ratios. This leads to additional design measures (e.g. discharge valves or early discharge outlets) for highly variable operating conditions (e.g. automotive AC).

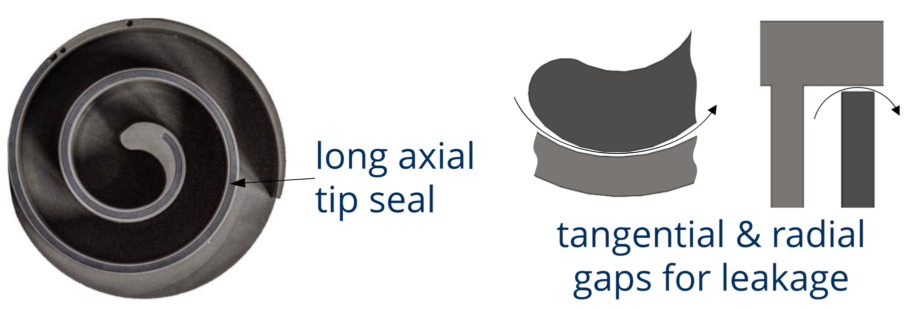

Fig. 3: Scroll with tip seal (left) and potential paths for internal leakage (right)

Examples for existing Scroll Machines

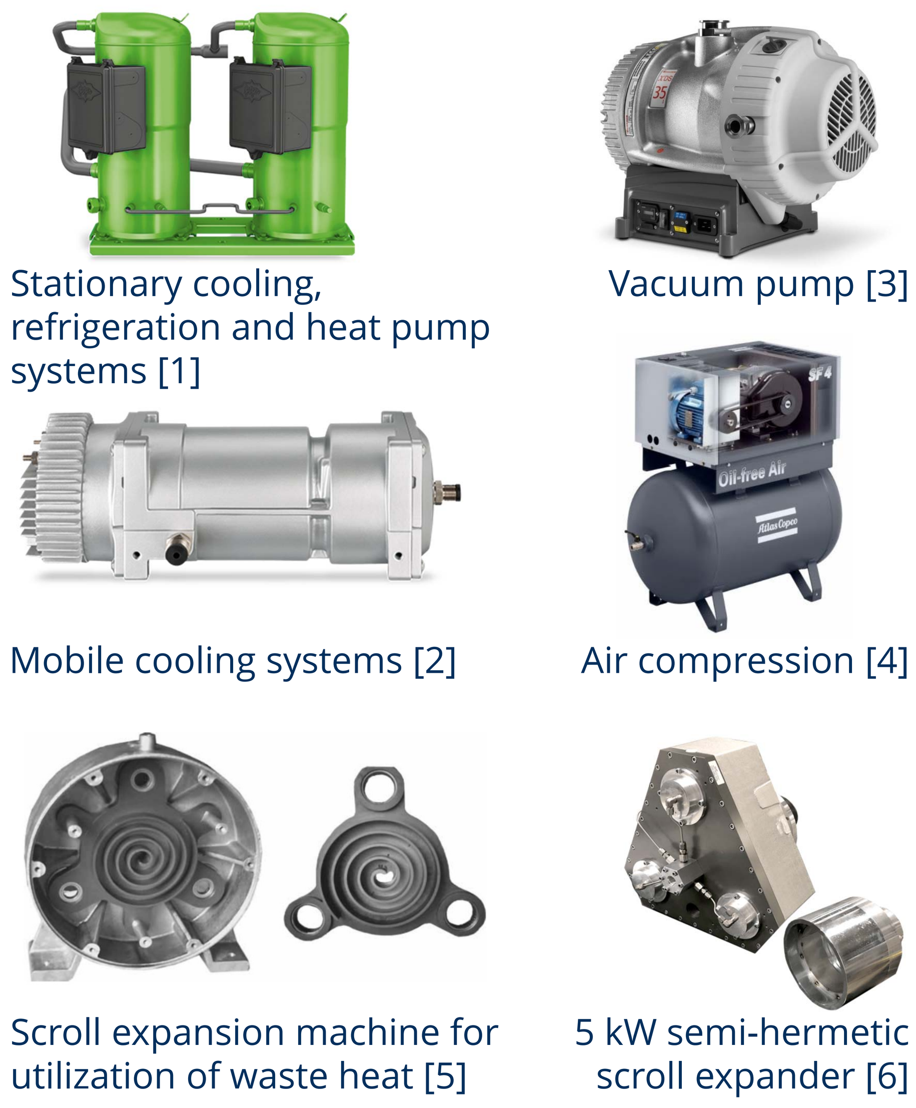

Fig. 4: Various existing scroll compressors and expansion machines

Latest Focus of Research

- Improvement of the scroll geometry to influence the volume ratio
- Models for closed process calculations and application of numerical procedures (FEM, CFD)
- Analysis of vapor and two-phase injection
- Damage analysis
- Back pressure control design
- Simulation of scroll compressor pulsation

Sources:

1 https://www.bitzer.de/shared_media/product_images/product_images_new/G_GS_2xGSD60182_1324-001_02F_G_3C_S_WW_0_ProductSeries767x431.png

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5 KIM, H. J., et al. Scroll expander for power generation from a low-grade steam source. Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy, 2007, 221. Jg., Nr. 5, S. 705-711.

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