

ALADIN II – Highly Efficient and Near-Zero Emission Micro Combined Heat and Power Plant

Recent energy policies smooth the way for future strategies that are partly based on various renewable energy sources, such as solar or wind. However, these sources are strongly dependent on environmental factors. In this context, decentralized power generation with combined heat-and-power (CHP) units becomes increasingly popular, as those units do not only maximize energy efficiency by providing heat and

power as close as possible to the consuming household, but are also able to provide regulative power to the electricity distribution network. The research project "ALADIN II" deals with the development of a micro-CHP which not only provides a high electric efficiency, but simultaneously minimizes the unit's pollutant emissions.

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Goals

- Development and construction of a testbench and four production-oriented prototypes
- Development of sophisticated cold-start strategies
 - reduced pollutant emissions
 - short heat-up intervals
- Development of a specialized engine oil
 - prolonged service intervals
- **Design Parameters:**
 - Power: $P_{el} \approx 7 \text{ kW}$ $P_{th} \approx 14 \text{ kW}$
 - Efficiency: $\eta_{el} \approx 32\%$ $\eta_{tot} \approx 95\%$
 - Runtime: 2,000 – 3,000 h/yr
- **Emissions:**
 - NOx < 5 mg/Nm³ at 5% O₂
 - CO < 3 mg/Nm³ at 5% O₂
 - HC < 2 mg/Nm³ at 5% O₂

Construction

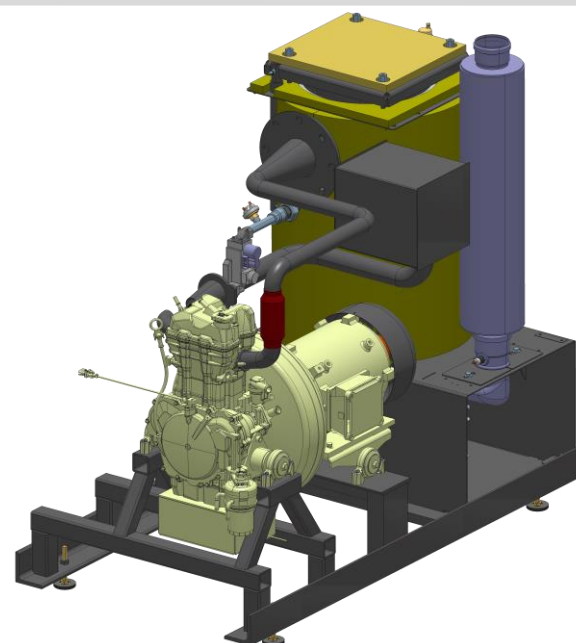


Fig. 1: CAD-Drawing of Prototype Unit

Research Topics

- Air-to-Fuel Ratio Control
 - Direct impact on pollutant emission formation
- Water Circuit Control
 - Control of key temperatures to maximize efficiency
- Optimization of Cold-Start and Warm-up Behavior
 - Direct impact on pollutant emission formation
 - Fast load uptake
 - Efficiency improvements
- Intelligent Operation Management
 - Interface to electricity market and grid status
 - Optimized On-Off-cycle
 - Grid balancing tasks

Power Flow

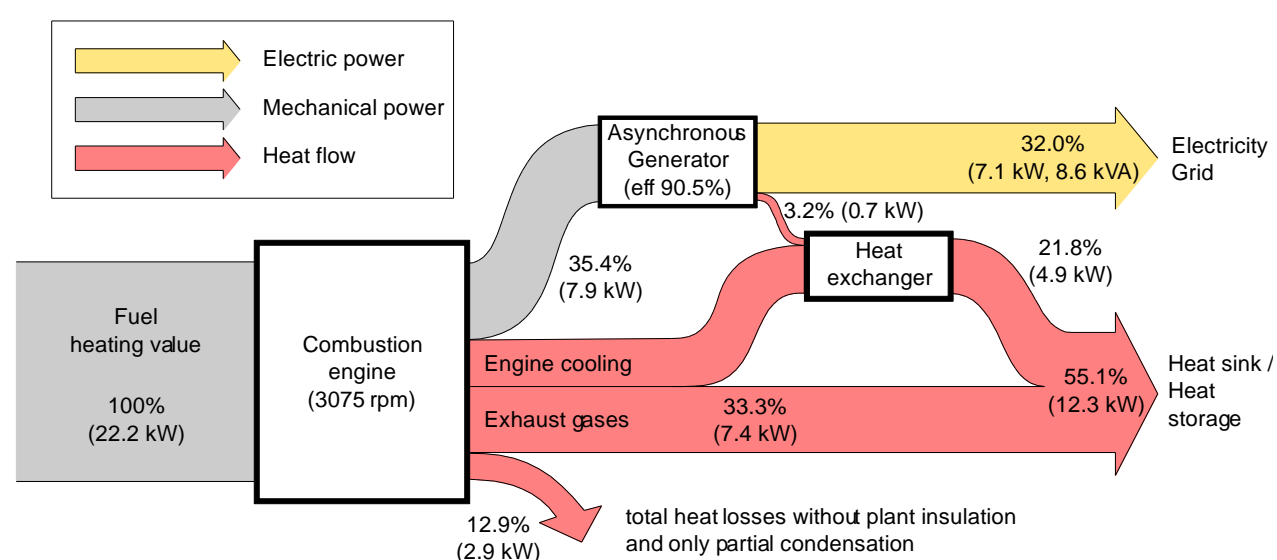


Fig. 3: Power Flow [1]

Expected Impact

The research project „Aladin II“ contributes to the energy transition by developing a decentralized heat and power generation concept that not only fulfills today's effective pollutant emission specifications, but demonstrates the technological potential to achieve almost near-zero emissions, while simultaneously providing a high electric efficiency. Combined with the compact design, the fast load-uptake and warm-up process with low transient emissions as well as reduced investment and low maintenance costs, the unit is expected to significantly differ from all commercially available combined heat and power plants.

References

- [1] Vögelin et al. "Highly efficient and near zero-emission micro combined heat and power gas engine appropriate for grid balancing"; Gas Engine Conference Dessau, 2015.

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