# CFD-based optimization of thermal integration of a Stirling engine's heater

M Eusha[a,b], F Mir[a], G Schories[a]
[a]TTZ Bremerhaven, Germany

Introduction

A β-type 1 kW Stirling engine with a cylindrical and finned heater was integrated with an exothermic reactor. The integration was optimized, in terms of the incoming velocity vector, using CFD analysis, maximizing the penetration of thermal power into the engine core. A secondary indicator was the dT across the enclosure. It was found that the greatest thermal power penetration is achieved when the velocity vector is split in a counter-blast arrangement. This project was financed by the European Commission (GA 727348).

Enclosure heat transfer simulated using CFD

Heater fins

$T_{wall,int.}$

T_H, P_H

$\mathbf{v}_l$

$\mathbf{v}_r$

$y = -y_{max}$

$y = 0$

$y = y_{max}$

$v_l = v_r$
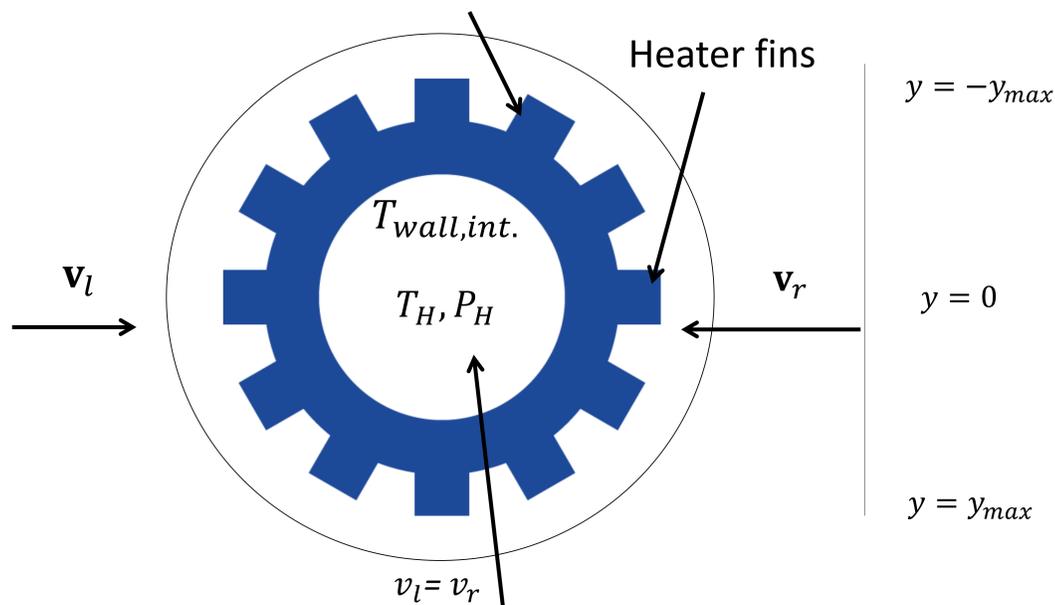
Stirling interior simulated numerically using the Formosa and Despresse framework [1]
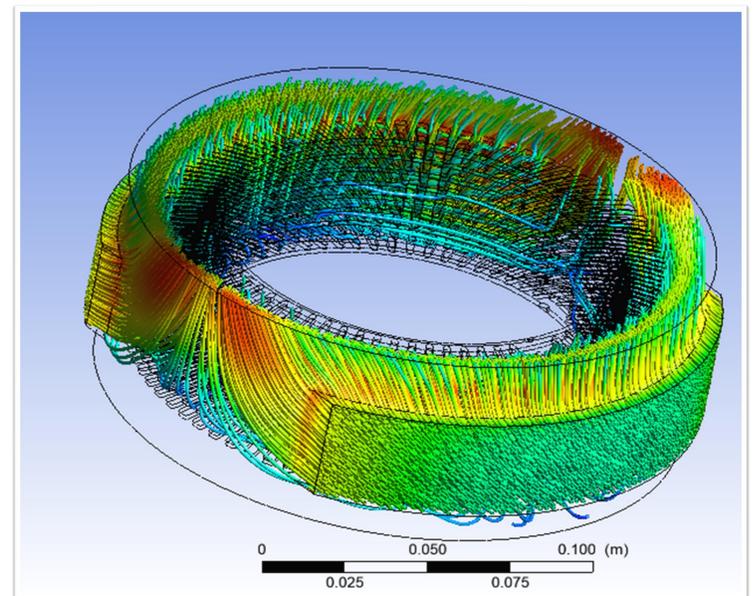
Figure 1: Optimization schematic

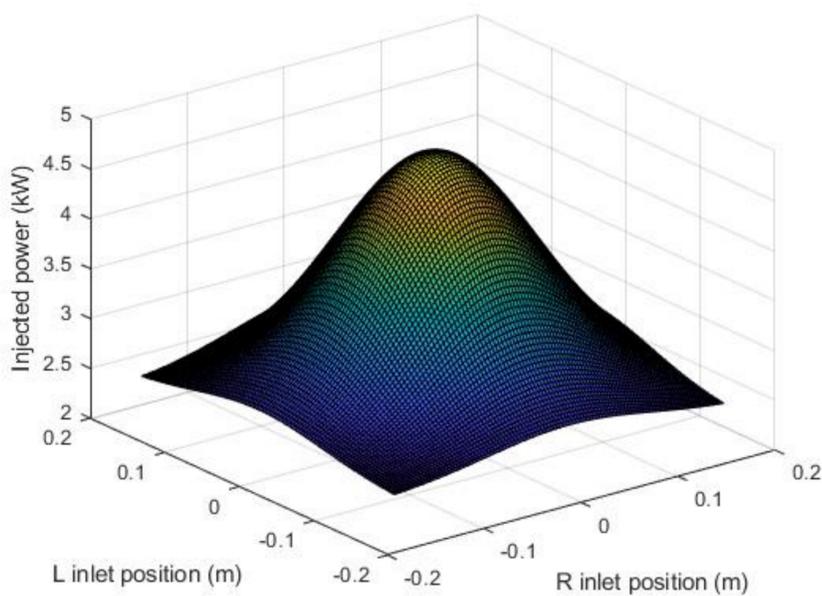Figure 2: Illustrative CFD for temperature distribution

Fig 3: Result of optimization: thermal power with respect to the relative position of inlets for $T_{in} \sim$ 830 K and m_{in} = 0.03 kg/s
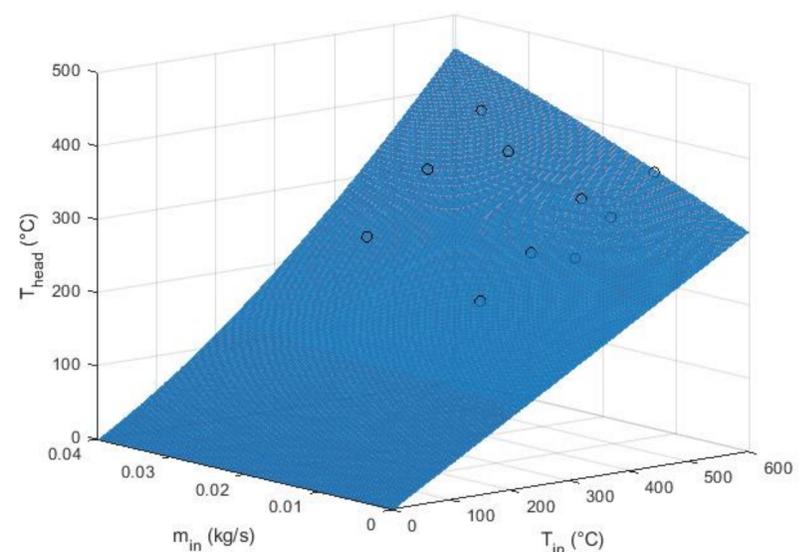

Fig 4: Engine's head temperature with respect to air mas flowrate and incoming temperature

Discussion and Conclusion

The optimized design was manufactured and was found to be in close agreement with the numerically predicted results. In non-combustion deployment scenarios of Stirling engines, it is important to pay attention to the geometric and orientational configurations as they significantly impact heat transfer efficiencies.

References

1. Formosa,F, G, Despresse, "Analytical model for Stirling cycle machine design ," 2010. [Online]. Available: https://www.semanticscholar.org/paper/Analytical-model-for-Stirling-cycle-machine-design-Formosa-Despesse/7b95623fb39fd3b022106c4ee5cd9ce9696469ff.

[b]Corresponding author: meusha@ttz-bremerhaven.de

ttz Bremerhaven