ASTER THERMOACOUSTICS

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Abstract Keynote presentation Kees de Blok

Thermoacoustics is a key enabling technology for the conversion of heat into acoustic power. Nowadays thermoacoustics in itself is well understood and has proven to be a generic applicable and efficient conversion technology. For practical and economic viable applications however, still two issues have to be solved in a practical and cost effective way. (1) heat to be converted need to be supplied at high or medium temperature and rejected at a lower temperature with minimal temperature loss and, (2) high acoustic (wave) power generated by the thermoacoustic process has to be converted into electricity. Focus of this keynote presentation is on the conversion of high acoustic power levels into electricity.

A common approach for converting acoustic power from thermoacoustic engines into electricity and vice versa is the use of so called resonant linear alternators or electro motors. These devices however shows severe limitations in terms of cost and scalability. The increase of moving mass when increasing power sets a practical limit to the output power mainly caused by the increase of periodic forces in the construction and by the difficulty to maintain clearance seals (<70 μm) stable over large stroke amplitudes.

Linear alternators make use of the pressure variation of the acoustic wave. There is however no physical reason why not using the periodic velocity component of the acoustic wave. A way to convert such a bi-directional flow into rotation is known from shore and off-shore electricity production plants based on an oscillating water column (OWC). In this type of power stations, waves force a water column in a chamber to go up and down. This chamber is connected to the open atmosphere and the periodic in- and outflow of air drives a bi-directional turbine of which the rotation direction is independent of the flow direction.

In a thermoacoustic system similar periodic flow conditions exist, so in principle, bi-directional turbines can be deployed for conversion of acoustic wave motion as well. While theory of these bi-directional turbine is well understood and documented for air at atmospheric pressure operating at very low frequencies (water waves), information is lacking about the behaviour of such turbines in high frequent acoustic flow fields and at elevated mean pressures.

The idea of converting high acoustic power flow by using bi-directional turbines was introduced early 2012 by Aster, actually as a result of failing to convert the high acoustic power from the 100kW TAP project into 10 kW of electricity by deploying linear alternators.

Since then, a lot of progress is made, by experimental and theoretical work, in understanding the principe of operation, modelling and design of such turbines. Results so far are encouraging. The conclusion from the this work is that this type of turbine provide a cost effective device for converting acoustic wave energy into rotation and from there into electricity on any power level.

The presentation will address the background and specific issues about the interacton of the turbine with the acoustic flow as well as experimental results obtained in various prototypes.