Low-order models of positive displacement expanders

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The objective of this tutorial session is to be able to build and parameterize low order models of displacement expanders for use in Organic Rankine Cycle systems. The models that will be presented during the session will be provided to the participants in different formats: EES, Matlab and Modelica files.

The first part of the tutorial session will recall the main features of displacement expanders. The working operation of major families of displacement machines will be explained: screw, piston, scroll and vane expanders. Major performance indicators will be defined. The sensitivity of the expander performance with the operating conditions and design characteristics (volume ratio, etc.) will be discussed.

The second part of the session will deal with the lumped-parameter modeling (or "grey-box" modeling) of displacement expanders. Such models rely on a limited number of physically meaningful equations representing the major physical phenomena occurring inside the machine: heat transfers, leakages, friction, over and under expansion. We will discuss about the identification of models parameters based on measurements or information provided by manufacturers. Examples of use of such models will be given.

Finally, the last part of the session will introduce empirical (or "black-box") models of displacement expanders. Such models consist of a set of empirical functions (such as polynomials) for the isentropic effectiveness and the filling factor. Their high numerical robustness and low-computational time make them suitable for dynamic simulation of ORC systems. Identification of such functions based on experimental data or on predictions by higher-order models will be discussed.

Participants are invited to bring their own laptop with updated versions of EES, Matlab or Dymola. However, this is not compulsory to follow the tutorial session.