THE CHOICE OF WORKING FLUID: THE MOST IMPORTANT STEP FOR A SUCCESSFUL ORGANIC RANKINE CYCLE (AND AN EFFICIENT TURBINE)

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ABSTRACT

Water is the choice working fluid for large–scale Rankine cycles operating with high temperature energy sources, in a wide variety of efficient cycle configurations: from the saturated cycles of nuclear power stations to the coal fired ultra-supercritical cycles. However, the thermodynamic properties of steam lead to multi-stage, capital-intensive turbines as well as to complex plant schemes: both these constraints make steam a working fluid not suitable for low power output applications.

On the contrary, the rationale of Organic Rankine Cycles is making technically feasible and economically attractive the power generation also for moderate-temperature, dispersed energy sources. This is obtained by selecting a proper working fluid, that makes simple plant arrangement and low-cost turbine possible.

After a short introduction on basic thermodynamic rules for ORCs, the presentation will focus mainly on how the turbine designer can optimize the working fluid most relevant thermodynamic properties. Molecular complexity, mass, critical pressure and temperature play a fundamental role in turbine design. Practical examples will be given, ranging from few kW to multi MW turbines, for a variety of solutions: axial, radial (in-flow or out-flow), single and multi-stage, high and low speed of revolution.