Robust 3D optimization of ORC turbine expanders

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Duration : 3 years ; Start October/November 2016

Required skills

The ideal candidate has at least a master degree le el in mechanical/aeronautical engineering or applied mathematics, ith a background in the fields of computational fluid d namics. A reasonabl good kno ledge of one or more programming languages (fortran, C, C++, p thon) is mandator .

Le ca d da d a e a e d d e d g e e / d d e de a e ec e c e ca e, g e ca e, g e e g e, g e a a e, e de de c e ce da e d a e de a ca e de f de e. U e c a a ce ad a e d e a gage de g a a (f a , C, C++,) e d e ab e.

Research subject

Dense gases are defined as single phase vapors, characterized by complex molecules and moderate to large molecular weights. The use of dense gases as working media in turbomachinery, referred to as Organic Rankine Cycle (ORC) turbines, is proposed as a method of recovery of variable energy sources such as waste heat from industrial processes. Whereas a traditional Rankine Cycle operates with water vapor as the working fluid, ORC turbines use an organic fluid such as hydrocarbons, silicon oils or other organic refrigerants. The low critical temperature, high density and elevated heat capacities of these fluids result in high suitability for low temperature operation, even as low as 80℃ [1]. Furthermore, the slope of the saturated vapor line for orgara

Laboratory developed fast 2D design tools for supersonic ORC injectors and rotor blades [11] and carried out preliminary investigations of the feasibility and the benefits of robustly optimized turbine expanders for ORC applications [12]. On the other hand, the research team explored more accurate and efficient robust optimization techniques for real-world applications [13].

The objective is to seek for a compact, highly efficient turbine expander with stable performance under highly variable operating conditions. The choice of the "stability" criteria requires specific sensitivity studies. The approach should lead to efficient 3D designs of the blades and to stable performance, specifically under highly variable operating conditions. A major difficulty for the application of automatic optimization tools to realistic 3D ORC turbine blades is the high computational cost of objective function evaluations. These are obtained by running a 3D CFD simulation per each design evaluated (for standard optimization), or multiple evaluations per design for robust optimization, multiple simulations being necessary for evaluating the averages and standard deviations of the objective functions.

The robust optimization approaches studied in the literature often combine evolutionary optimization algorithms, like genetic algorithms (GA) and an uncertainty quantification (UQ) technique. The GA may require several function evaluations before a converged solution is obtained. On the other hand, the UQ methodology may also require several function evaluations (i.e. CFD computations), according to the number of uncertain parameters and the UQ approach in use. Recently, our team investigated a promising, non intrusive, Kriging-based robust optimization technique was developed by coupling a Kriging uncertainty quantification method with a Kriging surrogate of the fitness functions, along with an automatic enrichment strategy. This approach was appl to the optimization of 2D ORC turbine blaes th and provie ac

Tentative schedule:

Workplace

The D nFluid Laborator   is located in the cit   centre of Paris, 13e Arrondissement. Part of the   ork (1/3 to ½ of the   hole time)   ill be conducted at Enertime Headquarter in Courbe oie.