Research theme	Synthesis based engineering tools
Research title	Computational design synthesis for single pressure heat recovery steam generators
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Background

Heat Recovery Steam Generators (HRSGs) are applied to generate steam from hot flue gasses, usually from gas turbines in large power plants. The thermal design of HRSGs – i.e. how fin tubes are arranged in the hot flue gas flow – determines largely the cost price, while it is complicated and time consuming to establish an optimal design.

The thermal design of HRSGs can be classified as a parametric routine design problem and can be automated, by developing a synthesis tool. The computer generates solutions based on an under-defined design problem specified by an engineer. By generating many solutions – hereby creating a 'cloud' of possible designs – an engineer can choose a solution that suits him best.
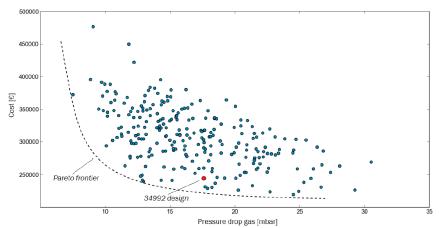
Assignment

The assignment is the development of a pilot synthesis tool that is able to show the capabilities of synthesis technology for the thermal design of single pressure HRSGs. A synthesis tool that presents the user with a cloud of possible design alternatives. The goal is to investigate whether synthesis technology could be advantageous for NEM.

Results

A synthesis tool is developed that generates design alternatives for the thermal design of single pressure heat recovery steam generators. The input for the synthesis tool is an under-constrained design problem – e.g. required steam temperature & flow, flue gas temperature, feed water temperature etc. - and its output is a set of design alternatives that satisfy the performance requirements. Within the defined scope, all design alternatives generated by the synthesis tool conform to NEM quality standards and ASME design codes.

The application showed that by using the synthesis tool engineering time can be significantly reduced. Normally it takes one or two days to establish a design, while it takes only a couple of seconds to generate design alternatives using the synthesis tool. The quality of the generated design alternatives is assessed by means of practical relevant design cases – including an existing plant. This showed that better designs can be chosen. The figure below shows 250 generated design alternatives (in blue) assessed on cost (vertical axis) and pressure drop of the flue gas (horizontal axis) for the design case of an existing plant. The red dot represents the design established by thermal engineers of NEM. This shows that for the same pressure drop, lower-cost designs could have been chosen.

Personal experience

An important consideration for me when I was looking for an assignment was to conduct this at a company. Looking back, I can say that it has been a really valuable experience. Conducting my assignment at a company taught me things I could not have learned at university. NEM has a really nice working environment. I joined Young NEM, they organize activities for employees under the age of 35 such as company visits and social activities. The assignment has been challenging, but in the end it was very rewarding.