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Creative cost-cutting

BASF's *i-TCM* system has reduced the company's equipment and engineering costs, writes Cath O'Driscoll

DESPITE TAKING into account a myriad of different technical parameters, traditional engineering designs for a new chemical plant do not always deliver the most economical solution or lowest overall cost process. In an attempt to overcome these limitations, engineers and modellers at BASF have devised an alternative approach that compares different process concepts based on monetary values that include both capital investment and projected operational costs. 'Presenting the results of plant simulations and optimisations in terms of "money flows" makes it possible to select the best alternative using one common set of criteria, and can result in some significant savings in total cost,' explains BASF's director of conceptual process engineering Axel Polt.

BASF developed its Intelligent Total Cost Minimisation (*i-TCM*) system using AspenTech's simulation software and its own in-house tools, and first applied it in 2003 to the design of a new 150 000 tonne/year plant for producing monomer precursor. 'We achieved a reduction in total equipment costs of approximately 5%,' Polt says, adding that this reduction has consistently been in the same range for a variety of subsequent applications, including for new plant designs of up to 400 000 tonne/year.

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One of the other big advantages is that: 'Reduced engineering effort is required because the optimisation routines in the solution result in fewer iteration loops in the process design, equipment design and engineering stages,' adds senior process engineer Alexander Wiesel. 'The new solution enables process design engineers to get equipment size and cost information directly from the simulation, allowing them to skip some iteration loops with their equipment design colleagues until the process design has nearly been completed.'

STANDARD PROCEDURE

Thanks to its wide applicability, *i-TCM* is now a standard procedure at BASF for major new plants and revamps. 'Revamping a plant is one of the most difficult tasks in process engineering,' Polt says. 'Usually it takes multiple iterative steps to set the operating parameters and conditions to suit the required capacity and to minimise costs. This is done by carrying out extensive case studies based on estimates from experienced process engineers and plant operators.' Based on early work with *i-TCM*, in some cases engineers have found the system halves the time for the conceptual process and equipment design in revamps.

Another advantage, Wiesel claims, is that the system allows users to make better use of available information. Plant operating data, for example, usefully show current operating conditions and maximal loads, while the 'as-built drawings' show construction details such as column diameters, packings, liquid distributors or heat exchanger areas, and dimensions. Inputting all these details into *i-TCM* allows process engineers to evaluate whether a piece of equipment will be able to handle a higher load, such as a capacity increase, or if it will fail due to thermal or hydraulic overload. 'In the case where it fails, the cost estimation routines give a price for exchanging that piece of equipment,' Wiesel elaborates. 'Thus, an additional result of the simulation of the revamp is a list of pieces and total cost for key equipment requiring replacement.'

THIRD PARTY PLANS

BASF regards *i-TCM* as 'a significant breakthrough in process design', says Polt. At the moment the technology is proprietary to BASF, but the company is thinking about offering a service to third parties, Polt states. Compared with traditional approaches, the concept provides two key advantages. First, 'the optimisation process can help to generate new ideas about how to operate or design a process, instead of simply repeating a design that has been used before. This frees you from guesses or estimates by individual process engineers, which are strongly dependent on their particular experience and preferences'. Secondly, 'the optimisation leads to a significant rationalisation of engineering efforts, time and engineering costs for competitive plants.'

Actual changes in plant design generally involve fine tuning of operating conditions. As examples, Wiesel cites head pressures in columns, adjustment of product recoveries, split ratios in divided wall columns and temperature approaches in heat exchanger network design. 'This is largely because the available commercial optimisation tools allow you to vary process parameters, but do not allow topological optimisations, eg distillation sequences.' A vision for the future, however, 'would be a simulation application that tells you: "The two components you have show an interesting mixing behaviour with this solvent. You should think about considering an extraction instead of the distillation you are currently using"'.

The BASF-Sinopec joint venture in Nanjing, China was developed using *i-TCM*

I-TCM DEVELOPMENT

i-TCM was developed by integrating a number of commercial and in-house software applications. The software includes a mixture of standard tools such as *Aspen Plus* and *Aspen Optimizer*, shortcut equipment design tools, and a linkage to in-house cost databases. Process engineers use the *Aspen Plus* simulation environment to create an accurate simulation model of the proposed plant concepts, explains AspenTech's Tobias Scheele. 'Once the basic equipment design has been completed, cost information is added to the models from the in-house databases. The detailed designs can then be optimised by using *Aspen Optimizer* to minimise the total costs. The best concept can then be selected by comparing the cost performance of each design.'

Process design optimisation carried out using i-TCM takes into account a range of costs including; investment costs /depreciation, raw material costs, utility costs, waste gas treatment costs, waste water treatment costs and side product costs or prices.

Money flows are used an alternative method to visualise plant performance. Icons for unit operations are replaced by the appropriate investment costs (expressed as the depreciation). The connecting streams have a value which is calculated by multiplying the raw material costs or product prices by the individual flow rates. Polt added 'In this manner, the individual costs for each stage in the process can be visualised more clearly, making it easier to focus attention on those items which offer the greatest potential for improving cost performance.'