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Where do you take those inferential models from?

Charts shown in my editorials, illustrating the performance of select first-principles models, have attracted much e-mail feedback. While mostly positive, some question why the editorials do not provide detail about the principles behind the models. I was taken aback by that criticism because of the distillation inferential models I use: Generalized cutpoint calculations (GCCs) and generalized distillation shortcut (GDS) are well documented in the public literature. Of the reactor models I use, reformer severity (REFS) and visbreaker (VISBS) models are also documented, though not as well.

Where is this perception coming from? *HP* demands that editorials not be specific in terms of model names, nor details of technology, especially when the writer has an axe to grind, and it is no secret that Petrocontrol (my company) specializes in first-principles inferential control models. We should accept that a person asked by *HP* to contribute editorials would have expertise, as well as potential conflicts of interest. Those conflicts are disclosed so that clients, or in this case readers, judge for themselves. My January 2006 editorial[1] compared empirical versus knowledge models, and it contains a diagram (Fig. 1) of my ambition to model each refinery unit showing available models in green.

The principles of GCC models were first published in detail in 1985,[2] and later, with less theoretical detail but more performance trends in about ten papers, two of which were published by *HP*.[3,4] GCC aims at wide-cut fractionators, where the feed and products are characterized by boiling curves. It has originally been developed to predict crude switches on a crude fractionator, and it uses heat balances to identify the crude volatility. That concept has proven to work because during crude switches the column operates off mass balance, whereas heat balance is much quicker. When lighter, more-volatile crude fills the fractionator with more vapor, GCC senses this situation within a minute or so. The quality inferences are based on reconstructing the true boiling point (TBP) curve from process data, and of course heat balances. Besides crude units, GCC has been applied to many other units with main fractionators.

GDS was first documented in 1995,[5] and, later again, with less theory and more performance trends in four papers, one of which was published by *HP*.[6] As opposed to GCC, which works with boiling curves, GDS is based on distinct components, and is suitable for a large variety of distillation columns. GDS relies is a shortcut method that estimates performance of a column section, typically the top or bottom quarter. It makes use of Colburn equations[7] that provide a ratio between tray *N* vapor composition to the bottom composition as a function of process conditions, and to work well, it must input a tray temperature reading of a representative tray. We all know that tray temperature reading contains more information than top or bottom temperature, and GDS is a technique for interpreting that information.

REFS has been applied in several locations but documented in the literature only once.[8] The function of REFS is to estimate octane (or aromatics content) and catalyst coking rate as a function of reactor conditions. A unique feature of this model is its ability to estimate feed properties from density measurement and unit conditions. Feed properties: boiling curve and paraffin, naphthenes and aromatic (PNA) content are needed for the correct inference of octane and coking rate.

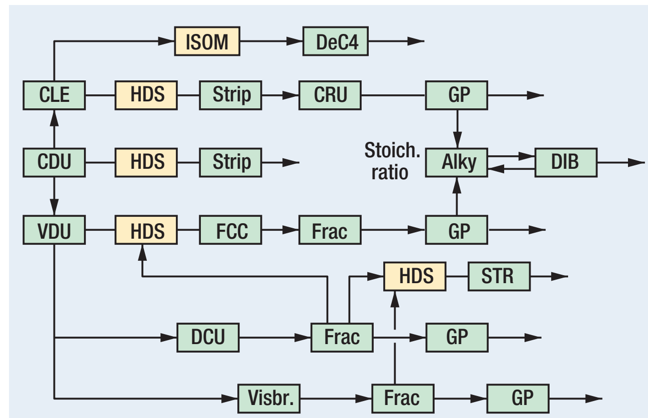

FIG. 1 A typical refinery structure. Units where Petrocontrol apply inferential models are shown in green.

That is what my editorials on first-principles inferential models are based on. Thirty-five years of APC experience have taught me that APC is as good as the inferential models it employs, and hence, my long-time dedication to high-fidelity models. **HP**

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The author is a principal consultant in advanced process control and online optimization with Petrocontrol. He specializes in the use of first-principles models for inferential process control and has developed a number of distillation and reactor models. Dr. Friedman's experience spans over 30 years in the hydrocarbon industry, working with Exxon Research and Engineering, KBC Advanced Technology and since 1992 with Petrocontrol. He holds a BS degree from the Israel Institute of Technology (Technion) and a PhD degree from Purdue University.

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