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Abstract

Objective/Scope: A unique data-driven approach, based on big data analytics, to build an intelligent energy management and optimization system is introduced, where huge amounts of observational raw plant data are processed/analyzed to extract real-time operational intelligence for quick decision making and to develop causal (cause-and-effect) models offline for real-time plant-wide energy optimization.

Methods, Procedures, Process: The overall approach is entirely based on data analytics techniques. For instance, clustering analysis and factor analysis are employed to sort out potential possible root causes of energy inefficiency of every operational unit. Correlation analysis (e.g., Pearson & Spearman) and time series analysis are used to pinpoint the most significant root cause from the multiple possible root causes. Nonlinear regression analysis combined with panel/residual analysis is performed to develop causal models from non-experimental plant data for plant-wide energy optimization..

Results, Observations, Conclusions: The resulting system monitors the overall energy performance of a huge industrial complex (Aramco/Abqaiq Plants) via only six energy KPIs. As soon as an energy KPI violation is detected, the system immediately identifies, based on online analysis of all relevant historical and current process data, the worst energy-performing unit, the root cause, and the corrective action to remedy the KPI inefficiency. This KPI approach ensures the optimization of individual operational units, which, however, is not necessarily equivalent to the optimization of the entire complex plant. To provide a complete solution, the system also offers plant-wide optimization intelligence to coordinate/optimize a large number of interconnected operational units, hereby eliminating potential optimization conflicts among the individual units. Abqaiq Plants has reaped millions in energy savings from the system. Improvements in energy efficiency are hereby realized through quick response and full participation across the organization in energy-saving activities. People with little process background can easily acquire and act on the actionable advice provided by the system - just one click away.

Novel/Additive Information: The availability of large amounts of operating data collected every day combined with rapid advances in data analytics has rendered the big data analytics approach a nowadays powerful technology to increase efficiency, reduce costs, and deliver operational intelligence. This represents a major paradigm shift from traditional model-driven approach to data-driven approach. The article illustrate a novel way to employ big data analytics for operational intelligence as well as plant-wide optimization in the process industry.