Multi-Site Optimization of Natural Gas Processing Operations to Maximize Asset Utilization

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Gathering significant volumes of natural gas and supplying processed gas and associated liquids such as liquefied petroleum gas (LPG) and natural gas liquids (NGL) to consumers usually involves connecting wells in different fields with an extensive network of processing and storage facilities that can be spread across vast geographical areas. The use of network modelling and optimisation technologies for strategic decision making can yield substantial benefits not only in economic and environmental terms but also in improved understanding of the interaction between the various components of the process and the overall business. Key benefits include increased profitability through better asset utilisation, improved reliability through the ability to rapidly reallocate production on equipment failure, better investment planning to reduce network bottlenecks, and flare reduction in order to minimise the environmental and economic penalties from inefficient operations.

Conventional approaches to the optimisation of large supply networks usually tend to rely on rather simple models of the individual nodes (e.g. production facilities and processing plants) in these networks, often taking the form of simple (often linear) relations between the flowrates of the various materials entering and leaving each node. Whilst this greatly simplifies the solution of the underlying mathematical optimisation problem, it may lead to solutions that are unimplementable in practice; pragmatic adjustments to ensure feasibility almost always lead to suboptimal solutions which, given the very substantial money flows in such large networks, may translate into significant loss of opportunity.

This paper describes an alternative approach to natural gas supply chain optimisation across distributed sites using a higher level of physical detail in describing the operation of the individual production and processing nodes, thereby ensuring that any solution obtained satisfies all important constraints on the operation of plant equipment. Until recently, this approach was considered to be impractical; however, the combination of modern equation oriented modelling techniques and the continual evolution of computer processing power now allows largescale models, comprising detailed models of individual equipment items within wide system envelopes, to be constructed and solved reliably with minimal user intervention. In practical terms, it is now possible to perform optimization of models comprising several hundreds of thousands of nonlinear equations subject to many tens of decision variables and process, equipment and product quality constraints.

The paper is illustrated with an example involving a largescale Middle Eastern gas processing network, which shows that gains of 5% on normal processing, representing tens or hundreds of millions of dollars annually, are now possible.