Multi-scale Dynamic Simulation and Optimization for Cost-effective and Air-quality Conscious Industrial Emission Reductions

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Abstract

Flaring emissions during CPI (chemical process industry) plant startups, shutdowns, and upsets causes tremendous raw material and energy losses and also results in adverse environmental and social impacts. For instance, an ethylene plant with 1.2 billion pounds of ethylene production per year may flare five million pounds of ethylene during one typical startup, which generates 15.4 million pounds of CO2, 7.5 K lbs of NOX, 40 K lbs of CO, and 100 K lbs of highly reactive VOCs. Unfortunately, current practices in flare minimization almost exclusively depend on industrial experience and the "end-of-the-pipe" control strategies. For instance, the installation of flare gas recovery units (FGRU) can capture flare gas for recycle and reuse. Conceivably, it is less desirable since the "waste gas" is already generated. Meanwhile, the capital expenditure and operating cost of FGRU is considerable. Therefore, the key issue for existing CPI facilities to achieve significant emission reductions without large expenditures is to renovate current process designs and/or improve process operational strategies in a systematic way, so as to proactively and economically reduces emission sources instead of traditional "end-of-the-pipe" flare handling.

In this presentation, a systematic methodology on multi-scale dynamic simulation and optimization for cost-effective and air-quality conscious industrial emission reductions will be introduced. Since off-specification streams are inevitable during the plant turnaround operations, to significantly reduce flaring emission, they must be either recycled to the upstream process for online reuse, or stored somewhere temporarily for future reprocessing, when the plant manufacturing returns to stable operation. Thus, the off-spec products will be able to be reused instead of being flared. This presentation will address modeling and optimization for emission reduction under chemical plant start-up, shutdown, and upset conditions, as well as associated local air-quality impact studies. Both theoretical development and real plant test results could be presented.

Short Bio: Dr. Qiang Xu is the Full Professor of Dan F. Smith Department of Chemical Engineering at Lamar University in Beaumont, Texas, USA. His main research areas include process synthesis, production scheduling, dynamic simulation and optimization with particular applications in industrial emission reduction, energy saving, process safety, and regional air-quality analysis. He has published 114 peer-reviewed papers and given over 200 invited talks and conference presentations. He is the recipient of 2016 Excellence in Process Development Research Award from AIChE, University Scholar Award in 2012, and University Merit Award in 2010. He is also the holder of Anita Riddle Faculty Fellow in 2017 and Distinguished Faculty Research Fellow in 2015 from Lamar University. He is currently the Vice Chair of Technology Transfer & Manufacturing Subdivision of AIChE and the Programming Chair of the Green Chemistry and Green Engineering Subdivision of ACS. Dr. Xu obtained his B.S. degrees in chemical engineering and environmental engineering respectively, both in 1998; Ph.D. degree in 2003 in chemical engineering, all from Tsinghua University in Beijing, China.