NATO CCMS Pilot Study on Clean Products and Processes
2003 Annual Meeting, May 11 - 15, 2003
Hotel San Michele, Cetraro, Italy

Development and Integration of New Processes for Greenhouse Gases Management in Multi-Plant, Chemical Production Complexes

T. A. Hertwig[a], A. Xu[b], D. B.Ozyurt[b], S. Indala[b] R.W. Pike[b], F. C. Knopf[b], J. R Hopper[c], and C. L. Yaws[c]

a IMC Phospates, Uncle Sam, LA 70792, tahertwig@imcglobal.com
b Louisiana State University, Louisiana State University, pike@che.lsu.edu, axu1@lsu.edu, knopf@che.lsu.edu
c Lamar University, Beaumont, TX 77710, hopperjr@hal.lamar.edu, yawscl@hal.lamar.edu

Abstract

The Chemical Complex and Cogeneration Analysis System is an advanced technology for energy conservation and pollution prevention. This System combines the Chemical Complex Analysis System with the Cogeneration Design System. The Chemical Complex (Multi-Plant) Analysis System is a new methodology that has been developed with EPA support to determine the best configuration of plants in a chemical complex based the AIChE Total Cost Assessment(TCA) for economic, energy, environmental and sustainable costs and incorporates EPA Pollution Assessment Methodology (WAR algorithm). The Cogeneration Design System examines corporate energy use in multiple plants and determines the best energy use based on economics, energy efficiency, regulatory emissions and environmental impacts from greenhouse gas emissions. It uses sequential layer analysis to evaluates each plant's current energy use as at an acceptable level or cost-effective improvements are possible. It includes cogeneration as a viable energy option and evaluates cogeneration system operating optimally.

The System uses a Windows graphical user interface. The process flow diagram for the complex is constructed, and equations for material and energy balances, rate equations and equilibrium relations for the plants entered and stored in the Access database using interactive data forms. Also, process unit capacities, availability of raw materials and demand for product are entered in the database. These equations give a complete description to predict the operations of the plants. The format for the equations is the GAMS programming language that is similar to Excel. The input includes incorporating new plants that use greenhouse gases as raw materials.

The System has been applied to an agricultural chemical production complex in the Baton Rouge-New Orleans Mississippi river corridor. Ammonia plants in this complex produce an excess of surplus of 0.65 million tons per year of high quality carbon dioxide that is being exhausted to the atmosphere. A new catalytic process that converts carbon dioxide and methane to acetic acid can use some of this excess, and preliminary results showed that replacing the conventional acetic acid process in the existing complex with the new process gave a potential savings of $750,000 per year for steam, 275 trillion BTUs per year in energy, 3.5 tons per year in NO_x and 49,100 tons per year in carbon dioxide emissions.

This System was developed in collaboration with process engineers and is to be used by corporate engineering groups for regional economic, energy, environmental and sustainable development planning to accomplish the following: energy efficient and environmentally acceptable plants and new products from greenhouse gases. With this System, engineers will have a new capability to consider projects in depths significantly beyond current capabilities. They will be able to convert the company's goals and capital into viable projects that are profitable and meet energy and environmental requirements by developing and applying a regional methodology for cogeneration, and conversion of greenhouse gases to saleable products.

The Advanced Process Analysis System is used to perform economic and environmental evaluations of a plant. The main components of this system are a flowsheeting program, an on-line optimization program, a chemical reactor analysis program, a heat exchanger network design program, and a pollution assessment module. A Windows interface has been used to integrate these programs into one user-friendly application. An accurate description of the process is obtained from process flowsheeting and on-line optimization. Then an evaluation of the best types of chemical reactors is performed to modify and improve the process, and pinch analysis is used to determine the best configuration for the heat exchanger network and determine the minimum utilities needed for the process. The pollution index evaluation is used to identify and minimize emissions. A tutorial has two plant simulations and two actual plants.

The Advanced Process Analysis System has been applied to actual plants including the alkylation plant at the Motiva refinery in Convent, Louisiana and sulfuric acid contact plant at IMC Agrico's agricultural chemicals complex in Uncle Sam, Louisiana. Detailed plant descriptions of the refinery alkylation process and the contact sulfuric acid process were used with the System in collaboration with the process engineers from these companies. This ensured that the programs work on actual plants and meet the needs and requirements of the process and design engineers.

These programs and users manuals with tutorials can be obtained from the LSU Minerals Processing Research Institute's web site, www.mpri.lsu.edu at no charge. The staff of the Minerals Processing Research Institute can provide assistance in using these programs.