Rohm and Haas: Chemical Plant Uses Pinch Analysis to Quantify Energy and Cost Savings Opportunities at Deer Park, Texas

Benefits

- Identified annual energy savings of 2.2 million MMBtu
- Identified annual cost savings of $7.7 million

Application

Pinch analysis provides a systematic approach to analyze energy networks and improve the energy efficiency of industrial processes. Pinch technology uses graphical representations of the energy flows in the process and utility streams to determine the minimum energy consumption a process should use to meet its specific production requirements. This technique can be applied in a variety of industries, including oil refining, chemicals, petrochemicals, pulp and paper, and food processing.

Summary

As a part of an ongoing effort to reduce energy usage at Rohm and Haas Company's Deer Park, Texas facility, a pinch analysis was conducted on the major production processes. The first phase of this analysis employed pinch targeting, a methodology for identifying energy-cost reduction potential based on the thermodynamic characteristics of a process. The second phase, to be completed later, will identify potential solutions corresponding to opportunities identified during the assessment. The assessment involved the four major production areas of the plant: the methyl methacrylate (MMA) plant, the acid recovery plant, the acrylate monomers plant, and the acetone cyanohydrin plant. Several opportunities for energy use reduction were identified, including modifying the thermal oxidizers in the acrylate monomers plant and balancing the steam system in the acetone cyanohydrin plant. The assessment team predicted that annual savings resulting from several energy conservation projects could total 2.2 million MMBtu and almost $7.7 million.

Public-Private Partnership

The U.S. Department of Energy's (DOE) Industrial Technologies Program (ITP) cosponsored the assessment. DOE promotes plant-wide energy efficiency assessments that will lead to improvements in industrial energy efficiency, productivity, and global competitiveness, and will reduce waste and environmental emissions. In this case, DOE contributed $100,000 of the total $300,000 assessment cost.

Plant Description

Rohm and Haas Company is one of the world's largest manufacturers of specialty chemicals. Most of its products are used by other industries to produce better-performing, high-quality end products and finished goods. Constructed in 1947, the Deer Park facility is Rohm and Haas' largest plant, employing nearly 800 workers. The specialty chemicals manufactured at the site include MMA, acrylic acid, amines, and various acrylates.

Production areas at the Deer Park facility include:

MMA Plant - produces stripped crude MMA at approximately 95% purity using acetone cyanohydrin (ACH), a sulfuric acid (H_2SO_4) catalyst, water, methanol, and various inhibitors.

Acid Recovery Plant - consists of sulfuric acid production units and a tail gas cleanup unit that reduces sulfur dioxide (SO_2) emissions to the environment; acid and organic residues from other areas of the plant are decomposed and regenerated into fresh H_2SO_4.

Rohm and Haas plant in Deer Park, Texas

Acrylate Monomers Plant - produces acrylic acid and esters in four major production processes: oxidation, separations, glacial acids, and esters.

Acetone Cyanohydrin Plant - produces ACH and hydrogen for use in other production areas and provides instrument air, nitrogen, ammonia, and refrigerated water to other operating units.

Assessment Approach

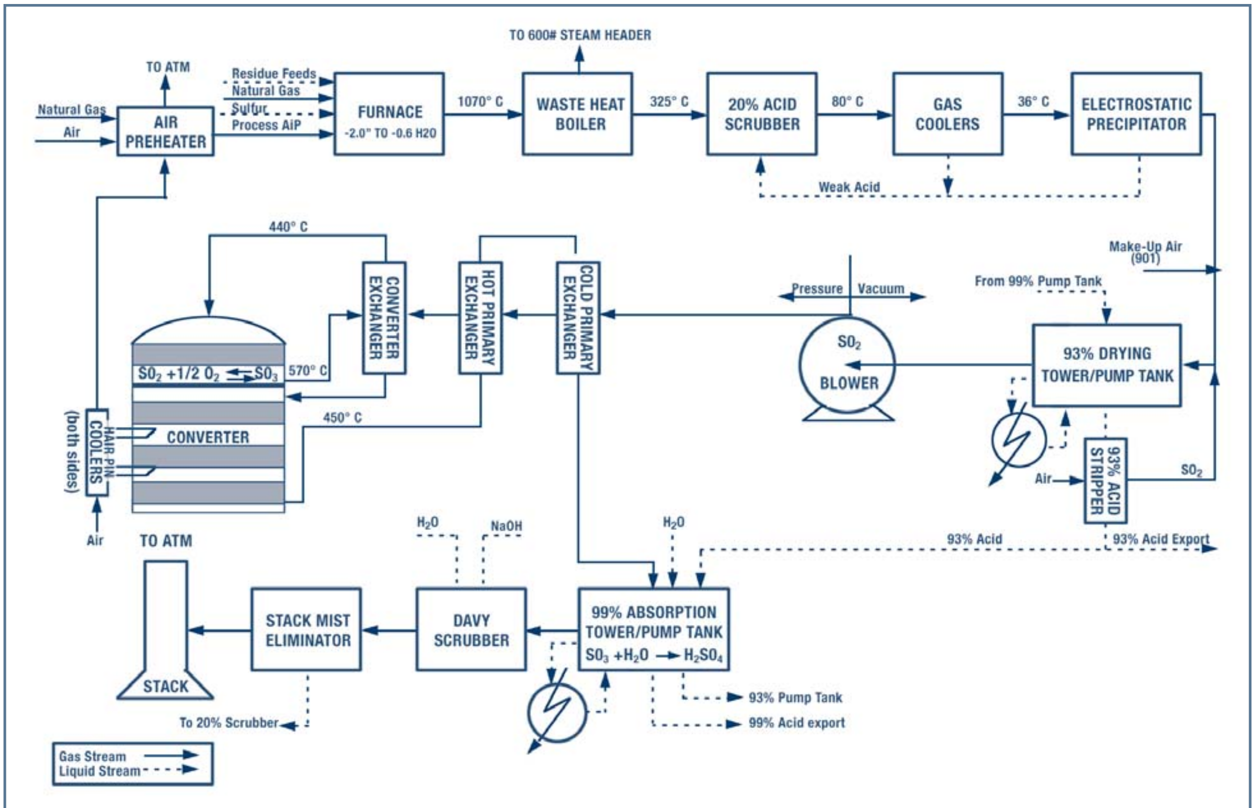
As a part of an ongoing effort to reduce energy usage at the Deer Park facility, Rohm and Haas Company decided to conduct a pinch analysis of the major production processes.

Introduced in the mid-1980s, pinch analysis provides a systematic approach to analyze energy networks and improve the energy efficiency of industrial processes. Pinch technology uses graphical representations of energy flows in process and utility streams to determine the minimum energy that a process should consume to meet its specific production requirements.

A complete pinch analysis is a two-stage methodology. The first stage, pinch targeting, identifies the scope for energy cost reduction based on the thermodynamic characteristics of the process. In the second stage, the pinch design method identifies specific process and heat recovery network modifications required to meet the targets. The first stage was completed at the Deer Park facility with the assistance of Veritech, an energy consulting firm based in Sterling, Virginia. The second stage will be undertaken by Rohm and Haas engineering staff, using a cost-benefit analysis to identify potential implementation solutions corresponding to the opportunities identified during the assessment.

Results and Opportunities Identified

Opportunities for reducing energy consumption identified during the pinch analysis for each plant include the following.



Acid Recovery Plant Process Flow Diagram

MMA Plant

Optimize heat exchanger network. This represents the bulk of potential savings. There are also opportunities to use steam at lower pressures and to use less expensive cold utilities. Hot and cold utility consumption could be reduced by modifying the heat recovery network to eliminate cross-pinch heat transfer. The greatest source of cross-pinch heat transfer is the recycle heater, which is a cold stream below the pinch that is currently being heated with steam. To eliminate this cross-pinch heat transfer, it would be necessary to replace the steam with heat from one or more hot streams below the pinch. These streams are currently rejecting their heat to water.

Acid Recovery Plant

Use secondary air directly in the furnace. After acquiring process heat in the hairpin coolers, secondary air from the converter is used as combustion air in the furnace air preheater. Energy efficiency would be increased by using secondary air directly in the furnace. This secondary air, mixed with ambient air, could be heated by furnace outlet gases and introduced directly into the furnace. This would also reduce the 600-pounds per square inch (psi) steam generation target because heat from the hairpin coolers would remain captured by the secondary air. The reduction in steam generation might be beneficial; moreover, use of the hot secondary air should reduce the amount of fuel required to maintain furnace temperature.

Generate steam at 900 psi rather than at 600 psi. Heat for steam generation is available at temperatures exceeding the saturation temperature of 900-psi steam; thus, steam at 900 psi rather than 600 psi could be produced and used to generate power.

Acrylate Monomers Plant

Optimize column feed temperature. There are a number of columns in the acrylate monomers plant where increased feed preheat temperature would reduce reboiler duties. These columns are currently reboiled by steam. In most cases, the reduction in reboiler duties would be achieved by reduced steam consumption. Using heat recovered from overhead condensers to provide the feed preheat may be an option.

Modify thermal oxidizers. Reduce fuel consumption by modifying the recuperative and regenerative thermal oxidizers.

Acetone Cyanohydrin Plant

Increase HCN converter feed temperature. Use exit gas heat to increase the temperature of the mixed feed to the converter. Alternatively, converter exit gas heat could be transferred to the colder ammonia (NH_3) and gas feed streams.

Utility Steam System

Balance steam system. Use exit gas from the acid recovery reactor to preheat ambient air that is currently heated by flue gas. Alternatively, 600-psi steam could be used to partially preheat the air. This would reduce fuel consumption and steam venting.

Table 1. Summary of Energy Conservation Opportunities

Process Area Assessed	Annual Energy Savings (MMBtu)	Annual Cost Savings
MMA Plant	309,000	$991,000
Acid Recovery Plant	582,000	$1,600,000
Acrylate Monomers Plant	996,000	$2,780,000
Acetone Cyanohydrin Plant	303,000	$2,300,000
Total	**2,190,000**	**$7,671,000**

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