Rohm and Haas: Company Uses Knoxville Plant Assessment Results to Develop Best Practices Guidelines and Benchmark for Its Other Sites

Benefits

- Identified savings of 47,000 MMBtu/yr in steam and fuel; 11,000 MWh/yr in electricity; and $1.5 million annually at the Knoxville plant
- Identified an additional savings of 23,000 MMBtu/yr; 6,000 MWh/yr; and $500,000 annually by replicating projects at two other plants
- Identified ways to increase productivity and reduce NO_x

Application

By calculating energy balances for energy-intensive process and utility systems, a chemical production facility can identify conservation opportunities. Results can be used to develop best practices guidelines and benchmarks for comparison at similar facilities.

Summary

Rohm and Haas first conducted a plant-wide energy assessment at its Knoxville, Tennessee, facility, then replicated the assessment methodology at plants in LaMirada, California, and Louisville, Kentucky. The assessment team identified annual energy savings of nearly 47,000 million British thermal units (MMBtu) in steam and fuel and 11,000 megawatt-hours (MWh) in electricity at the Knoxville plant. Annual cost savings were estimated at almost $1.5 million. When the company replicated the assessment at LaMirada and Louisville, the combined additional cost savings were more than $500,000 annually. Combined annual energy savings were about 23,000 MMBtu and 6,000 MWh for the two plants.

DOE-Industry Partnership

The U.S. Department of Energy's (DOE) Industrial Technologies Program (ITP) cosponsored the assessment through a competitive process. 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 $83,450 of the total $166,900 assessment cost.

Company Background

Rohm and Haas Company is one of the world's largest manufacturers of specialty chemicals —technologically sophisticated materials used in a variety of major markets. These markets include the paint and coatings industry; electronics; household products, detergents, and personal care; water treatment; adhesives; plastics; and salt. Rohm and Haas has annual sales of approximately $6 billion and more than 17,000 employees. It operates nearly 140 research and manufacturing locations in 27 countries.

After a plant-wide assessment (PWA) was conducted at Rohm and Haas' Knoxville facility, the assessment team replicated the PWA methodology at plants in LaMirada and Louisville. These plants primarily produce a variety of coatings products. The assessment team analyzed entire plants at Knoxville and LaMirada, but studied only the coatings area of the Louisville plant.

Energy requirements at these sites include cooling of the exothermic polymerization; product agitation; process heating; material handling; air pollution control; and typical building heating, ventilation, and lighting systems. Typical site energy systems include fuel, steam, power, refrigerated water, cooling tower water, and compressed air.

Assessment Approach

The assessment team began by considering energy conservation opportunities at the Knoxville plant. The assessment team:

- Completed an energy use analysis of the plant, identifying current and future needs
- Developed energy reduction options for the site
- Established an energy reduction plan
- Used the results from the assessment to develop best practices guidelines and a benchmark for comparison at other sites.

Specifically, the assessment team examined the following plant systems:

- Electrical
- Fuel oil
- Natural gas
- Steam
- Cooling
- Compressed air
- Water
- Thermal oxidation

Users were identified for each system and an overall energy balance was generated. Based on the system energy balances, the assessment team determined the marginal cost of each utility. Marginal cost is the out-of-pocket cost of using an incremental quantity of each utility. This information enabled the assessment team to quantify individual conservation measures such as air leak repair, turning off equipment, etc.

For the Knoxville plant, the assessment involved the following steps.

- The assessment team constructed a model of the steam system to evaluate potential benefits from piping and control changes, use of letdown turbines, and cogeneration alternatives.
- Heat and material balances were developed for the process units to establish preliminary energy targets for use in pinch analysis. The assessment team used pinch analysis to provide an order-of-magnitude energy savings potential and to identify conservation projects. The analysis identified several heat exchange opportunities between waste streams and feed streams.
- The cooling systems analysis included consideration of flow balancing and refrigeration equipment loading.
- The compressed air systems analysis included compressor sizing and operational control.

The projects identified for the Knoxville plant were assessed for possible implementation at the LaMirada and Louisville plants. The assessment team determined whether a) the project could be directly implemented at the site, b) the project was applicable with modification or, c) the project was not applicable. Simplified assessments were also conducted at these plants to identify other energy conservation opportunities and best practices. After the assessments were complete, the assessment team augmented the corporate best practices plan with experience from these sites, and developed a best practice benchmark for similar process plant energy use. Rohm and Haas intends to disseminate this benchmark to all its plants worldwide.

Table 1. Projects Identified During the Rohm and Haas Plant-Wide Energy Assessments

Project	Annual Projected Energy Savings: Fuel (MMBtu) (e.g., gas, oil, coal)	Steam (MMBtu)	Electricity (MWh)	Annual Projected Economic Impact: Annual Savings ($)[1]	Approximate Capital Cost ($)	Simple Payback Period Before Taxes (Years)
Knoxville Plant						
Increase efficiency of steam generation facility	18,500	N/A	N/A	500,000	2,000,000	4
Improve steam system maintenance	N/A	6,200	N/A	50,000	N/A	0
Recover low-level preheated water	N/A	3,700	N/A	30,000	120,000	4
Upgrade process system	N/A	18,500	N/A	300,000	1,200,000	4
Optimize refrigerated water flow	N/A	N/A	1,200	60,000	10,000	0.2
Optimize refrigerated water temperature	N/A	N/A	300	15,000	N/A	0
Substitute cooling tower water for refrigerated water in winter	N/A	N/A	2,900	145,000	800,000	5.5
Optimize cooling tower	N/A	N/A	3,000	150,000	550,000	3.7
Optimize compressed air operations and manage leaks	N/A	N/A	3,300	245,000	650,000	2.7
Totals: Knoxville Plant	**18,500**	**28,400**	**10,700**	**1,495,000**	**5,330,000**	**N/A**
LaMirada Plant						
Optimize cooling system pumping	N/A	N/A	450	56,000	8,000	0.15
Optimize compressed air systems	N/A	N/A	200	25,000	N/A	0
Optimize cleaning system	N/A	N/A	170	21,000	N/a	0
Optimize O_2 level in thermal oxidizer	3,100	N/A	N/A	25,000	30,000	1.2
Totals: LaMirada Plant	**3,100**	**N/A**	**820**	**127,000**	**38,000**	**N/A**
Louisville Plant						
Upgrade steam system (trap program, winterization, condensate recovery, etc.)	N/A	20,000	N/A	160,000	250,000	1.6
Optimize refrigerated water	N/A	N/A	5,000	250,000	750,000	3
Totals: Louisville Plant	**N/A**	**20,000**	**5,000**	**410,000**	**1,000,000**	**N/A**

[1]The annual savings include nonenergy savings, e.g., reduced water and sewer use, decreased maintenance, and increased productivity.

Results

The assessment team identified annual energy savings of nearly 47,000 MMBtu in steam and fuel and 11,000 MWh in electricity at the Knoxville plant. Annual cost savings were estimated at almost $1.5 million. When the assessment was replicated at LaMirada and Louisville, combined additional cost savings totaled more than $500,000 annually. Combined annual energy savings were about 23,000 MMBtu and 6,000 MWh for the two plants. The assessment team identified nonenergy benefits from implementing the projects, including reducing water use and sewer discharge and maintenance costs.

Productivity gains, environmental benefits, and labor savings were also identified. The assessment team used a water pinch analysis to identify opportunities to recycle water streams and to reduce water flow and sewer discharge by approximately 20%. One nonenergy benefit the assessment team identified was reducing environmental impacts by reducing nitrogen oxide (NO_x) at the boiler house.

The benefits of this approach included leveraging the effort required to do the original assessment over many sites. Lessons learned from the initial assessment enabled the assessment team to implement subsequent assessments more efficiently. The experience from the initial effort helped establish a common benchmark for similar sites. Staff can apply this benchmark at sites with similar processes to cost-effectively identify conservation opportunities.

Projects Identified

The following are specific projects identified at the Knoxville plant.

Increase efficiency of steam generation facility. The existing plant steam generation facility would be upgraded with new firetube boilers. Although implementation of this project is primarily motivated by the age of the existing boilers, the proposed new system would provide higher efficiency, more appropriately sized boilers with steam generation controls to manage the variable steam load of the plant.

Improve steam system maintenance.

Traps: An annual steam trap survey and preventive maintenance program would be established for the site.

Heaters: A similar program for the steam heaters would be implemented. This program would include a maintenance program to extend life of the heaters and improve efficiency of unit heaters across the plant.

Insulation on steam headers: The quality of the steam to the end users farthest away from the supply should be significantly increased by improving the insulation on the main steam headers. A thermal survey of the header system is being conducted.

It is estimated that these measures have a combined potential of decreasing steam demand by about 2%.

Recover low-level preheated water. The production process requires low-level preheated water in addition to boiler makeup water. Two methods are being considered to recover low-level heat for these needs: 1) Direct contact natural gas-fired heaters with an intermediate heat exchanger to isolate the process water, and 2) direct contact heat exchange from the new boilers' flue gas. These units are extremely thermally efficient. The plant could reduce peak steam demand by about 5% by implementing one of these measures.

Upgrade process system. A process system upgrade could reduce steam demand by approximately 10%.

Optimize refrigerated water flow. The plant's current average cooling load is less than one-third of the on-line capacity of the three operating chillers. Rohm and Haas may significantly reduce pumping costs by balancing flow and modifying usage.

Optimize refrigerated water temperature. The assessment team is studying original design parameters for the cooling water (refrigerated and cooling tower) demands. By increasing the cooling water supply temperature by 1 degree, the plant could significantly decrease operating costs. The assessment team is investigating potential impact on production.

Substitute cooling tower water for refrigerated water in winter. Rohm and Haas is investigating two methods of operating cooling towers during winter months that would let the plant shut down the chillers: 1) switch directly to cooling tower water, or 2) use a secondary heat exchanger.

Optimize cooling towers.

Controls: Currently, single-speed fans with no thermal load feedback are used for cooling tower control. Preliminary analysis indicates that if the control system were optimized, there is potential to reduce cooling tower electrical load by 50%.

Pump optimization: Pumps could be repaired or replaced to match the current load profile. The operating scheme could be optimized to reduce unnecessary operating time.

Cooling tower repairs: Cooling tower performance could be improved by upgrading or replacing the towers.

Optimize compressed air operations and manage leaks.

High-efficiency consolidated compressed air system: Currently, there are two independent compressed air systems in the plant, neither of which efficiently meets their users' demands. The main plant air system has effectively reached its end of life. The second compressed air system is oversized for its current application, so it operates only cyclically and therefore experiences increased wear. The assessment team proposed combining these systems with an appropriately sized system of compressors (2 to 4 units) that will effectively manage and meet the plant's variable air demand. This measure could reduce electrical costs by 15%.

Compressed air conservation projects: These projects aim to minimize the large fluctuations in air demands. The plant intends to group several improvements recommended in an air audit, which will decouple the supply-side equipment from the demand-side users. These projects include: a) installing an energy-efficient control valve at the air reservoir; b) isolating the high-volume, low-pressure users, either by installing lower pressure blowers or a dedicated low-pressure surge tank; and c) installing high-efficiency traps and drains throughout the distribution

Rohm and Haas' Knoxville Plant

header. By installing these components, the plant will reduce the new compressor system's overall peak capacity.

Air leak program: The assessment team estimated that 28% of the plant air load is lost to leaks. This is significantly higher than industry-accepted allowances. Therefore, the plant will establish a leak management program. The target is to reduce leaks to 10% (industry benchmark) over the next 3 years.

Maintenance improvements: The plant will implement compressed air piping installation guidelines. Poor installation practices for compressed air take-offs, tubing runs, and fitting designs have caused higher-than-acceptable pressure drops and leaks. The plant will follow guidelines for proper installation and fitting upgrades in future installations.

Pump replacement: The plant would replace air-operated sumps with electric sump pumps.

BestPractices is part of the Industrial Technologies Program, and it supports the Industries of the Future strategy. This strategy helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together emerging technologies and energy-management best practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

BestPractices emphasizes plant systems, where significant efficiency improvements and savings can be achieved. Industry gains easy access to near-term and long-term solutions for improving the performance of motor, steam, compressed air, and process heating systems. In addition, the Industrial Assessment Centers provide comprehensive industrial energy evaluations to small- and medium-size manufacturers.

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