



CHEMICALS

Best Practices Assessment Case Study

January 2003

OFFICE OF INDUSTRIAL TECHNOLOGIES

ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY

BENEFITS

- Reduces electricity use by an estimated 35.9 million kWh/yr
- Reduces steam use by an estimated 70,000 MMBtu/yr
- Saves an estimated \$1.2 million per year in operating and energy costs
- Reduces environmental impacts
- Improves production capacity

APPLICATIONS

Akzo Nobel's Surface Chemistry plant in Morris, Illinois, has implemented an "Energy Efficiency Plan" to help identify its primary energy-intensive processes and reduce energy consumption. This plan required an energy efficiency assessment, which helped the company identify several energy- and cost-saving projects that may be replicated in the chemicals industry.

Akzo Nobel Morris Plant Implements a Site-Wide Energy Efficiency Plan

Summary

Akzo Nobel's Energy Efficiency Plan (EEP) is designed to help plant personnel monitor energy consumption during production and to identify potential energy-savings opportunities. This is accomplished by using either standard pinch studies or by analyzing the primary energy users in the plant. By monitoring the specific energy consumption on a per-unit-product basis, plant management and operations personnel can assess and improve the plant's energy performance.

The EEP evaluation has shown that the energy use at the Morris site was higher on a per-product basis than at similar sites within the organization. Rising energy costs prompted the company to optimize the site's energy efficiency. The future focus will be on reducing the overall consumption of energy, not just on minimizing energy costs. Akzo Nobel's corporate energy conservation program is also motivated by the company's goal to reduce environmental impacts.

DOE-Industry Partnership

The U.S. Department of Energy's (DOE) Office of Industrial Technologies (OIT) co-sponsored the assessment. OIT promotes plant-wide energy efficiency assessments that will lead to improvements in industrial energy efficiency, waste reduction, productivity, and global competitiveness. In this case, OIT contributed \$47,500 of the total \$95,000 assessment cost.

Akzo Nobel's Morris, Illinois Facility



Company Background

Akzo Nobel, headquartered in the Netherlands, is one of the world's leading chemical companies. It manufactures products used in the healthcare industry, paints and coatings, chemical specialties, and fibers. The company has more than 66,000 employees in more than 80 countries. Akzo Nobel's global activities follow a decentralized "Business Unit" structure and are divided into three distinct groups: Pharma (prescription drugs and hospital supplies), Coatings, and Chemicals. Each group is composed of several business units that report directly to Akzo Nobel's Board of Management.

Akzo Nobel's Surface Chemistry plant in Morris, Illinois, is part of the Chemicals Group. The plant began operating in 1973 and now has more than 100 employees. The plant manufactures industrial chemicals derived from naturally occurring fats and oils. The basic raw materials are tallow and vegetable oils, including coconut oil and soybean oil. Other raw materials used in large quantities are ammonia, hydrogen, and methyl chloride.

Primary processing units at the Morris site include a fat splitter, a nitrile unit, continuous and batch hydrogenation units, distillation units, esterification units, and quaternization units. The plant produces primary, secondary, and tertiary amines, di-amines, and quaternary ammonium chlorides. These intermediates and products are used as surfactants in agricultural products, personal care products, detergents, and fabric softeners. They are also used as surfactants in a wide range of other industrial processes, including the food, chemical, highway paving, metal processing, mining, petroleum, paint, ink, paper, pharmaceutical, rubber, and polymer-processing industries.

Assessment Approach

One of Akzo Nobel's corporate goals is to reduce the energy consumed during product manufacture. An EEP introduced at its European sites in 1994 has helped staff effectively monitor energy consumption for both entire sites and specific processes and help identify potential energy savings projects.

Historically, energy costs at the North American plants have been a smaller component of their total production costs compared to their European counterparts; this is the major reason that energy efficiency programs have not traditionally been emphasized in the United States. Nonetheless, increasing global energy costs have prompted Akzo Nobel to initiate energy-reduction measures at U.S. manufacturing facilities. During the 1990s, the U.S. plants showed little improvement in energy efficiency compared to the European plants. Therefore, Akzo Nobel decided to implement EEP at the most energy-intensive U.S. sites. The Morris, Illinois, site was chosen as the U.S. pilot plant.

The EEP process consists of two measures.

- Company staff monitor the specific (per-unit-product) energy consumption, in which the different forms of energy are expressed in primary energy, or fuel equivalents such as natural gas, coal, or electricity. This allows plant management and operations personnel to assess the plant's energy performance.
- Assessment personnel explore energy savings potential using either pinch-energy studies or by focusing on the major energy users in the plant.

These measures lead to specific recommendations for improvements.

Akzo Nobel Energy, a Business Unit within Akzo Nobel that is headquartered in Europe and experienced in the EEP process, led the Morris assessment. Implementing the EEP within Akzo Nobel has demonstrated the following.

- A substantial improvement in energy consumption can be accomplished.
- By providing a benchmark, energy consumption among plants can be compared.
- Manufacturing processes can have fewer environmental impacts.
- The introduction of energy-efficient technologies—such as co-generation, closing loops, heat integration within a process, and process optimization—considerably reduces the overall energy consumption.

Results

Assessment personnel measured the energy consumption of the different manufacturing areas at the Morris plant and compared it against a reference value.¹ The company will use the results of the plant-wide assessment as a baseline to develop energy management measures that will become standard plant operation. These measures include cogeneration of steam and electricity, process improvement in the nitrile unit, heat recovery from fatty acid distillation, and steam reduction. In addition, improving metering of energy use will facilitate these goals.

Based on current data, the company estimates total potential annual electricity savings of 35.9 million kilowatt-hours (kWh) and potential annual steam savings of 70,000 million British thermal units (MMBtu). The cogeneration unit would increase natural gas consumption by about 200,000 MMBtu per year (MMBtu/yr) but is key to the electricity and steam savings. Furthermore, the plant can optimize heat integration. In total, these savings represent roughly 15 percent of the energy intake, or \$1,170,413 per year. Akzo Nobel estimates that an additional 3 percent savings can be achieved by introducing an energy management system.

During the assessment, plant staff identified a number of smaller energy optimization projects that the company began implementing right away. Upgraded and integrated steam boiler controls saved about 10 percent in steam generation costs after only 1 month of operation. Energy recovery on a distillation unit is projected to increase the unit capacity by 10 percent, and process studies initiated on a refrigeration system show a potential for a 15 percent reduction in energy consumption by changing the existing control configurations.

Projects Identified

Potential energy savings projects identified at the Morris site included the following.

Cogeneration of Steam and Electricity. A steam and electric power cogeneration unit is feasible. Potential energy savings are estimated at 37.6 million kilowatt hours per year (kWh/yr), with an increase in fuel consumption of 193,170 MMBtu/yr. The company estimates that with a project investment of \$4.5 to \$5 million, the payback period will be 4 to 5 years. The company will schedule project implementation based on availability of capital funds.

¹ The lack of reliable data with respect to energy distribution to specific manufacturing units within the site made it clear that the existing metering systems needed improvement.

Process Improvement in Nitrile Unit. The nitrile production unit consumes large amounts of energy. The company estimates it could save approximately 70,000 MMBtu of steam per year by implementing a proprietary process improvement. An associated addition of a recycle compressor would increase electricity usage by 1.7 million kWh/yr. Even so, Akzo Nobel estimates a payback period of only 2 to 3 years on the \$1.1 million cost to implement this project.

Heat Recovery from Fatty Acid Distillation. Based on the current temperatures, thermal exchange between the overhead product of the main distillation column and the feed to the light ends column may yield energy savings of 6,830 MMBtu/yr. These gains are based on reducing the load on the hot oil unit supplying the distillation unit. A larger incentive here is that the overall energy gain can be utilized to increase the unit production by up to 10 percent without a major investment in a new hot oil system. The project cost and payback period are estimated to be \$250,000 and 6 to 7 years, respectively.

Steam Reduction. Akzo Nobel currently does not measure steam in many areas. If steam measurement instrumentation were installed and the use of 150-psig steam were attributed to specific process areas, the plant could employ waste reduction measures. The company predicts substantial savings from such measures, but the savings cannot be quantified until flow meters are installed.

Table 1 summarizes potential energy savings from three projects identified during the Morris plant assessment.

Table 1. Potential Annual Energy Savings at Morris Plant

Project	Annual Energy Savings			Project Cost (\$)	Payback Period (yr)
	Steam (MMBtu)	Natural Gas (MMBtu)	Electricity (kWh)		
Cogeneration		-200,000	37,600,000	5,000,000	4–5
Proprietary Nitrile Unit Process Improvement	70,000		-1,700,000	1,100,000	2–3
Heat Exchanging Fatty Acid Distillation		6,830		250,000	6–7
Totals	70,000	-193,170	35,900,000	6,350,000	

Industry of the Future—Chemicals

The chemical industry is one of several energy- and waste-intensive industries that participate in OIT's Industries of the Future initiative. In December 1996, the chemical industry published a report entitled **Technology Vision 2020: The U.S. Chemical Industry** that helps establish technical priorities for improving the industry's competitiveness and develops recommendations to strengthen cooperation among industry, government, and academia. It also provides direction for continuous improvement through step-change technology in new chemical science and engineering technology, supply chain management, information systems, and manufacturing and operations.

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BestPractices is part of the Office of Industrial Technologies Industries of the Future strategy, which helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together emerging technologies and best energy-management 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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DOE/GO-102003-1644
January 2003