Raytheon: Compressed Air System Upgrade Saves Energy and Improves Performance

Benefits

- Saves $141,500 per year
- Saves 1,559,000 kWh annually
- Reduces maintenance costs
- Improves air quality
- Achieves a 1.2-year simple payback

Applications

Compressed air systems are found throughout industry and can consume a significant portion of the electricity used by manufacturing plants. Upgrading worn and inefficient compressed air components within a system-level strategy to improve system efficiency can yield energy savings and better performance.

Summary

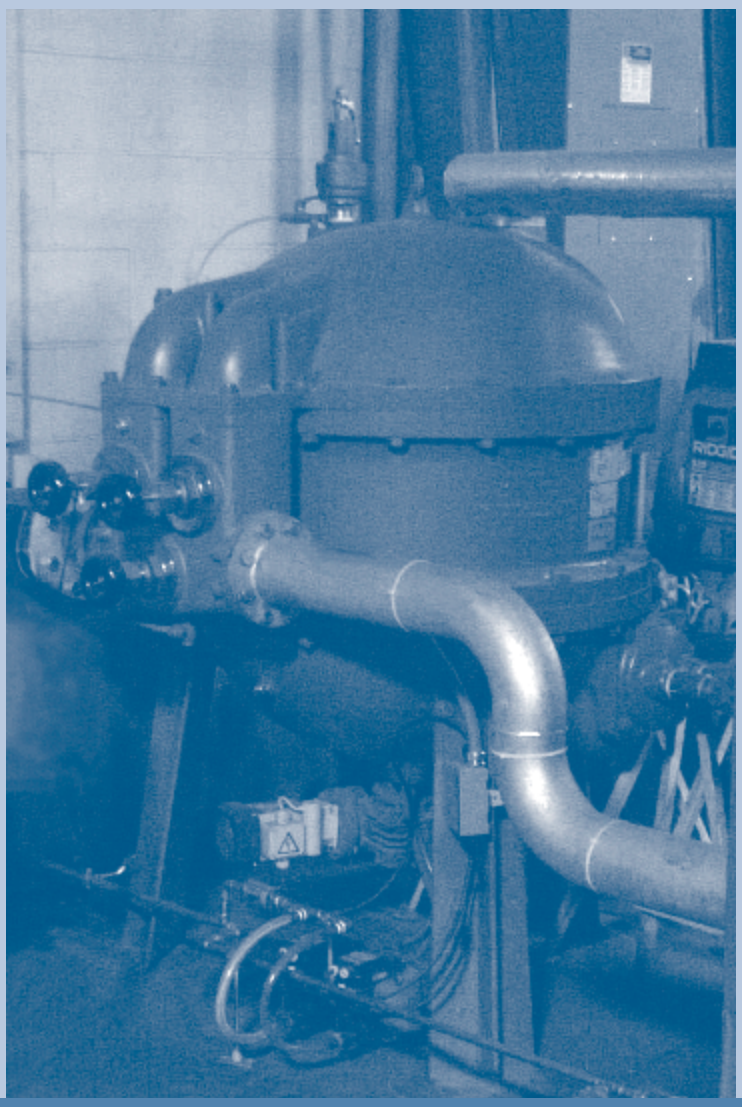
In 2003, Raytheon Company's Integrated Defense Systems business upgraded the efficiency of the compressed air system at its Integrated Air Defense Center (IADC) in Andover, Massachusetts. The project included the replacement of worn compressors and dryers, the installation of a more sophisticated control strategy, and an aggressive leak detection and repair campaign. These measures significantly improved the system's efficiency and led to important savings in energy and maintenance costs. The total cost of implementing the project was $342,000, but a $174,000 incentive payment from National Grid, a utility service provider, effectively reduced it to $168,000. With total annual energy and maintenance cost savings of $141,500 and energy savings of 1,559,000 kWh, the simple payback is 1.2 years.

Company/Plant Background

Based in Waltham, Massachusetts, Raytheon was founded more than 80 years ago as a maker of radio tubes. The company began developing radar systems in the 1940s and has since grown into a major manufacturer of defense-related electronics. In addition to producing high-technology, defense-related electronics, the company converts such technologies for use in commercial and residential applications. Today Raytheon operates in many strategic business areas, including government and commercial electronics, space, information technology, technical services, and business aviation and special mission aircraft. It employs more than 78,000 people and has annual revenues of $18 billion.

Raytheon has long been known as a leader in conserving natural resources and protecting the environment. The company has been an active Energy Star® partner since 1999, and it was recognized in 2003 by the U.S. Environmental Protection Agency and the U.S. Department of Energy (DOE) as a "Partner of the Year." Energy-related issues receive critical attention at all Raytheon locations, particularly those with manufacturing operations.

At Raytheon's IADC, compressed air is important for the plant's production processes because it supports many precision operations as well as a variety



A compressed air dryer at the Raytheon plant.

of pneumatic tools and air-operated cylinders. Before this project was implemented, the plant's compressed air system was served by four aging, lubricant-injected, rotary screw compressors totaling 1,050 horsepower (hp). This compressed air system generated an average of 1,850 standard cubic feet per minute (scfm) and sought to maintain a system pressure level of 105 pounds per square inch gauge (psig) so that end-use applications would have 95 psig air.

Project Overview

Conscious of the need to remain competitive, the company established an energy management program at the IADC facility many years ago. After attending a Compressed Air Challenge (CAC) workshop, plant personnel elected to commission a system-level audit of the compressed air system to determine how it could be optimized. The timing was opportune because the plant was scheduled to be reconfigured in the near future. To review the system, plant engineers worked with Energy & Resource Solutions (ERS), a DOE Qualified Specialist based in Haverhill, Massachusetts. ERS used the AIRMaster+ software tool to gauge the system's efficiency, evaluate the leak load, and obtain the baseline data against which the results of the project could be measured.

The evaluation found that the existing compressors did not operate efficiently, for several reasons. First, they were individually controlled. One unit was in a separate room, so when it operated it often reacted to control pressures that were different from those affecting units in the other room. Second, the compressors' onboard controls did not function properly, and this caused two compressors to operate at full load during conditions in which they should have been operating at part load. Third, because the compressors were installed in the early 1980s, they were near the end of their useful lives. In addition, a thorough ultrasonic leak detection campaign found that more than 400 leaks in the system were consuming as much as 750 scfm, or 40% of the system's normal output.

Project Implementation

Using recommendations from the ERS evaluation, the IADC engineers and operations personnel initiated a project that would bring the system's efficiency up to the level estimated with AIRMaster+. They replaced the existing compressors with two 250-hp lubricant-free rotary screw compressors and located them in one room. They installed a multiple compressor network control system to effectively modulate these compressors. They also replaced the dryers and installed a large storage receiver to replace two older ones. Because the plant's air demand was stable, pressure stabilization devices were not necessary. Finally, staff at the IADC facility repaired the leaks that were identified and tagged during the evaluation. Their work eliminated more than 700 scfm of the system's leakage.

Raytheon's plant in Andover, Massachusetts.

AIRMaster+

AIRMaster+ is an assessment and analysis software tool that enables industrial users to optimize equipment and improve operations and maintenance practices. It helps to maximize the efficiency and performance of compressed air systems. Using plant-specific data, the software effectively evaluates supply-side operational costs for various equipment configurations and system profiles. It provides accurate estimates of potential savings from various energy efficiency scenarios and calculates associated simple payback periods.

AIRMaster+ was developed by DOE's Office of Energy Efficiency and Renewable Energy (EERE); please see www.oit.doe.gov/bestpractices/factsheets/airmaster.pdf for more information, and visit www.oit.doe.gov/bestpractices/steam/airmaster.html to download the software.

Project Results

The project improved the system's efficiency, which yielded important energy savings. Before the project was implemented, the IADC facility depended on the operation of one 250-hp and one 350-hp compressor simultaneously to support a demand of 1,850 scfm. The plant currently operates one 250-hp compressor at full load and a second 250-hp unit at part load to deliver 1,400 scfm. In addition, because the pressure drop across the system declined, the plant needs to maintain a system pressure of only 100 psig. Furthermore, the system's air quality is better.

Because both lower compressor capacity and reduced compressor operating time are now required, the plant saves $140,000 (1,559,000 kWh) in annual electricity costs. Also, because the new compressors are less maintenance-intensive, annual maintenance savings are $1,500, making the total savings $141,500 per year. Total project costs were $342,000, but with the incentive payment of $174,000 from National Grid, project costs effectively became $168,000, yielding a 1.2 year simple payback. The incentive payment was conditional and depended upon a successful reduction in energy consumption, as estimated by ERS using AIRMaster+ during the evaluation. Once the project was complete, measured energy use by the compressed air system was 6% under the predicted values in the AIRMaster+ scenario, which satisfied the criteria for success established by National Grid.

Lessons Learned

Using software tools can be very valuable in optimizing industrial system efficiency. The use of AIRMaster+ allowed the Raytheon IADC to evaluate several "what if" scenarios before acting to improve the efficiency of its compressed air system. AIRMaster+ also proved useful as a validation tool once the project was completed. The tool's estimated energy consumption levels established a reference point for Raytheon's utility service provider, National Grid, to determine the size of the incentive it could offer. By using a system-level approach, Raytheon engineers optimized their compressed air system to a degree that exceeded the compressed air energy consumption calculations predicted by AIRMaster+. This strategy has yielded important energy savings and better system performance.

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.

Project Partners

Raytheon Company
Andover, MA

Energy & Resource Solutions
Haverhill, MA

National Grid
Northborough, MA

For Additional Information, Please Contact:

EERE Information Center
1-877-EERE-INF
(1-877-337-3463)
www.eere.energy.gov

Visit our home page at
www.eere.energy.gov/industry

Industrial Technologies Program
Energy Efficiency and Renewable Energy
U.S. Department of Energy
Washington, DC 20585-0121

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 20% postconsumer waste

DOE/GO-102005-1935
April 2005