Showcase Demonstration CASE STUDY

MOTOR CHALLENGE

a Program of the U.S. Department of Energy

THE CHALLENGE: IMPROVING THE EFFICIENCY OF A TUBE DRAWING BENCH

Summary

Greenville Tube Company (GT), a manufacturer of high-precision, small-diameter stainless steel tubing, conducted an in-house system performance optimization project to improve the efficiency of its No. 6 tube drawing bench. This tube drawing bench plays an integral role in the production process, but severely hindered the productivity and energy efficiency of the facility. GT's plant engineer, with the technical assistance of Evans Electric Motors, Inc. and Baldor Electric Company, evaluated the systemic problems in GT's production facility and replaced the original motor and inefficient eddy current clutch drive with an energy-efficient motor with vector control. As a result of the changes implemented, GT, a subsidiary of the Delaware-based Chart Industries, discovered that energy efficiency and improved productivity often go hand-in-hand. This Showcase Demonstration Project reduced total annual energy consumption by 148,847 kWh, or 34 percent and resulted in electrical, labor, and material savings of $77,266. The simple payback was just over 5 months.

Project Profile	
Industry:	Steel Pipes and Tubes
Process:	Steel Tube Drawing
System:	Tube Drawing Bench
Technology:	Energy-Efficient Motor, Vector Drive Controller, and Reactor

Company Background

While GT's headquarters is located in Greenville, Pennsylvania, it's production facility is located in Clarksville, Arkansas. The 100,000 square foot Clarksville plant produces approximately 1 million linear feet of custom stainless steel tubing per month for its customers in the automotive, aerospace, food, medical equipment, pharmaceutical, and petrochemical industries. Acquired in 1988 by Chart Industries, an industrial process equipment manufacturer, GT has carved a niche for itself as a reliable and flexible supplier in situations where a customer is experiencing costly downtime due to equipment failure and requires a specific size and type of tubing quickly.

Greenville Tube Production Facility

Project Overview

The production process at the Clarksville facility consists of drawing stainless steel tubing through dies to reduce their diameter and/or wall thickness. This drawing process is carried out on a drawbench. The No. 6 drawbench is the only drawbench in the facility that performs "breaking" draws. Each tube typically goes through several "breaking" draws which rapidly form the tube close to its specified

The energy savings network

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final dimensions. Later, the tube undergoes a few final "finishing" draws to achieve the exact tube size desired. The No. 6 drawbench operates in three 8-hour shifts, performing approximately 400 draws per shift 5 days per week throughout the year.

SIC: 3317

Products: Stainless Steel Tubing

Location: Clarksville, Arkansas

Employees: 200

Showcase Team Leaders:
Reggie Holstead and Paul Anderson

Company Energy Philosophy:
Apply the most energy-efficient equipment and procedures commencerate with our short lead time requirements.

Before the performance optimization project, the No. 6 drawbench was powered by a 150-hp motor running at 1,770 rpm. This motor was coupled to a speed reducer (gear box) through an eddy current clutch. In an investigation aimed at halting nuisance tripping in GT's power distribution system, the Clarksville facility's plant engineer determined that the 150-hp motor and eddy current clutch drive system were responsible for bottlenecking the production process. The investigation also identified several parts of the system in need of repair or replacement.

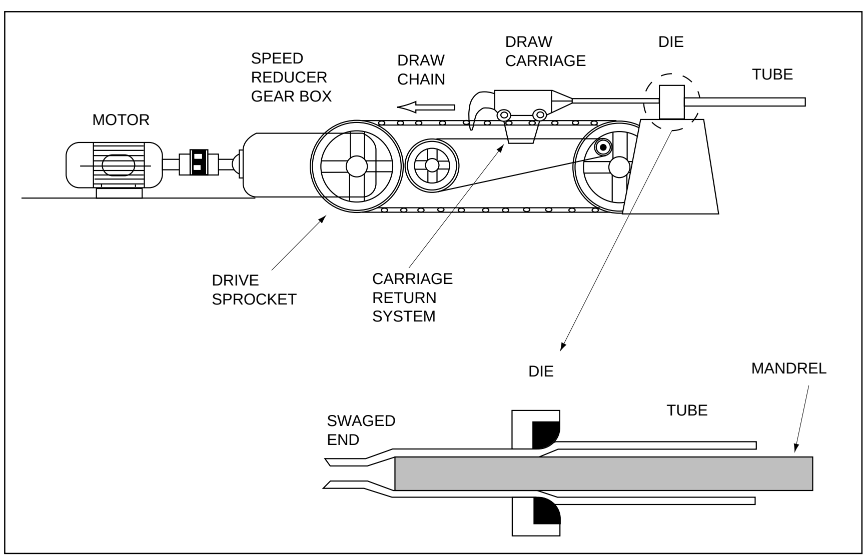
Project Team

To address the discoveries of the plant engineer's investigation, while adhering to GT's energy philosophy of applying the most energy-efficient equipment and procedures possible to maintain short lead times, a Showcase Demonstration team was established in 1994 to analyze the problem. Joining GT staff on the project were Baldor Electric Company and Evans Electric Motors, Inc. Baldor was responsible for designing and commissioning motor controls and supplying the high-efficiency motor and vector drive control. Evans Electric, a Baldor distributor, was responsible for project design and start-up of the motor and drive. DOE's Independent Performance Validation (IPV) team reviewed the results and conclusions of the project and provided technical assistance needed to validate the savings.

The Systems Approach

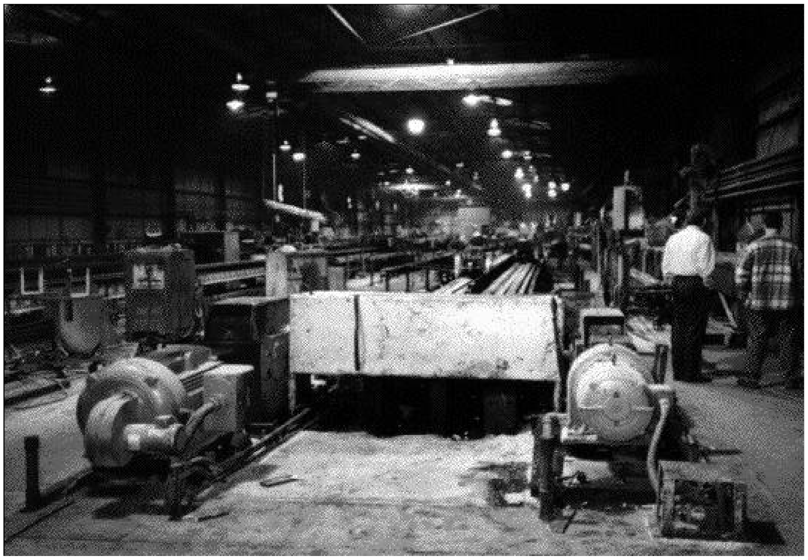
DOE's IPV team used data collected by the GT plant engineer to analyze the existing system. In keeping with a systems approach, the team evaluated the entire drawbench drive system, not just the undersized motor that was bottlenecking the production process. This included closely observing the operation of several other machines at the facility operating with equipment similar to the No. 6 drawbench and noting where similar operating parameters could be applied to the No. 6 drawbench.

Due to the wide variability in tube diameter, wall thickness, material used, and order sizes received each week, a single representative GT product does not exist. To obtain hard data representative of actual operation, the IPV team randomly selected orders and then performed a detailed analysis of the intermediate steps to which the tubing would be subjected. The IPV team also conducted detailed interviews with GT's vice-president, plant manager, and the shop foreman. Finally, in order to measure the direct power savings resulting from the system modification, the IPV team compared the power requirement that the plant engineer measured in his initial study (the base case) against the measured modified system power requirements (the optimized case).



Tube Drawing Bench

Project Implementation



No. 6 Tube Drawing Bench

In his evaluation of the plant, the plant engineer discovered a number of problems plaguing the No. 6 drawbench. These problems resulted from the combination of an antiquated power distribution system and an inefficient eddy current clutch drive. The drive motor, with a full load amp rating of 250 amps, was at times drawing over 900 amps. The thermal load on the power distribution system therefore needed to be reduced to prevent the frequent overload trips. The plant engineer also wanted to increase the torque output to the drawbench, improve overall drive efficiency, and reduce energy consumption. Finally, the engineer wanted to install a mechanism that would improve the operator's low speed control over the motor. This would make a quick latch of the carriage easier to accomplish while maintaining high efficiency levels and improving final product quality.

In order to accomplish these goals, the Showcase Demonstration team replaced the magnetic starter and eddy current clutch with a Baldor vector controller and line reactor — the control was installed in a NEMA 12 enclosure with an air conditioner — and replaced the 150-hp, 1,770 rpm motor with a high-efficiency 200-hp, 1,180 rpm Baldor Electric motor.

Vector Drive Controls

Vector drive controls, which can be coupled to variable frequency drives (VFDs), continuously monitor the current, voltage, and position of AC induction motors. By plugging these values into algorithms, torque, speed, position, and other critical parameters can be controlled, thus providing several high-performance applications with a more reliable motor. Prior to the development of vector drive controls, only DC motors, which are less reliable than their AC counterparts, could be used in applications requiring accurate torque and speed control.

Results

As a result of the changes implemented by the Showcase Demonstration team, the No. 6 drawbench now requires less energy to draw a tube, even though the motor power was increased from 150-hp to 200-hp. For a typical draw, the eddy current coupling system required 190-hp to draw a tube, while the more efficient vector drive requires only 87-hp. The projected total annual operating time was also reduced by 623 hours as a result of the modifications since the greater horsepower available enabled many of the tubes to be reduced to the desired size with a smaller number of breaking draws. This enabled the No. 6 drawbench to take over work previously done on other, less efficient benches. The modifications reduced the No. 6 drawing bench's total annual energy consumption from 439,065 kWh to 290,218 kWh and reduced the total annual electricity costs associated with the No. 6 drawing bench by 34 percent from the base case cost of $20,812.

An estimated 2,762 hours of labor per year will be saved as the result of these changes. GT personnel estimate that one draw was eliminated from 50 percent of the orders processed. Time is not only saved through the reduced number of draws required to "break" a tube, but is also saved from the ancillary operations that are required by the drawing process, such as degreasing, cut-off, swaging, and annealing. Furthermore, assuming a labor rate of $8.50 per hour, the time reduction amounts to labor cost savings of $23,473 per year. The reduced number of draws necessary also saved an estimated $41,322 of stainless steel, as fewer draws equate to fewer swaged ends cut off after each draw.

Including other direct savings of $5,415, pushes the total cost savings to $77,266.

The expenditures necessary to carry out the project included: $11,203 for the new vector motor, $18,982 for the enclosure and air conditioner, and $7,005 for installation, totaling $37,190. Based on annual savings of $77,266 (see table), a simple payback for the modifications was achieved in just over 5 months.

Another benefit resulting from this project was the identification of other benches that might be good candidates for future drawbench modifications. Finally, use of the vector drive and the improved process control system enabled the drawbench operator to control drawbench speed more precisely, thus resulting in an improved final product.

Lessons Learned

During the project, the GT Showcase Demonstration Team learned a number of valuable lessons. First, more extensive and long-term metering of the power demands and operating modes, both before and after a project's implementation, are necessary. In meeting this need, the GT members of the team found the advice provided by its outside partners — Evans Electric and Baldor — to be crucial, as assessment and evaluation were conducted with a high level of expertise. Furthermore, the team learned that if installation time is limited, critical spare parts should be on-site or at least quickly obtainable. Evans Electric's ability to immediately replace a shaft encoder damaged during shipment enabled the project installation to be completed over the weekend as planned.

Performance Improvement Summary

Annual Energy and Cost Savings

Electricity	148,847 kWh	$ 7,056
Labor Hours	2,762 hours	$23,473
Stainless Steel		$41,322
Other Direct		$ 5,415
TOTAL		$77,266

Total Annual Emissions Reductions

CO_2	92,842 lbs
Carbon Equivalent	25,321 lbs
SO_x	318 lbs
NO_x	293 lbs
PM-10	7.6 lbs
VOC	1.5 lbs
CO	23 lbs

* Note: Emissions reductions would be greater for most facilities. More than half of the electricity saved at GT was generated by hydroelectric plants.

About Motor Challenge

The Motor Challenge is a joint effort by the U.S. Department of Energy (DOE), industry, motor systems equipment manufacturers and distributors, and other key stakeholders to put information about energy-efficient electric motor system technology in the hands of people who can use it.

Showcase Demonstration Projects target electric motor-driven system efficiency and productivity opportunities in specific industrial applications. They show that efficiency potential can be realized in a cost-effective manner and encourage replication at other facilities.

DOE provided technical assistance and independent performance validation (IPV) of energy savings. A DOE-sponsored IPV team reviewed the test plan and provided assistance, as requested by the host site, on testing procedures, instrumentation techniques, and data acquisition. The DOE team developed a detailed IPV Report thoroughly documenting the project. The Report is available by calling the number listed below. DOE did not witness the actual test data, and the conclusions in this case study are based solely on data provided by the host site and their partners.

For more information on becoming involved in the Motor Challenge or sponsoring a Showcase Demonstration, call the Motor Challenge Information Clearinghouse at (800) 862-2086.

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