NICE³

Project Fact Sheet

Atmosphere Recovery and Regeneration in Heat Treating Operations

Benefits

- For a typical batch furnace requiring 700 cubic feet per hour of controlled atmosphere, 96% recovery and regeneration offers the following:
  - 92% less energy to generate the atmosphere
  - 40% less energy for the overall heat treating process
  - 90% reduction in atmosphere gas emissions
  - $200,000 to $500,000 in annual cost savings
- Thorough, high-speed analysis of all atmosphere gas constituents
- Substantial reduction in plant ventilation requirements
- Elimination of atmosphere flaring
- Improved part quality and a reduction in rework
- Improved furnace throughput and safety
- Installation cost payback in 6 to 24 months

Applications

Automotive, farm and construction equipment, aerospace, and numerous other manufacturers of parts using any type of controlled atmosphere furnace can benefit from this cost-saving, pollution-reducing innovation. This technology applies to carburizing, annealing, tempering, sintering, and forging. Primary and secondary metal refiners, particularly those using direct reduction processes, can also benefit. The technology is also applicable to chemical processing and petroleum refining operations.

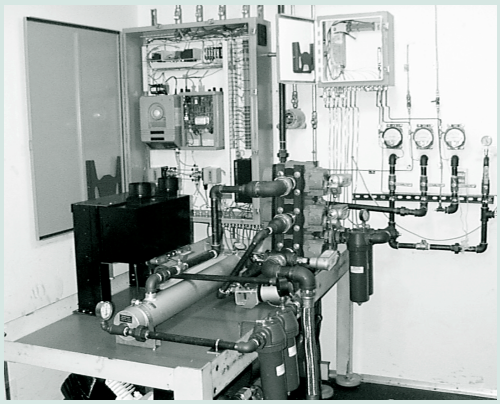
New atmosphere gas recovery system for furnaces reduces air emissions, energy use, and part-processing time

Dana Corporation and Atmosphere Recovery, Inc. (ARI), with assistance from the Department of Energy's NICE³ Program, have demonstrated at full-scale a new technology that cleans and reuses more than 90% of the process gas in carburizing furnaces. This innovative system integrates commercially available nitrogen gas separation membrane technology with a proprietary procedure for gas extraction, analyses, control, and constituent gas correction. A high-speed laser-based process gas analyzer was also developed as a part of the technology.

High-temperature industrial processes, including heat treating, brazing, sintering, and metal refining, typically maintain a reducing atmosphere over parts or material being processed in a furnace. Carburizing to increase steel surface hardness is one example of a widely used heat treatment operation. This process consumes large quantities of hydrocarbons, usually natural gas or methanol, to produce an atmosphere containing about 20% carbon monoxide (CO). In a conventional carburizing system, after flowing across the steel parts inside the furnace, the carbon monoxide is discharged without any pollution control through gas flares. This traditional method not only emits high concentrations of CO, but also requires significant energy to sustain. The new system reduces conventional pollutants and emissions from atmospherically controlled furnaces by over 90%.

The ARI system will help U.S. firms compete with overseas producers not subject to stringent environmental constraints on carburizing and other furnace operations. Wide scale adoption of the ARI recovery and regeneration process should enable U.S. heat treating operations to function well within existing and future environmental standards.

Atmosphere Recovery and Regeneration System



A new furnace atmosphere recovery system for steel heat treaters integrates gas membrane separation technology with a gas analysis and regeneration system that will dramatically reduce emissions, costs, and energy use.

OFFICE OF INDUSTRIAL TECHNOLOGIES
ENERGY EFFICIENCY AND RENEWABLE ENERGY • U.S. DEPARTMENT OF ENERGY

Project Description

Goal: The project goal was to demonstrate at a full-scale facility new technology that brings substantial improvements in atmosphere recovery and heat treating for high temperature furnace operations, with subsequent reductions in energy use, waste, and costs.

The ARI recovery system uses commercially available gas separation membrane technology and a proprietary procedure for gas analysis, control, and constituent gas correction. The furnace atmosphere discharge vent is sealed, and formerly discharged gas is cooled and piped to the ARI regeneration unit for compression and removal of impurities. The system removes excess hydrogen, oxygen, carbon dioxide, and water vapor, and restores appropriate levels of nitrogen, CO, and hydrogen. Primary separation occurs through preferential retention of nitrogen and carbon monoxide in the waste atmosphere gas components on the "upstream" (pressurized) side of the membrane surface while allowing impurities to pass through the membrane at higher rates. Along with programmable controllers, a specially developed Raman laser-based gas analyzer monitors and optimizes the process. After processing, the recovered gas is piped back to the furnace for reuse, while removed hydrogen gas is captured as burner fuel.

Dana Corporation demonstrated this new technology with assistance from Atmosphere Recovery, Inc., BOC Gases, the Minnesota Department of Public Service, and the NICE^3 Program in the Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- Project began in 1995 and was completed in September 1997.
- Needed equipment obtained and demonstration unit constructed.
- System operation was monitored, and adjustments and necessary component improvements were made.
- Prototype reengineered for commercial introduction.
- Laser gas analyzer developed and tested.
- Systems and analzyers manufactured and marketed.
- Commercialization of the technology is in progress. First unit intended for commercialization should be in place by fall 2000.

NICE^3—National Industrial Competitiveness through Energy, Environment, and Economics: An innovative, cost-sharing program to promote energy efficiency, clean production, and economic competitiveness in industry. This grant program provides funding to state and industry partners for the first commercial demonstration of energy efficient and clean production manufacturing and industrial technologies. Total project cost for a single award must be cost-shared at a minimum of 50% by a combination of state and industrial partner dollars. The DOE share for each award shall not exceed $500,000 to the industrial partner and up to $25,000 to the sponsoring state agency for a maximum of $525,000.

Project Partners

Atmosphere Recovery, Inc.
Plymouth, MN

BOC Gases
Murray Hill, NJ

Dana Corporation
Plymouth, MN

Minnesota Department of Public Service
St. Paul, MN

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