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.

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.
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 NICE3 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 analyzers manufactured and marketed.
- Commercialization of the technology is in progress. First unit intended for commercialization should be in place by fall 2000.

FOR PROJECT INFORMATION, CONTACT:
Ronald Rich
Atmosphere Recovery, Inc.
15800 32nd Avenue North, #110
Plymouth, MN 55447-1468
Phone: (612) 557-8675
Fax: (612) 557-8668
rrr@atmrcv.com

FOR PROGRAM INFORMATION, CONTACT:
Lisa Barnett
Program Manager, NICE3 Program
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585
Phone: (202) 586-2212
Fax: (202) 586-7114
lisa.barnett@ee.doe.gov

Visit our home page at
www.oit.doe.gov

Office of Industrial Technologies
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, DC 20585

DOE/GO-102000-0948
Order# NICE3OT-14
April 2000