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Using Coke Oven Gas in a Blast Furnace Saves Over $6 Million Annually at a Steel Mill

Summary

Like most steel companies, U.S. Steel (USS) had been using coke oven gas (COG), a by-product of coke manufacturing, as a fuel in their coke ovens, boilers, and reheat furnaces. Since the dynamic nature of the steel-making process results in widely varying needs for energy, USS had to flare some of the COG during periods of low energy demand.

In an effort to save energy and reduce costs, USS developed a system at their Mon Valley Works located just outside Pittsburgh, Pennsylvania that enabled them to use COG in their blast furnaces. Although other steelmakers in North America have attempted this, USS is the first to successfully use COG in blast furnaces. To accomplish this, USS thoroughly cleans the gas, boosts its pressure, and uses modified blast furnace tuyeres (nozzles). The project cost approximately $6 million to implement and resulted in $6.1 million in annual savings, giving a simple payback of just under one year.

Benefits

- Saves over $6 million annually
- Reduces natural gas consumption
- Eliminates coke oven gas flaring
- Reduces emissions of pollutants
- Lowers overall electricity costs

Applications

Innovative use of “waste” fuels can reduce energy costs at some industrial plants. In some cases, effective use of the waste fuel may require equipment and process modifications.

Edgar Thomas Plant

Company Background

U.S. Steel Group is part of USX Corporation, which is headquartered in Pittsburgh, Pennsylvania. USX is a major worldwide producer of oil and natural gas, and is also the nation's largest producer of steel products. The USS subsidiary manufactures a wide variety of steel products, coke, and taconite pellets.

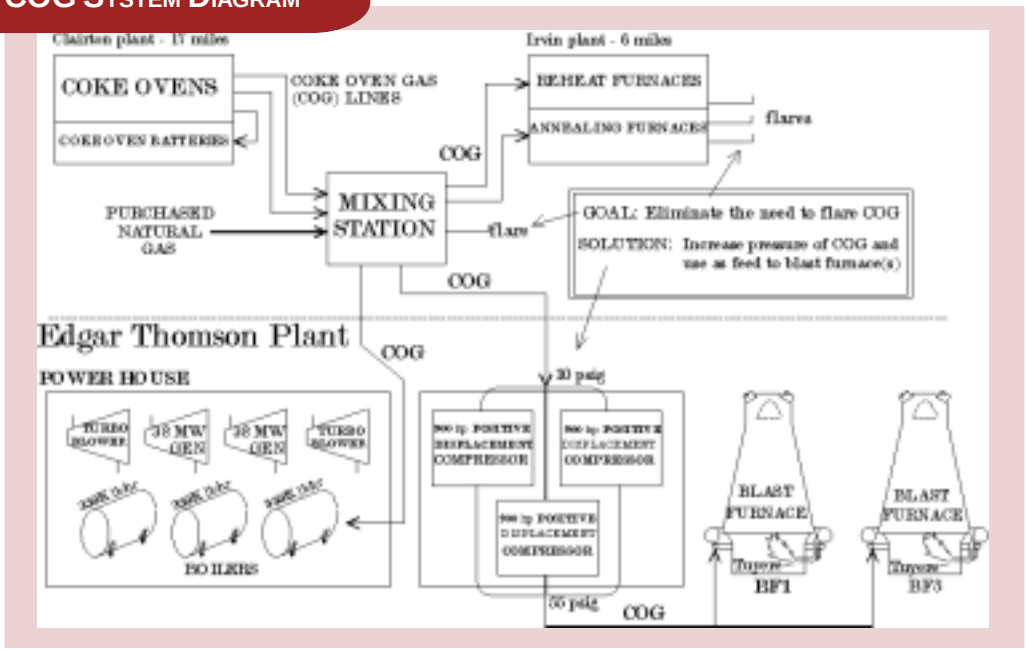
The Mon Valley Works, comprised of the Edgar Thomson Plant in Braddock and the Irvin Plant in West Miffin, is an integrated steel-making facility, converting iron ore into steel and a variety of sheet steel products. The Clairton Plant, located about 17 miles upriver from the Mon Valley Works, is a state-of-the-art coke plant.

Project Background

Coke is an essential input to the steel-making process and is produced by heating coal in coke ovens. To make coke, coal is heated in the absence of oxygen to drive volatile matter from it. Coke oven gas, a low-BTU gas, is produced as a by-product of the process. Approximately 40% of the COG is used as a fuel in the coke oven.

At most steel plants, the remaining COG is used to fuel equipment such as boilers and reheat furnaces. The boilers supply steam for electricity generation, turbine-driven equipment such as pumps and fans, and for process heat. Because of the dynamic nature of the steel making process, electricity, steam,

COG System Diagram



and reheat demand vary significantly over time. In most plants, during periods of low electric, steam, and reheat demand, some COG has to be flared because there is no use for it. Recognizing the flared COG as a valuable source of energy and cost savings, USS developed a project to utilize it.

Project Overview

USS targeted their blast furnaces as a potential use for the COG because the furnaces use a significant amount of natural gas. In the steel-making process, natural gas is injected along with "hot blast" through tuyeres (nozzles) into the blast furnaces. In order to use the COG to displace some of the natural gas, USS had to make modifications to a number of systems.

USS already had a state-of-the art COG processing and cleaning facility at their Clairton coke plant. The facility processes the COG until its content is approximately 50-60 percent hydrogen. Importantly, the sulfur content of the COG is significantly reduced during the processing, which allows it to be used in the blast furnace.

USS installed three 900 horsepower compressors and the associated piping to boost the incoming COG pressure from 10 psig to 55 psig for injection into the furnaces. Since not enough COG would be available to completely satisfy the blast furnace injection requirements, USS purchased instrumentation and equipment so that natural gas could be added to supplement the COG.

COG Compressors

USS also made modifications to the blast furnace tuyeres that allowed them to successfully use the COG. They modified the interior surfaces of the tuyeres to withstand the additional heat and added nozzles to the blowpipes through which the COG and hot blast are injected.

Project Results

USS's project to use COG in their blast furnaces reduces natural gas consumption, eliminates COG flaring, and helps to reduced their overall electricity costs. USS has been successfully feeding COG to the blast furnaces for over six years, and annual savings are estimated at over $6.1 million. With total project costs of about $6 million, the payback for the project was under one year.

Part of the overall financial success of the project was a thorough analysis of all major energy uses and costs in the three plants. After looking at their costs for self-generated electricity and negotiating favorable rates with an electricity supplier, USS determined that it was more cost-effective to use the COG in the blast furnace than to fuel the boilers that fed the steam turbines they were using to generate electricity. Because of this, the amount of COG used in the blast furnaces considerably exceeded what was previously flared.

Lessons Learned

USS's first attempt at using COG in the blast furnaces was met with some problems. Instead of giving up on the project, USS continued the effort, making modifications to the blast furnace tuyeres so that the COG could be used successfully. In many cases, innovative, state-of-the-art projects such as this one will encounter some difficulties that are ultimately overcome.

Industry of the Future—Steel

Through OIT's Industries of the Future initiative, the Steel Association, on behalf of the steel industry, has partnered with the U.S. Department of Energy (DOE) to spur technological innovations that will reduce energy consumption, pollution, and production costs. In March 1996, the industry outlined its vision for maintaining and building its competitive position in the world market in the document, The Re-emergent Steel Industry: Industry/Government Partnerships for the Future.

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BestPractices is part of the Office of Industrial Technologies' (OIT's) Industries of the Future strategy, which helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together the best-available and emerging technologies and practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

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