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SubCom® Case Study: AHMSA – Heating of High Density Iron Ore Concentrate Slurry Project

AHMSA

Location: Monclova, Coahuila, Mexico

Year Completed: 2008

Project Overview

Altos Hornos de Mexico. SA (AHMSA) is an integrated steel producer located at Monclova, Coahuila, Mexico. The plant receives iron ore concentrates from its mine at Hercules, Coahuila 300 km to the west, as well as imports from Brazil. The steel plant produces 3.5 million tpy of molten steel which is transformed into value-added steel products including plate, sheet, rails and heavy shapes.

The iron ore concentrates are received from the Hercules mine as a slurry by pipeline. At the plant, the slurry is dewatered in thickeners and then fed to the pelletizing plant. Here the iron ore concentrate is further dewatered on disc filters, then mixed with bentonite binder and formed into pellets on pelletizing drums. The pellets are then sintered in a travelling grate kiln to form hard spheres. The pelletized product is charged to blast furnaces for the production of pig iron which is then converted to steel in the steelmaking furnaces.

Around 2006, AHMSA undertook planning of a production expansion. In the iron ore concentrate pelletizing process, elevated slurry feed temperatures to the filters increase the filtration rate and improve the cake moisture. AHMSA wanted to investigate methods to heat the iron ore concentrate slurry prior to filtration. By increasing the filtration capacity, they could meet the increased production rate without further capital expenditure for more filters. They approached Inproheat about using SubCom® to provide the heating of the slurry. There had been no industrial experience with heating heavy slurries with submerged combustion at that time. AHMSA technical personnel were intrigued with the possibility of utilizing this highly energy efficient method that would overcome the difficulty of heating slurries with heat exchangers, and avoid dilution of the slurry by direct steam injection. AHMSA commissioned a 3 MM Btu/h pilot SubCom® system to test in their plant. The results of the pilot tests justified the purchase of a full scale SubCom® system to provide the slurry heating needs.

AHMSA placed an order with Inproheat to supply a five-burner, 57.5 MM Btu/h SubCom® slurry heating system in 2007 for delivery in mid-2008.

The Challenges

The iron ore concentrate slurry from the thickener underflows at the plant have a density of 65% solids by weight, with a specific gravity of 2.12. The thickener underflow is pumped to a group of five agitated holding tanks before being sent to the pelletizing plant. Each tank is 50 feet in diameter by 50 feet high. AHMSA wanted to use one of these tanks as the host for the SubCom® system. The design temperature rise for the slurry was from 70° to 140°F. In order to achieve higher thermal efficiency, a heat recovery unit (HRU) was included in the design. Because the installation was to be in an existing tank, it was not practical to install the HRU inside the tank so an external HRU was devised, capturing the gases inside the tank head space and directing them to the external HRU. Because the existing tank was open-topped, a gas-tight tank top had to be designed.

The new tank top had to support the weight of the five combustion air blowers, burner-combustion chamber assemblies, fuel train racks and the external HRU. Provision for of a possible 6th burner for future installation was also made in the design.

The high concentration of solids and viscosity of the slurry raised concerns about the ability of the self-cooling chamber design to maintain acceptably low temperatures on the non-submerged section of the combustion chambers.

Field control of the cooling slipstream of slurry required flow measurement of this stream. Conventional inline, intrusive type flow meters would be subject to rapid erosion by the hard iron oxide particles in the slurry, and magnetic flow meters behave erratically in the presence of ferromagnetic particles in the flow stream.

The Solutions

Inproheat designed and supplied a 5-burner 57.5 MM Btu/h SubCom® system to heat 855 tph of slurry containing 65 weight% solids. The design included integration of the equipment into an existing 50′ diameter agitated tank. Because of the high slurry density created a number of issues in the design of the equipment. The rapid settling characteristics necessitated a new design of HRU to prevent solids from settling and plugging the flow path. An upflow design was developed that enabled continuous upflow of the slurry through the gas contact zone and then gravity flow into the heating tank.

The combustion chambers were designed to allow settled solids to be ejected from the interior after a shutdown during the subsequent purge cycle.

Inproheat provided the structural design for steel supports and decking on the tank to provide support for the SubCom® equipment, and to capture and funnel the off-gas into the HRU.

As a contingency to provide cooling of the non-submerged area of the combustion chambers, a simple external cooling collar was designed that would distribute a small slipstream of feed slurry over the surface. The design was tested at the University of British Columbia's Mining and Minerals Processing research facility using concentrate samples that had been shipped from the AHMSA plant. The tests proved that the collar would distribute slurry evenly over the exposed surface and provide cooling.

A new recently developed type of sonar flow meter with successful applications measuring iron ore slurries was found and incorporated into the instrumentation system for AHMSA. This instrument provided flow measurement to control the cooling slipstream of feed slurry to the chambers

Inproheat designed the process piping layouts for the cooling slurry as well as the fuel piping connections, layout of the fuel trains and combustion air blowers.

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