United States Steel: Prevention of Corrosion of Structural Steel and Utility Piping

Overview
During the continuous casting process, cooling water is used to cool the cast steel and evaporates into a saturated steam vapor. The current HVAC system does not fully capture all of the steam leaving behind a large amount of lingering steam. Corrosion occurs by the condensation of the steam and other gaseous by-products from the casting process and create hydrofluoric acid build up on all the structural steel and utility piping in the housing.

Objectives
The overall objective of this project is to develop and analyze various solutions to help prevent corrosion due to steam build up in the continuous caster unit housing. There are three main components to be analyzed in which will alter corrosion rate in the building housing the caster unit the HVAC system, protective coatings and the auxiliary room air supply.

Approach
1) Initial visit to sponsor to gather customer needs. Gained a sense of the project scope and problem. Multiple visits were conducted throughout the semester to collect needed information including:
   a) Flow data, absolute humidity, and temperature of the current HVAC system
2) Preliminary research on the current status of the problems in steel mills
3) Broke the problem down into multiple parts
   a) HVAC system, chemical protection and the auxiliary room air supply
4) Each approach was analyzed simultaneously
   a) HVAC analysis involved finding out the flow rate inside the duct, the losses of the duct and if the exhaust fan are of sufficient size (under or oversized)
   b) Chemical protection involved researching metal coatings and water additives.
   c) Auxiliary room air supply involved the addition of several fans/blowers
5) AutoCAD was used to design new duct work to improve the HVAC system. Centerline jet velocity decay curves were used to calculate the additional fans/blowers velocities.
6) A comparison was performed between the chemical composition of the mold powder flux and of the residue substance from the steelwork. This confirmed it was Hydrogen Fluoride.

Outcomes
1) The modified duct system would reduce loss by 12 meters of air and put the inlet directly in the cloud of steam.
   a) Cost -> Labor + Modified Duct -> $2000 + $3500 = $5500
2) The addition fans/blowers would greatly reduce the relative humidity and remove the stagnant steam build up.
   a) Cost -> Labor+Fans = $1518 + $2500 = $4018
3) The chemical protective coatings provide an almost permanent solution to the problem.
   a) Cost -> for Electroless Nickel = $1-$3/Mil-ft^2