Improved Performance Characteristics of Steel Pipe and Tube

Overview
PTC Alliance, a manufacturer of plain carbon and low-alloy steel products, would like to explore additive manufacturing to enhance their products for entrance into oil and gas applications. It is our mission to identify additive coating techniques that may result in enhanced corrosion resistance for the extreme hydrogen sulfide environment. It is the mission of the Penn State Student Team to explore and identify appropriate additive and coating systems that may result in enhanced mechanical and corrosion resistant properties of plain carbon steel substrates, with particular focus on potential use in extreme oil and gas industry applications.

Objectives
This project was split into three tasks: providing a proof-of-concept by depositing a coating onto a steel sample, researching alternative deposition techniques and materials, and identifying corrosion mechanisms within the industry.

Approach
- Had a site visit on 1/29/15 to gather background information on manufacturing steps behind their products and clarified what our sponsor wanted from the project.
- Set up weekly conference calls on Thursdays and used these to determine the objectives outline in the initial project proposal.
- Through determining the objectives, we split the project into the three tasks and delegated to task managers according to their skills.
- Each task manager broke down their tasks into smaller objectives and milestones onto the Gantt chart.
- Had weekly team meetings to talk about updates and stay on time and relayed that information to the sponsor through the weekly conference calls.
- Project manager updated team on deadlines and assisted as necessary to complete the project on time and assured sponsor’s needs were being met.

Outcomes
The proof-of-concept was successful in determining that stainless steel can be applied to a low-carbon steel substrate via laser cladding deposition. This deposit developed a 1-2 mm coating with fine austenitic grains and Vickers hardness value of 200-230 HV. The salt spray corrosion test exceeded minimum requirements by 43%, but the coating material was not optimized for the hydrogen sulfide environment. The chosen alternative material is Inconel 622 deposited via laser cladding. This coating system will provide strong metallurgical bonds and the versatility of future material experiments. Hydrogen blistering, hydrogen-induced cracking, sulfide stress corrosion, and hydrogen embrittlement have been identified as the corrosion mechanisms that lead to failure in the oil and gas industry.