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Explosive Clad Metals for Geothermal Energy Recovery

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Abstract : Geothermal fluids can provide a nearly unlimited source of renewable energy but are often highly corrosive due to dissolved carbon dioxide (CO2), hydrogen sulphide (H2S), Ammonia (NH3) and chloride ions. The corrosive environment drives material selection for many components, including piping, heat exchangers and pressure vessels, to higher alloys of stainless steel, nickel-based alloys and titanium. The use of these alloys is cost-prohibitive and does not offer the pressure rating of carbon steel. One solution, explosion cladding, has been proven to reduce the capital cost of the geothermal equipment while retaining the mechanical and corrosion properties of both the base metal and the cladded surface metal. Explosion cladding is a solid-state welding process that uses precision explosions to bond two dissimilar metals while retaining the mechanical, electrical and corrosion properties. The process is commonly used to clad steel with a thin layer of corrosion-resistant alloy metal, such as stainless steel, brass, nickel, silver, titanium, or zirconium. Additionally, explosion welding can join a wider array of compatible and non-compatible metals with more than 260 metal combinations possible. The explosion weld is achieved in milliseconds; therefore, no bulk heating occurs, and the metals experience no dilution. By adhering to a strict set of manufacturing requirements, both the shear strength and tensile strength of the bond will exceed the strength of the weaker metal, ensuring the reliability of the bond. For over 50 years, explosion cladding has been used in the oil and gas and chemical processing industries and has provided significant economic benefit in reduced maintenance and lower capital costs over solid construction. The focus of this paper will be on the many benefits of the use of explosion clad in process equipment instead of more expensive solid alloy construction. The method of clad-plate production with explosion welding as well as the methods employed to ensure sound bonding of the metals. It will also include the origins of explosion cladding as well as recent technological developments. Traditionally explosion clad plate was formed into vessels, tube sheets and heads but recent advances include explosion welded piping. The final portion of the paper will give examples of the use of explosion-clad metals in geothermal energy recovery. The classes of materials used for geothermal brine will be discussed, including stainless steels, nickel alloys and titanium. These examples will include heat exchangers (tube sheets), high pressure and horizontal separators, standard pressure crystallizers, piping and well casings. It is important to educate engineers and designers on material options as they develop equipment for geothermal resources. Explosion cladding is a niche technology that can be successful in many situations, like geothermal energy recovery, where high temperature, high pressure and corrosive environments are typical. Applications for explosion clad metals include vessel and heat exchanger components as well as piping.

Keywords : clad metal, explosion welding, separator material, well casing material, piping material
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