ABSTRACT

Hardfacing is the most important and common technique for the design and manufacture of valve materials in high temperature materials and petrochemical applications, as recommended by American Petrochemical Industries (API). As per the API standards, the resultant hardfaced surface needs to be in 2.0 mm thickness. Currently hardfacing techniques are carried by tungsten inert gas welding (TIG), metal inert gas welding (MIG), Plasma spray and Laser cladding processes. Clad material may be cobalt based or nickel based alloys. These materials are selected based on the chemical and physical properties corrosion or wear properties. These materials are commercially available in the form of rods, wires or powders. The processes involve with minimum building of clad material to the thickness 8mm, 6mm, 1.0 mm and 0.5 mm thickness respectively followed by hard machining. The draw backs with the conventional hardfacing techniques are hydrogen induced cracking, porosity and other internal defects. To reduce these defects an attempt is made to hardface the material with cobalt based alloy flux cored wire of Stellite 6 (St 6) and compare it with flux cored nickel based alloys FW2 and FW3. Further to optimize the time, cost and material involved in the above processes an attempt is made to coat the substrate by introducing nano coating and controlled thermal spray coating with ceramic materials like zirconium, molybdenum, tungsten and titanium alloys. These alloys exhibit hydrophobic properties in addition to the high corrosion and wear resistance, with low porosity.

The hard facing of the substrate ASTM A216 alloys by flux core arc welding (FCAW) St-6 wire was done based on the mathematical modeling taking into account of the Current, Nozzle tip distance, weld feed
rate etc., and output as bead width dilution and penetration by automatic TIG welding machine is sponsored by the industry. To validate the results the wear test, corrosion tests and SEM analysis had been carried out. The test procedure was repeated for the samples of Nickel based alloys FW2 and FW3. The results indicated better corrosion resistance for FCAW-St 6 than FW2 and FW3 coated samples. The process developed a heat affected zone and modified crystal structure at the junction of the hardfaced surface. The results also showed porosity on the materials which at the accepted level for steam processing industries and the process needs to be improved for petrochemical valve industries, most importantly for underwater sea applications.

The high energy process of plasma spray process was conducted with tungsten cobalt alloy, zirconium and molybdenum materials for testing the adherence, corrosion and wear properties of materials. The materials exhibited better and improved properties than hardfacing of alloys, but the materials were not able to build-up in large scale as the materials are coated in nano and micro scales. This process involves high cost and eliminates machining operation, wherein masking is not common.

The processes of high energy plasma spray coating are being replaced by sol-gel process and electrophoretic deposition processes to suit industrial applications as the above processes involve job quantity and high energy dissipation and heat affected zone (HAZ). The materials zirconia, an unstable material, molybdenum, titanium in form of liquids or powder with alloying elements were processed to form a gel and they are made to adhere to the surface by ionizing methods to form nano-coating of these materials. SEM analysis with Energy dispersion spectrometer indicated the presence of coated materials with porosity of less than 1%, better bonding, high wear resistance of 0.107 mills/year and the potentiostat corrosion testing proved
better corrosion resistance compared to hardfacing and high energy processes. The proposed nano-coating of materials had been taken as a part of an industry for implementation of the project replacing the conventional hardfacing techniques as prescribed by American Petroleum standards which are followed worldwide.