Chapter 1

Introduction

1.1 Principles, theory, rationale

Serviceable engineering components are not only on their bulk material properties but also on surface characteristic and the design. Especially in wear resistance components. Their surfaces must be performed in variety complex environments of many industrial functions. The surface area of industrial components may require the treatment to enhance the surface characteristics. Surface treatments causing microstructure changes in the bulk material, including heating and cooling/quenching through induction, flame, laser and electron beam techniques, or mechanical treatments. There are the chemical altering of a surface, including carburizing, nitriding, carbonitriding, boriding, siliconizing, chromizing and aluminizing [1].

Thermal spray process is being widely diffused for industrial applications in order to improve surface protection against corrosion and wear effects for several applications in power generation plants [2]. It can produce a coating for the new surface and surface reparation components of the machine after running. Presently, the improvement of the coating produced by thermal spray technique has many advantages such as; molten or partly molten coating materials droplets which are deposited onto substrate without melting it; semisolids particles form splats when impacting at the substrate are due to their low temperature and high kinetic energy form a gas jet. It leads to a bonding effect because of mechanical interlocking, adhesion, diffusion, chemical reaction, and sometimes particle fusion of the contact surface [3]. Therefore, usually non heat treatment of the chemical compositions is observed owing to the moderate heat input by thermal spray coating processes. The substrate temperature seldom exceeds 150 °C and quenched in a very short period of time, which has not effect on substrate. Furthermore, it can produce a coating thickness between 150-500 micrometer and it can be used with some substrates and materials coating for example; metallic, ceramic, cermets and some polymeric. In addition, hard facing is another surface treatment where the bulk material's surface is given a protective layer of other material superior to its properties such as WC-Co, WC-Ni, WC-Cr and WC-Fe base etc. WC-M can support all mechanisms of the wear which is nano particle size and conventional particle size [4, 5, 6]. Properties of the coating depend on in flight particle performances such as temperature, velocity, particle size, the effects of spray parameter and technique post-treatment of the coating which enhances the surface characteristics [7].

Electric arc or wire arc spraying is one of thermal spray processes, in which heating and melting occur when two oppositely charged wires, comprising the spray material, are fed together in such a manner that a controlled arc occurs at their intersection. With one struck, the arc continuously melts the wires, and compressed air is directly blown behind the point of contact. It is atomizes and projects the molten droplets, which deform on the impact with the work piece and adhere to form a coating [8, 9]. Wire arc spraying is an economical spraying process that has become popular in the thermal spray industry because it combines low operating and equipment costs with high deposition efficiencies [10]. It is normally denser and stronger than any other combustion spray coating process. High spray rate and efficiency make a process for spraying large areas [11]. Typical used applications include thermal barriers, wear and corrosion resistance, such as those in sugar industry, atmospheric fluidized bed combustion boilers, plastic injection molds, thin coating for circuit boards, coating on bridges and other infrastructure components, and it is also used for repairing many aircraft engine components etc [8,12,13]. Arc spray process is used with a wide range of materials; such as: metal and alloy, metal matrix composites including carbide or cermets packed into a core of wire for this work requirement of wear resistance. At present, the manufacturing of cored wire included conventional size of powder and nanoparticle size embedded of the cored wire for enhance the coating properties [11, 14, 15]. The properties of the coating by arc spray process depend on of the droplet formation, in flight particle (size and temperature), velocity and effect of spray parameters (voltage, ampere, distance, gas atomize presser and gas type, etc.) and most importance is materials for producing the coating [16].

Cermets coatings are widely used in wear situations because they combine several advantages such as resistance to abrasion, erosion, corrosive atmospheres and high temperature. WC-M is one of the most useful cermets thermal spraying materials [17]. WC composites have very high hardness and wear resistance. The superior wear resistance of WC-Co cermets is determined by evenly distributed fine WC particles bonded to the Co matrix. Increasing the percentage of Co raises the toughness but lowers the hardness and wear resistance [18, 4]. Recently, the development of cored wire technology has enabled the use of cermets in the arc spray process for spraying cermets materials. The cermets are packed in a ductile electrically conductive sheath that is drawn to form a cored wire [13].

Several previous work have shown development procedure and processes of thermal spray coating for enhancing quality property coating. Moreover, composite materials such as WC-Co, WC-Ni, WC-Cr, and WC-Fe base as well as metal alloys which is Cr-Mo-W-B-Si were handled. There were many developed processes such as nozzle, design of nitrogen as a gas jet in order to improve the characteristics of the coating. This project aims to characterize and compare the WC-M composite coatings produced by arc spray processes and also to investigate the effect of post treatment. The three selected different core wires in this work include WC-Cr-Ni; WC-Cr-Fe and W-Cr-Fe nanocomposite core wires. The properties of the coatings will be investigated such as microstructure, phase, chemical composition, mechanical properties, wear test and corrosion test. Therefore the result will be to evaluate for the best application of off-shore pump plunger reparation.

1.2 Research objective

1. To characterize and compare arc sprayed WC-M composite coatings prepared by different types of cored wire
2. To evaluate the most potential coating for of off-shore pump plunger reparation

1.3 Usefulness of the research (Theoretical and/or Applied)

1. Obtaining suitable material and spray process for pump plunger reparation.
2. Thermal spray coating application for industrial maintenance.