Chapter 2

Literature Review

2.1 Arc spray processes

During the last several years, there has been subsequent extension into the field of the arc spray processes, raising to a continuous succession of coating materials and technology development that has led to a significant number of industrial applications. It can be used to effectively deposit surface coating with superior hardness, corrosion and wear resistance. The properties of the arc sprayed coatings depended on correlation between parameters of operation, such as current; voltage; spray distant; pressure air; etc. It will affect the microstructure and mechanical properties. When direct relationships do exist between spray conditions, oxide presents in the coating and microhardness. It is found that the Yung's modulus of the coating depend on the made lamellar thickness and finer lamellae and later it decreases because of higher oxide, when using atomize gas by nitrogen will illustrate less oxide content than normal air. When nitrogen flow rate increased so the contain oxide decreased but Young's modulus increased because of homogeneity of the coating [19].

In-flight particles and splat are important and those affect characteristics of the arc sprayed coatings. It comes from melting the materials in the anode and cathode and becomes the coatings. The previous research found that particles produced by the anode were almost two times as larger in diameter as those from the cathode [10]. In additions, several other parameters influence the properties of in-flight particles and splat such as electricity, voltage, feed rate of wire, type and an amount of pressure, angle and the type of nozzle, spraying distance, predicted by such computer programs as computational fluid dynamics: CFD and Taguchi's fractional-factorial L9 (34-2) technique. It was shown that when the voltage and gas or air increased, the particle size directly decreases but it affected the lowering velocity of in-flight particles. Microstructure analysis indicated that the CD/CL nozzle tended to produce coating with finer microstructure, low porosity and higher oxide. But it can be modified by the spray nozzle with an open or a change in the nitrogen gas [8, 12, 16, 20].

2.2 Cored wire for the arc spray process

The wires used for arc spraying be electrically conductive to generate the arc. The limitation of wire arc spraying to conductive metallic materials can be drawn into wires. The wear resistant applications require coatings containing hard ceramic/carbide materials, which cannot be drawn as solid wires. The development of cored wire technology has enabled the use of arc spray process for high wear resistant consisting of carbide materials. The hard powder was packed in a ductile electrically conductive shell drawn from cored wire [13]. There was currently the research of cored wires for the wear resistance and the increasing hardness. This composed of B-Mo-C-W and Fe balance [11]. Moreover, it also developed cored wires. Applying to repair to the pipe heat exchanger for boilers (atmospheric fluidized bed combustion, AFBC) in which wire spray contained Si 1.6%, Cr 2.9%, Mn 1.65%, B 3.75% and Fe balance had been operated. There were the cored wires including Si 1.25%, Cr 14%, Mn 0.55%, B 1.87%, WC 26% min, TiC 6% min, and Fe balance used for anti-erosion and high temperature. Sometimes coating with the appropriate tribological behavior needed to perform with the Fe-Al/WC cored wires, so coating showed both high hardness and low friction [21].

The corrosion resistance performance of Ni-base coatings containing Mo (5%) or B (2-4%) had better show more anti-chlorine ion corrosion performance than that of Ni-base coatings without Mo element, and PS45 (Ni-Cr-Ti) coating. The anti-chlorine ion corrosion coatings could be used for resolving the corrosion protection problem of the equipment and pipes contacting sour, alkali, salt liquid in petrochemical engineering applications [15].

2.3 Nanocomposite cored wire for the use of the arc spray process

Recently, there had been an intensive research in the area of the thermal process of nanostructures materials for their high strength and structure applications [22]. The engineering of thermal spray coating consisting of nanostructure components was being used as a means of various improvements with two or multi phases by adding a nano particle size, providing the possibility of having a more uniform distribution of the components within the structure for enhanced properties [5]. The SHS 7170 cored wire had alloy containing by wt% chromium (20 t0 25), molybdenum (<10), tungsten (<10), boron (<10), carbon (<5), silicon (<5), manganese (<5), and the balance iron. The as-sprayed SHS7170 coatings were found with amorphous matrix structure containing carbide crystallites with sizes ranging from 60 to 140 nm. After heating the temperatures above the peak crystalline temperature (566 °C), a solid/state transformation occurred that results in the formation of an intimate three-phase matrix structure consisting of the same complex boride and carbide phases, along with α -iron inter dispersed on a structural scale from 60 to 110 nm. The nanocomposite microstructure contained clean grain boundaries, which were found to be extremely stable and resist coarsening throughout the range of temperatures found in boilers.

Additionally, the properties of the coating were presented including the good bond strength, hardness, bend resistance, and impact resistance. The elevated-temperature erosion resistance of the SHS7170 wire-arc coatings was found to be superior based on thickness loss when it was compared with the existing wire arc coatings after test. The universal ability of the SHS7170 coatings to resist erosion with the contact angle and at temperatures at least up to 600 °C almost independently is important for real-world boiler applications, and it was the result of its unique and stable nanoscale structure, which is uniform on bulk-length scales [14].

2.4 Post-spraying treatment of the coating

Post spray treatment had shown the result in enhanced performance of the coating by means of both heat treatment and sealing materials [7, 25-30]. Heat treatment process could improve microstructure coating and homogeneity coating, reduction porosity and increased hardness with better mechanical properties. Elimination of the brittle phases, such as W_2C, W could also create a bonding within the microstructure of coatings. In addition, the increase of sliding wear resistant of the coating and friction reduction was due to a small crystal up [26]. Sealing process, a post treatment employed for reduction of coating porosity and corrosion rate. Several materials have been reported including phenolic resin, aluminum phosphate, polymethyl silicon, urethane URS, epoxy ERS and ketone [27].