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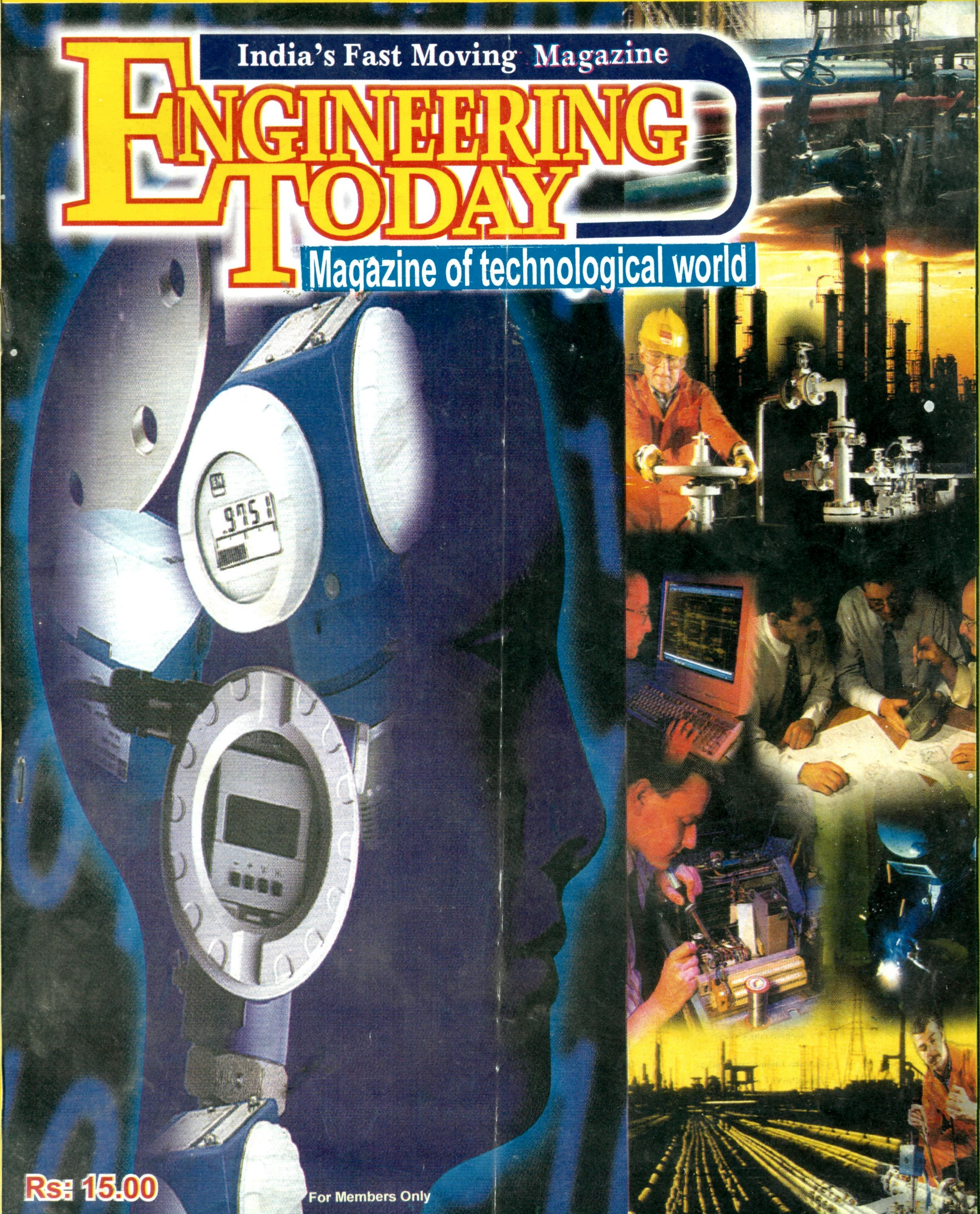

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RED MUD - FLY ASH COMPOSITE COATING ON METAL SUBSTRATES

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ABSTRACT

Thermal spraying in plasma environment is a versatile surface technique, which has the advantage of being able to deposit metals, ceramics and or a combination of these, generating homogeneous coating of desired microstructures. The surface coatings help in protecting against corrosion and may act as insulating barriers. In the present work, two abundant industrial wastes viz. red mud (the waste generated in alumina plants) and fly ash (waste from thermal power plants) are taken, mixed in a definite proportion and the mixture was spray coated on aluminium , copper, mild steel and stainless steel substrates. Coatings were made at different operating power levels *of the plasma torch. It* is *observed that the quality and structure of the coating are greatly affected by the input power to the torch. The substrate- coating interface bonding strengths for different samples were found out by pullout method. Coating-substrate interface morphology is studied by scanning electron microscopy. Potential areas of application are suggested.*

INTRODUCTION

The current trend in the structural-design philosophy is based on the use of substrate with the required mechanical properties and a thin coating onto it to exhibit desired surface properties . Plasma spraying is a versatile surface coating technique, which has the advantage of being able to deposit metals, ceramics and or a combination of these generating homogeneous coating with desired microstructures[l]. It utilizes the exotic properties of plasma medium to effect physical, chemical or metallurgical reactions to produce new materials or impart new functional properties to conventional materials [21. The surface coatings help in protecting against corrosion and often act as insulating barriers. But in spite of all its advantages, plasma spraying finds limited application adoption One of the reasons for this is the high cost of the spray grade powders required for coating. This *tynwem* -can he addressed to by exploring the possibility of using some industrial wastes as coating material. During last decade, although a large number of investigations have been carried-out on processing of plasma spray ceramic coatings, not much effort has been made to use low grade materials for plasma spray purpose. Mishra and Ananthapadmanabban [31 , in 1998 made the first successful attempt to spray coat ra" fly-ash and fly-ash+alumina mixture on metal substrates through plasma processing,

Subsequently they repeated the plasma spraying process with fly-ash mixed with ilmenite, graphite and aluminium powder respectively in different proportions leading to development of protective coatings of high effectiveness [41 .

The present work aims at developing and studying coatings with a mixture of two abundant industrial wastes (Red mud and Fly ash from aluminium extraction industries) on metal substrates. Conventional atmospheric plasma spray technique has been used to develop these coatings.

EXPERIMENTAL

The raw materials (red mud and fly ash) collected from NALCO, Orissa were sieved to obtain a particle size of about 60-100 micron, suitable for spraying purpose. Redmud and flyash powders were taken at a ratio 10:3 by weight and were mixed thoroughly in a planetary ball mill to get a homogeneous mixture. This mixture has been sprayed on aluminium, copper, mild steel and stainless steel substrates of dimensions 50x20x3mm and the coated specimens were subjected to certain tests for characterisation. Spray coating was done using a 40 kW plasma spray system at the Laser & Plasma Technology Division, BARC, Mumbai. This is a typical atmospheric plasma spray system working in the non-transferred arc mode. The major subsystems of the set up include the plasma spray torch, power supply, powder feeder, plasma gas supply, control console, cooling water and spray booth. Pre-spray preparations included sandblasting of the specimens with a sandblasting machine via compressed air at a pressure of 3kg/cm2. A current regulated DC 2power supply was used. A four stage closed loop centrifugal pump at a pressure of lOkg/cm supplied cooling water for the system. Primary plasma gas argon and secondary gas nitrogen was taken from normal cylinders at an outlet pressure of 4kg/cm2. The plasma input power was varied from 6 to 16 kW by controlling the gas flow rate and arc current. The powder feed rate was kept constant at about l0 gm/min by a turntable type volumetric powder feeder. Operating parameters used in the experiments are given in table 1. To evaluate the adhesion strength of the coating with the substrates, a special types of jig was fabricated . Cylindrical MS dummy samples of length 25mm and dia 9.5mm were prepared . The surface of the dummies were roughened by punching . These dummies were then fixed on the top of the coatings with the help of a polymeric adhesive and were pulled with a tension after fixing on the jig . The load at the fracture was recorded for strength calculation . The morphology at the substrate-coating interface was studied using Jeol T-330 Scanning Electron Microscope .

RESULTS AND DISCUSSION

The first requirement of any coating mainly depends on its adhesion on to the substrates . The adherence strength of the coating is measured using coating pull out method . The variation of adherence strength with operating power level for all substrates is shown in Fig.No. 1 It is found that with the increase in the power level there is an increase in the adherence strength up to a certain level of operating power of the torch . Although this trend is observed for all types of substrates, the magnitude differs . For mild steel substrates the strength has varied from 4.2-9 MPa to 12.78 MPa, having a maximum of 12.78 MPa at the power level of 12 kW . For aluminium this value ranges from 5.40 MPa to 9.31 MPa, with the maximum at

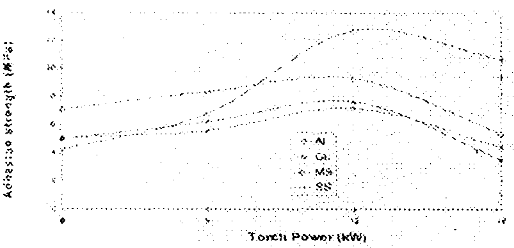


FIG NO -1 VARIATION OF ADHESION STRENGTH WITH POWER FOR VARIOUS SUBSTRATES

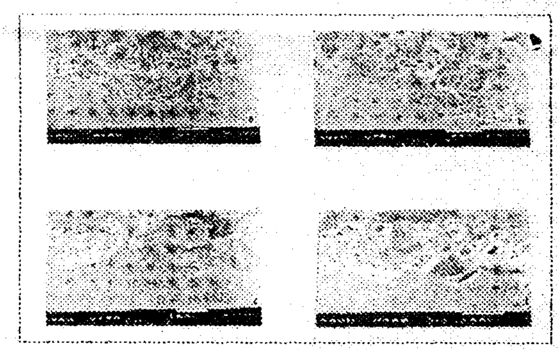
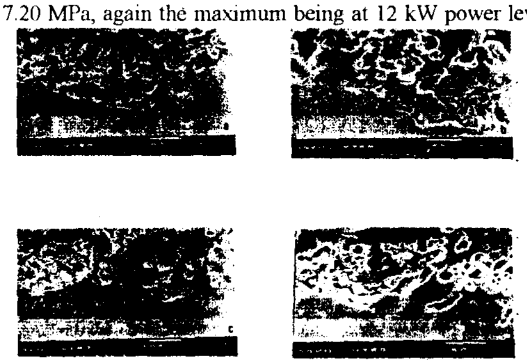


FIG NO 2 (a, b, c, d) VARIATION OF ADHESION STRENGTH WITH POWER LEVELS FOR COATINGS ON MILD STEEL SUBSTRATES

12 kW power level

. For stainless steel the adherence strength varies from 4.46 MPa to 7.20 MPa, again the maximum being at 12 kW power level .



The same trend is found in case of copper substrate for which the adherence strength ranges from 3.56 MPa to 7.68 MPa . Here also the maximum strength is recorded for an operating power level of 12 kW . From this data it appears that the maximum value of coating adherence strength is recorded with the mild steel substrate followed by aluminium .

The morphology at the metal-ceramic interface has also been studied. While developing a overlay ceramic coating on metal surface, out of a large number of parameters, the conductivity coefficient(of the substrates) and the beat dissipation coefficients (of the coating material) and the environment play the major roles . The interface structure of the coatings on mild steel are shown in Fig.2 (a, b, c, d). It is observed that at lower power level the coating metal interface are not properly matched i.e. cavitation along the particle boundary (due to stacking mismatch of particles) giving rise to a higher amount of porosity 1 cavitation along the interface . This effect although gets reduced with increasing the spraying temperature (i.e. the power level) . There is also a change in the dimension and origin / occurrence of porosity . However, an optimum amount of porosity may be required for a satisfactory overlay ceramic coating . The particle size and their agglomeration! and spreading of coagulated phases are changing with operating power level .

CONCLUSIONS:

Red mud mixed with fly-ash was found to be a suitable material for depositing thermal spray coating on metals. Coatings were made at different input power levels of the plasma torch . It was observed that the quality and structure of the coating is affected by input power to the torch adherence strength of coating with the substrate was measured and found to vary between 4-13 Mpa. A maximum coating adherence strength of ~ 13Mpa is observed with the coating depositor on mild steel substrate at the power level of 12KW. The coating interfaces morphology reveals that the coating is homogeneous at intermediate power level.

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