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LEHIGH UNIVERSITY

BETHLEHEM, PA

Robotic Weld Overlay Coatings
For Erosion Control

Progress Report Perpared For U.S.
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Quarterly Technical Progress Report
For The Period January 1993 through
March 1993

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I. Introduction

Twelve weld overlay hardfacing alloys have been selected for preliminary erosion testing based upon a literature review [1]. These alloys have been separated into three major groups: 1) Cobalt containing alloys, 2) Nickel-base alloys, 3) Iron base alloys. These alloys are being applied to carbon steel substrates and will undergo preliminary erosion testing to identify candidates weld overlay alloys for erosion control in CFB boilers. The candidate alloys selected from the preliminary erosion tests will then undergo more detailed evaluations in future research. The work completed towards the preliminary erosion tests is outlined below.

II. Coating Deposition Procedure.

A fully automatic welding laboratory is being used for deposition of hardfacing weld overlays alloys. The welding laboratory consists of a Thermodynamics power source and plasma console unit interfaced to a Texas Instruments/Siemens 405 programmable control unit. Plasma arc welding is conducted with an L-Tec plasma arc torch which delivers fluidized powder alloys directly through the torch into the weld pool. The laboratory is also capable of conducting five other automated welding processes. The plasma arc welding process was selected based on its ability to apply a wide range of overlay alloys and obtain a high degree of control over the overlay dilution.

Photographs of the welding laboratory are shown in Figures 1 and 2. A schematic of the Plasma ARC Welding unit is shown in Figure 3. With this process, the heat required for welding is generated by an arc which is maintained between a non-consumable tungsten electrode and the base metal. The tungsten electrode in the PAW torch is recessed within the gas nozzle and two gases are used. An argon orifice gas flows at high velocity through the orifice body and forces the arc to form a cylindrical shape. An auxiliary argon shielding gas protects the weld metal from atmospheric gases. The intensity of the heat source is controlled primarily by adjusting the current that flows through the arc. Also, the recessed tungsten electrode permits the use of powder filler metals which can be transported directly through the torch.

The welding parameters such as voltage, travel speed, current, and filler metal feed rate were optimized in order to provide similar heat inputs and coating thicknesses for each alloy that has been selected. It was established that these parameters have the greatest effect on Plasma Arc Welding process performance [2]. At this point, four weld overlay hardfacing alloys have been deposited on 1018 steel substrate and are listed below:

1) C22-nickel base alloy
2) Inconel 625-nickel base alloy
3) 420 SS- martensitic stainless steel
4) 308 SS- austenitic stainless steel

Powders of hardfacing alloys were provided by ANVAL powder corporation. The compositions of weld overlay powders have been previously described [1]. Weld overlays were deposited on 1018 steel substrates (12inch x 12inch). The surfaces were prepared to a 24 grit finish and cleaned in acetone prior to welding. The process parameters that were used for each deposited alloy are listed in Table 1. The heat generated per unit length of weld was calculated by using the following equation: $H=VI/S$, where V is the voltage drop across the electrode, I is a current through the arc, and S is the travel speed of the heat source [3].

After the overlays coatings were deposited on the 1018 steel substrate they were sectioned, by using an abrasive (Al_2O_3) cut off wheel, into 0.5inch x 0.5inch coupons for erosion testing. The sample of the C22 weld overlay coating after sectioning is shown in Figure 4.

III. Future work.

After all twelve coatings are deposited on the 1018 steel substrate, they will be tested in the erosion tester at 400^0C to establish the steady state erosion rate of each weld overlay alloy. Based on the preliminary tests, two candidate alloys will be selected for more detailed evaluations which will include variation in composition and processing parameters. These two coatings will also be characterized using microscopy techniques and will undergo mechanical property measurements such as hardness and bend testing.

IV. References.

1. Levin, B.F., ''Weld Overlay Coatings For Erosion Control", Literature Review, Prepared for U.S. Department of Energy, Lehigh University, Energy Research Center, 93-5000-6-11, 1993.

2. DuPont, J.N., "Optimization and Selection of Arc Welding Processes For Applying Protective Weld Overlay Coatings", Literature Review, Lehigh University, Energy Research Center 93-500-3-3, 1993

2. Metals Handbook, Vol. 6., 7th Ed., Gas Metal Arc Welding, ASM, Metals Park, Ohio, 1983.

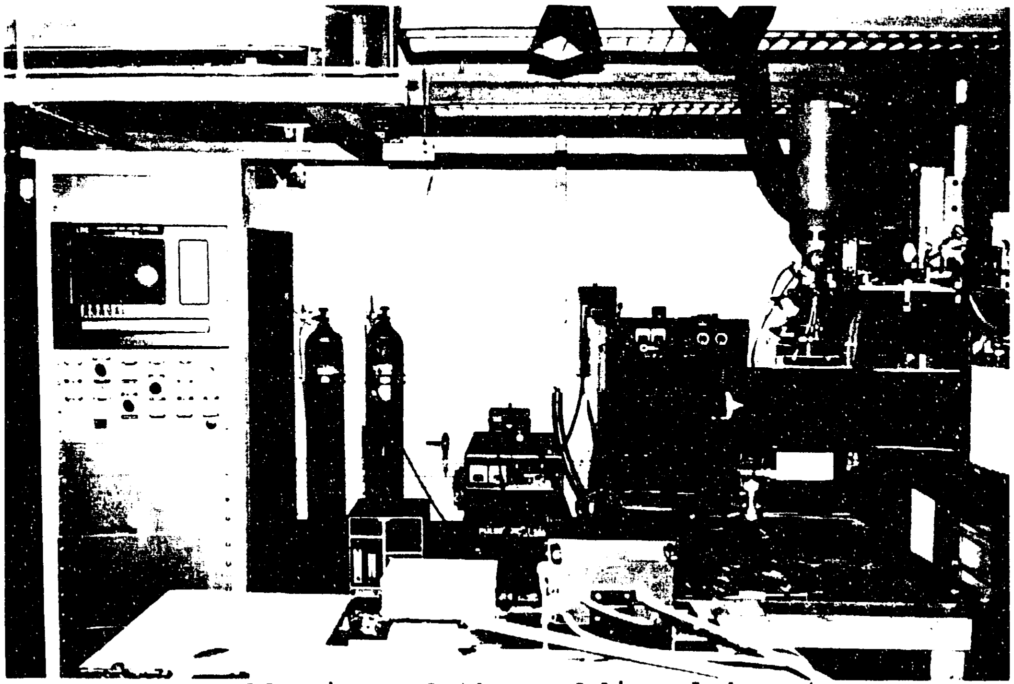

Figure 1. Overall view of the welding laboratory.

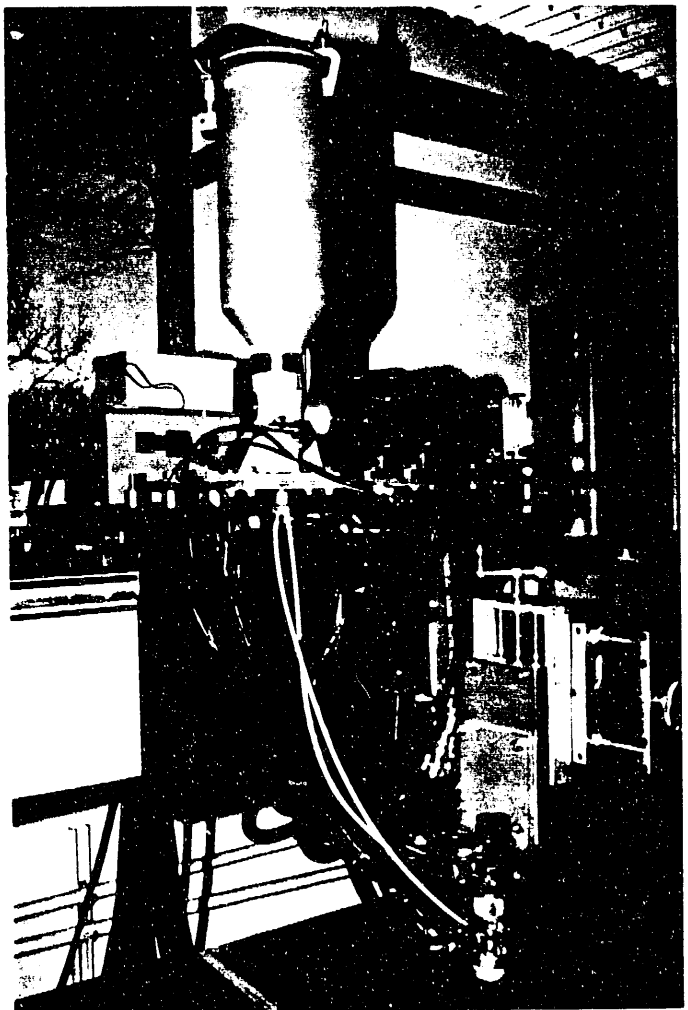

Figure 2. A photograph of the Plasma Arc Torch Assembly.

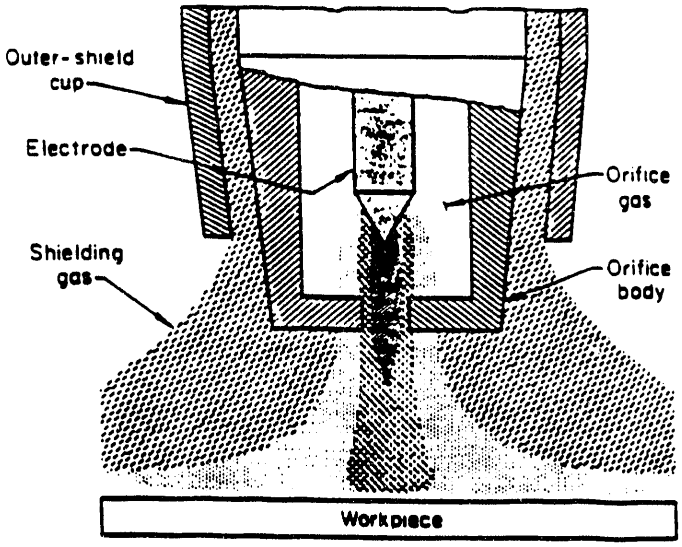

Figure 3. A schematic of the Plasma Arc Welding.

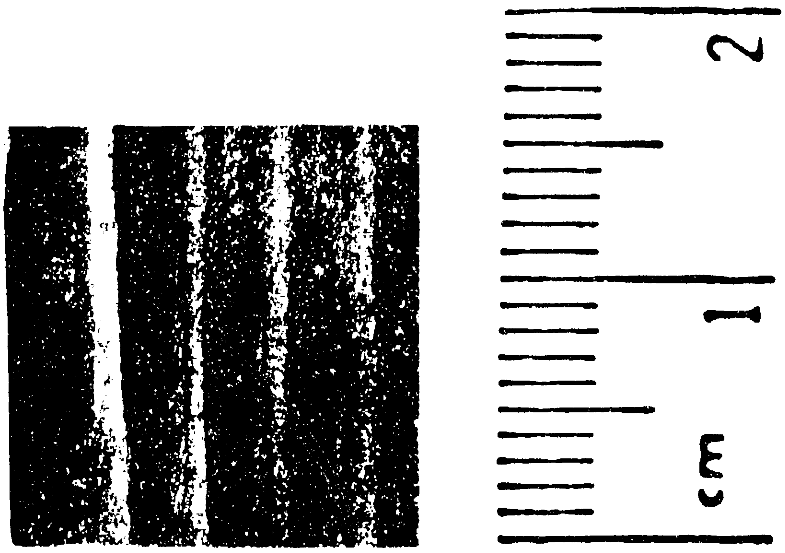

Figure 4. A photograph (top view) of the nickel base (C22) weld overlay coating sample (0.5 inch x 0.5 inch) for erosion testing. Coating was deposited on 1018 steel substrate.

Table 1. Process Parameters for Deposition of Hardfacing Weld Overlays Alloys.

Hardfacing Weld Overlay Alloy	Powder size um	Heat impute J/mm	Powder feed rate cm^3/min	Interpass temperature C^0
C22 (Nickel base alloy	53-177	1474	0.9	<100
Inconel 625 (Nickel base alloy)	44-177	1296	1.0	<100
420 SS (martensitic stainless steel	44-177	1542	0.9	<100
308 SS (austenitic stainless steel)	44-177	1429	0.8	<100

Plasma Gas Flow Rate-5 SCFH (argon)

Shielding Gas Flow Rate-30 SCFH (argon)

Powder Gas Flow Rate- 10 SCFH (argon)

These parameters were kept constant for all materials.

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