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Reduction of valve scrap in plasma transferred ARC welding

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Abstract -Welding processes often appear to consume greater fractions of the product cost and to create more of the production difficulties than might be expected. The plasma transferred arc welding is used to weld the head of the exhaust valve. Due to this welding deposit crack and deposit unfill occurs in the exhaust valve. In PTA machine some parameters occurs like power rate, torch angle, gas flow.The main scope is to identify the major reason for rejections that occurred in Plasma Arc Welding of IC engine valve components. By controlling the runout in PTA machine input job and by changing the parameter in PTA machine the scrap is reduced from 10.3% to 2.1% in deposit crack and from 10% to 0.81% in deposit unfill.

Index words-plasma transferred arc welding, scrap, exhaust valve, welding.

I.INTRODUCTION

A heat engine is a machine, which converts heat energy into mechanical energy. The combustion of fuel such as coal, petrol, diesel generates heat. The valve are main part for the engine. Two types of valves are there one is inlet valve another one is exhaust valve. Inlet valve is used to allow the fresh air or mixture into the cylinder. These valves are manufactured in mono metal. Exhaust valves are manufactured in bi metal. These valves are used to allow burnt and unburnt gases to escape from the cylinder. Inlet and exhaust valves are mounted on the cylinder head or on the cylinder block. Welding and joining processes are essential for the development of virtually every manufactured product. However, these processes often appear to consume greater fractions of the product costand to create more of the production difficulties than might be expected. There are a number of reasons that explain this situation. First, welding and joining are multifaceted, both in terms of process variations (such as fastening, adhesive bonding, soldering, brazing, arc welding, diffusion bonding, and resistance welding) and in the disciplines needed for problem solving (such as mechanics, materials science, physics, chemistry, and electronics). An engineer with unusually broad and deep training is required to bring these disciplines together and to apply them effectively to a variety of processes.

Fig.1 Exhaust Valve of an engine

Second, welding or joining difficulties usually occur far into the manufacturing process, where the relative value of scrapped parts is high. Third, a very large percentage of product failures occur at joints because they are usually located at the highest stress points of an assembly and are therefore the weakest parts of that assembly. Careful attention to the joining processes can produce great rewards in manufacturing economy and product reliability. There are many fusion welding processes, one of the greatest difficulties for the manufacturing engineer is to determine which process will produce acceptable properties at the lowest cost. There are no simple answers. Any change in the part geometry, material, value of the end product, or size of the production run, as well as the availability of joining equipment, can influence the choice of joining method.

II.LITERATURE SURVEY

[1] MohammedMohaideen Ferozhkhan*"Plasma transferred arc welding of stellite 6 alloy on stainless steel for wear resistance"*Austenitic stainless steel was deposited on 9Cr-1Mo steel (ASME Grade 91) by flux cored arc welding process and above that Stellite 6 (Co-Cr alloy) was coated by plasma transferred arc welding process to improve wear resistance for high temperature valves applications.

[2]D.Rajenthirakumar, T.Karthick*"Defect reduction in Gas tungsten in arc welding process using failure mode effect analysis"*.It is a method that evaluates possible failures in the system, design, process or service. It aims to continuously improve and decrease these kinds of failure modes. In this present work, Process FMEA is done on Gas Tungsten Arc Welding (TIG) process of American Iron and Steel Institute (AISI) Type 304L Stainless Steel material. A series of welding process with different sample pieces are done and the potential failures and defects are categorized based on FMEA and Risk Priority Number (RPN) is assigned.

[3] Mahesh S.Shinde, K.H.Inamdar"*Reduction in tig welding defects for productivity improvement using six sigma"*The weld defects are a major concern leading to rework, higher costs and thus affecting the delivery schedule of the job. The process starts with Welding of long seams and circular seams in the job, and subsequently carrying out the NDT to find any defects during welding. A number of defects are being observed in the welding Process. Defects in welding may be found out in two methods, i.e. by Radiographic Tests and by Ultrasonic Tests.

[4]M.Chithirai Pon Selven, Nethri Rammohan"*Plasma Arc Welding"*Plasma arc welding is a non-conventional form of welding which can be applied to almost any existing metals. The various process parameters in plasma arc welding such as plasma gas flow rate, torch height, front weld width, back weld width etc. play an important role in the prediction of the weld geometry and quality.

[5]M.Panturu, D.Chicet, C.Paulin*"Wear aspects of Internal combustion Engine Valve"*One vital organ is the engine valves, which is subjected during operation to combined thermal, mechanical, corrosion and wear solicitations, which are leading to severe corrosion and complete breakdown. In this paper were analysed aspects of valves wear and the active surfaces were coated using the atmospheric plasma spraying method (APS) with two commercial powders: Ni-Al and YSZ. Microstructural analyses were made on these layers and also observations regarding the possibility of using them as thermal barrier and anti-oxidant coatings.

[6] J.C.Metcalfe, M.B.C.Quigley **"***Heat Transfer in Plasma Arc Welding"*Plasma arc welding, unlike gas tungsten arc welding, convection and radiation arc the dominant processes with the contribution from anode effects somewhat smaller. In 10 kw argon plasma welding arc an efficiency of heat transfer to the anode of 60 to 66% is to be expected.

III.PLASMA TRANSFERRED ARC WELDING

The Plasma Transferred Arc Process (PTA) has been in use since 1962 for surfacing of parts . The applications possible with PTA are hardfacing to protect against extreme conditions in service life like heat, abrasion, corrosion, erosion,adhesive and abrasive wear etc. It is also use to recondition worn out parts or build up of mis machined parts.

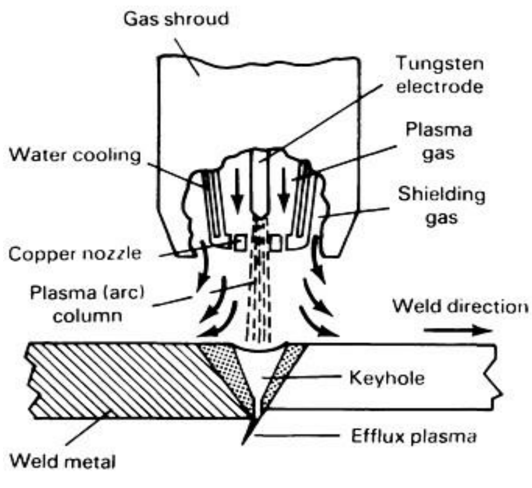

Fig.2 Plasma arc welding process, showing constriction of the arc by a copper

Plasma transferred arc welding can be defined as a gas-shielded arc welding process where the coalescence of metals is achieved via the heat transferred by an arc that is created between a tungsten electrode and a work piece. The arc is constricted by a copper alloy nozzle orifice to form a highly collimated arc column.The plasma is formed through the ionization of a portion of the plasma (orifice) gas. The process can be operated with or without a filler wire addition. PTA is suitable for manual, semi or fully automatic operations using manipulators, positioners, oscillators and microprocessor controls. It can be used with Robots and adapted with CNC systems. It produces a very high quality deposit offering optimal protection with minimal dilution or deformation of the base material which are relatively low cost surfaces in the case of Hardfacing.

IV.NOZZLE AND A KEYHOLE THROUGH THE PLATE

Once the equipment is set up and the welding sequence is initiated, the plasma and shielding gases are switched on. A pilot arc is then struck between a tungsten alloy electrode and the copper alloy nozzle within the torch (nontransferred arc mode), usually by applying a highfrequency open-circuit voltage. When the torch is brought in close proximity to the workpiece or when the selected welding current is initiated, the arc is transferred from the electrode to the workpiece through the orifice in the copper alloy nozzle (transferred arc mode), at which point a weld pool is formed. The PAW process can be used in two distinct operating modes, often described as the melt-in mode and the keyhole mode.The melt-in-mode refers to a weld pool similar to that which typically forms in the Gas Tungsten Arc Welding (GTAW) process, where a bowl shaped portion of the workpiece material that is under the arc is melted.The power source, which supplies the main power for the welding system, is usually supplemented with a sequence controller and control console. The sequence controller sequences the timing of gas flow, arc initiation, main welding current control, and any up-slope and downslope parameters.

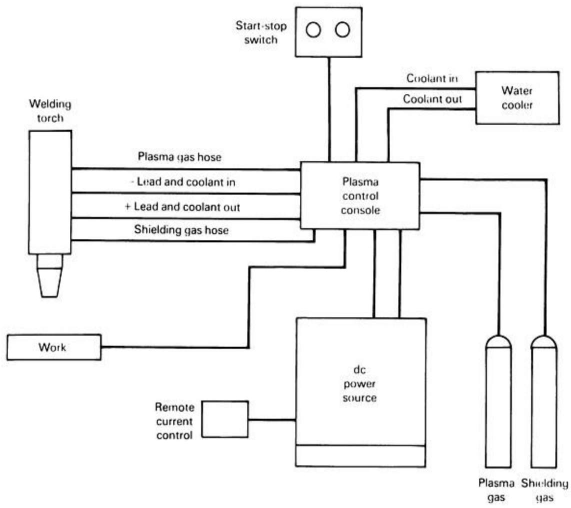

Fig.3 Typical Equipment for Plasma arc welding

V. EXPERIMENTAL SETUP

Our experimental set up comprises of the following instruments which categorized below based on their function.

Visual Examination

1.Macroscopic photography

Metallurgical Analysis

1. Specimen preparation (25 mm dia round mould)
2. Scanning Electron Microscope
3. Liquid Penetrant Examination

Fig.4 PTA Operation

VI.STAGES OF ANALYSIS

1. Problem Identification and Selection (Problem definition, background and importance of problem)
2. Observation (Data Analysis)

3. Analysis (Analysis causes with data and find out the root causes)
4. Action (Implement countermeasures / solutions) Check (Verify methods and results)

VII. DEPOSIT CRACK & UNFILL LOW

Deposit material crack will be detected at liquid penetrant inspection stage and the crack photographs with various magnified conditions are as below,

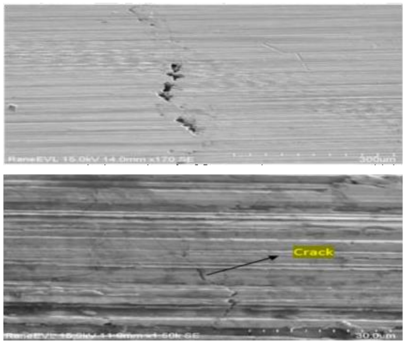

Fig.5 Crack portion in magnified photographs

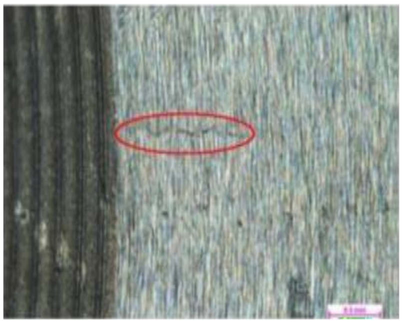

Fig.6 Crack portion in macro photographs

Deposit material un-fill will be detected at visual inspection stage and the various locations of the defects as below,

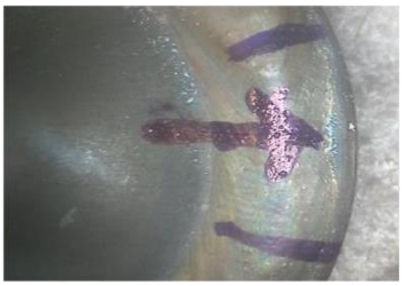

Fig.7 Seat Unfill

Fig.8 Head Unfill

VIII.RESULT AND DISCUSSION

After the process parameter optimization the deposit material crack rejection were reduced form 10% (Avg of 3 months to 0.8 %) and with the controlled runout I/P to the process rejection were reduced from

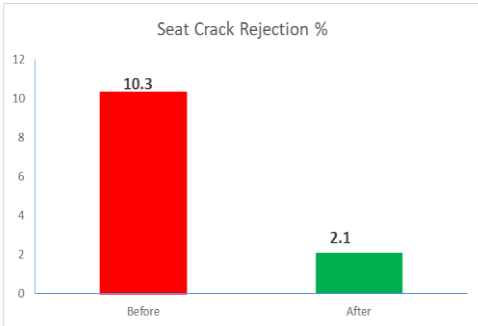

Fig. 9 Rejection Reduction-Deposit Crack

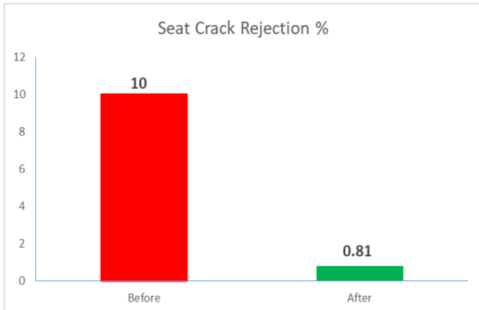

Fig.10 Rejection Reduction-Deposit unfill

IX. CONCLUSION

The Plasma Transferred arc welded joints of IC engine valves were investigated based on the experimental results. From the effect of process parameters, it is found that heat input is having greater influence on deposit material crack Microstructures have been studied for the welded valves of optimum parameters and observation shows that good strengthened weld zone is found in the optimized weld condition which have lesser rejections compare with the higher heat input. Response to input relation was developed by factorials method and the interaction plots were drawn and based on the extrapolation of the interaction plots process parameter were optimized Input condition of the material to be welded should be within the controlled process limit otherwise it will leads to the rejection in account of material filling up.

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