ABSTRACT

With the phenomenal increase in the volume and variety of offshore installations and the inherent advantages of welded fabrication the welding engineer is confronted with the problem of underwater welding - establishing its parameters as well as evaluating the quality of the weld. Though underwater welding has been in use since 1917 but no basic research work seems to have been reported till late fifties. Thereafter, a number of research papers have been published on various aspects of the problem. Though the papers published in the recent past and the present day literature have given an insight into the different aspects of the problem yet no definite conclusions have been arrived at.

In the light of lack of any definite conclusions, the present work was undertaken with a view to gaining better knowledge about underwater shielded metal arc welding. The various aspects explored included Metal transfer, Loss or gain of deoxidizers, Temperature distribution, Weld bead geometry and Shape relationships, Microhardness and Microstructure studies as well as the Residual stresses.

Metal transfer was studied by oscillographic recordings of arc voltage and current transients as well as with electronic counter and dynograph. The effect of arc length,electrode polarity and surrounding media on growth and detachment of molten

droplets have been studied in detail. Metal transfer with bunched electrodes has also been investigated. The phenomenon of arc re-ignition as well as the electrical parameters for full length consumption of the electrode have also been explored.

The loss or gain of manganese and silicon as affected by arc voltage and salinity of water have been investigated. It has been found that whereas the manganese contents of the weld metal are depleted, there is a considerable pick-up of silicon.

The study of temperature distribution in underwater welding of horizontal flat plate was undertaken. A 3-dimensional heat transfer model has been attempted. It has been found that the model so developed can predict, with sufficient accuracy, the temperature cycle length and the peak temperature of a point. The results have also been compared with those of open air welding conditions.

The weld bead geometry and shape relationships as affected by arc voltage, welding speed, salinity of water, electrode to work angle as well as the condition whether this angle is leading or lagging have been investigated. Dimensional analysis technique was employed to determine the effects of hydrostatic pressure, arc current and electrode diameter. Equations have been developed which can predict the effect of all the aforementioned welding parameters and extraneous factors on weld bead geometry and shape relationships.

Microhardness and microstructure studies revealed that the fusion boundary zone with martensite and bainite predomination in the grains is the most vulnerable part of underwater welds. The peak hardness value of the HAZ was the highest in salt water welds.

The residual stresses were studied with X-ray diffraction technique. It has been found that the sum of the principal surface stresses developed in underwater welds are of the order of 75% that of the stresses in open air welds - with the welding parameters remaining same.