PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

Reheat Cracking in 2<latex>$\frac{1}{4}$</latex>CrMo Weld Metal: The Influence of Residual Elements and Microstructure

A. D. Batte and M. C. Murphy

Phil. Trans. R. Soc. Lond. A 1980 **295**, 293-294
doi: 10.1098/rsta.1980.0111

Phil. Trans. R. Soc. Lond. A **295**, 293–294 (1980) [293]
Printed in Great Britain

Reheat cracking in 2¼CrMo weld metal: the influence of residual elements and microstructure*

By A. D. Batte and M. C. Murphy
NEI Parsons Ltd, Newcastle-upon-Tyne, U.K.

Although the incidence has been low, reheat cracking has led to major problems in welded creep resistant steam power plant. Circumferential cracks have formed in the heat-affected zones of CrMoV pipe-like joints and transverse cracks in the 2¼%CrMo weld metal (Schüller *et al.* 1974). The alloy content and the stress relief heat treatment conditions have been shown to determine the underlying reheat cracking characteristics of low alloy steel types (Vougioukas *et al.* 1974), but residual element content and the type of microstructure determine whether or not the problem is of practical significance.

Reheat cracking susceptibility in weld metals, measured by the notch bend relaxation test (Batte *et al.* 1976), has been shown to be generally independent of specimen orientation. The extent of cracking in multipass welds, however, has been found to depend on the type of microstructure present. Cracking occurs more readily in the coarse grained unrefined regions, clearly delineated by smooth grain boundaries, than in the partly or fully refined regions formed in the deposited weld metal by subsequent weld passes.

To define the relative importance of residual element content and microstructural refinement in 2¼%CrMo weld metal, welding wires were drawn from ingots cast with three levels of residual element content, from the purest obtainable to those normal in commercial practice. Each wire was then deposited by using both the submerged arc (two fluxes) and the tungsten inert gas (t.i.g.) process to manufacture a thick section weld. The composition and thermal effect of the successive weld beads was thus different in the various deposits made from a given wire.

The measured susceptibility to reheat cracking of the deposits in each series increased slightly as the residual element content increased. However, the susceptibility of the t.i.g. deposits was always much less than that of the submerged arc deposits. Examination of the failed specimens revealed that although all had fully bainitic microstructures, the amount of coarse grained material in the t.i.g. deposits (15–25%) was only half that in the submerged arc deposits (35–45%).

Consideration of the welding process suggests that under suitable welding conditions the extent of microstructural refinement can be maximized by arranging successive weld beads in a single stack. A weld made in this way was almost fully refined (6% coarse grained material) and was essentially unsusceptible to reheat cracking even though the wire used was of low purity.

Hence it is concluded that weld process control can be used to prevent reheat cracking in production. Special measures to reduce the residual element content below the levels generally obtained in current practice are therefore unnecessary.

* Extended abstract; the full paper appears in *Metals Technol., Lond.* **6**, 62 (1979).

References (Batte & Murphy)

Batte, A. D., Miller, R. C. & Murphy, M. C. 1976 In *Bruchuntersuchungen und Schadenklärung*, pp. 173–180. Munich and Berlin: Allianz Versicherings-AG.
Schüller, H.-J., Hagn, L. & Woitscheck, A. 1974 *Maschinenschaden* **47**, 69–74.
Vougioukas, P., Forch, K. & Piehl, K.-H. 1974 *Stahl Eisen* **94**, 805–813.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES