(739) THE MANUFACTURE OF NEAR NET-SHAPE PRODUCTS BY THE OSPREY PREFORM PROCESS

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1. INTRODUCTION

The Osprey Process(1) is a rapid solidification process capable of generating near net-shape products in one integrated operation. The process comprises the steps of converting a stream of molten alloy into a spray of droplets by means of inert gas atomisation and directing the droplets onto a collecting surface where they re-coalesce to form a near net-shape product.

The production of a near net-shape product (i.e. a preform) in an integrated atomisation/deposition operation offers significant economic benefits compared to ingot and powder routes of manufacture. In addition, rapid solidification results in spray-deposited preforms which are characterised by a uniform, microcrystalline structure without macrosegregation, irrespective of the thickness of the spray deposit. As with other rapid solidification processes, it is possible to develop new alloy compositions which cannot be fabricated by conventional ingot routes because of severe segregation problems. The Osprey Process also offers a simple and economic method of producing coated products (e.g. tubes, bars and strip) and metal matrix composite preforms by injecting ceramic particles into the atomising zone during the deposition operation.

The present paper is a review of the process and product developments that have been carried out by Osprey Metals, Sumitomo Heavy Industries and other licensees of the Process.

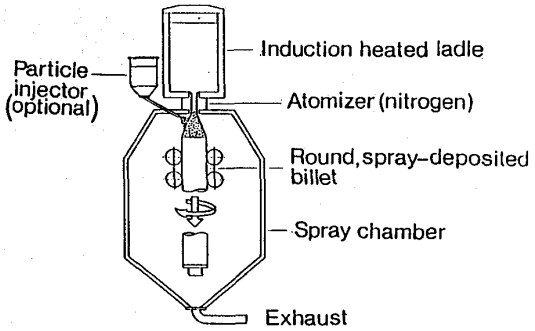

Fig. 1. The Osprey bar/disc process

2. PLANT AND EQUIPMENT

Equipment has been developed for producing tubular, round and flat products.

2.1. TUBULAR PREFORMS

To produce a tube preform atomised droplets are deposited onto a rotating tubular collector which traverses through the spray. Stainless Steel and Superalloy tubing up to 8m long in the size ranges 100-440mm O.D. with wall thicknesses up to 50mm have been produced by Sandvik in Sweden. Atomising rates are typical in the range 80-100kg. per minute. After machining and heat treatment the tubes are fully dense with properties at least equivalent to wrought material. The tubes can either be used at this stage or further processed to thinner wall tubes by direct cold rolling; no hot rolling is required. Because of a significantly shorter processing route compared to P/M or wrought routes considerable cost savings are made, particularly in terms of material yields, energy consumption and material inventory.

2.2. BAR, BILLET OR INGOT PREFORMS

Solid, round preforms are produced by spray-depositing atomised droplets onto a rotating, disc-shaped collector which retracts during the deposition operation in such a way as to maintain a constant distance between the atomiser and the deposition surface. (Fig.1.). A wide range of steel and superalloy discs(2) with diameters in the range 100-250mm and round steel bars up to 1 metre long and 150mm dia. have been produced on a development basis.

2.3. FLAT PRODUCTS

Strip can be produced by traversing a flat collector under a rapidly oscillating spray in order to ensure uniform distribution of deposited metal across the width of the collector. At the current state of development, steel strip in the thickness range 5-10mm, up to 1 metre wide and 2m long has been ptoduced(3).

3. STRUCTURE AND PROPERTIES

By depositing the atomised droplets onto the surface of previously deposited metal, which is in a semi-solid/semi-liquid condition, it is possible to produce high density preforms with a uniformly fine microstructure without macro-segregation. In an alloy such as IN 625 the grain size is typically ASTM 7-8 and the properties in the as-sprayed condition are generally equivalent or better than wrought or P/M alloys. Hot or cold workability of the alloys is excellent and after working the properties often exceed those of conventionally produced alloys(4).

Examples of improved properties have been demonstrated in service with roll preforms produced by Sumitomo Heavy Industries. The life of high speed steel rolls tested in a wire-rod mill exceed the life of conventionally produced rolls by a factor of approximately three.

4. CONCLUSIONS

The production of tubular, bar and strip preforms indicates the flexibility of the Osprey Process for the manufacture of near net-shape products.

The reduced number of process operations compared to wrought or P/M routes provides the possibilities of considerable cost savings.

The unique and desirable microstructures generated by spray-deposition suggests improved performance in service and the potential for developing new alloy compositions, coated products and metal-matrix composites.

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