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Aluminum Spray Forming—An Extended Abstract*

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1. Background

COMMERCIAL production of aluminum sheet materials by spray atomization and deposition is an attractive manufacturing alternative to the conventional ingot metallurgy-based process, as well as to continuous casting processes, due to the expected combination of reduced energy requirement, lower cost, and improved product characteristics. To realize the full potential of this technology, it is necessary to optimize the behavior of currently available state-of-the-art atomization devices and explore nozzle design concepts whose spray characteristics are tailored to the continuous production of aluminum alloys. Foremost is the need to optimize the design and operating conditions of linear atomization systems (Fig. 1) for the efficient production of aluminum sheet products.

Spray forming, as a means to manufacture aluminum sheet products, has not occurred despite process advances in aluminum (billet) manufacturing over the past 15 to 20 years. This effort has focused on advanced alloys and composites because these products cannot be produced by conventional ingot metallurgy processing. Examples of spray-formed materials available today are Al-Li alloy systems and Al-SiC composite extrusion billets for lightweight, high-modulus airframe components. Sheet production for aluminum and other metals has been less well explored.

2. Benefits

Successful completion of this program will enable the aluminum industry to produce aluminum sheet products with increased energy efficiency and reduced cost. Aluminum sheet spray forming saves energy by eliminating intermediate, energy-intensive, hot rolling steps necessary with conventional ingot casting/hot rolling processes. Overspray losses are targeted for 5% maximum as a technical goal in the program due to adverse effects on energy savings and cost reduction. An energy savings of 15% is achieved by spray forming versus ingot casting with 10% overspray, and 27% savings is achieved with no overspray. An even larger potential energy savings (0.19×10^{15} Btu/year) is estimated with increased use of aluminum for the lightweight automobile structures that are possible with spray forming. Formability and other properties of wrought aluminum products are often sensitive to high iron, silicon contents, and other impurities inherent with recycling. Because of the high solidification rates achieved, spray forming is able to relax tolerance limits for these elements, permitting higher recycle rates than are now possible.

Cost savings possible from use of spray forming come from the following sources:

- Process cost savings with spray forming versus conventional ingot casting
- Opportunities for cost savings with spray forming by using increased amounts of off-specification or recycled feedstock above limits that cannot be used in conventional ingot casting or continuous casting
- Opportunities for cost savings by substituting spray-formed aluminum alloy products for other aluminum alloys produced by more expensive processes and/or other materials. It is estimated that spray forming results in a 13% reduction in costs with respect to conventional ingot casting/hot rolling.

3. Program Overview

Alcoa's approach to research and development of spray forming encompasses four separate yet interrelated and interactive tasks, including spray deposition/process development; alu-

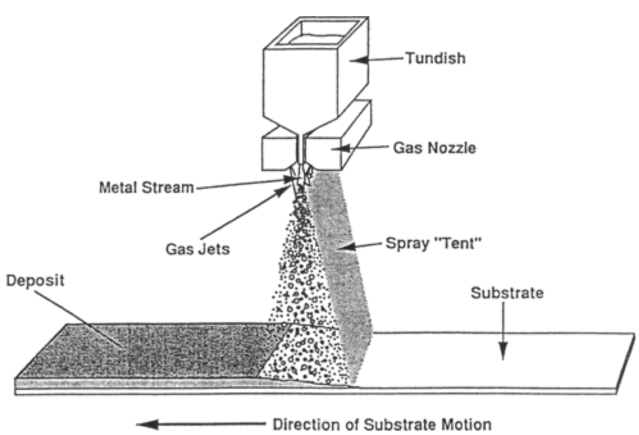

Fig. 1 Spray forming/linear atomizer concept

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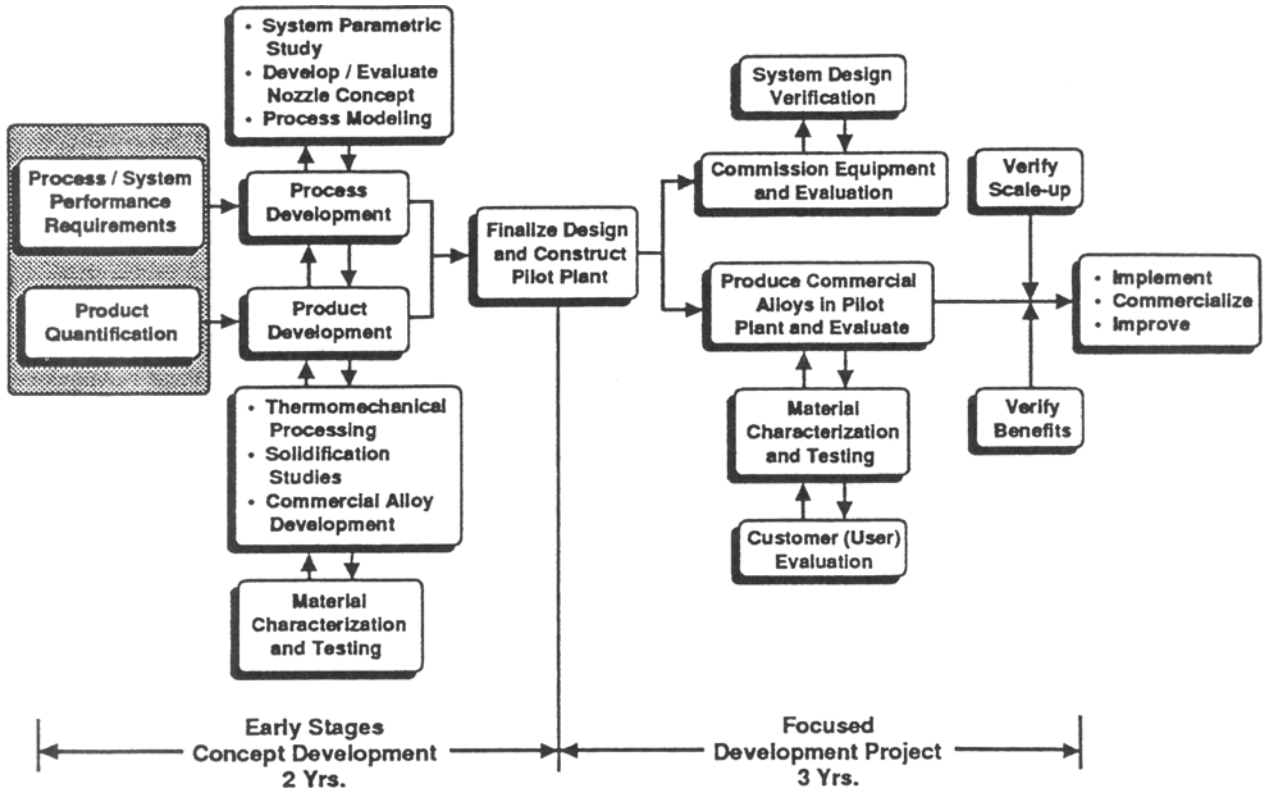

Fig. 2 Project technical approach flow model

minum product development; design, construction, and commissioning of a pilot plant; and production of aluminum sheet products for test evaluation.

The program is divided into two stages with approximately two years planned for process development, followed by a three-year pilot plant demonstration stage (Fig. 2).