

INTRODUCTION

The purpose of this program was to develop the manufacturing capabilities of the hydrostatic extrusion process and was divided into two phases with the following general objectives:

Phase I. Process-Development Studies

- Part 1. (a) To study the effect of critical process variables on pressure requirements and surface quality in hydrostatic extrusion of AISI 4340 steel, Ti-6Al-4V titanium alloy, and 7075 aluminum alloy.
- (b) To correlate all available hydrostatic-extrusion-pressure data with material properties wherever possible in order to assist direction of the experimental effort and maximize the information developed on the present program.
- Part 2. To explore the hydrostatic extrudability of TZM molybdenum alloy, beryllium, A286 iron-base superalloy, Alloy 718 nickel-base superalloy, powder compacts, and other selected materials.
- Part 3. To conduct a design study for high-temperature, high-pressure hydrostatic-extrusion tooling based on (1) estimated pressure requirements for high-ratio extrusion of materials of interest to the Air Force, (2) latest high-pressure-vessel technology, and (3) latest tooling materials available.
- Part 4. To conduct a process economic study on the construction, installation, and operation of equipment with the same operational and size requirements as the tooling developed in the previous program on Contract No. AF 33(600)-43328.

Phase II. Process-Application Studies

- Part 1. To evaluate the application of the hydrostatic-extrusion process for sizing and finishing conventionally hot-extruded (or rolled) structural shapes by various combinations of drawing and extruding. Primary emphasis was to be on AISI 4340 steel, although some effort was to be devoted to Ti-6Al-4V, 7075-0 aluminum, and selected refractory metals.

- Part 2. To determine the feasibility of producing wire and filaments from beryllium, TZM molybdenum alloy, and Ti-6Al-4V titanium alloy by combinations of hydrostatic extrusion and drawing.
- Part 3. To develop tooling and define process parameters necessary for the reduction of tube blanks to finished tubing from AISI 4340 steel, 7075-0 aluminum, and Ti-6Al-4V titanium.

The results of the experimental and analytical work connected with Phases I and II were covered in Interim Engineering Progress Reports I through IX.

This, the Final Technical Report in two volumes, contains the results of the program in their entirety. Volume I contains Section 1, "A Study of the Critical Process Variables in the Hydrostatic Extrusion of Several Materials" and Section 2, "Production Aspects of Hydrostatic Extrusion". Volume II contains Section 3, "Analysis of Several High-Pressure Container-Design Concepts" and Section 4, "Hydrostatic-Extrusion Containers Designed and Constructed in the Program". The experimental program started December 1, 1964, and was completed on July 8, 1967.