DEVELOPMENT OF THE MANUFACTURING CAPABILITIES OF THE HYDROSTATIC EXTRUSION PROCESS

by

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INTRODUCTION

The purpose of the present research program is to develop the manufacturing capabilities of the hydrostatic extrusion process with the aim of extruding high-quality shapes from materials of interest to the Air Force. It is a continuation of the previous program on Contract No. AF 33(600)-43328. The current program is 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 in 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 will be on AISI 4340 steel, although some effort will 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 finish tubing from AISI 4340 steel, 7075-0 aluminum, and Ti-6Al-4V titanium.

In addition to the continuing study of critical process variables, experimental efforts during the last quarter were directed toward extrusion of advanced materials, extrusion of tubing, sizing of shapes, fabrication of wire, and compaction of powders. The specific areas covered with each material are given below:

Material	Parameters Evaluated
7075-0 Aluminum	Lubricants Billet nose design Extrusion ratio T-sections Re-extrusion of T-sections
Dispersion-Hardened Aluminum	Extrusion ratio
Ti-6Al-4V Titanium Alloy	Stem speed Lubricant coating at 400 F T-section Powder compaction
TZM Molybdenum Alloy and Beryllium	Die design 500 F extrusion
Beryllium Wire	Die design 500 F extrusion
Superalloys Alloy 718 and A286	Extrusion ratio 500 F extrusion