Advanced metal forming processes

Subjects of interest

- Introduction/Objectives
- Superplastic forming
- Pressing and sintering
- Isostatic pressing
Objectives

- This chapter aims to provide additional information on several techniques of metal forming processes other than those conventional processes already mentioned in previous chapters.

- The requirements for the process selection will be added, which are based on advantages and disadvantages of each type of non-conventional metal forming processes.
Introduction

- Advanced techniques for metal forming are listed below;

1) Superplastic forming
2) Pressing and sintering
3) Isostatic pressing (hot and cold)
The term **superplasticity** is used to describe materials that can be formed to **high strains** without the formation of **unstable tensile necks**.

- Require controlled conditions of appropriate **temperature** and **strain rate**, by using **low force**.
- Produce **complex shapes** (3D) with essentially **constant section thickness**.
- Good **surface finishes**.
- **Poor creep** due to small grain size.
- Machines and dies are costly.
Female forming

• **Graphite coated blank** put into *heated hydraulic press*.
• **Air pressure** forces sheet into close contact with mould.

Female drape forming

• **Graphite-coated blank** clamped over *‘tray’* containing *heated male mould*.
• **Air pressure** forces metal into close contact with mould.
Plug-assisted snap back male forming

- **Graphite-coated blank** put into heated press.
- Blank formed into a bubble.
- Male mould pressed into bubble.
- **Air pressure** forces metal into close contact with mould.
Pressing and sintering

- **Powder** is pressed in closed dies to form a green compact which is then sintered at elevated temperature.

- Produce 3D solid shapes for mainly metals and ceramics.

- Near net shape process → 100% material utilization.

- Automated machinery and dies are relatively costly.

**Sequence of operations for production of cylindrical bearing**

**Sintering Operation**
**Sintering** is the "welding" together of separate powder particles into a single solid material,

- Takes place below the melting point of the material, but at a temperature sufficiently high to allow an acceptable rate of diffusion to occur.
Isostatic pressing

- Powder is placed within a deformable container and subjected to *hydrostatic pressure*.
- Produce **3D** bulk solid shapes for metals and ceramics.
- Allows *simultaneous densification* of metal powder → products have relatively *low porosity*.
- **Distortion** is possible in high aspect ratio components
- Near net shape process → **100%** material utilization.
- High operating cost.
**Hot Isostatic Pressing (HIP)**

- **Components** are loaded into furnace, which is placed into pressure vessel.
- **Temperature and pressure** are raised simultaneously and held.
- **Cooling** is carried out as the gas is released (clean and recycled) and the furnace is removed from the pressure vessel.
- Components are removed from the furnace.
Cold Isostatic Pressing (CIP)

- **Powder** is sealed in a flexible mould (or ‘bag’), of for example polyurethane and then subjected to a uniform *hydrostatic pressure*.
References

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