4.7 HYDROFORMING SHEET STEEL

The practice of hydroforming sheet metal products has existed for many years. Hydroforming processes have exhibited several distinct advantages, which include:

- Intricate or very deep shape making capabilities due to a more uniform strain distribution of the sheet metal material
- Excellent surface finish
- The capacity to produce rigid panels due to strain hardening
- Ability to handle modest directional die-lock conditions
- Shorter tooling development times
- Reduced tooling and parts costs at low production volumes

However, the processes have been historically identified with three disadvantages:

- Slow process, sometimes requiring several minutes per cycle (although several parts can often be made per cycle)
- Expensive capital costs requiring dedicated, specialized presses
- Minimal automation requiring hand feeding of blanks and part removal

Recently, hydroforming processes have been developed that offer, in specific applications:

- Reduced mass parts
- Improved quality parts
- The use of existing presses and skilled labor

The processes are designed to replace existing draw die operations and produce hydroformed sheet metal parts. The press action is utilized to apply a force that effects a seal to prevent the leakage of fluid, which is usually water with a rust inhibitor added. Part shape, quality and strength are improved by developing uniform strain distributions. There are two basic systems for controlling the interaction of the fluid and the tool:

1. Sheet steel is forced into a female cavity by water under pressure, supplied either by a pump or by press action, as shown in Figure 4.7-1
2. Sheet steel is deformed by a male punch, which acts against fluid under pressure, as shown in Figure 4.7-2

The potential for cost savings is enhanced through a low cost tooling strategy that utilizes a master shoe and die inserts. The master shoe is defined as the equipment that can be used for any part that is made in the press. Die inserts contain the specific part shapes. Unlike standard dies, which may require matched male and female inserts, hydroform dies require only one insert, which results in significant tooling cost savings.

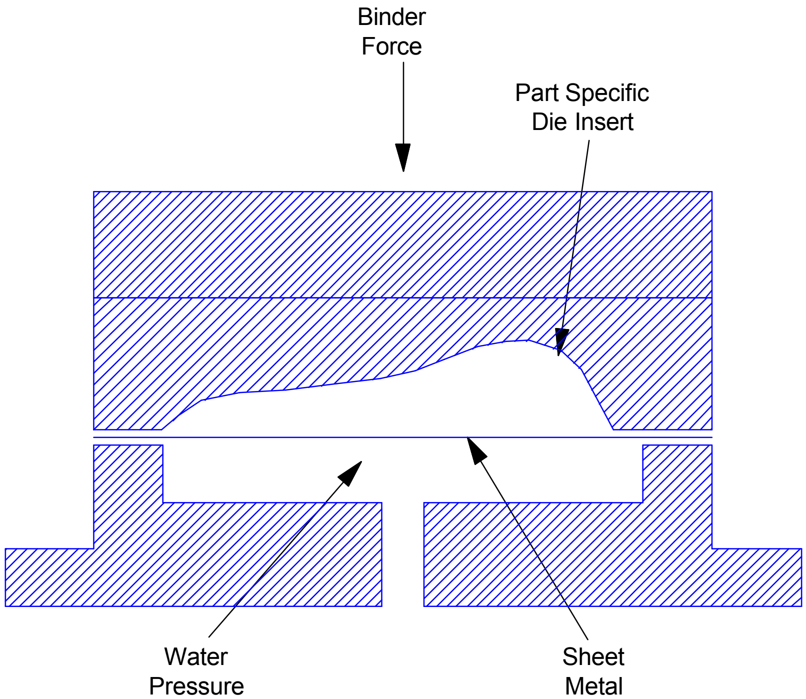

Figure 4.7-1 Hydroforming using fluid under pressure to form the shape in a female cavity

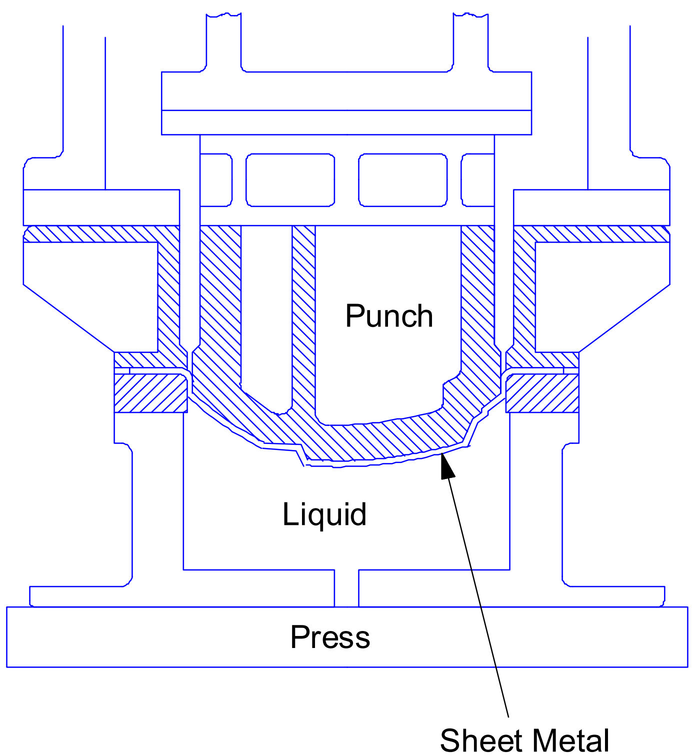

Figure 4.7-2 Hydroforming using a male punch to form the shape against fluid under pressure

Examples of parts made by hydroforming include very deep drawn quarter panels, rear compartment panels and fenders on low volume production vehicles and oil pans for mass production truck diesel engines.

Table 4.7-1 gives illustrative quantitative information on the current features of hydroforming technology. Values are based on typical applications, and will vary according to the application and type of hydroforming process employed.

Table 4.7-1 Features of Current Hydroforming Technology

Feature	Current Hydroforming Technology
Tooling Requirement	Only one part specific die is required.
Tooling Cost, Draw Stage Only	Typical cost $350,000 for the first part, $50-100,000 for additional parts that use the same master shoe.
Production speeds	2 to 12 parts per minute, depending on depth and size.
Sheet Metal Blank Requirements	Sheet metal blank requirements: HS: Lockout enables smallest blank size.
Surface Quality	Excellent surface quality on fluid side. Typical quality on die side.
Prototype tool to production time	6 to 12 months, because prototype developments can be used in production.
Ease of making engineering changes	Simple design minimizes change time. Low cost die materials could further reduce timing.
Panel stiffness after forming	Good because: HS: Biaxial strains of 3-5%.