PRACTICAL USE OF SERVO PRESS MOTION AND SERVO CUSHION
IN STAMPING

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New materials require new manufacturing methods. Deep drawing of Advanced High Strength Steels (AHSS) and certain Aluminum alloys (i.e. 6xxx) require flexible forming operations. Therefore, the use of servo presses and servo hydraulic cushions continue to increase.

The servo presses are used mainly because of their capability to increase production rate (larger SPM than mechanical presses, and use in pendulum mode and reduction of stroke length). However, there are many other useful characteristics of servo presses that may allow to optimize forming operations. Figure 1 illustrates the major differences between the ram motion of conventional mechanical press and the servo press. These characteristics include:

1. Shorter cycle time (larger SPM)
2. Variable stroke (TDC/BDC)
3. “Best” forming speed
4. Dwell/slow down in stroke before forming
5. Attach/detach mode
6. Synchronization with automatic part transfer
7. Energy savings

As mentioned in earlier Stamping Journal articles [1,2], controlling the material flow is critical to avoid splits or wrinkles in drawing operations. There are several methods that can be used to achieve this goal. The force required to stretch the blank can be generated either by drawbeads and pneumatic (air or nitrogen) or hydraulic cushions. Each of these alternatives have some advantages and disadvantages.

As seen in Figure 2, the way the cushion force is transmitted from the binder (or blank holder) to the blank can be done in various ways:

- the cushion force is applied on the spacers during the forming process and affects the elastic deflection of the dies. Figure 3 illustrates the drawbeads and spacers in a die, where the BHF (Blank Holder Force) is applied by nitrogen cylinders.
- drawbeads are used to restrict metal flow (stretching) on the blank in strategic zones.
- servo control of the hydraulic cushion can be used to apply constant or variable, BHF (i.e. variation of cushion force vs ram stroke).

The spacers and drawbeads have been used in the industry for a long time, mainly because they are relatively inexpensive and practical. Some companies have gone further in the use of these technologies and automated them in certain way. One example is the “intelligent tool” developed by Audi to adjust the spacer height to an optimal value according to laser measurements of the flange motion during the drawing process [1].

The use of servo hydraulic cushions has the advantage that they are assembled into the press so that there is usually no need to have nitrogen cylinders that are built into each die set. Servo cushions may improve the drawing conditions, in certain applications, as discussed in an earlier Stamping Journal article [2]. Possible use of servo presses and servo cushions include:
- Attach/Detach and Restriking (increase draw depth / reduce springback), Figure 4.
- Dwell at BDC or during forming (reduce springback)
- Slow speed on touch (improve lubrication/reduce shock/improve cushion response)
- Pulsation of servo cushion (reduce friction at flange/increase draw depth)
- Variable BHF during stroke (eliminate draw beads in some cases/ increase dent resistance/ reduce springback)
- Variation of BHF between successive strokes to compensate for variations in material or lubrication

A very interesting option to be explored is the feasibility of replacing the spacers and drawbeads with servo cushions (Figure 2), especially when using multi point cushions [3]. This mode of operation, may save material and can allow to use various servo press characteristics listed above.

The Center for Precision Forming (CPF) at The Ohio State University, is investigating the applications of servo presses and servo cushions, in cooperation with AIDA-America, Batesville Tool & Die, IRMCO, Hyson and Shiloh Industries. Results of some of these preliminary tests, without spacers, are given in Figure 5 and Figure 6.

**Effect of press speed**

Better results (no fracture) have been observed when forming parts at a higher ram speed while keeping constant the rest of the parameters (cushion force, draw depth, lubricant used, etc.), Figure 5a. However, the reasons for these improvements are still being investigated.

**Effect of attach/detach method**

When constant ram motion is used and the part fails (by fracture), one option that has proven to be effective in some cases, Figures 4 and 5b, is the attach/detach method which consists of reversing the ram motion during the forming portion of the stroke, enough to separate the binder from the die (detach). Later, the ram motion is reversed once again to form the part (attach).

**Effect of pulsating cushion force**

It is well known that the vibrations in the flange may improve the lubrication conditions in certain cases. Some of the latest models of servo cushions have the capability to pulsate. Experiments were carried out to prove this principle. In some cases, results showed improvement is drawability, Figure 6.

**Effect of Variable Cushion Force**

This is maybe the most widely known servo cushion capability. It allows to replicate approximately, forming with spacers by increasing the BHF towards the end of forming operations. Increasing the BHF, near the end of the stroke helps to stretch the material and reduce springback.

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References


Figure 3 Use of spacers/stand-off blocks in a stamping die (courtesy Superior Cam)

Figure 4 Prevention of fracture by controlled slide motion [4]
Figure 5 a) Effect of press speed (Al 5182-O/1.2 mm, was successfully formed using 20SPM, fractured using 5 SPM). b) Effect of attach/detach mode (DP980/1.1 mm, successfully formed using attach/detach method, fractured using continuous ram motion).

Figure 6 Effect of pulsating cushion force (1008 steel/1.0 mm, was successfully formed using pulsating BHF= 85 kN to 20 kN (5 pulses/sec)).