Inline Punching and Cutoff Applications in Roll Forming

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Hydraulics are becoming prevalent in roll forming as more operations are done in-line at faster line speeds with smaller footprints. This review compares the latest hydraulic technology to current mechanical and air press applications used in roll forming.

A hydraulic press once meant a slow-moving ram with a cycle time of a few seconds, or a pause at the bottom of the stroke before returning to the top (Figure 1). In theory, integrating hydraulics into a roll forming line doesn't make much sense unless a positive stop or some type of accelerator system is used

Figure 1. Without using a positive stop or some type of accelerator system, hydraulics don't make much sense in roll forming.

But hydraulics have been a part of punching and cutoff dies in roll forming lines for years - not as the main actuator for the dies, but in secondary roles that incorporate pickup mechanisms, material gripper units, pull back systems, and cam actuators (Figure 2)

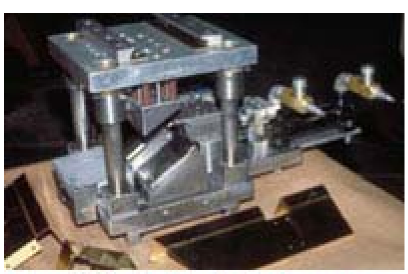
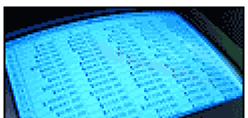


Figure 2. Hydraulics typically serve secondary roles in a roll forming line.

These systems usually run at low pressures, where cylinder cycle time or overall cylinder stroke doesn't cause much concern. The continuing evolution and reliability of hydraulicsand electronics now makes it worthwhile to add these high speed, versatile systems to existing and new roll forming lines.

Hydraulic Presses

Benefits increase with a correctly-sized hydraulic system. Hydraulic systems improve accuracy with open-loop measuring by producing extremely fast, repetitive ram action with a cylinder. This provides more measuring flexibility through closed loop, positive stop, flag trip and pick up finger mechanisms. Hydraulics shrink the overall line layout by cost-effectively buying tonnage and die space. They normally



improve noise levels by operating more quietly than the constant pounding of an air press.

Hydraulics can dial-in an accurate bottom stop for forming and/or embossing, allowing the total die stack up to be locked in. Other types of presses need clearance at the bottom of the stroke so die movement is not restricted and material won't buckle between the roll mill and press.

Hydraulics punch or form features in a part from top and bottom or at different angles, producing parts with a roll design that is more beneficial than previously possible. Hydraulics perform ‘outside the box' applications that were never considered in-line before due to press limitations associated with self-piercing nut assembly or in-die-tapping applications (Figure 3). Hydraulics provide full tonnage through the complete stroke of the cylinder for punching at different levels of the part and with longer strokes, all without worrying about tonnage loss incurred with other types of presses

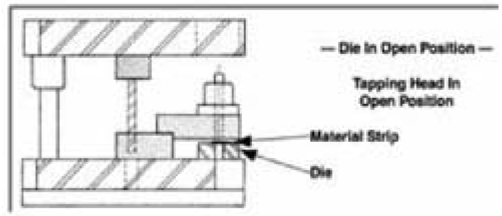


Figure 3. This general arrangement drawing shows the function of the tapping unit. <smaller, italicized font>Courtesy of Hutchinson Tool Sales

Correctly sizing the hydraulic system requires basic information to set parameters. First, identify the minimum and maximum part lengths or features being punched or cutoff, plus the desired line speeds at the minimum and maximum lengths (to determine whether the system can be sized). Be sure to include any parts that might run through the line in the future. This prevents costly system redesign and rework later.

Next, calculate the tolerances of each part feature and length to run in the system. Tolerances identify the required up-and-down cycle time and the type of measuring system that can be incorporated. Total cutting or forming tonnage and the die stroke are also needed to determine the cylinder bore size and running pressure of the system.

Figure 4. A self-contained style die is simple to changeover and good for open-loop measuring.

Using this information, choose the correct system components and consider the die types that are available.

Die Styles

General die types used with hydraulics in conjunction with roll forming lines include *self-contained style dies* that don't require a stationary or flying press frame along with the die. Their flexibility cuts die design costs and saves overall line space (Figure 4).

The overall weight of a self-contained die is less than flying press frames. This helps in open-loop measuring applications, in turn saving money on closed-loop systems. Changing over a self-contained slugless cutoff die is simple and quick because only a few screws are removed to disassemble the cutting sections from the close-fitting pocket type holder.

With slug-type cutoff dies changeover time

might increase due to hydraulic hoses that must be removed from the cylinder (Figure 5). The cylinder may also have to be removed from the die and the die disassembled, which takes longer than a die in press frame or conventional type press.

A *flying fixed press* with a die inside runs more styles of dies with faster changeovers (Figure 6). This press is ideal when using multiple dies because standard punching and cutoff dies are cheaper than a self-contained style. Initial sizing of the system is crucial with this press. The tonnage, stroke and speed must be correct for all applications being run. The weight here may slow down the overall line speed in an open-loop measuring system. Costs increase with a closed-loop system due to a larger servo motor moving the heavier mass.

Figure 6. The fast changeover of a flying fixed press with a die inside makes it ideal when using multiple dies.

A *fixed press with a die flying inside* offers flexible placement of the press system with the design of larger tonnage systems. The press can mimic an air or mechanical press on an adjustable base at the end of a roll forming line. Another option is to place the press right on the roll forming base, in-between roll stands (Figure 7). This saves room compared to splitting the base and installing a larger mechanical press in-between.

However, the ability to build a larger system creates a need to design the press and the mounting surface so they can handle the tonnage and force generated from the system. Some of the same problems occurring withconventional presses can also present themselves with this style.

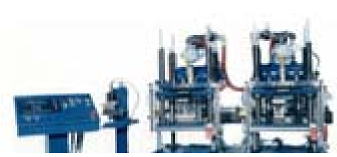
Incorporating hydraulics into a roll forming line has some disadvantages. With high-speed cycle times (up-and-down under .25-sec), the required large tonnage and/or long strokes might increase the sizing of the hydraulic system to the point that internal shock or cavitation occurs from oil flows being so great. This shock is usually more damaging to the hydraulic system itself, and may cause the hydraulics to leak from different areas of the system.

Figure 7. A fixed press with a die flying inside can mimic an air or mechanical press on an adjustable bed.

Custom high-speed hydraulics are not versatile enough to add drastically different part configuration to an existing line. The new part may require the system to have a different cycle time or longer stroke. A hydraulic system currently sized for a 30-ton application may not work for a future 30-ton operation due to speed or cylinder-stroke differences. Also, most hydraulic systems cost more than compatible tonnage air presses. Even weighing these possible disadvantages, hydraulics can still be a viable solution for the application.

Conventional Presses

Other commonly used presses in roll forming lines are mechanical (under-driven presses, mechanical OBI or straight side) and air presses (bladder or air cylinder). These all have advantages and disadvantages that depend their use in the



application.

Air presses produce high speed, extremely fast, very repetitive ram action. They are highly repeatable for open loop measuring, and cost-effective in buying tonnage and die space. These presses are usually lightweight and easy to move from line to line if required. They cost less than hydraulic or mechanical presses. Compared to a bladder-type press, a cylinder-type air press has more ram stability and no real loss of tonnage as stroke length increases.

The downside here is that the noise and vibration air presses generate can increase tool maintenance. Without hitting a solid stop block, an accurate bottom-stopping position is difficult to achieve when embossing, stamping or forming in an air press. Hitting a solid stop creates lots of vibration and noise that increases possible damage to the press and die. A bladder-type press starts losing tonnage through longer strokes. Its air consumption increases as the press tonnage increases and taxes the existing air system - or requires an entirely new one.

Figure 9. The large, stable ram on a straight side press reduces concern about the frame flexing.

A *mechanical press* does pre-notching, midline, post and cutoff operations. New and used mechanical presses are readily available in many different beds and ram sizes within a tonnage range.

A *straight side press* provides a large ram size with stability, meaning less concern about the frame flexing (Figure 9). This helps some off-center loading when using gag-type punching dies. The straight side gives limited stock width clearance going through press frame windows. This requires more stationary pre-notch applications due to the added costs of getting a flying die in-and-out of the press.

An *OBI / OBS press* is a lower-priced option to a straight side press in the same tonnage range (Figure 10). It offers more accessibility for either a stationary die or a flying die to slide in-and-out the entry or exit side of the press. An OBI / OBS ram is not as stable and its frame tends to flex more compared to the straight side.

The popularity of a *mechanical underdriven press* in roll forming is comparable to an air press, because of its high ram speed at a competitive cost compared to other mechanical presses (Figure 11). But in a 4-post ram design the ram is not as stable as a straight side, meaning problems can arise due to the offset loading of the ram. Because adjusting the shut height is more difficult than other style mechanical presses, using a common shut height for dies keeps changeover time down.

Figure 10. An OBI / OBS press easily slides a stationary die or a flying die in-and-out the entry or exit side.

Mechanicals tend to be the quietest, most vibration-free press. Their tooling typically lasts longer than an air press. Mechanicals are best for high SPM requirements, with stationary pre-notch dies where little single stroking is required. However, mechanical presses include very little tonnage when more than a ½-in off the stroke bottom. Most presses are rated for full tonnage anywhere from 1/16-in to ¼-in from the bottom.

Mechanicals are meant to run on continuous stroke. Depending on their different applications in a roll forming line, they often run on single stroke. This advances wear on their clutch and brake assemblies.

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