Press Technology Comparative Analysis

1.0 Introduction

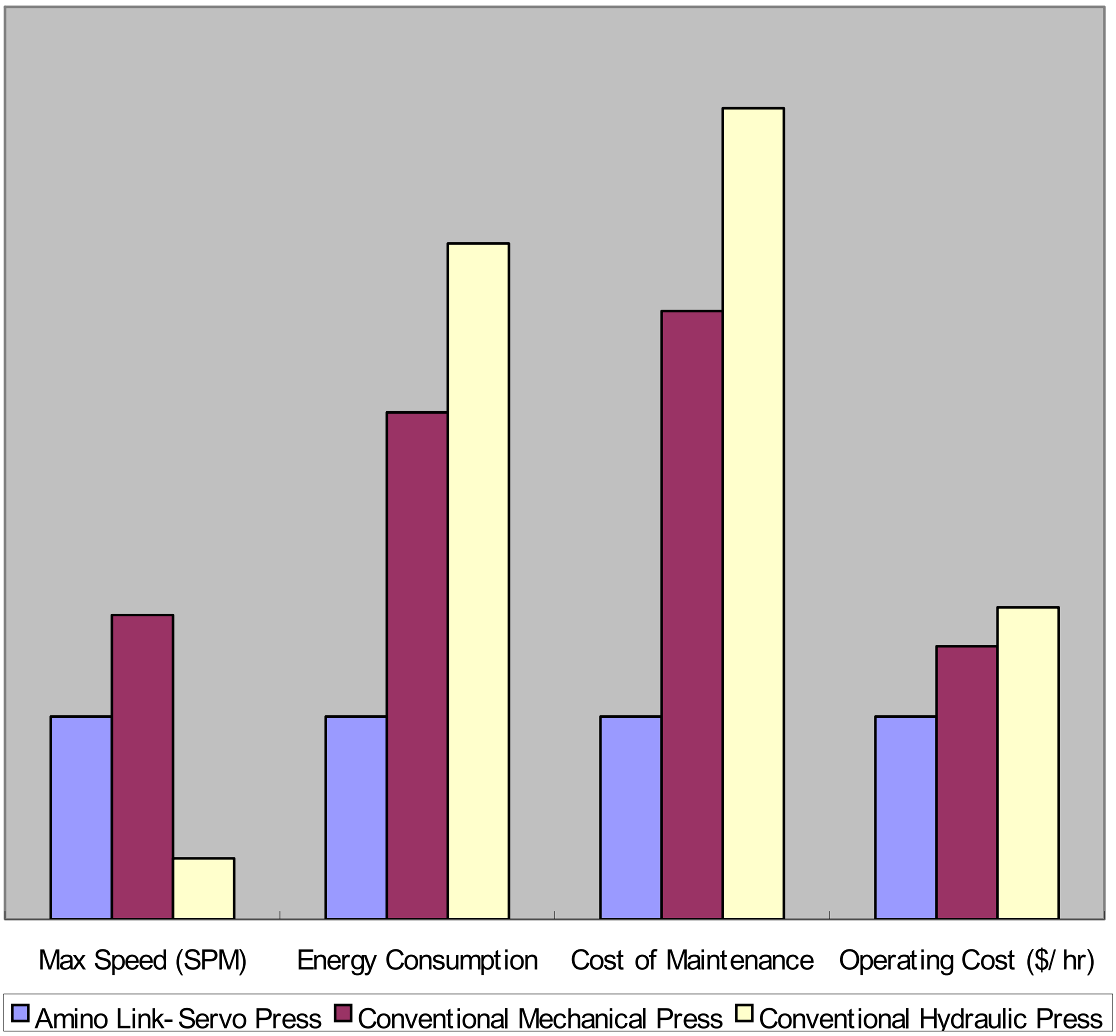
This purpose of this paper is to compare Amino's link-servo press to conventional mechanical and hydraulic presses. The analysis will be divided into two sections. The first section will compare the presses on the basis of measurables. The second section will focus on more qualitative aspects of the three presses.

The measurables investigated in the first section are maximum speed, energy consumption, required maintenance and cost of operation. It should be noted that although every effort has been made to provide values representative of the capabilities of each type of press, they should not be taken to indicate the performance of the press for every type of part. Refer to the sections for the individual metrics for a more detailed explanation of the assumptions used.

The second section will look at some of the qualitative aspects of the presses such as formability and flexibility, ergonomics and safety, and other qualitative implications of the quantitative metrics.

2.0 Quantitative Comparison

Below is a graph comparing the three press types using various metrics. Because the graph is meant to be representative, the quantitative values in each case have been scaled so that they can be displayed on the same graph.



Refer to the following text for a more detailed description of each metric.

2.1 Maximum Speed

The maximum speed metric is meant to indicate the maximum speed of which the press is capable. It should not be interpreted as the speed normally used for or even suitable to a given forming operation, but rather a measure of the physical capability of the press. Furthermore, although this metric is termed the maximum speed it should not be inferred that any of the presses can be operated at a reduced speed. For discussions about these last 2 points, refer to 3.1 Formability and Flexibility.

Not surprisingly, the mechanical press is the fastest, followed by Amino's link-servo press and finally by the hydraulic press. The mechanical press, with its dedicated motion, is well suited to high speed stamping. The link-servo press is also capable of higher speeds but as it is not built primarily for such applications, it cannot achieve the same throughput as a mechanical press. At the other end of the scale is the hydraulic press where hydraulic fluid flow rates limit the speed of the press.

2.3 Energy Consumption

Energy consumption is quite simply the amount of net power the press requires to perform a single stroke.

The hydraulic press consumes the most power, followed by the mechanical press and lastly by Amino's link-servo press. This difference is a direct result of the press mechanisms. The biggest difference comes from the fact that both the mechanical and hydraulic systems are continuously consuming power even during loading or unloading of material. The servo motor on a link-servo press however can be turned off during loading and unloading to reduce power consumption. The link-servo press also uses regenerative braking to generate power during stroke deceleration, thus reducing its net power consumption.

2.3 Cost of Maintenance

Cost of maintenance reflects the total costs in both parts and labour required to maintain the press.

Again, the hydraulic press comes in as the most expensive. The high cost comes from direct costs such as the large number of hydraulic components (filters, valves, etc) as well as from indirect sources such as contamination of the hydraulic fluid. Next is the mechanical press. Similar to the hydraulic press, the mechanical press typically has a large number of components (clutches, transmissions, etc) which must be maintained. Finally is the link-servo press. Unlike the mechanical and hydraulic presses, the link-servo press has relatively few components (a servo motor, a ball screw, and simple mechanical linkages) thus reducing the number of items needing to be maintained as well as reducing the complexity of necessary repairs or maintenance.

2.4 Operating Cost

Operating cost is meant to represent the total cost of operating the press. It includes such variable factors as power consumption and maintenance, as well as overhead items such as initial cost averaged over the life of the press.

Similar to the previous 2 metrics, the hydraulic press comes in as the most expensive, followed by the mechanical press and finally by the link servo. However, the difference in this case is not as pronounced. The higher initial cost of Amino's link-servo press reduces the magnitude of the savings realized by its lower operating costs.

3.0 Qualitative Comparison

Although metrics such as those above are invaluable in evaluating a capital investment such as a press, they only tell part of the story. Other factors must also be considered. Thought must be given to the suitability of the press to make the current desired part. If the press is not to dedicated to a single product line, the ease with which the press can be set or adapted to produce other parts. Beyond the production-specific concerns are also other issues such as safety, as well as the impact of the press's behaviour on tooling and secondary operations.

Below is a discussion of some of these considerations with respect to the three types of presses.

3.1 Formability and Flexibility

Formability is closely tied to the metric of speed. A short cycle time increases the impact on the blank, and as such reduces the amount of forming that can be performed in a single hit without fracture. Conversely, a long cycle time enables better material flow which in turn facilitates greater deformation before failure.

Based on this, it can be said that although mechanical presses are good for high volumes of relatively easily formed parts, they are not well suited to deeper draws or more difficult to form parts. By similar reasoning, the slow cycle time of a hydraulic press, while a detriment to large volume production, is ideal for the production of deep drawn or difficult to form parts.

Amino's link-servo press however does not have a single fixed motion curve. Unlike a mechanical press which is in continuously cycles up and down at a fixed speed or a hydraulic press whose speed is limited by the fluid flow rate to the cylinder and whose force is determined by the fluid pressure, the degree of motion control inherent with a servo motor allows the link-servo press to operate over a wide range of speeds and pressures. As such a link-servo press can be set to function with the quick hard strokes of a mechanical press, or the slow forming cycles of a hydraulic press, giving the link-servo press a greater range of formability than either of the conventional presses.

Beyond just emulating conventional presses though, virtually any type of motion curve can be set into the link-servo press. Pulsing cycles are possible, as is a holding time (for example, at the completion of a stroke) where the punch maintains pressure but does not move. To achieve the benefits of both types of conventional presses, hybrid cycles are also possible. The punch can be lowered quickly, similar to the case of a mechanical press. However, before it engages the blank, the punch can be slowed to form the part in a manner comparable to a hydraulic press. This achieves formability similar to that of a hydraulic press with a cycle time closer to that of a mechanical press.

3.2 Safety

Another qualitative aspect of press operation is safety. Although not tied to productivity or other metrics, safety is nonetheless of vital importance for the consideration of large pieces of equipment such as presses. As a result all of the 3 presses considered here are equipped with safety systems. However, the effectiveness of these systems can be limited by the type of mechanism driving the press motion.

In the case of a mechanical press, a typical method of stopping the press motion is the use of a clutch brake. However, due to the inertia of the drive mechanism, it is possible for the shaft to rotate up to 20° after the brake has engaged (if maintained properly).

In the case of a hydraulic press, the press motion can be halted by stopping the flow of hydraulic fluid into the cylinder. Due to the relatively slow rate of travel of the cylinder, this can be an effective means of stopping the motion of the press. However, although the motion has stopped, the pressure remains and must be dissipated before the press can be opened.

In the case of Amino's link-servo press, the press motion is stopped through the use of a hydro-safety lock mechanism. This mechanism can engaged twice as fast as the average brake on a mechanical press. Beyond that however are the mechanics of the press itself. Because the press is driven by a servo motor and ball screw there is not the inertia to restrain as is the case with the mechanical press nor is there the necessity to bleed a fluid circuit as in the case of the hydraulic press.

3.3 Effects on Neighbouring Processes

One additional quality of these presses that warrants consideration is the press's impact and effect on its neighbouring processes and tooling. Although this is not a characteristic of the press, it is an important factor in determining the suitability of a press to a given task.

One area this issue manifests itself is tooling life. In this regard, the slow action of the hydraulic press is an advantage in minimizing the wear on the tooling. Conversely, the hard fast strikes of a mechanical press greatly increase tool damage. In the middle of course is the link-servo press which can vary between these two extremes depending on what type of motion curve it is set with. However, even when emulating a mechanical press, it is still possible to slow up the motion just before contact with the material, reducing the impact damage to the tooling.

Another issue of compatibility with neighbouring processes was touched on indirectly in 3.1 Formability and Flexibility. This matter is the ease with which the press can accommodate new tooling, either during first-off trials or after tool changes. Because both mechanical and hydraulic presses have limited adjustment functionality, there may be the need to extensively tweak the tools themselves in order to achieve a quality part. Although this may also be the case with the link-servo press, there is also the possibility with that press to make fine adjustments to the forming parameters and motions which may be able to accommodate for slight irregularities in not only the tool set in the link-servo press but also slight imperfections coming from previous processes.

Although there are many other qualitative bases upon which the three presses can be compared, the above examples help to illustrate some of the associated issues of each press technologies.

4.0 Summary

Presented above has been a rough comparative analysis of three different press technologies; a conventional mechanical press, a conventional hydraulic press and Amino's link-servo press. Because this was the most general of comparisons it is not possible to state definitively which technology is the best. However, as the scope of intended press work is defined, the analysis above can be refined and solidified, likely pointing to one technology being the best suited for the desired application.