The Molding Process

LESSON 4: Clamp End Parts and Their Functions – Part II

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This lesson is a continuation of the previous lesson about the clamp end of the machine. It begins with a discussion of the basic components of a machine hydraulic system. The movements of the clamp end parts are then covered in the same order in which the action takes place during the machine cycle.

As a conclusion, molding machine clamping capacity will be discussed. Clamping tonnage and the mold size that a machine can accommodate are among the important size specifications to be learned.

Objectives of Lesson 4

1. Learn the basic components of a machine hydraulic system
2. Begin to understand the sequence of movements in the clamp end of the machine
3. Learn what specifications are used to rate machine clamp capacity

Objective One

Hydraulic System Components

Every molding machine has several components that are related to the hydraulic system. The important parts of the hydraulic system and their locations on the molding machine are shown in Figure 1.

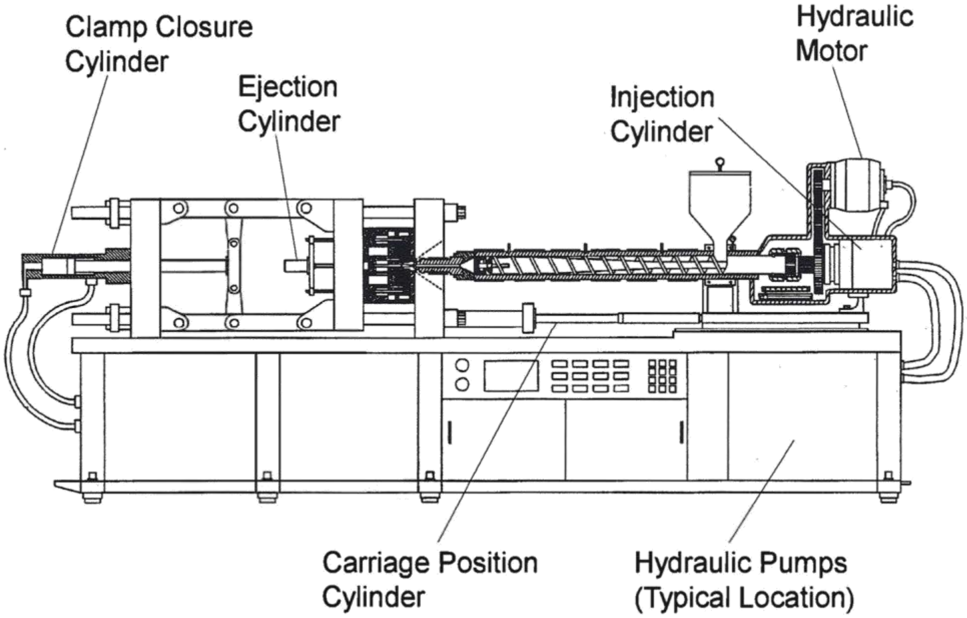

Figure 1 - Hydraulic System Components

Oil Reservoir

The oil reservoir is usually a tank or a cavity in the machine base that holds the oil that is not being used during a particular part of the machine cycle. The oil reservoir must be able to hold enough oil to run the machine through each segment of the cycle. Most modem machines will automatically shut down if the oil level gets too low, or if the oil gets too hot. It is important to check the hydraulic oil system regularly to prevent this from happening.

Oil Filters

When the oil is pumped out of the reservoir, or when it is returning to the reservoir, it usually passes through one or more oil filters to remove any impurities from the oil. It is very important that the oil filters be changed periodically to keep the hydraulic oil as clean as possible. If the hydraulic fluid contains metal fragments or other foreign material, it cannot lubricate properly and might clog sensitive valves, or damage other moving parts of the machine.

Exercise One

Oil Filters

On several machines, locate the oil filters and check to see if they have indicators on them to show if the filters need to be changed. Do any need to be changed?

Machine Number	Filter Location	Has an Indicator?	Needs to be Changed?

Instructor Date

Oil Pumps

The hydraulic oil pumps are responsible for moving the oil around the machine and supplying high pressure oil to the various hydraulic cylinders and motors. Many machines have more than one hydraulic pump. Different pumps are used for different pressure or volume needs.

Valving

Molding machines contain many valves in the hydraulic system. These valves are often buried in a large block of steel called a manifold block. Signals from the control panel change the position of the valves, which in tum divert flow to the various hydraulic cylinders that move the machine components. A complete molding cycle is established when the valves are oper-ated in the proper sequence.

Hydraulic Core Pull System

Hydraulic core pulls are small hydraulic cylinders that are mounted on the top, bottom, or sides of the mold. These cylinders use hydraulic oil pressure from the pumps to slide cores in and out of the mold.

Hydraulic Ejection System

Many molding machines use a hydraulic ejection system for ejecting the parts from the mold. These systems use a hydraulic cylinder and oil pressure from the pumps to move the ejector plate and ejector pins.

Exercise Two

Hydraulic Parts

On several machines, identify for your instructor the following hydraulic system parts.

Machine Number	Oil Pump	Valve Manifold

Instructor Date

Objective Two

Clamp Movements

The movements of the clamp are broken down into small, special-ized steps to minimize the time it takes to open and close the mold, while providing for the proper pressure and safety needs. The following description and figures show the principles of a typical clamp movement cycle. First, the clamp is set to close at high speed and low pressure (Figure 2).

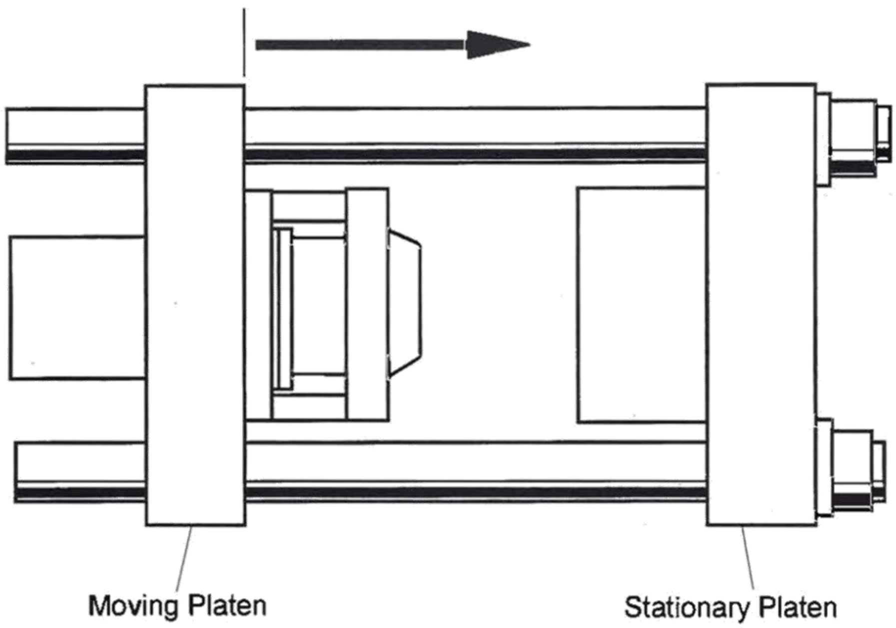

Figure 2 - Clamp Closing from Open Position

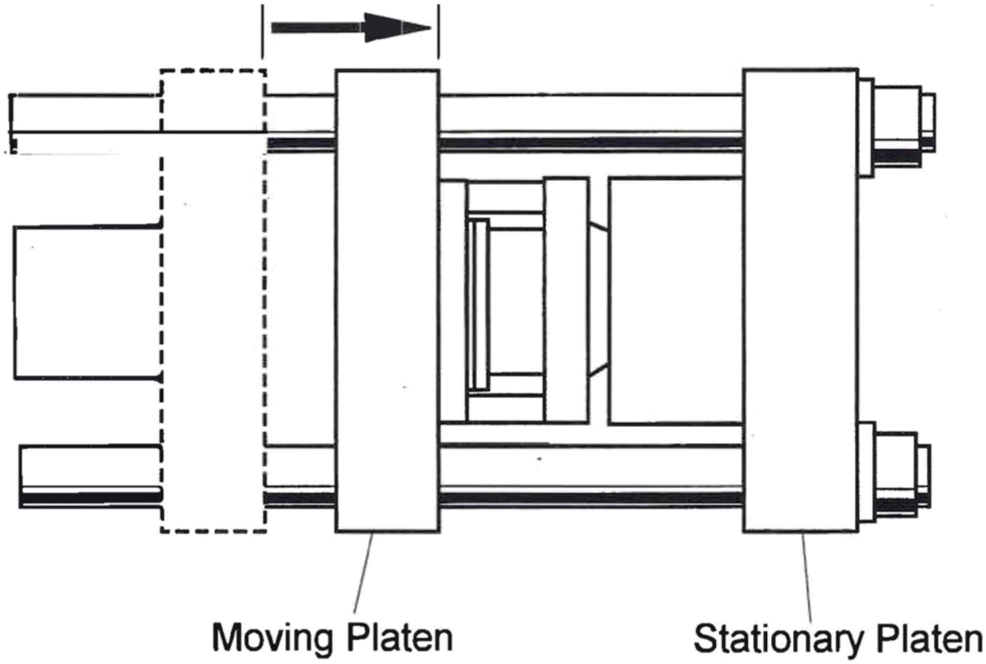

Figure 3 - Fast Close Stroke

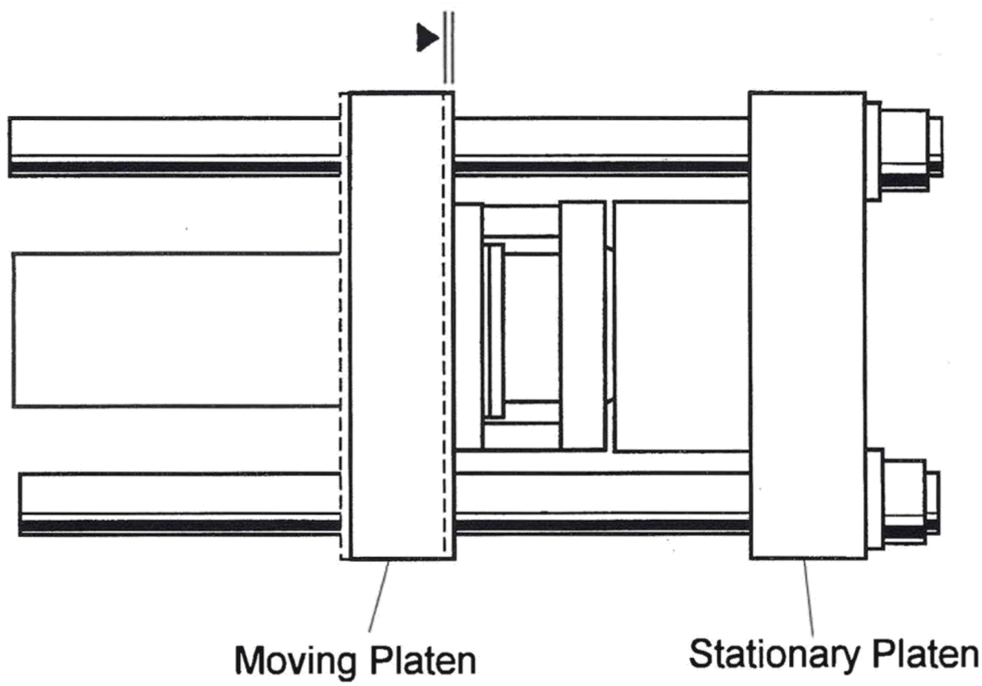

Figure 3 - Slow Mold Close

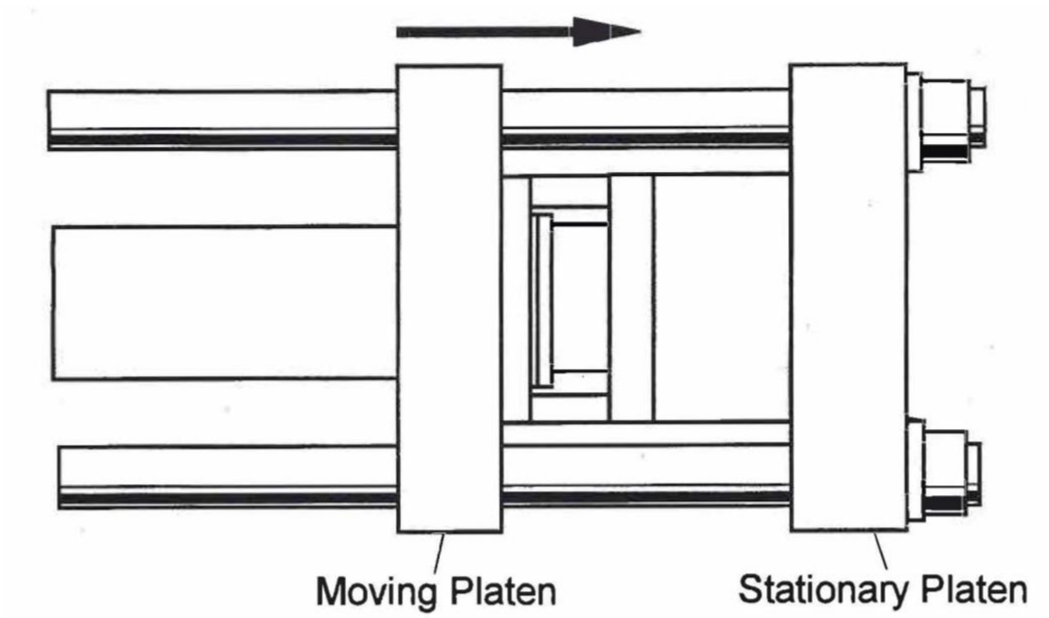

Figure 5 - High Pressure Lock

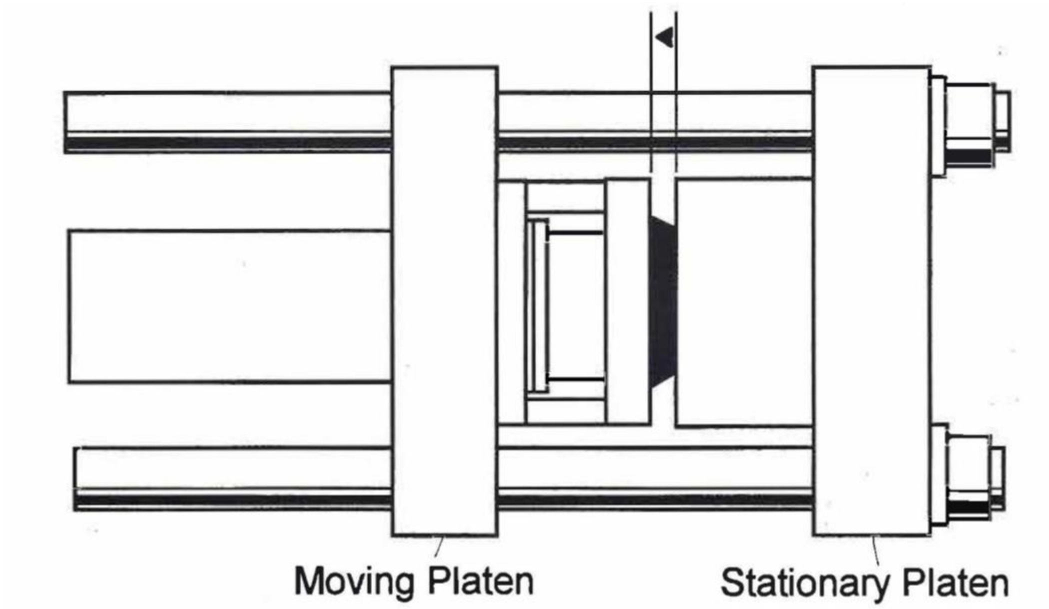

Figure 6 - Slow Mold Breakaway

A fraction of an inch before the mold faces touch (Figure 4), the high pressure engages to lock up the mold (Figure 5). After the part has been shot and cooled, the mold opening sequence begins. It is normally started with a slow mold breakaway (Figure 6).

This slow movement is used to prevent possible part damage as the part separates itself from the cavity side of the mold. Once the part is released from the stationary part of the mold, the mold open speed is increased until the mold is almost completely open. This is followed by another mold slow down just before the full opening stroke is reached (Figure 7). This slowdown stage minimizes shock to the clamp system. The final opening stroke is set just great enough to be able to get the part out, thereby minimizing the overall clamp stroke. When the mold is open, the part is ready to be ejected.

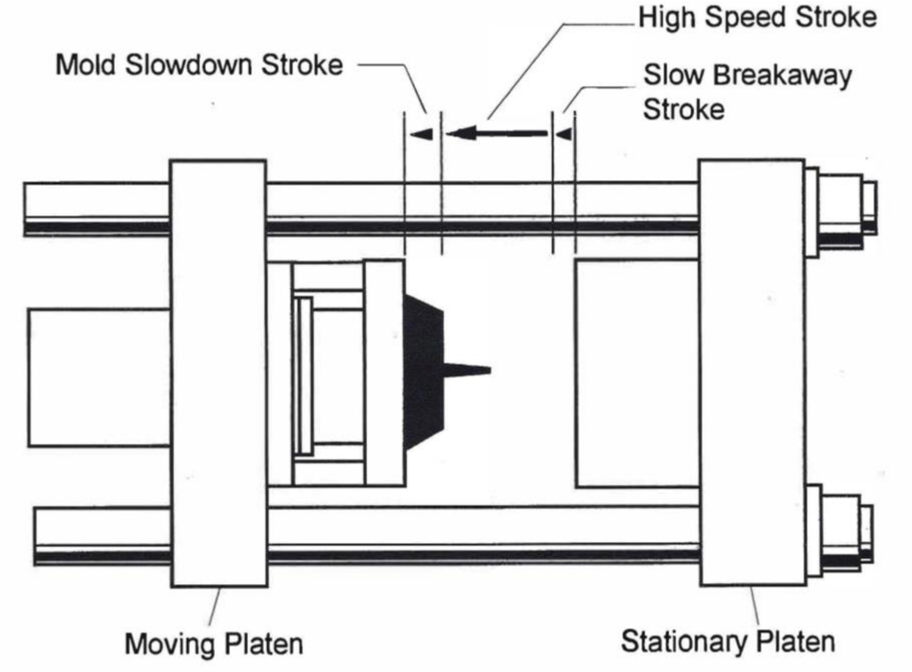

Figure 7 - Fast Mold Open

Exercise Three

Clamp Times

On three different machines in the shop, use a stop watch to time the opening and closing of the mold, to the nearest tenth of a second.

Machine Number	Part	Opening Time	Closing Time

Which portions of any of the above clamp cycle times look like they could possibly be reduced?

Instructor Date

Objective Three

Clamp End Machine Ratings

Clamp Tonnage

The most common way to specify the size of a molding machine, and specifically its clamp size, is by its clamp tonnage. Molding machines are available in sizes from under 25 tons to over 5,000 tons. The majority of machines fall in the range of 100 to 750 tons.

Large clamp tonnages are necessary because most plastics re-quire at least three tons of clamp force per square inch to keep from flashing. Flashing is where the plastic is forced out of the mold between the mold halves (parting line).

The clamp tonnage calculation for a 10 inch square sample plaque would be: 10 inches x 10 inches = 100 square inches x 3 tons per square inch = 300 tons of required clamp force.

Tie Bar Spacing

The other clamp end specifications generally deal with machine mold handling capability. The first two, as shown in Figure 8, are the tie bar spacing and platen sizing. Most molds are hung from above when mounted into the machine. In this case, the width of the mold cannot exceed the horizontal tie bar spacing. The height of the mold can be as great as the vertical platen height.

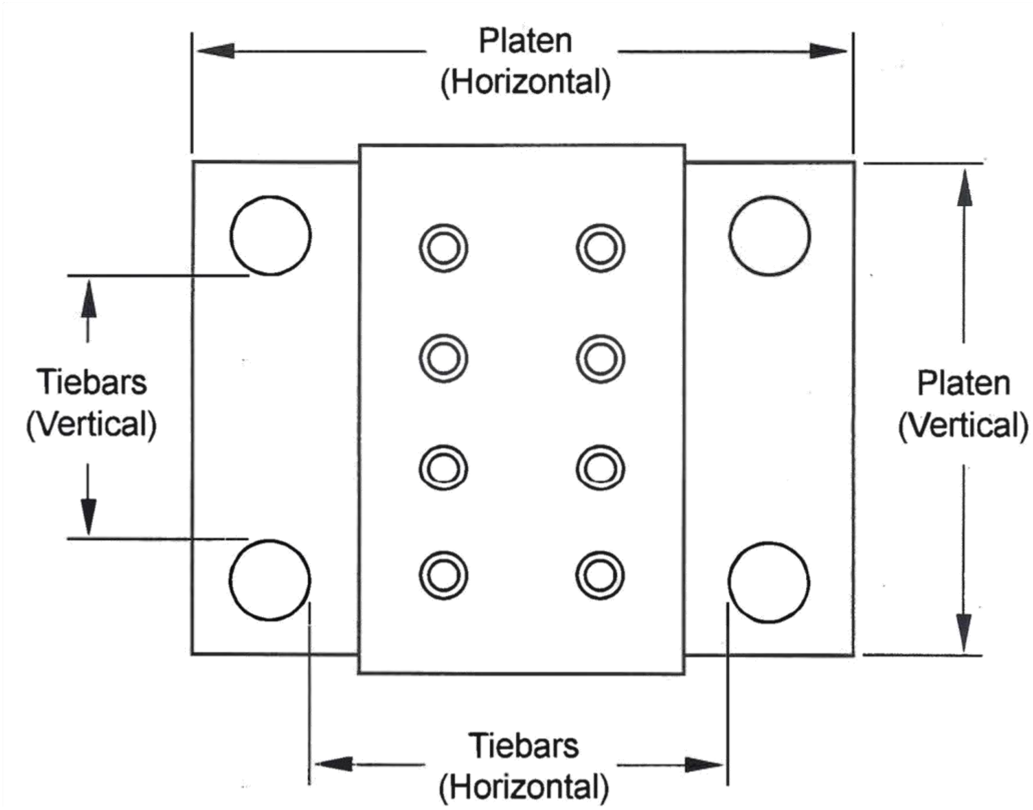

Figure 8 - Tie Bar Spacing

Exercise Four

Clamp Tonnage

while you are in the shop, identify the clamp tonnage of as many machines as you can. Rate them from the largest to the smallest in the following chart.

Clamp Tonnage	# Machines of this Tonnage	Manufacturers Name

Instructor Date

Maximum Clamp Stroke

The maximum clamp stroke is the total stroke distance that the moveable platen is capable of moving (Figure 9).

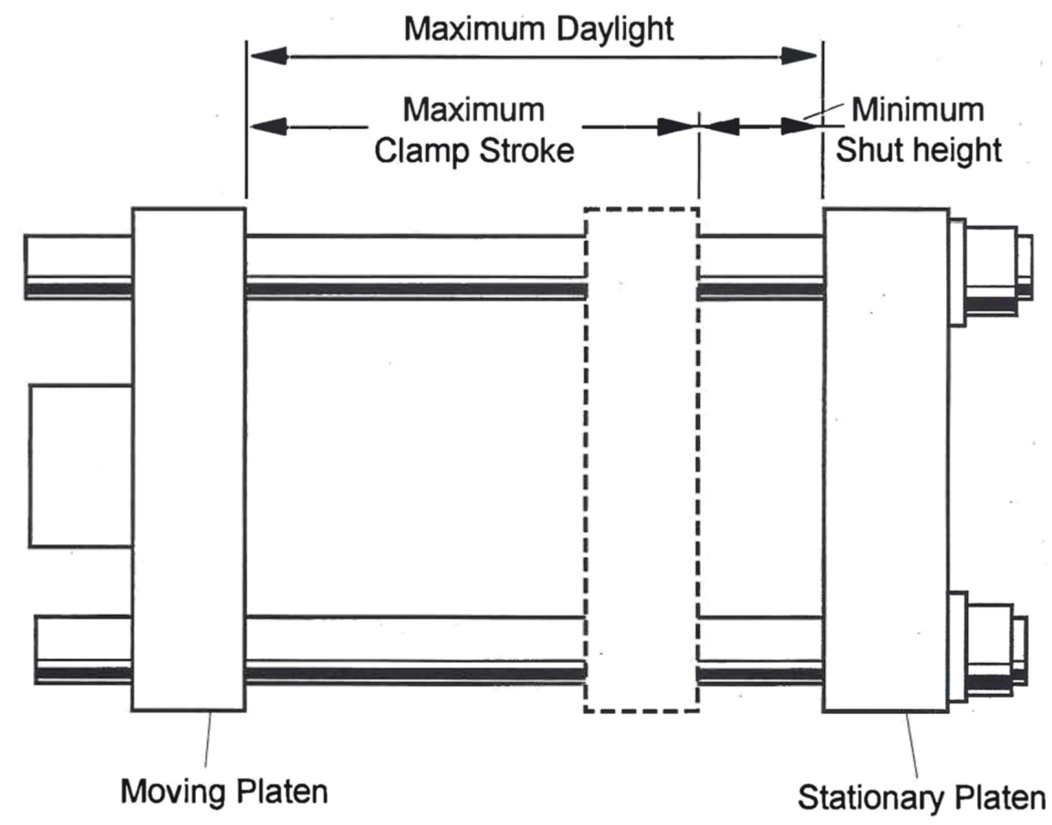

Figure 4 - Maximum Clamp Stroke

Minimum Shut Height

The minimum shut height is the closest distance that the moveable platen can get to the stationary platen when the moveable platen mechanism is fully extended (Figure 9). It defines the minimum mold thickness that the machine can hold. If the mold is too thin to be clamped in the machine, spacer plates will need to be added behind the mold halves.

Open Daylight

The open daylight or maximum daylight is the maximum distance between the platens when the moveable platen is fully retracted. It is equivalent to the maximum clamp stroke added to the minimum shut height.

Maximum Shut Height

The maximum shut height is the largest mold thickness (height) that will still allow the machine to close and lock the mold halves.

On toggle clamp machines, the linkages must be fully extended to lock up the mold. If the tails tock is fully retracted and the toggle is locked up, then the distance left between the two mold platens is the maximum mold height available (Figure I 0).

In comparison, hydraulic clamp machines are adjustable out to their maximum open daylight. The maximum mold height can only be determined on an individual basis by adding the mold thickness to the required mold opening stroke.

Ejection Specifications

The hydraulic ejection system also has a maximum capable stroke distance and a maximum ejector force rating. Mechanical ejec-tion capabilities are based on the mold opening force available from the machine.

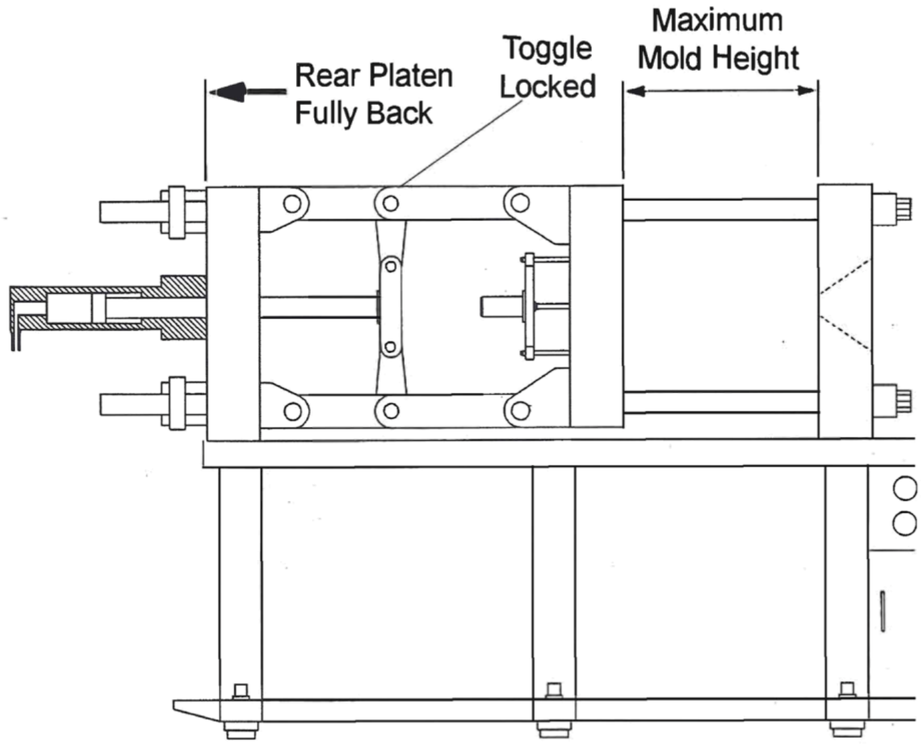

Figure 10 - Maximum Mold Height

Example

Clamp End Specifications for a typical 400 ton hydraulic clamp machine:

Clamp Force	400 tons
Clamp Opening Force	50 tons
Tie Rod Diameter	5 inches
Maximum Daylight	34 inches
Maximum Clamp	22 inches
Minimum Mold Thickness	12 inches
Maximum Mold Thickness	N.A. (34 inches)
Ejector Stroke	7 inches
Ejector Force	8 tons

Self-Test

1. Which one of the following hydraulic components should be checked periodically?
   a. The hydraulic valves
   b. The oil pump
   c. The oil filters
2. The manifold block holds these hydraulic components:
   a. Oil filters
   b. Oil pumps
   c. Limit switches
   d. Valves
3. Hydraulic core pulls are mounted to the:
   a. Mold
   b. Stationary platen
   c. Ejector plate
   d. Machine base
4. When an injection mold is first opened it is best to open it:
   a. Fast
   b. Slow

5. A properly set clamp will kick into high pressure mode:
   a. When the mold starts to close
   b. When the mold starts to slow down
   c. A fraction of an inch before the mold faces touch
6. The most common way to specify the size of the clamp end of a machine is by its:
   a. Tonnage
   b. Maximum clamp stroke
   c. Maximum shut height
7. Will a mold that is 20:x26" fit into a machine with 24" x 24" tie bar spacing?
   a. Yes
   b. No
8. If there is no mold in the machine, can the two platens be brought into contact with each other?
   a. Yes
   b. No
9. The thickest mold a machine can handle is determined by the:
   a. Maximum shut height
   b. Tie bar spacing
   c. Platen size

Glossary

Closure Cylinder - hydraulic cylinder responsible for moving linkages and opening and closing the machine.

Daylight - the distance between opened mold halves or platens.

Hydraulic Core Pull - the hydraulic system used to slide cores in and out of the mold.

Linkages - the mechanical component arms that make up a toggle clamp.

Manifold Block - steel block on the machine that houses the hydraulic valves.

Platen - large, steel vertical plates on the clamp end of the machine.

Tail Stock - another name for the rear stationary platen.

Tie Bars - large, steel bars used on the clamp end of machine to connect and support the platens.

Shut Height - the amount of space available between the platens in which to clamp the mold.

Hydraulic Valve - a valve used to divert hydraulic fluid to various hydraulic cylinders or motors to control their motion.