10 Forging

Forging: make or shape a metal object by heating it in a fire or furnace and hammering

Forging is carried out in many different ways. One way to classify the operations is by working temperature. Most forging operations are performed hot or warm, owing to the significant deformation demanded by the process and the need to reduce strength and increase ductility of the work metal.

The advantage of cold forging is the increased strength that results from strain hardening of the component.

Forging hammer: a forging machine that applies an impact load.

Forging press: a forging machine that applies gradual pressure.

Another difference among forging operations is the degree to which the flow of the work metal is constrained by the dies.

By this classification, there are three types of forging operations:

1. Open-die forging: In open-die forging, the work is compressed between two flat (or almost flat) dies, thus allowing the metal to flow without constraint in a lateral direction relative to the die surfaces, as shown in figure 10.1.

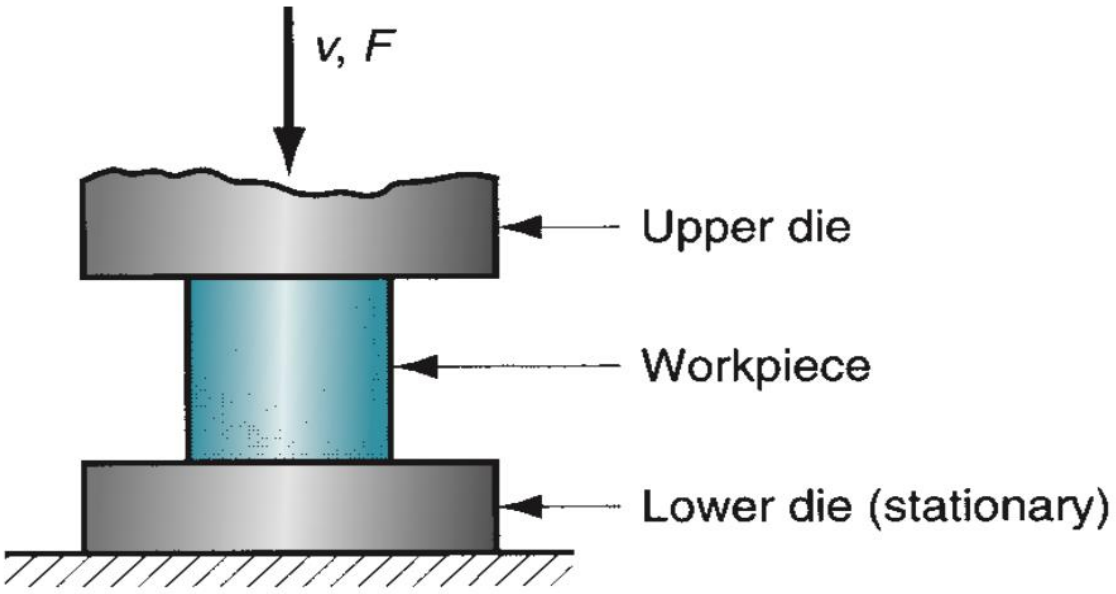
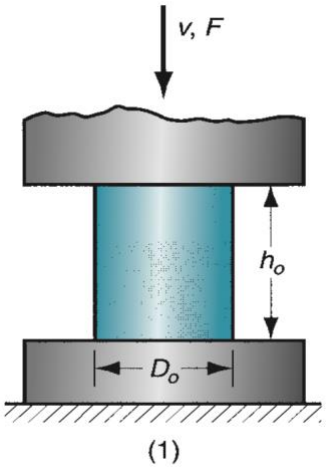


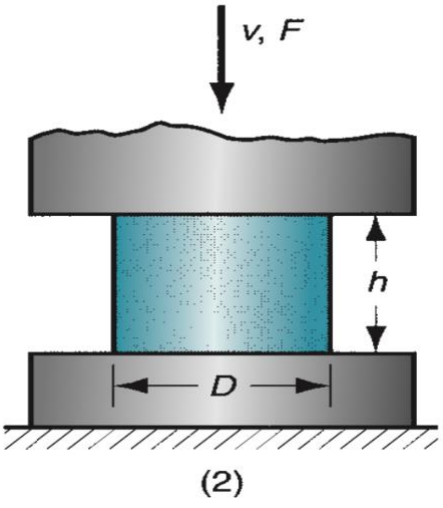
Figure 10.1 Open-die forging.

The simplest case of open-die forging involves compression of a workpart of cylindrical cross section between two flat dies, much in the manner of a compression test. This forging operation, known as *upsetting* or upset forging, reduces the height of the work and increases its diameter.

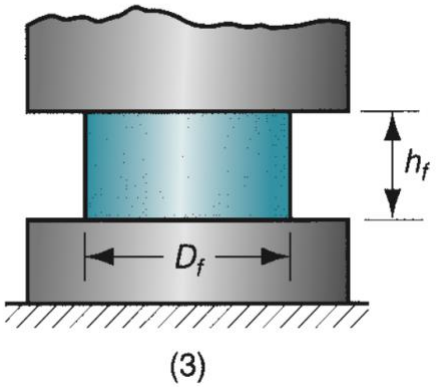
If open-die forging is carried out under ideal conditions of no friction between work and die surfaces, then homogeneous deformation occurs, and the radial flow of the material is uniform throughout its height, as shown in Figure 10.2.



(1) start of process with workpiece at its original length and diameter.



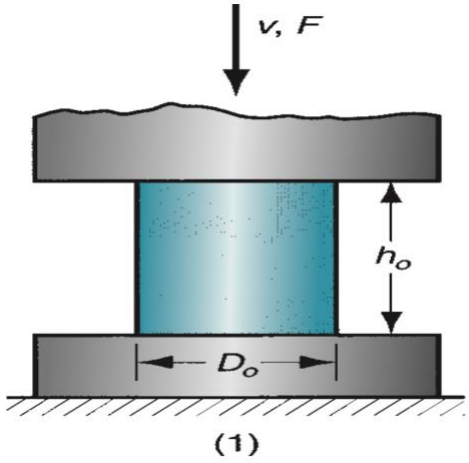
(2) partial compression.



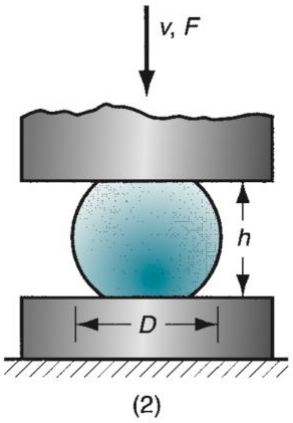
(3) final size.

Figure 10.2 Homogeneous deformation of a cylindrical workpart under ideal conditions in an open-die forging operation.

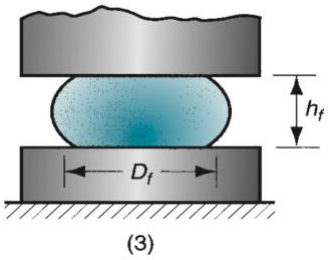
An actual upsetting operation does not occur quite as shown in Figure 10.2 because friction opposes the flow of work metal at the die surfaces. This creates the barreling effect shown in Figure 10.3.



(1) start of process.



(2) partial deformation.



(3) final shape.

Figure 10.3 Actual deformation of a cylindrical workpart in open-die forging, showing barreling.

2. Impression-die forging: In impression-die forging, the die surfaces contain a shape or impression that is imparted to the work during compression, thus constraining metal flow to a significant degree. In this type of operation, a portion of the work metal flows beyond the die impression to form flash, as shown in the Figure 10.4. Flash is excess metal that must be trimmed off later.

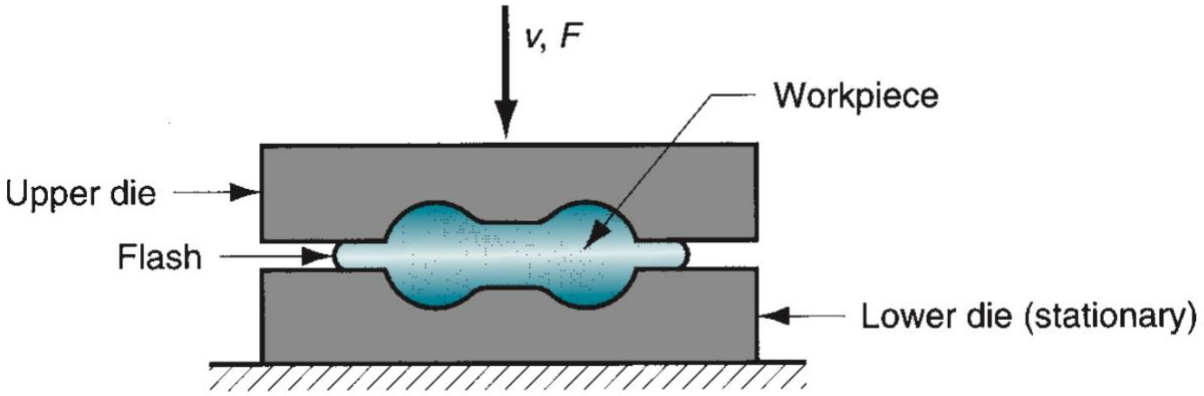
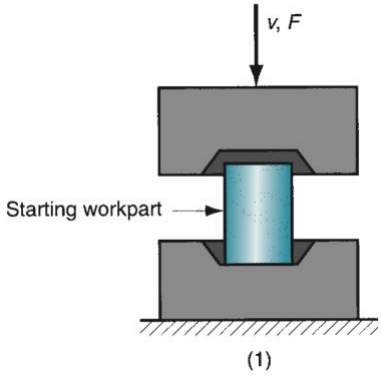
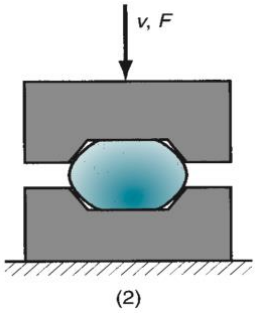


Figure 10.4 Impression-die forging.

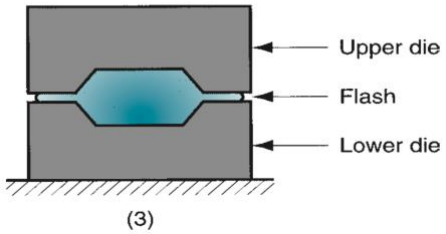
Impression-die forging, sometimes called closed-die forging, is performed with dies that contain the inverse of the desired shape of the part. The process is illustrated in a three-step sequence in Figure 10.5.



(1) just prior to initial contact with raw workpiece.



(2) partial compression.



(3) final die closure, causing flash to form in gap between die plates.

Figure 10.5: Sequence in impression-die forging.

3. Flashless forging: In flashless forging, the work is completely constrained within the die and no excess flash is produced. The volume of the starting workpiece must be controlled very closely so that it matches the volume of the die cavity, as shown in Figure 10.6.

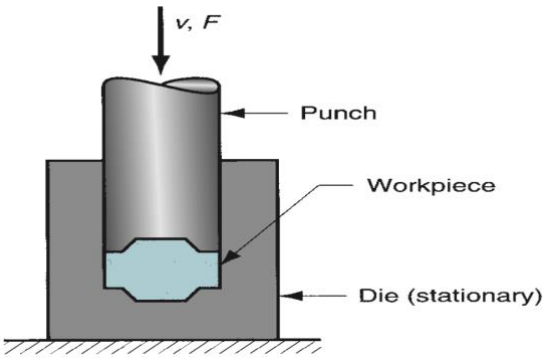
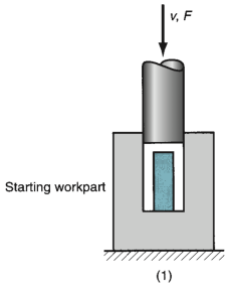
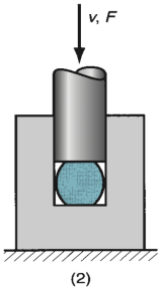


Figure 10.6 Flashless forging.

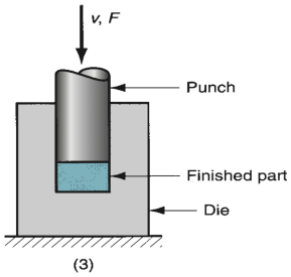
The distinction is that in closed-die forging, the raw workpiece is completely contained within the die cavity during compression, and no flash is formed. The process sequence is illustrated in Figure 10.7. The term flashless forging is appropriate to identify this process.



(1) just before initial contact with workpiece.



(2) partial compression.



(3) final punch and die closure.

Figure 10.7 Flashless forging: Symbols v and F indicate motion, velocity and applied force, respectively.