**The lesson 4**

# Forging Process

## Introduction:

Forging is one of the oldest forms of metalworking. It produces parts and components that are stronger than those that are machined or cast. As metal is shaped during the forging process, its internal grain structure deforms to follow the general shape of the part or component.

## 1. Origins of Forging

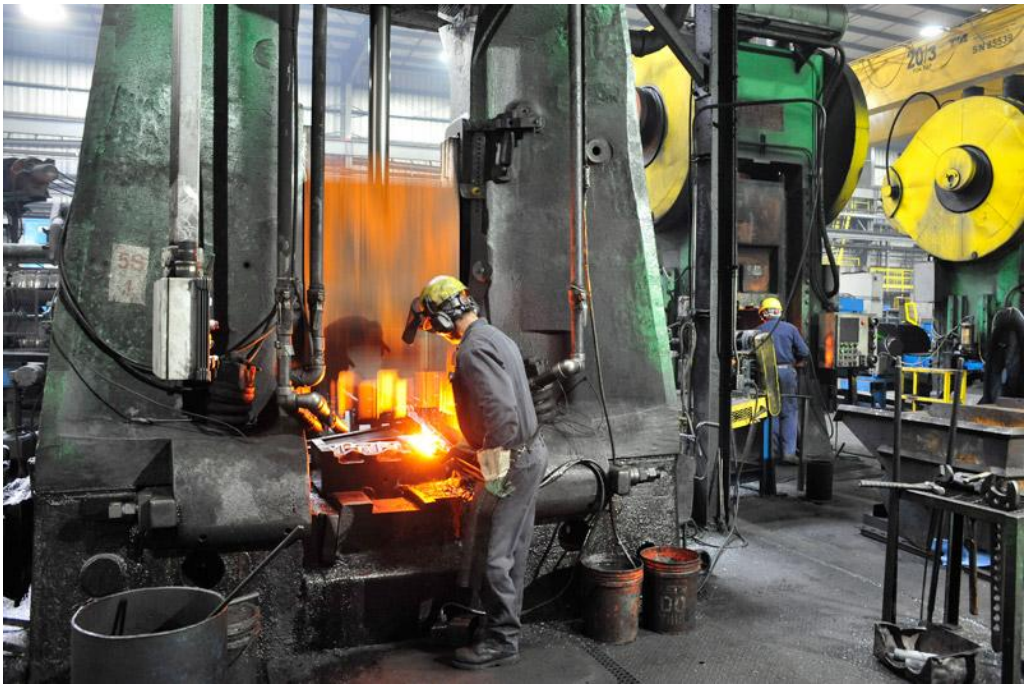
It is speculated that the process of forging dates back as far as the Egyptians, Romans, and Greeks. They used the process of forging to create their tools and weapons using the metals they had to hand. These metals included copper, bronze, and iron more often than not. As brighter and more colourful metals, these may also have been used to create architectural or decorative objects for the home.

As copper and bronze are softer metals, they lacked the strength and durability that is now often seen in forged products. Although this is now known as the mechanical process that takes place during forging, in the early days of forging, they had to develop techniques like tempering and quenching in order to help improve the strength overall.

### 1.1. The Development of Forging in 20th Century

The second half of the 20th century saw improved productivity due to the growth of solid-state electrical induction heaters. The induction heating technique empowered greater throughput and enhanced dimensional control of the forged components.

The industrial revolution and the World War II also had a great impact on the forging industry and its techniques. It paved way for enhanced forging press equipment, forging processes, and forging machine.



Modern Forging Process

## 2. Why use forgings and where are they used?

In forging metal may be:

1. Drawn out to increase its length and decrease it cross-section.

2. Upset to decrease the length and increase the cross-section.

3. Squeezed in closed impression dies to produce the desired shape by compelling the metal flow in to multi-directions.

### 2.1. Applications of Forging

The following common types of jobs are produced by forging:

*I.* **Box-end wrenches**, always made from forgings, are subjected to very high stresses due to hammering; excellent for providing highest torque to tighten the bolts.
*II.* Riveting of shells for boilers, tanks and furnaces.
*III.* Machinery parts and steel furniture

*IV.* Bolts, headed pins, keys, eye bolts, hooks, shackles, hinges, aldrops, hangers and racks, hooks, and other lifting tackles for cranes and hoists.

*V.* Arms, weapons and cutting tools

*VI.* Helical and laminated springs

*VII.* Beams for aircraft wings, turbine disks, gears, wheels.

Figure  shows typical products made from forging operations

## 2.2. Advantages of forging

1. Physical properties (such as strength, ductility and toughness) are much better in a forging than in the base metal, which has, crystals randomly oriented.
2. Forging produces beneficial grain-flow pattern in the direction of the shape of the forged component, resulting in tough fibrous structure conforming to the outline of the part.
3. Forging yields parts that have high strength to weight ratio, they can be used reliably for highly stressed and critical applications.

4. Forging produces products with higher structural integrity, which are consistent from piece to piece, without any porosity, voids, inclusions and other defects as in case of casting.
5. Reduced testing requirements.

### 2.3. Disadvantages of forging

1. Hot metal oxidizes rapidly and the scale thus formed gives poor surface finish,
2. Close dimensional tolerances on forgings may not be maintained.
3. Metal has to be worked within a particular range of temperature:

### 2.4. Metals and their forging temperatures

The degree to which a metal can be forged depends on its composition and structure. The low and medium carbon steels are readily forged but high carbon and alloy steels are more difficult to forge.

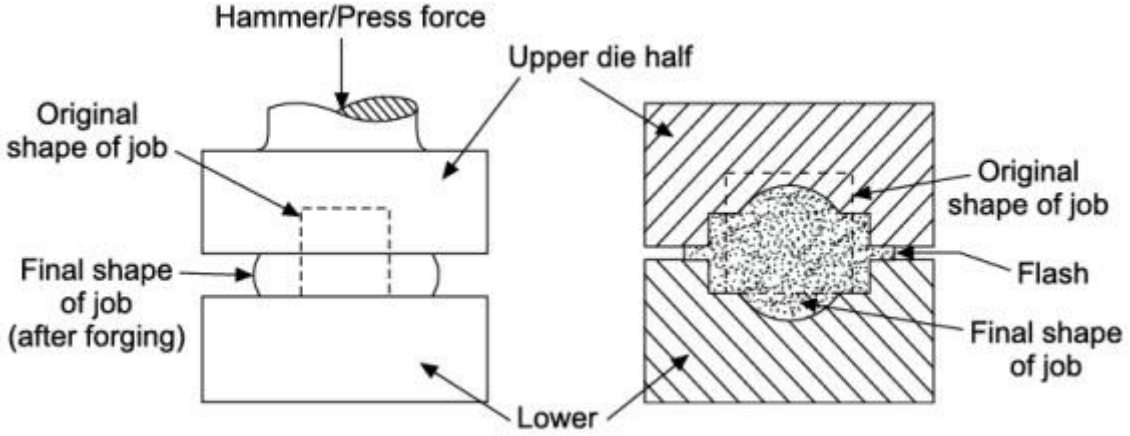
**Table 1**: Forging temperatures of ferrous and non-ferrous metals

| Material to be forged | Temperature range($^{o}$C) |
|---|---|
| Mild steel | 815-1250 |
| Medium carbon steel | 760-1250 |
| High carbon steel | 760-1130 |
| Stainless steel | 940-1180 |
| Copper alloys | 550-900 |
| Aluminum and forging alloys | 370-480 |
| Magnesium alloys | 315 |
| Wrought iron | 860-1340 |

## 3. Classification of Forging

Forging can be classified into two categories

1. Open die forging, and
2. Closed die forging




(a): Open die forging (b): Closed die forging

## Glossary

Forging: Le forgeage
Casting: Le moulage
Drawn: étiré
Increase its length: augmenter sa longueur
Decrease it cross-section: diminuer sa section transversale
Upset:
Squeezed in closed:Serré dans le fermé
Box-end wrenches : Clés à fourche
Hammering : martelage
Torque to tighten: couple de serrage
Bolts : boulons
Furniture : Meubles
Bolts, headed pins, keys, eye bolts, hooks, shackles, hinges, aldrops, hangers and racks, hooks, and other lifting tackles for cranes and hoists: Boulons, goupilles à tête, clés, anneaux de levage, crochets, manilles, charnières, ancres, cintres et crémaillères, crochets, et autres dispositifs de levage pour grues et palans.
Implements : Instruments
Gears, Wheels : engrenages, roues
Crack : fissure
Distorted : déformé
Burn : brûler
Scale: le tartre
Mild steel: Acier doux
Medium carbon steel: Acier à teneur moyenne en carbone
Stainless steel : Acier inoxydable
Wrought iron : Fer forge
Open die forging: Forgeage à matrice ouverte
Closed die forging: Forgeage à matrice fermée