Forging

Process Description

Forging is the manufacturing process where metal is pressed, pounded or squeezed under great pressure into high strength parts. The result is a metal part that has refined grain structure and improved physical properties. Physical properties (such as strength, ductility and toughness) are much better in a forging than in the base metal. Forgings yield parts that have high strength to weight ratio which lets you use thinner sections without sacrificing safety factors.

Forgings are consistent from piece to piece, without any of the porosity, voids, inclusions and other defects that are common with other metal forming processes like casting. Thus, finishing operations such as machining do not expose voids, because there aren't any.

Here are some of the advantages to forging:

- Higher Strength – through grain refinement and preferential grain flow
- Lighter Weight – higher strength / weight ratio lets you use thinner sections
- Improved Mechanical Properties – impact resistance, fatigue resistance, and last longer
- Structural Uniformity – avoids gas pockets and hidden inclusions that can show up later
- Repeatable Dimensions – dimensional uniformity with machining are simplified
- Less Material Waste – Many surfaces can be used as-forged, with little machining
- Wide Choice of Materials – Almost any metal can be forged
- Product Saleability – Forged parts are synonymous with reliability

There are some cost related factors to consider:

- Cost of Dies – short runs of small parts can make die too expensive per piece
- Finish Machining Required – many complex machined areas increases costs
- High Complexity, Low Strength – if voids and inclusions don't matter, consider casting

The Total Cost of a Forged Part Consists of:

1. Metal
2. Forging Dies
3. Forging Operations
4. Heat Treating (if necessary)
5. Finish Machining
6. Testing (if required)

Economies in any one of these stages can bring the total cost of forging below alternate methods.

Selecting the Alloy:

If there were any general rule on when to consider forging from casting, powdered metal, or raw stock, it might be to use them when you need to intensify one or more of the properties of ordinary processed metal, for example grain structure and it's advantages. Material selection is usually one of the first steps in designing your part. It may come before the design itself. But if it doesn't, you should at least choose it before your design is finalized because the material you choose may influence the design details.

Forgeability:

The temperature range over which the alloy can be worked is the main factor that determines its forgeability. Alloys with a narrow range are more difficult to forge, because they stay workable for only a short time as they cool from the upper to the lower limit of their range. The general effects of forgeability on the design and producibility of part are:

Easy-to-forge metals

1. More intricate shapes and large sizes
2. More finished details; less machining needed

3. Closer tolerances
4. Better surface finishes
5. Thinner webs and ribs
6. Smaller fillet and corner radii
7. Fewer forging steps; less preliminary blocking
8. Longer forging-die life

Hard-to-forge metals

1. Simpler and smaller parts
2. Fewer finished details; more machining needed
3. Increased tolerances
4. Coarser surface finishes
5. Thicker webs and ribs
6. Larger fillet and corner radii
7. More forging steps; more preliminary blocking
8. Shorter forging-die life

If several alloys provide the properties you need, choose the one with greater forgeability. You'll get and easier and more economical forging job.

Non-Ferrous Forging Alloys

Aluminum

- ✓ 2014-T6
- ✓ 2024-T6
- ✓ 6061-T6
- ✓ 6151-T6
- ✓ 7075-T6

Brass and Bronze

- ✓ 377 Forging Brass
- ✓ 365 Forging Brass
- ✓ *** Low Leaded Brass (<1%)
- ✓ 642 Aluminum-Silicone Brass
- ✓ 464 Naval Brass
- ✓ 485 Leaded Naval Brass
- ✓ 675 Manganese Bronze Type A
- ✓ 674 High Manganese Bronze
- ✓ 673 Leaded High Manganese Bronze
- ✓ 670 Manganese Bronze Type B
- ✓ 385 Architectural Bronze

Copper

- ✓ 101 Oxygen Free Electronic
- ✓ 102 Oxygen Free
- ✓ 110 Electrolytic Tough Pitch
- ✓ 145 Phosphorus Deoxidized
- ✓ 150 Zirconium Copper
- ✓ 182 Chromium Copper
- ✓ 220 Commercial Bronze

Ferrous Forging Alloys

Alloy and Carbon Steel

- ✓ 1004 thru 1080
- ✓ SA105
- ✓ SA350
- ✓ A707
- ✓ 4130
- ✓ 4140
- ✓ 8620
- ✓ 8630

Stainless Steel

- ✓ 17-4
- ✓ 304
- ✓ 310
- ✓ 316
- ✓ 317
- ✓ 321
- ✓ 347
- ✓ 410
- ✓ 416
- ✓ 420
- ✓ 440