

6.9 Case Study No. 9 High Performance Gears

Component name:	High Performance Gears
Forging Process:	Hot Closed Impression Die
Size, mm (in.):	76 to 432 mm (3 to 17 in.) diameter, face widths to 203 mm (8 in.)
Alloy:	8620 Steel
Tensile strength, MPa (psi): ¹	635 (92,000)
Yield strength, MPa (psi): ¹	355 (52,000)
Hardness, BHN:L	180
Elongation: ¹ 2	26.3%
Reduction in Area: 1.2	59.7%
Impact Toughness, J (ft-lb): ²	99.7 (73.5)
Secondary Operations:	Cold draw through finish sizing die and grind
Heat treatment:	Normalize before shipment
Alternate process:	Forge the blank, rough and finish hob
Annual Production:	5000 to 7000

¹Standard handbook values

²As normalized

A family of gears, such as the ones shown in Figure 6-9, is being produced to near-net shape by hot forging in closed impression dies. Finish grinding allowances range from as little as 0.1 mm (0.004 in.) up to 2 mm (0.080 in.). The process offers two distinct advantages over the alternative of forging the blank and hobbing the teeth.

1. Near-net shape forging reduces production costs by requiring only a finish grinding operation, which incurs lower costs both for processing and capital investment than hobbing operations.
2. The continuous and uninterrupted grain flow established in forging the teeth virtually eliminates residual stresses in the teeth, resulting in substantially higher gear life.

These advantages required that several critical manufacturing problems be solved, including high scrap rates, lower die life and high costs of grinding. The problems were solved by interaction of the forging engineers with gear designers and quality technicians and grinding wheel suppliers.

The high degree of forging precision is achieved by very close control of process variables in all stages. For example:

- The steel bar stock is turned and polished to improve the surface, and cut to precise lengths to ensure tight control of the volume of steel that is placed into the closed dies.
- Temperature of the forging stock is maintained to within $\pm 14^{\circ}\text{C}$ (25°F) in an induction heating furnace.
- Special press controls were developed in-house to ensure repeatability of press operations.

In addition to reduced cost, the process offers the potential for reducing the metal content of the gears by designing to the higher tooth strength that is developed by the process.

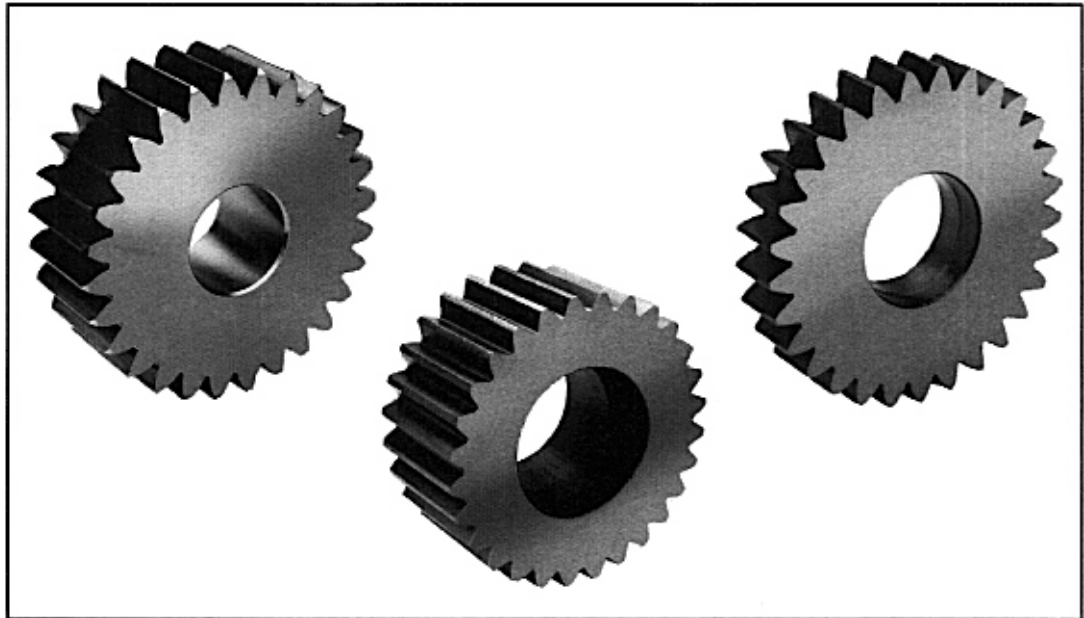


Figure 6-9