EKSTRUSION

TULIS JUDUL DISINI

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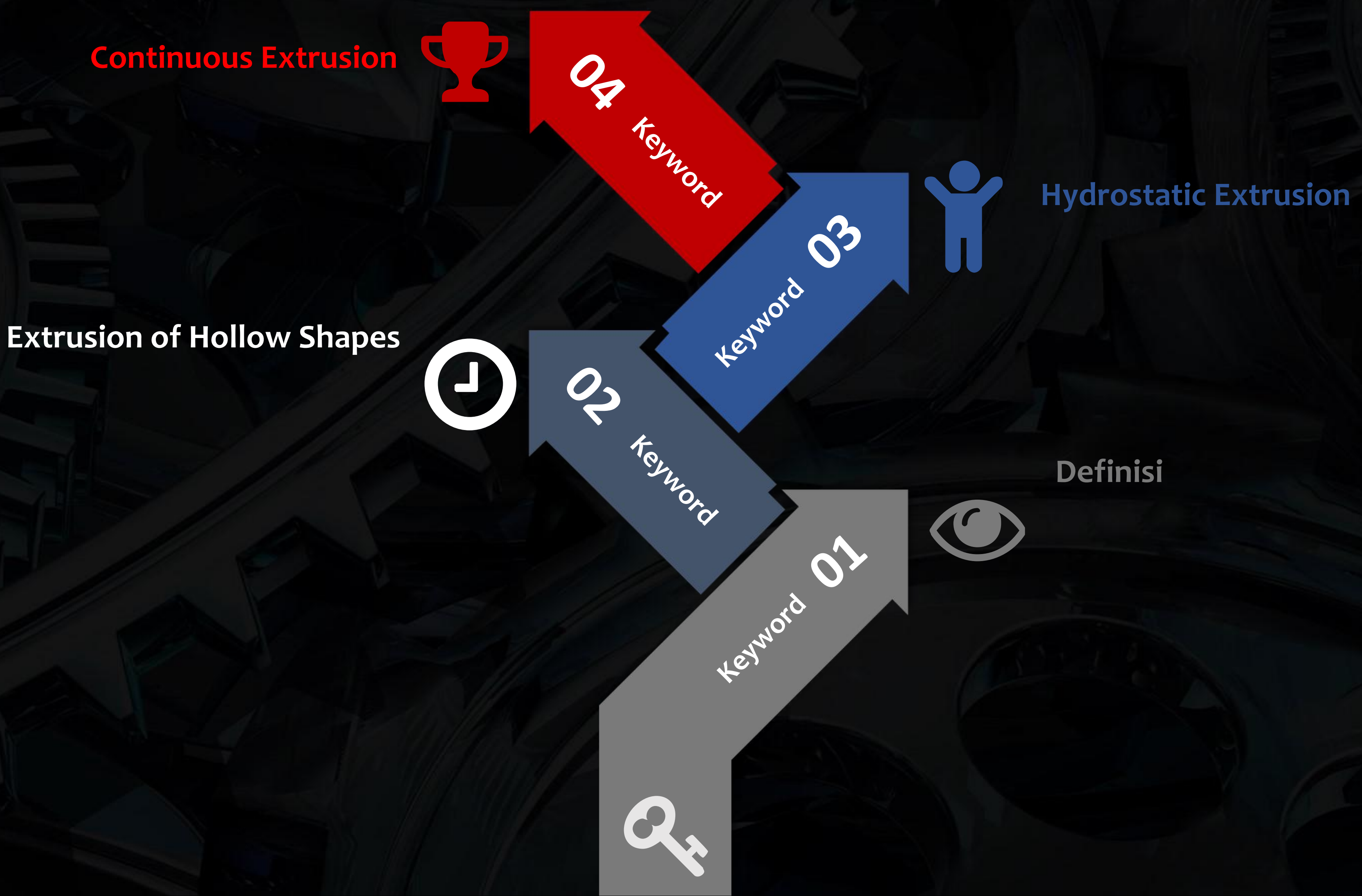
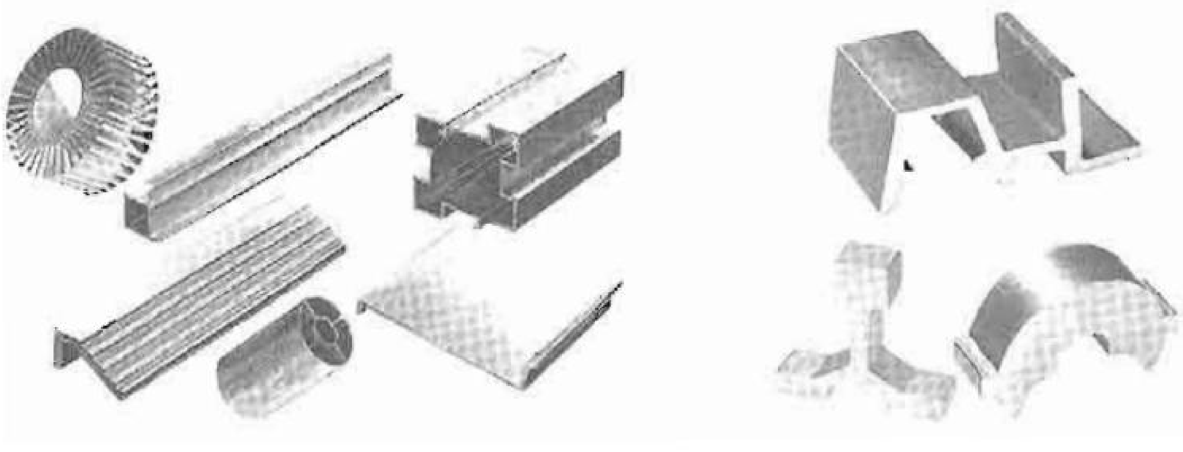


DEFINISI

In the *extrusion* process, metal is compressed and forced to flow through a suitably shaped die to form a product with reduced but constant cross section. Although extrusion may be performed either hot or cold, hot extrusion is commonly employed for many metals to reduce the forces required, eliminate cold-working effects, and reduce directional properties. Basically, the extrusion process is like squeezing toothpaste out of a tube. In the case of metals, a common arrangement is to have a heated billet placed inside a confining chamber. A ram advances from one end, causing the billet to first upset and conform to the confining chamber. As the ram continues to advance, the pressure builds until the material flows plastically through the die and *extrudes*, as depicted in Figure 16-25. The stress state within the material is one of triaxial compression.



IGURE 16-26 Typical shapes oduced by extrusion (Left) uminum products. *(Courtesy of uminum Company of America, ttsburgh, PA.)* (Right) Steel oducts. *(Courtesy of Allegheny dlum Steel Corporation, ttsburgh, PA.)*

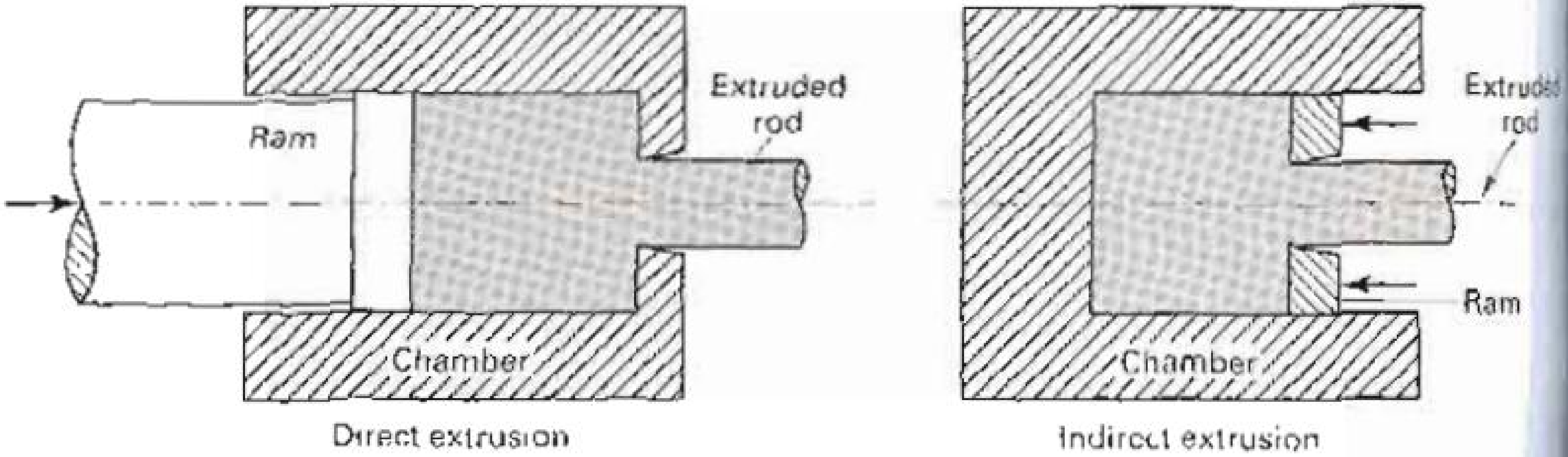


FIGURE 16-27 Direct and indirect extrusion. In direct extrusion, the ram and billet both move and friction between the billet and the chamber opposes forward motion. For indirect extrusion, the billet is stationary. There is no billet–chamber friction, since there is no relative motion.

EXTRUSION OF HOLLOW SHAPES (1)

Hollow shapes, and shapes with multiple longitudinal cavities, can be extruded by several methods. For tubular products, the stationary or moving *mandrel* processes of Figure 16-30 are quite common. The die forms the outer profile, while the mandrel shapes and sizes the interior.

For products with multiple or more complex cavities, a *spider-mandrel* die (also know as a porthole, bridge, or torpedo die) may be required. As illustrated in Figure 16-31, met flows around the arms of a "spider," and a further reduction then forces the material bac together. Since the metal is never exposed to contamination, perfect welds result. Unfor tunately, lubricants cannot be used since they will contaminate the surfaces to be welde The process is therefore limited to materials that can be extruded without lubrication an can also be easily pressure welded.

Since additional tooling is required, hollow extrusions will obviously cost mor than solid ones, but a wide variety of continuous cross-section shapes can be produce that cannot be made economically by any other process.

EXTRUSION OF HOLLOW SHAPES (2)

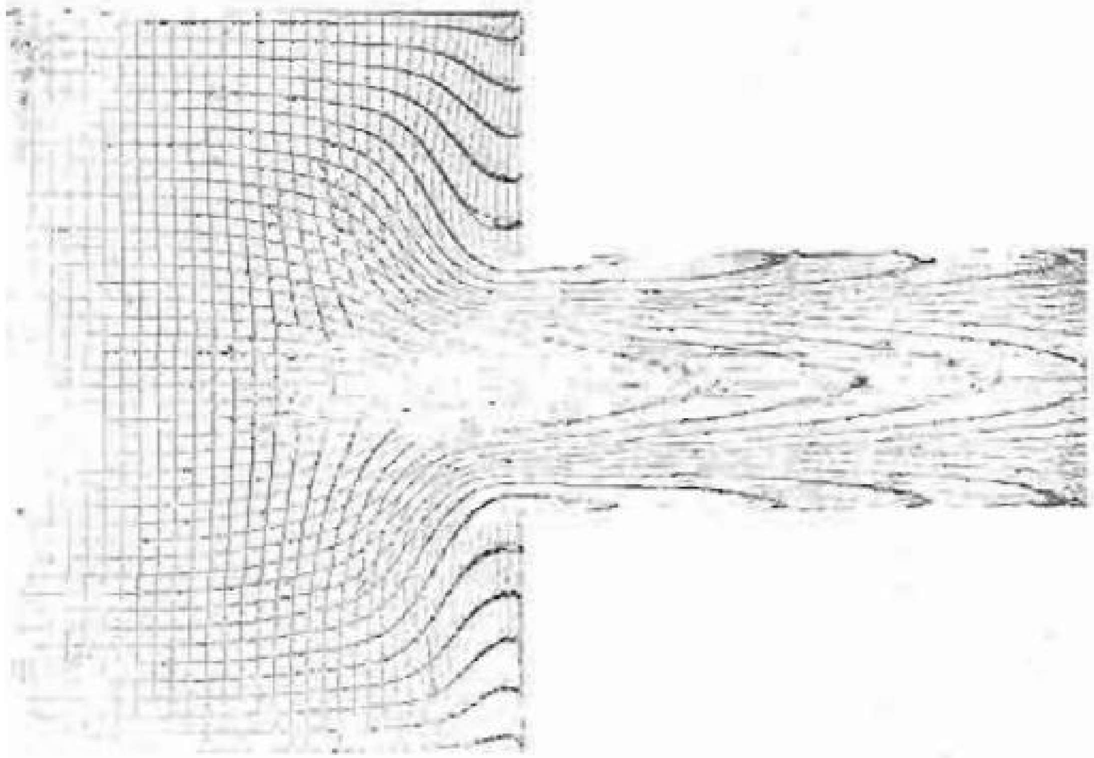


FIGURE 16-29 *Grid pattern showing the metal flow in a direct extrusion. The billet was sectioned and the grid pattern was engraved prior to extrusion*

EXTRUSION OF HOLLOW SHAPES (3)

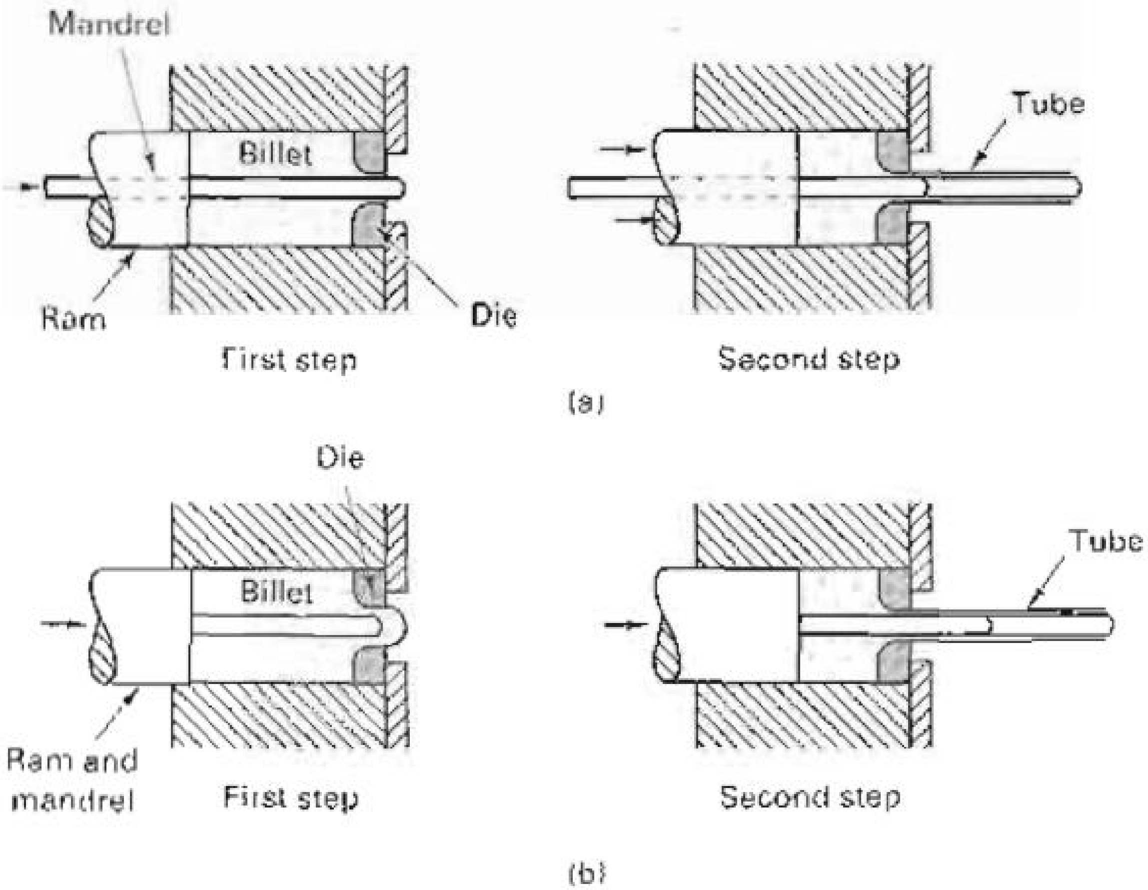


FIGURE 16-30 Two methods of extruding hollow shapes using internal mandrels. In part (a) the mandrel and ram have independent motions; in part (b) they move as a single unit.

Break Time

15 Minutes

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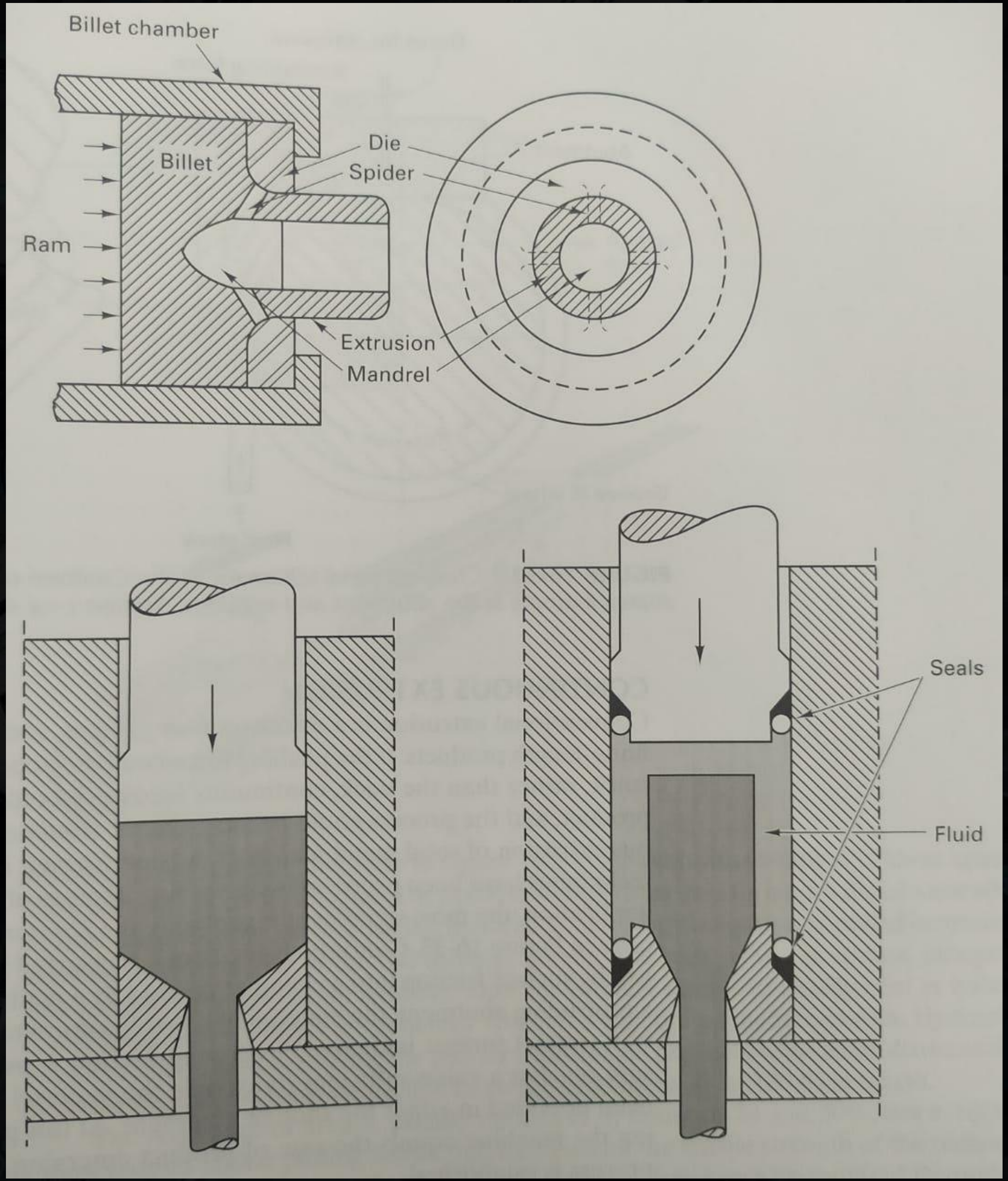
HYDROSTATIC EXTRUSION (1)

Another type of extrusion, known as *hydrostatic extrusion*, is illustrated schematica in Figure 16-32. Here high-pressure fluid surrounds the workpiece and applies the for necessary to extrude it through the die. The product emerges into either atmospher pressure or a lower-pressure fluid-filled chamber. The process resembles direct extrusi but the pressurized fluid surrounding the billet prevents any upsetting. Since the bill does not come into contact with the surrounding chamber, billet–chamber friction eliminated. In addition, the pressurized fluid can also emerge between the billet and th die, acting in the form of a lubricant.

While the efficiency can be significantly greater than most other extrusion processes, there are problems related to the fluid and the associated high pressures (which typically range between 900 and 1700 MPa or 125 to 250 ksi). Temperatures are limited since the fluid acts as a heat sink, and many of the pressurizing fluids (typically light hydrocarbons and oils) burn or decompose at moderately low temperatures. Seals must be designed to contain the pressurized fluid without leaking, and measures must be taken to prevent the complete ejection of the product, often referred to as *blowout*. Because of these features, hydrostatic extrusion is usually employed only where the process offers unique advantages that cannot be duplicated by the more conventional methods.

Pressure-to-pressure extrusion is one of the unique capabilities. In this variant, the product emerges from one pressurized chamber into a second high-pressure chamber. In effect, the metal deformation is performed in a highly compressed environment. Crack formation begins with void formation, void growth, and void coalescence. Since voids are suppressed in a compressed environment, the result is a phenomenon known as *pressure-induced ductility*. Relatively brittle materials such as molybdenum, beryllium, tungsten, and various intermetallic compounds can be plastically deformed without fracture, and materials with limited ductility become highly formable. Products can be made that could not be otherwise produced, and materials can be considered that would otherwise have been rejected because of their limited ductility at room temperature and atmospheric pressure.

HYDROSTATIC EXTRUSION (2)



CONTINUOUS EXTRUSION (1)

Conventional extrusion is a discontinuous process, converting finite-length billets int finite-length products. If the pushing force could be applied to the periphery of the feed stock, rather than the back, continuous feedstock could be converted into continuou product, and the process could become one of *continuous extrusion*. The first contin ous extrusion of solid metal feedstock was performed in 1970. Since then, a number o techniques have been proposed with varying degrees of success. In terms of commerci application, the most significant is probably the *Conform process*, illustrated schemat cally in Figure 16-33. Continuous feedstock is inserted into a grooved wheel and is dr ven by surface friction into a chamber created by a mating die segment. Upon impactin a protruding abutment, the material upsets to conform to the chamber, and the increase wall contact further increases the driving friction. Upsetting continues until the pre sure reaches a value sufficient to extrude the material through a die opening that ha been provided in either the shoe or abutment. At this point, the rate of material ente ing the machine equals the rate of product emerging, and a steady-state continuo process is established.

Since surface friction is the propulsion force, the feedstock can take a variety o forms, including solid rod, metal powder, punchouts from other forming operations, o chips from machining. Metallic and nonmetallic powders can be intimately mixed an co-extruded. Rapidly solidified material can be extruded without exposure to the ele vated temperatures that would harm the properties. Polymeric materials and even fibe reinforced plastics have been successfully extruded. The most common feed, howeve is coiled aluminum or copper rod.

Continuous extrusion complements and competes with wire drawing and sha rolling as a means of producing nonferrous products with small, but uniform, cross se tions. It is particularly attractive for complex profiles and cross sections that contain o or more holes. Since extrusion operations can perform massive reductions throug single die, one Conform operation can produce an amount of deformation equivale to 10 conventional drawing or cold-rolling passes. In addition, sufficient heat can be ge erated by the deformation that the product will emerge in an annealed condition, rea for further processing without intermediate heat treatment.

CONTINUOUS EXTRUSION (2)

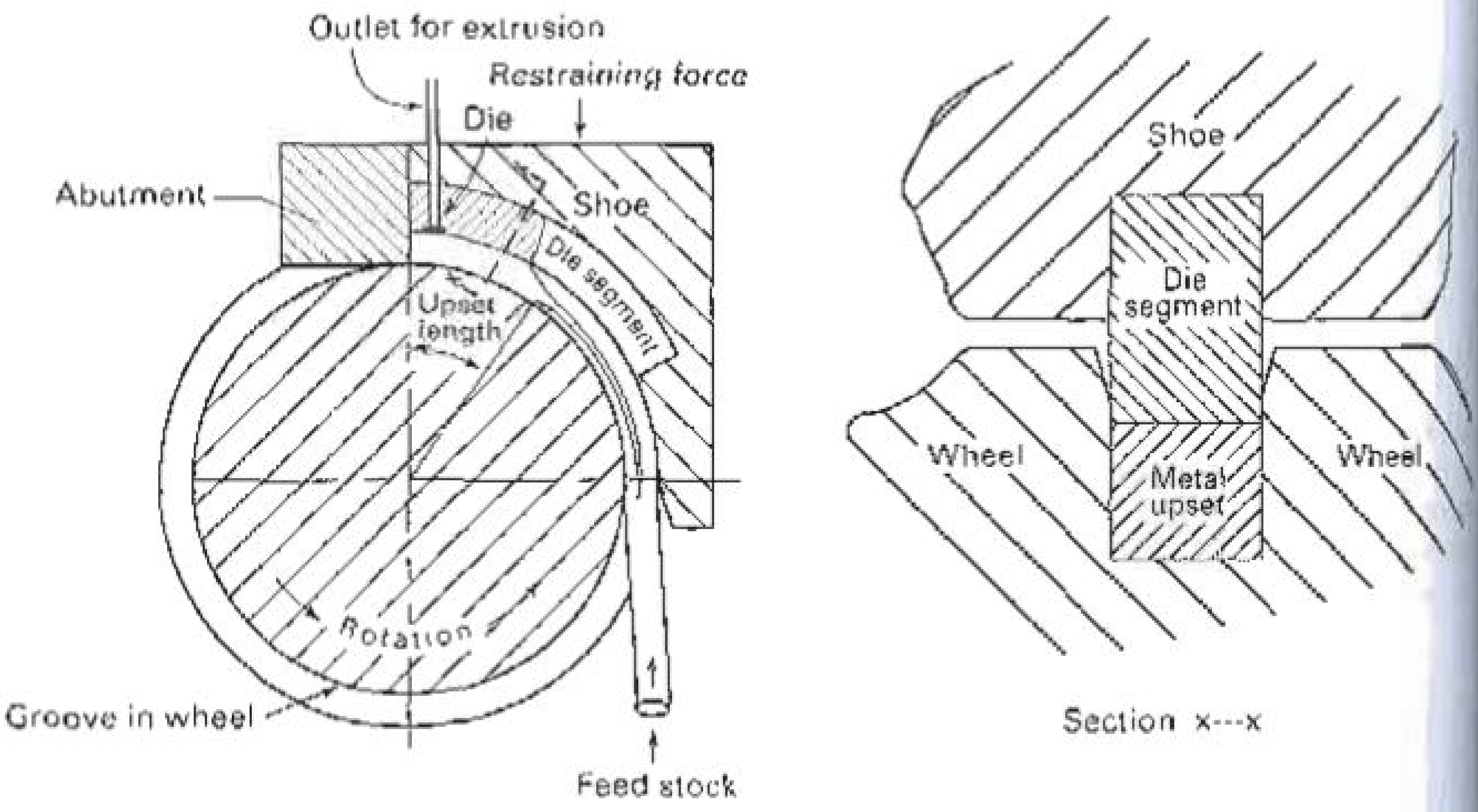


FIGURE 16-33 Cross-sectional schematic of the Conform continuous extrusion process. The material upsets at the abutment and extrudes. Section x–x shows the material in the shoe.

TERIMA KASIH

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