Cold Forging Technology Offers Key Advantages

Faster Processing for High-volume Productivity
Lower Material Costs by Eliminating Waste
Superior Strength and Integrity of Formed Parts
Enhanced Appearance and Surface Finishing

This Tech Bulletin provides an overview of Cold Forging processes and how they can be leveraged to deliver higher productivity, lower costs and improved quality. Cold forging technology is applicable for a wide variety of parts that require high-volume production and critical strength parameters in the automotive, medical aerospace, consumer products and other industry sectors.

Topics addressed in this Tech Bulletin include:

- Overview of Cold Forging
- Higher Productivity for High-volumes
- Material Savings and Cost Reduction
- Improved Part Integrity and Strength
- Enhanced Appearance and Surface Finishing
- Application Considerations
- Materials suitable for Cold Forging
- Summary
- Future Tech Bulletins




Overview of Cold Forging

Cold forging is basically an “impact forming” process that deforms a piece of raw material plastically, under high compressive force, between a punch and a die using suitable equipment such as a machine press.

Some basic cold forging techniques include Extrusion (forward, backward, forward & backward), Coining, Upsetting, and Swaging. These techniques may take place in the same punch stroke or in separate operations, depending on the specific application requirements.

In essence, cold forging is a displacement process that forms the existing material into the desired shape as compared with conventional machining, which uses a removal process to take away material to create the desired shape. As seen in the following sections, this distinction offers several significant advantages. The final section provides some of the key factors that should be kept in mind when considering cold forging.

There are generally two types of die used in cold forging:
Open Forging – Material is allowed to escape after cavity is filled. Advantage: Lower stress and load. Disadvantage: Some post machining may be required depending on application requirements.
Close Forging – Die cavity volume is exactly the same as material volume in order to get to net shape or near net shape. Advantage: Eliminates post machining. Disadvantage: High stress and load. Die may result in serious damage if material is excess.

Higher Productivity for High-volumes

A primary reason that many companies move a process to cold forging is the need for achieving higher throughput from the production line. In many cases, conventional processes, such as machining, weldments or other fabrication methods, involve multiple-pass operations to remove material and to finish the part (e.g. vertical, horizontal, bulk removal, detail touch-up, etc.). In contrast, cold forging is typically a single-pass forming process that deforms the existing material into the desired shape.

Depending on the specific part parameters, the time savings per piece can deliver major productivity advantages. For example, some parts that take 3 to 5 minutes per piece for machining have been converted to cold forging with throughput of over 50 parts per minute.

The opportunity for achieving over 100 to 200 times productivity improvement offers fast ROI on the investment in cold forging die and tooling. Therefore many companies have opted to use other methods only for prototyping and early production phases, with a transition to cold forging planned into the higher volume production ramp-up.

Material Savings and Cost Reduction

Another key advantage of cold forging is the elimination of wasted material. Instead of removing a significant amount of the raw material, a cold forging process makes use of it all.

Input to the cold forging process is in the form of “billets” of material, which are cut from the raw stock bulk material (coil, beam, sheet, etc.). Each billet is the exact amount of material needed for the final part so there is no waste or loss of material. This waste-free process can offer a significant benefit in high volume production where the waste-per-part can become a key cost consideration and/or in situations where the raw material is costly, such as specialized alloys or scarce metals.

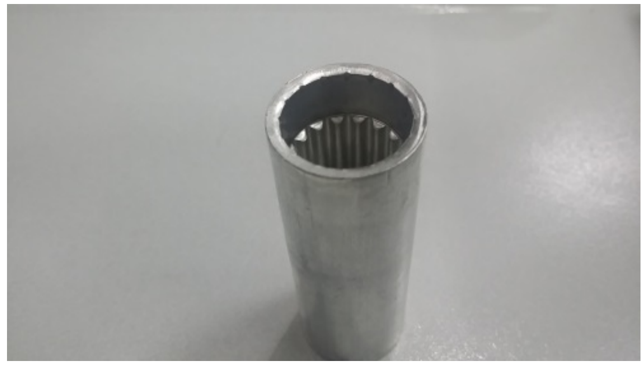
Improved Part Integrity and Strength

A very important factor is the ability of cold forging to significantly improve the strength and integrity of the final part. Forging yields much stronger parts than can be achieved with casting, weldments, or powder metal processes and it is also superior to machining of raw bar or plate metal.

The high compression process used in cold forging actually displaces and rearranges the grain of the base material such that any inherent weaknesses are eliminated. This can be particularly important for part designs where the required shape could experience weak points along the existing grain of the base material, such as long protrusions that cut across the grain or narrow points that could be prone to breakage under stress. The cold forging process inherently overcomes these problems by eliminating the need for engineers to worry about any issues with the underlying grain of the raw material.

Enhanced Appearance and Surface Finishing

Cold forging also offers distinct advantages over machining, casting, weldments and other fabrication processes in that the part appearance and surface smoothness does not typically require post-processing steps.



Depending on the specific requirements of the application, other parts need to be cleaned up to remove burrs, grooves, striations, or other artifacts from the machining process. This is not a problem with finished parts that have been created through the cold forging compression process.

Application Considerations

Cold Forging is not appropriate for every application but it can offer very significant advantages in the right situations. Because it requires specialized equipment, tooling and die investments, the use of cold forging needs to be balanced against overall production volumes, material costs, strength requirements and ROI projections.

In some instances, where strength, shape and surface smoothness are critical issues, Cold Forging is the only process that can successfully produce parts that meet the required specifications.

Therefore some parts such as complex Pinion Gears are being designed specifically for Cold Forging because they can't be manufactured via machining or other processes in the first place.

Outsourcing to an experienced cold forging partner can offset the capital equipment investments so that Non-Recurring Engineering (NRE) costs can be focus on tooling and die creation. However, your cold forging partner needs to have extensive experience with a wide range of applications and with key process optimization issues including the following:

<u>Material volume</u> (billet size control) The billet size has to be controlled precisely if Close Forging is employed. Extra material has nowhere to escape in the cavity and this can cause excessively high stress within the die, thus risking serious damage. Comparatively for Open Forging, extra material will generally not result in damage as material escape route is usually designed into the process.

<u>Bonderising</u> This is a dipping process that coats billet surfaces with phosphate and soap to help to ease material flow over the punch/die during forging process. This helps to reduce friction, force and stress and also to improve surface quality.

<u>Annealing</u> This is a process that softens the material and lowers the flow stress for easier material flow. Intermediate annealing, applied in between forging stages, is necessary when cold working induces work hardening to the extent that no further cold working is practical or possible.

<u>Lubrication</u> In cold forging, high viscosity oil is critical to reducing bare metal to metal contact. However, in order to also dissipate heat generated, right amount of thin oil is usually added.

Materials suitable for Cold Forging:

- Carbon steels – Low to Medium Carbon Steels up to 0.60% carbon.
- Stainless steels – 300 and 400 Series.
- Alloy steels of suitable mechanical properties and ductility.
- Copper & its alloys.
- Aluminum & its alloys.

For parts with higher strength requirements, it is a general practice to use a lower temper grade for cold forging (e.g. annealed) and then post heat treat to the required hardness/strength.

Summary

Understanding cold forging trade-offs and selecting a partner with deep experience in cold forging applications, including vertical integration with other processes, can offer designers and production engineers a valuable alternative to conventional machining or casting processes.

The key to success is to start early in the design process and to consider overall production volume and ramp-up requirements so that cold forging can be leveraged for optimal ROI and quality results.

Compared with other competing technologies, such as machining, die casting, plastic injection molding, weldments, and metal injection molding (MIM), cold forging creates products with a higher impact strength, a higher structural integrity, and better accuracy while using less material. The process is highly productive and optimal for surface finishing.

Future Cold Forging Tech Bulletins:

This overview Tech Bulletin has provided an introduction to Cold Forging technology and a brief summary of its advantages in terms of productivity, material savings and strength.

Follow-on Tech Bulletins will provide more in-depth discussions of specific Cold Forging issues, opportunities and applications. Topics will include:

- Comparison of Cold Forging to machining
- Comparison of Cold Forging to casting
- Comparison of Cold Forging to weldments and fabrication methods
- Application of Cold Forging for Automotive Suspension and Drivetrain Parts
- Integration of Cold Forging with Progressive Stamping Processes
- Vertical and Horizontal Cold Forging

More information regarding cold forging technologies can be found on the web by visiting
http://www.interplex.com/services/cold-forging