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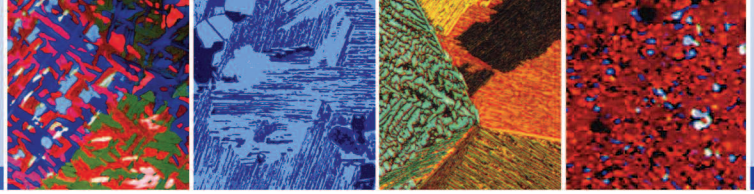

Reduce Material Waste and Labor Costs with Flowforming, a Net Shape Metal Forming Process

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"In recent years, the rapid increase in the cost of raw materials and the growing appreciation of their finite availability has caused many industries to examine their manufacturing techniques and consider alternatives to traditional methods, with the aim of making economical use of the materials available. One of these 'new' techniques is that of metal spinning and its derivatives, shear forming and flow forming.[1]"

While this quote certainly rings true today, it was actually written in 1976 by C. L. Packham of Leifeld & Co., the manufacturer of flowforming equipment.

Nearly thirty years later, we once again face the rising costs of materials. In the last 18 months alone, titanium and nickel prices have tripled. Making the problem worse, these materials are not readily available in tubular form. Therefore, when cylindrical components are needed in Titanium or Inconel more often than not, they are machined from solid bar with expensive operations and costly material wastes. By flowforming these expensive materials, customers keeps their components' costs down in two significant ways. First, flowforming begins with a short preform, usually a fourth of the of the overall finished component's length. Hence, there is minimal material waste when machining the short preform. Second, because the piece is flowformed to either net shape or near net shape, there is the elimination of costly machining operations that are conventionally employed to produce cylindrical components such as trepanning, gun drilling and boring.

What is causing this recent metal crisis? With the beginning of this millennium, there was a depression in the metal industry and metal distributors were maintaining very low inventories. In the beginning of 2004, the international metal industry began to pick up and distributors could not keep their stock. They began to place larger orders on metal mills. "The laws of supply and demand certainly apply to our industry and with supply down, prices began to skyrocket… In early 2005, the depth of the crisis worsened when Fortune 500 companies, in an effort to protect their manufacturing schedules, began decimating the inventories of distributors Worldwide."[2]

What can be done about today's high material prices and the difficulty in locating titanium and nickel alloys? What Packham professed in 1976 still holds true today: flowforming is a solution for many projects. What began as a derivative of spinning is now a well-established, proven method of manufacturing deserving of its own reputation.

Nickel preform on the left with flowformed component on the right.

Flowforming: The Process

Flowforming is a chipless, net-shape cold metal forming process that produces thin-wall, very precise, cylindrical components with or without closed bottoms. While forming extremely straight and concentric parts, tight dimensional accuracies on the diameter and wall thickness are realized. Thin-walled components that have large length-to-diameter ratios are perfect for flowforming. Although adiabatic heat is generated from the plastic deformation, the process is flooded with refrigerated coolant to dissipate the heat. This ensures that the material is always worked well below its recrystallization temperature. This "cold work" process causes the material's strength and hardness properties to be increased. Additionally, dimensional accuracies are consistently achieved well beyond accuracies that could ever be realized through hot-forming processes.

[1] C.L. Packham, "Metal spinning and shear and flow forming." Metallurgical & Metal Forming. June, '76.
[2] Gamble, Allen. "Crisis in the Metals Industry." www.metalsuppliersonline.com. May, 2005.

Flowforming reduces material consumption and manufacturing costs in many ways.

- Beginning with a short, thick preform and then flowforming it to greater than four times its original length (75% wall reduction) reduces material waste compared to machining.
- Flowforming is a net shape forming process, which increases material utilization and often eliminates the need for secondary operations, including machining heavy wall forgings or extrusions, and final machining, gun drilling or trepanning solid bar/billet.
- Flowforming produces seamless parts, which eliminates the cost of welding and the associated costs of testing the welds.
- Hardness levels in the mid 40s (Rockwell C scale) are realized through the combination of pre-hardened preforms that are subsequently cold worked from the flowforming process. This approach reduces distortion issues associated with heat treatment of a thin wall component. Furnace fixture costs and the costs associated with straightening post-heat treating distortion are also eliminated.
- Flanges, stub ends, or closed bottoms can be an integral part of the flowformed component, which eliminates the cost of manufacturing the flanges or bottoms and the cost of circumferentially welding them to the cylindrical component.

In addition to the economical benefits, there are dimensional, mechanical and metallurgical benefits.

Flowformed sizes, components and metals

Dynamic Flowform manufactures dimensionally precise components ranging in diameter from 0.866 to 24.500 inches, with wall thicknesses ranging from 0.006 to 0.500 inches and lengths up to 28 feet. With the flowforming process, there is virtually no limiting relationship between diameter and minimum wall thickness, meaning components with large diameters can have very thin walls.

Some of the components that Dynamic has flowformed include accumulator cylinders for aircraft, high strength bearing sleeves, bicycle tubing, drive shafts for jet engines, housings for the oil exploration industry, nuclear waste containers, satellite rocket nozzles, and structural parts for aircraft and military vehicles.

Many different metals can be flowformed utilizing the same equipment, tooling, and setups. Advanced metals ranging from high strength aluminum to doped zirconium, which are often solely available in bar or billet, are successfully flowformed into precision tubular parts. Seamless components that have length-to-diameter ratios such as 4 to 1 and as high as 20 to 1 often realize the greatest cost savings.

Design engineers, metallurgists, and procurement groups who are seeking ways to save metal and money are now turning to flowforming. Those who always appreciated the dimensional, mechanical, and metallurgical benefits of this manufacturing process are now strategically taking advantage of the economics of flowforming.

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