The development of its P/M technology has allowed Stackpole to expand its product line to high-performance components such as selectively densified engine balancer gears and synchronizer assemblies for manual transmissions (Figure 3), and transmission sprockets with unique, helical gears (Figure 4). The firm has doubled its existing manufacturing facility to more than 19,000 square metres to accommodate the increased production. Additional production capacity is made possible by the firm's recent acquisition of Perth Metal Industries of Stratford, Ontario. Stackpole is expanding these facilities for operation in mid 1999.

Figure 4: Helical Transmission Gears

Your Invitation to Work with Us

We are interested in collaborating with you. Please contact the Business Office to discuss your particular needs.

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C E T C CANMET ENERGY TECHNOLOGY CENTRE

INDUSTRY ENERGY RESEARCH AND DEVELOPMENT PROGRAM

CLEAN ENERGY TECHNOLOGIES

POWDER METALLURGY

From Powder to Auto Parts

With help from the Industry Energy Research and Development (IERD) program, a Canadian firm has harnessed the technology of powder metallurgy (P/M) for the manufacture of high-performance automotive parts.

Using advanced P/M techniques, Stackpole Limited is producing a range of high-performance automotive parts at globally competitive prices while saving an estimated 400 Terajoules (TJ) of energy each year.

Figure 1: Phased Teeth Sprockets

The Conventional Process

The conventional method of manufacturing automotive parts involves numerous operations, including casting, metal forming (with presses, drop hammers and forging machines), drilling, boring, turning, milling, hobbing and grinding. The formed part may be heat-treated to develop the final properties of the material. All of these procedures are energy intensive.

Stackpole Limited, a Toronto-based manufacturer, believed there must be a better way. In 1982, the company applied to the IERD program for help in developing techniques for producing high-quality automotive parts using powder metallurgy. Powder metallurgy (P/M) is a process for converting fine metal powders into solid products. It is particularly useful for manufacturing complex shapes to close tolerances in high volumes and at relatively low production costs.

Recognizing the inherent potential for energy savings, the IERD program agreed to co-fund the project. The IERD program, which is administered by the CANMET Energy Technology Centre-Ottawa of Natural Resources Canada (NRCan), helps Canadian firms develop and commercialize new, energy-saving technologies, products and processes.

The Energy-Efficient Process

Powder metallurgy uses a blend of very fine metal powders that are carefully selected for particle size and shape. The mixture's main constituent is iron powder, to which small quantities of other elements are added to produce alloys with specific properties (tensile strength, toughness, hardness etc.). The blended powder and a lubricant are compacted under high pressure in a shaped die to form a "green" component.

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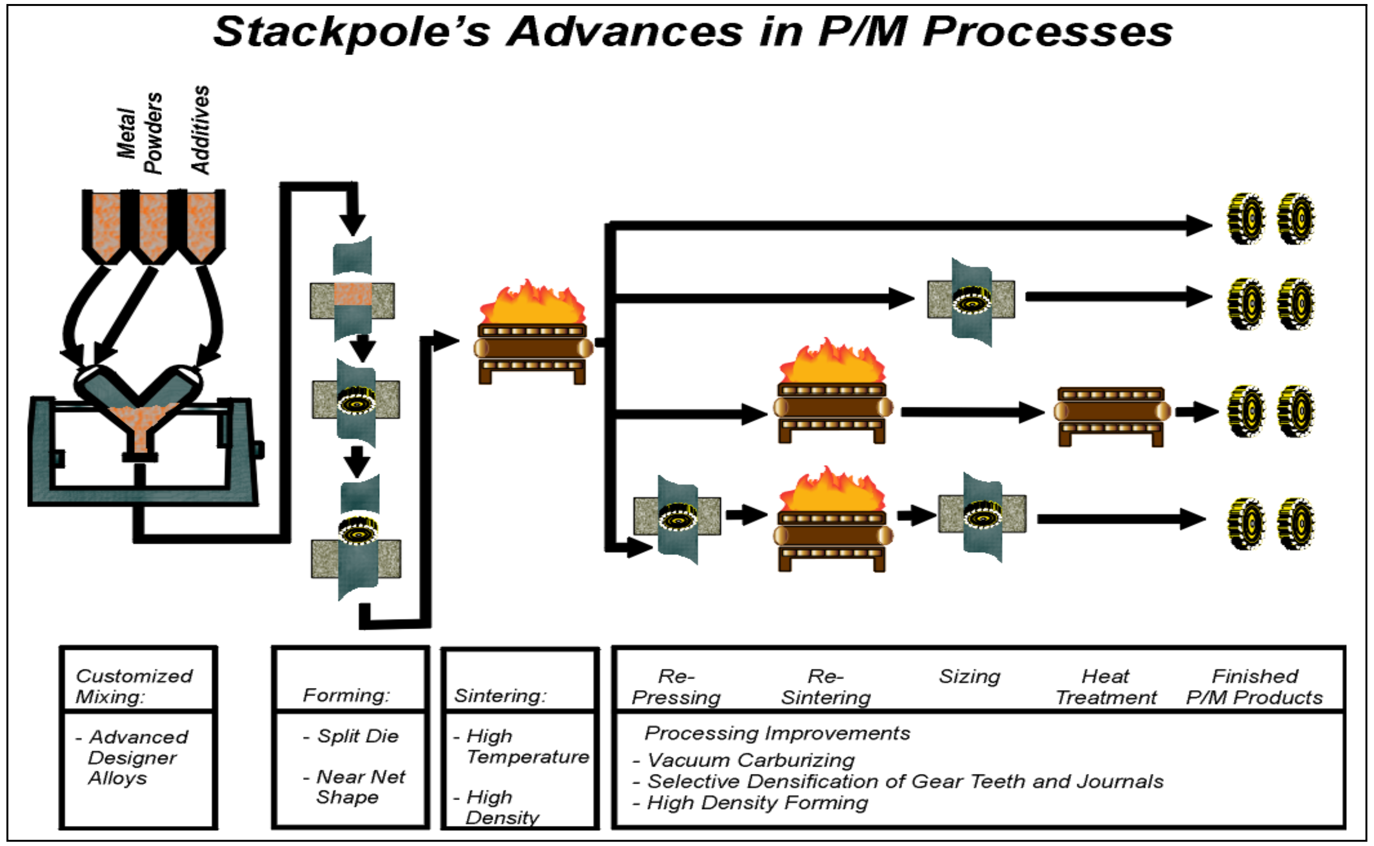

Figure 2: Process Diagram

Under pressure, individual particles in the die become mechanically interlocked. Although it is still weak, the part now has sufficient strength to be moved to the next stage of production (sintering) where its full strength will be developed.

In the sintering furnace, when a critical temperature is reached, surface oxides are reduced by the surrounding atmosphere, activating the surface and allowing strong, metallic bonds to form. The temperature of the furnace must be kept well below the melting point of iron or the part will lose its shape. After sintering, the parts undergo a variety of secondary operations, including cold sizing or coining, to improve dimensional accuracy and increase surface density.

In the final stage of the process, the part may undergo heat treatment to improve tensile strength, surface hardness and other qualities, especially at the surface.

A process diagram depicts this in Figure 2. Stackpole has followed a long-term, focused R&D strategy to create new markets for P/M by increasing mechanical properties, in particular, the fatigue endurance strength of P/M. Under projects supported by the IERD program between 1987 to 1996, the company has been able to progressively increase the properties of its products to levels higher than those attainable by conventional P/M technologies. Stackpole has developed significant, patented technical innovations using advanced alloying, high temperature sintering and selective densification to obtain very high dynamic strength. These new technologies have opened new markets, allowing Stackpole's advanced P/M parts to replace conventional, machined, cast and wrought steels, with considerable cost and energy savings. The majority of these advanced technology components are exported.

Figure 3: Belt Tensioner Bracket and Synchronizer Gear Assembly

Under a project supported by IERD, running from 1996 to 2000, the company has developed new high-density materials and processes to achieve high-core densities in products such as transmission gears. These novel net shape processes represent the latest phase in the company's long-term mission to develop P/M components with dynamic properties at least equal to those of high-strength, low-alloy steels. The target market for these advanced technology products is automotive transmission gears and connecting rods. These components, which are currently dominated by machined, heat-treated steels, represent a new market potential for P/M of over $1 billion.

Energy Savings and Environmental Benefits to Date

Powder metallurgy allows a part to be shaped in three to four steps, bypassing the numerous metallurgical and mechanical operations involved in conventional metal forging and tooling. The result is significant energy savings. By using P/M in place of conventional manufacturing techniques, Stackpole is saving an estimated 400 TJ each year, or about 66,000 barrels of oil equivalent (BOE). In terms of reducing carbon dioxide (CO_2) emissions, a reduction in energy use of 400 TJ/annum of natural gas by using P/M technology, equates to reducing CO_2 emissions by about 20,000 tonnes per annum in Canada.

Projected Energy Savings and Environmental Benefits

Powder metallurgy benefits the environment in several ways. First, air pollution is reduced. By eliminating the melting and hot forging operations, fewer combustion gases are released.

Secondly, there is also less waste. Because P/M parts are near final form, cutting and machining operations are eliminated, which means that less scrap metal is produced. These benefits translate into lower fuel consumption and fewer emissions. In terms of reducing CO_2 emissions, a reduction in energy use of 1.6 Petajoules (PJ)/annum of natural gas using P/M technology in place of conventional manufacturing techniques for the production of automotive transmission gears and connecting rods in Canada would about equate to a CO_2 emission reduction of 83,000 tonnes per annum.

Economics

Stackpole's total investment in these projects is expected to be about $65 million, of which the IERD Program support will add up to $6 million. Implementation of the technology has allowed the company to produce a wider range of higher quality products at globally competitive prices.

Markets

Stackpole now operates three separate facilities in Canada. The company's high-strength parts plant in Mississauga, Ontario (among the most modern in North America), is producing more than 500,000 parts each week for the North-American automotive industry.