Japan's powder shipments **up**: prize winners are revealed

Japanese powder shipments were up last year in terms of both value and volume with bearings, machine parts – which includes PM automotive components – and friction materials showing the largest increases...

As 2007 drew towards a close, iron powder shipments were up by more than 10% year-on-year and copper powder shipments by more than 13%, according to figures released by the Japan Powder Metallurgy Association. Most of the part categories tracked by the association were showing value increases in the low teens in percentage terms with a total monthly value in October of Yen 14 billion.

Monthly iron powder shipments in October had risen to 12 182 tons from the 2006 figure of 11 030 tons, while monthly copper powder shipments had risen from 530 tons to 601 tons in the same period.

However, the increase in iron powder shipments was by no means a smooth progression. The figures languished in the first two months of the year, jumping suddenly in March to a high point for the 12-month period of 12 523 tons.

Meanwhile, the JPMA unveiled the prize winners in its annual Development Prize awards competition. The winners were judged in four sections: New Design; New Materials; New Powders and Effort.

New Design

Density and complexity

SUMITOMO Electric Industries took three of the six prizes on offer in the New Design section of the Japan Powder Metallurgy Association's Development Prize Awards. But Porite Corporation were close behind with two prizes, one of which was a PM part that replaced a component formerly manufactured by metal injection moulding (MIM).

The first of the Sumitomo Electric prizes was awarded for a system to tranfer torque in a drive system froma high output source to a lower output user unit.

Sumitomo said: "The torque of an input shaft is transferred to an output shaft by inserting an output gear shaft into an internal spline of a planetary carrier in a 4WD transfer unit. The size of the output shaft differs depending on the maximum output torque of the unit. Since the size of the low torque output shaft is much smaller than that of the high torque unit, the carrier connecting the low torque unit is complex in shape and difficult to manufacture." Sumitomo developed such a part for PM manufacture

This part has an outside spline on the flange and this is inserted into an internal spline of a carrier. The flange has nine holes located near the boss for weight reduction. The boss has an internal spline and an output gear shaft is inserted into this spline for torque transfer to an

Figure 1. The winning carrier.

output shaft. The internal spline has a back taper for smooth insertion of the shaft. The shape of this part is complicated and the original shape was designed for cold forging.

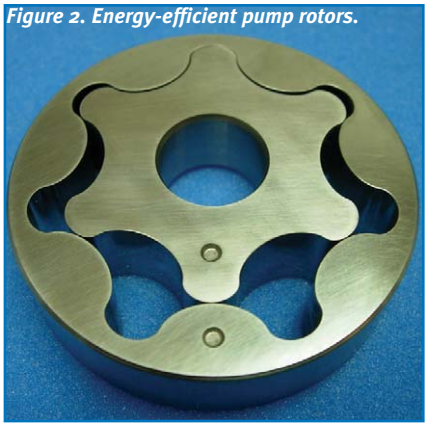
Discussions with the customer at the design stage resulted in a PM design that could realise a 6% weight saving. Compaction without machining was brought about through the disgn of the compaction tool and an improved ejection process. The internal spline of the boss requires both impact strength and hertzian fatigue strength. These strengths are achieved by densifying the component to 7.0g/cm^3 minimum and induction hardening. The density achieved in the compaction process is 6.9g/cm^3 because of the position of the internal spline. The back taper's density of than 7.0g/cm^3 is achieved by the sizing process. Both the sizing process and material shape are optimised by finite element method (FEM) analysis. This PM part realised common use of the input side design for both high and low output shafts with weight and cost reduction.

Cutting energy losses

ENERGY losses from automotive oil pumps are a major concern for engine designers. Sumitomo Electric looked at a typical oil pump and came up with a new design. These products are PM internal gear pump rotors which are used for automotive engine oil pumps, automatic transmissions and continuously variable transmissions and fuel feed pumps of diesel engines.

In spite of a recent strong demand for low fuel consumption the energy losses from this area seem to be steady. It is estimated that 10% of engine energy loss is from engine oil pumps, and about 20-30% of that is associated with automatic transmission oil pumps. It is no surprise that customer demand for highly efficient oil pumps to improve efficiency and, consequently, fuel consumption.

Figure 2. Energy-efficient pump rotors.



Energy loss of geared oil pumps depends on friction loss which is influenced by the side face of rotors and outside surface of an outer rotor. Therefore, in order to reduce its loss, new tooth profiles were developed to increase the theoretical discharge volume from a unit with an outer rotor of the same dimensions.

The conventional tooth profile of the inner rotor has one base circle, and the displacement distance, which relates to discharge volume, is decided by the base circle and the number of teeth. As the theoretical discharge volume depends on displacement distance and one base circle, the newly developed inner rotor's profile has two base circles to enlarge displacement distance, and the profiles between these circles are involute curves. The outer rotor profile is generated from the inner rotor profile. The design parameters were optimised by theoretical calculation and evaluating sample tests.

As a result, the theoretical discharge volume of the newly developed internal gear rotors is 12% higher than that of the same size conventional rotors, although the actual discharge volume is about 10% higher. So long as the required actual discharge volume stays constant. The rotor can be downsized and energy losses reduced. Downsizing enabled the drive torque of the newly developed oil pump to reduce about by about 10% of the conventional one.

Electro-magnetic VCT

VARIABLE Cam Timing (VCT) System is used for almost all new model vehicles, and generally actuated by oil hydraulic system. However, in its third award-winning entry in the New Design section, Sumitomo Electric Industries looked for an alternative. They concluded that market requirements for high engine performance, low fuel consumption, and low emissions demanded an electro-magnetically actuated VCT system. They developed one.

This newly developed housing sprocket is compacted in one compacting stroke, avoiding a previous need for customer assembly. A CNC multi-level compacting press system was developed for making complicated shapes and required dimensional tolerances were achieved without sizing operations.

Figure 3. PM Sprocket and body for VCT.

Teeth bite on safety

SAFETY considerations are an important aspect of automobile design, and was certainly something that Mitsubishi Materials PMG Corporation took into account in their prize-winning development of toothed equipment manufactured as sintered parts for the steering tilt mechanism of an automobile. The item consisted of Tooth Lock A, Cam A and Cam B.

These products were developed to increase the expansion and contraction holding power of the connection mechanism for the gear that satisfies collision safety levels as part of a wider project to develop a new steering column.

This system consists of Tooth Lock A, which possesses 22 teeth, and Cam A whose surface form differs and whose surface is uneven. Tooth Lock A was required to have the correct tooth forms, high strength and flatness. Cam A was required to have accuracy in its unevenness.

The form and flatness guarantee for the Tooth Lock were achieved by optimisation of the die form and rationalisation of operation. Powder filling was improved