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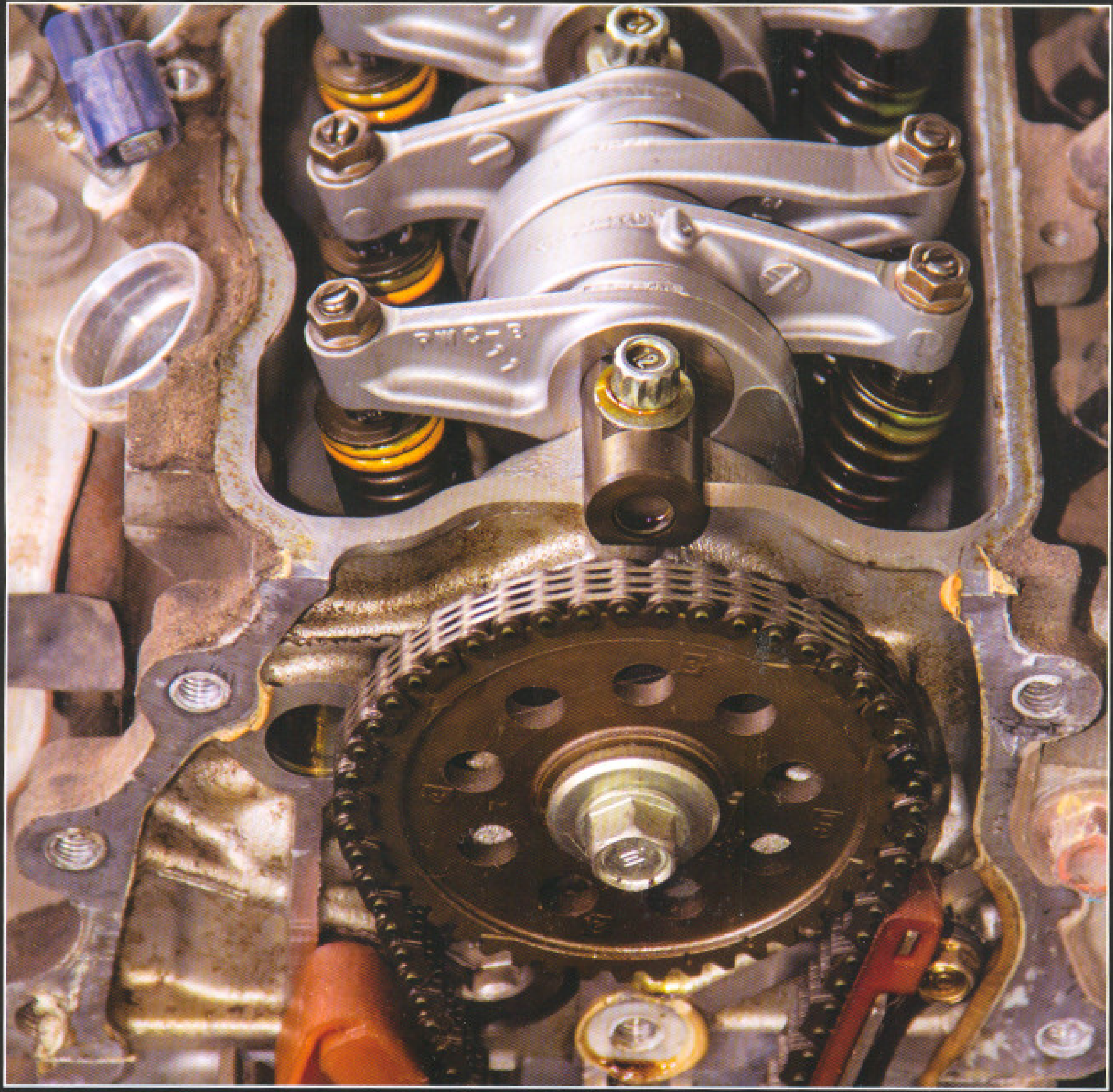

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High-quality end product starts with super-fine metal powders

Read how a Japanese metal powder manufacturer improved product quality and efficiencies via a water-jet atomisation process—and a little help from a special rotary batch mixer.

Nippon Atomized Metal Powders Corporation uses a patented water-jet atomisation process to make high-quality super-fine metal powders from copper, bronze, brass, silver, gold, and stainless steel that are of consistent composition and particle size. Nippon Atomized Metal Powders refined the process of water jet atomisation to produce metal powders with well-shaped, uniform particles in the range 1.5–500 microns. Applications for the metal powders include electronic components and assemblies, bearings, cutting and polishing tools, jewellry, and metal injection moulding, all which benefit from the fine particle sizes.

Figure 1: Batches of metal powder typically weighing 4,000–5,000 kg are loaded into the Munson rotary batch mixer from an overhead container that is moved into position by a crane.

Following the water atomisation stage, the resulting metal powders are dried, screened and blended. Each step must be carried out correctly to yield the correct particle size distribution for the planned end-use. A key item in the blending – and one of the few non-Japanese equipment items in the factory – is a 700-THCX-90-SS rotary batch mixer supplied by Munson Machinery Co. Inc., Utica, New York. Koji Yamamoto is General Manager of the R&D division of Nippon Atomized and heads one of the firm's two production divisions. He says the mixer meets his requirements to blend large batches with short cycle times and complete discharge. Most importantly, Mr. Yamamoto says, the mixer is effective at avoiding particle size segregation on discharge.

Making metal powders in a long tradition

Nippon Atomized Metal Powders was established in 1964 in the city of Noda, which is around 40 km north of Tokyo and is known as the home of Kikkoman soy sauce. In 1980 the firm moved to a new site in Noda, and in 2012 it built a new site in a neighbouring prefecture to make super-fine metal powders by the water jet atomisation process.

Today the company employs around 100 people and has an annual output of about 2640 tonnes, of which one-third is exported. Powdered metal products include:

- Copper, silver and gold powders for conductive pastes used in electronics
- Bronze powders for bonding industrial diamonds in tools which cut silicon wafers and stone, and polish glass
- Bronze and brass powders for bearings in electric motors and car parts
- Silver and gold powders for metal clay, a craft material developed in Japan
- Soft magnetic alloy powders for inductors used in electronic power supplies
- Small amounts of stainless steel powders for metal injection moulding (MIM)

Water spray creates fine metal particles

Processes for making metal powders include atomisation with gas or water jets, centrifugal sprays, mechanical milling, and electrolysis. Water jet atomisation technology was invented by a Japanese research institution and licenced and improved upon by Nippon Atomized Metal Powders.

In the water atomisation method, Mr. Yamamoto explains, water pumped at high pressure through a ring-shaped nozzle creates a convergent conical jet. Molten metal fed into the centre of the cone is blasted into fine droplets, which solidify into powder as they fall into a tank of water beneath the nozzle. Compared to other methods, water jet atomisation is economical and flexible, according to Mr. Yamamoto. It allows tight control over density, particle shape and diameter–from microns to millimetres–and works with many different metals and alloys.

A drawback of the original water atomisation process is that the particles can have poor shape and fineness compared to those made by gas atomisation. Nippon Atomized developed an improved process running at higher pressures, which produces super-fine powders with spherical particles down to 1.5 microns.

A number of process variables must be controlled to achieve good results,

Figure 2: As the rotary batch mixer discharges, particle size distribution remains unchanged, which was not the case with other mixers used by Nippon Atomized Metal Powders.

Figure 3: The 2.5 cu m capacity rotary batch mixer evacuates fully, eliminating wasted material and allowing rapid, thorough cleaning between changeovers.

Figure 4: Copper-tin pre-alloyed bronze powder for diamond cutting is the finest (20-30 micron) homogenised in the 2.5 cu m capacity rotary batch mixer.

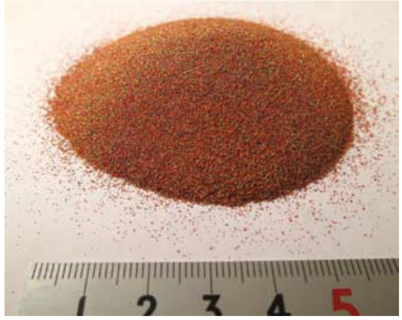

Figure 5: Pure copper powder, the coarsest powder processed in the rotary batch mixer, ranges from 85-100 microns.

Figure 6: Nippon Atomized Metal Powders' main product for oil-less bearings is partially premixed copper-tin bronze powder.

Yamamoto explained. For the water jet, critical variables are the aspect angle, water pressure, and flow rate. The temperatures of the molten metal, the water, and the surrounding atmosphere are also important. Finally, downstream operations such as drying and blending of the powders must be done correctly to maintain powder quality.

Turning scrap into valuable products

Raw materials enter the site in various forms, many of them recycled. The copper, for instance, is a mixture of electrolytically refined virgin metal and scrap from electric cables and the electronics manufacturing industry. Stainless steel arrives as scrap. Other raw materials include high-purity tin, gold, and silver.

How it works: The metals are melted in an induction furnace. As the melt forms, the furnace operator uses a spectrograph to adjust and control the resulting alloy compositions within close limits. Downstream of the furnace is the water atomisation machine, followed by equipment to dewater and dry the metal powder. Powders pass through a gyratory box screener to control particle size. For the finest powders, ultrasonic sieving and an air classifier carry out the same task. Finally, the powders are homogenised and blended, sieved again, and packed into drums for shipping.

Material rejected at various points in the process is returned to the appropriate stage: re-sieving, re-mixing, atomisation, re-melting. A small fraction ends up as waste that is sold to mining companies or scrap merchants. The Munson rotary batch mixer plays a key role in producing metal powders having particle sizes from 10 micron up to 500 micron (30 mesh) and specific gravities in the range 1.8–3.5. The mixer's volume is 2.5 cu m, and typical batch sizes are 4,000–5,000 kg.

"We use the mixer mainly as a homogeniser to avoid material segregation," Yamamoto explained. "We need to be sure that particle size distribution is the same across the batch, and from one batch to the next. With the Munson, we get good blending and complete discharge without segregation, and short mixing time, even with the large capacity."

Nippon Atomized purchased the mixer to increase capacity. The company's previous double-cone blender was limited to 1,500 kg per charge and a batch took 20 minutes to blend, Yamamoto explained. "This was too small and too slow for our production needs," he said. "The rotary batch mixer blends up to 5,000 kg in just 5–7 minutes."

The unit's four-way mixing action – tumble, turn, cut and fold – achieves batch uniformity rapidly, and more gently than with agitated blenders. Continuous rotation keeps material in motion at all times, preventing particle-size segregation during discharge.

Yamamoto says Nippon Atomized Metal Powders imported a mixer because the company wanted complete discharge without segregation, plus large capacity. "There are no Japanese mixers that combine these important features," he stated.

The Japanese powder metallurgy industry mostly uses V-blenders and double-cone blenders. These mixer types provide complete discharge, but on discharge there tends to be segregation of particle sizes. "In general, the particle size distribution moves from fine to coarse as the mixer is discharged," Yamamoto stated. "The Munson mixer avoids this problem." (Incidentally, Nippon Atomized Metal Powders said it learned about the mixer from an article in a powder metal trade publication showing how GKN Sinter Metals Inc. had successfully used it for metal powders.

Overcoming challenges proved worthwhile

Headroom is tight, says Mr. Yamamoto, and it was a challenge to fit everything into the available space, as the mixer is loaded from an overhead container that is moved into position by a crane. Customer acceptance was also an issue, he says, and even now some customers are reluctant to change to the offshore mixer for their products.

However, any initial headaches were well worthwhile, Yamamoto says, with the mixer proving both effective and reliable after nearly three years in operation. When a change of grade is required, cleaning is straightforward; a small quantity of the new product is used to clean the mixer and is then recycled.

"What's more, we don't have to worry about maintenance," Yamamoto said. "With our previous mixer, the design of the machine caused a lot of trouble with the axle and the drive chain. As long as the drum alignment is okay, the rotary batch mixer is trouble-free, and the quality of blending means lower costs for quality control."

Now, Yamamoto says, "I want to replace our other old mixers with Munson machines."

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