



JIPTM

REDUCED IRON POWDERS
ATOMIZED IRON AND STEEL POWDERS



JFE Steel is a leading iron powder manufacturer with a wide range of products including reduced iron powders, atomized iron powders, etc. Its steel-making technologies and know-hows are being applied to the development and production of such a variety of products.

Reduced iron powder

Middle/low density sintered parts

Magnetic materials

Friction materials

For powder metallurgy applications

Middle/high density sintered parts

Magnetic materials

High strength sintered parts

Heat resistant and wear resistant sintered parts

with a wide range of products,
powders, and alloyed steel powders.
be applied

- Body warmers
- Chemical reaction agents
- Deoxidation agents
- Gas cutting agents
- Soil purifying agents
- Welding materials
- Sound insulators
- Toner carriers
- Agricultural applications

**For applications
other than powder
metallurgy**

Pure iron
powder

**Atomized
iron and steel
powder**

Alloyed steel
powder

ADVANTAGES

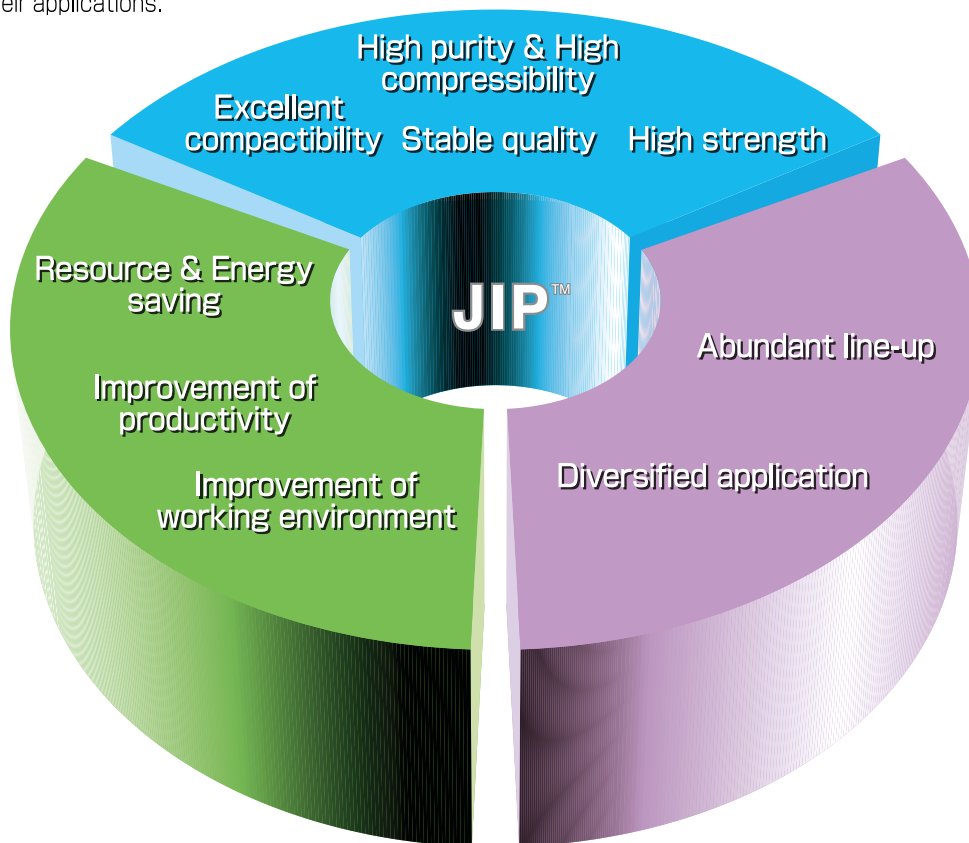
JIP™ iron and steel powders, developed with the steel-manufacturing know-hows, provide high-level supports for various industries.

A WIDE RANGED LINEUP OF REDUCED AND ATOMIZED IRON / STEEL POWDERS

JFE Steel has been manufacturing and selling reduced iron powders since 1965, and atomized iron/steel powders since 1978. In addition, it started the operation of a new atomizing plant in 1991. From its wide ranged product lineup, customers can select the product most suitable for their applications.

DIVERSIFIED APPLICATIONS

In addition to the application of powder metallurgy mainly in the automobile industry, our products are used for varieties of genre such as for body warmer, welding rod, gas cutting, deoxidation material, and chemical reaction material.



DOGGED PERSEVERANCE IN NEW PRODUCTS DEVELOPMENT

High quality atomized iron powder which has excellent compressibility and compactibility as well as less variation in quality; and each kind of alloyed steel powder used for high strength parts and heat-resistant /wear resistant parts; and also segregation-free JIP™ Clean Mix which prevents the segregation of graphite — we have developed various kinds of products which won high evaluation from the users. We are continuing further efforts for another development.

STABLE QUALITY AND EXCELLENT PROPERTY

The products are manufactured under integrated production control and strict quality control. The quality is always stable with least variation and superb property.

Types and Applications

| | Types | | Designation | Use | Performance, example of parts | | | |
|---|--|---------------------------------|--|--|---|--|----------------------------|--|
| Powder metallurgy | Iron powder | Reduced iron powder | JIP 240M | Automobile parts, Electrical appliance parts, Office equipment parts, General machine parts etc. | Good compactibility, Good sintering property | Shock absorber parts, Pulley, Sprocket, Oil pump gear, Clutch parts, Compressor parts, Synchronizer hub, Driven gear, etc. | | |
| | | | JIP 255M | | | | | |
| | | | JIP 270M | | | | | |
| | | | JIP 270MS | | | | | |
| | | | JIP 255M-90 | | | | | |
| | | Atomized iron powder | JIP 260A | | Good compactibility, High purity High compressibility | | | |
| | | | JIP 280A | | | | | |
| | | | JIP 301A | | | | | |
| | Alloyed steel powder | Completely alloyed steel powder | JIP 300A | | High density parts | | Extra high compressibility | Cam, Sprocket, Lever, Clutch parts, Synchronizer hub, Oil pump gear, Timing belt pulley, Driven gear, etc. |
| | | | JIP 304A | | | | | |
| | Alloyed steel powder | Partially alloyed steel powder | JIP SIGMALOY 2010 | Automobile parts, Electrical appliance parts, Office equipment parts, General machine parts etc. | Extra high strength High wear resistance | Synchronizer hub, Clutch parts, Retaining plate, Turbine hub, Power steering oil pump parts, Valve guide, Valve seat, etc. | | |
| | | | JIP SIGMALOY 215S | | | | | |
| | | | JIP SIGMALOY 415S | | | | | |
| | | Mo Hybrid alloyed steel powder | JIP AH4515 | | High strength, High wear resistance | | | |
| | | Completely alloyed steel powder | JIP 4655S | | | | | |
| | | | JIP 5MOS | | | | | |
| | | | JIP 4MOA | | | | | |
| | | | JIP 5CRA | | | | | |
| | | | JIP 4100V | | | | | |
| | | | JIP 20CRV | | | | | |
| JIP 30CRV | | | | | | | | |
| JIP 25MOA | | | | | | | | |
| JIP 35MOA | | | | | | | | |
| JIP 50MOA | | | | | | | | |
| JIP 65COA | High strength, Heat resistance, High wear resistance | | | | | | | |
| Segregation free premixed powder | JIP Clean Mix | | All purpose of powder metallurgy | See page 22 | Valve seat | | | |
| | JIP Clean Mix | | All purpose of powder metallurgy | See page 22 | | | | |
| For applications other than powder metallurgy | Iron powder | JIP B-80 | | Friction materials | Good friction property | | | |
| | | JIP MG270H | | Magnetic materials | Good permeability | | | |
| | | JIP 303A-60 | | Deoxidation materials | Less gas generation | | | |
| | | JIP WH-100 | | Welding materials | High weldability | | | |
| | | JIP G | | Gas cutting agents | Good cutting efficiency | | | |
| | | JIP 300AG | | | | | | |
| | | JIP K-100T | | Body warmers Chemical reaction agents | Long time keeping | | | |
| | | JIP KB-90 | | | Large specific surface area and quick reaction speed | | | |
| | | JIP 300R | | Chemical reaction agents | Satisfactory reactivity | | | |
| | | JIP 301SGMR | | | Satisfactory reactivity, High purity | | | |
| | Iron oxide | JIP S-100 | | Sound insulators | Satisfactory sound insulation | | | |
| Premixed powder | JIP S91 MIX | | For direct seeded rice using iron coated seeds | Satisfactory coating | | | | |

JIP™ iron powder supports high-technology for automobiles.

■ Powder metallurgy

● Parts of automobiles

● ENGINE PARTS

- Cam shaft pulley
- Cam shaft sprocket
- Crank shaft pulley
- Crank shaft sprocket
- Cap crank bearing
- Valve guide
- Valve seat
- Rocker arm chip
- Oil pump inner rotor
- Oil pump outer rotor
- etc.

● STEERING PARTS

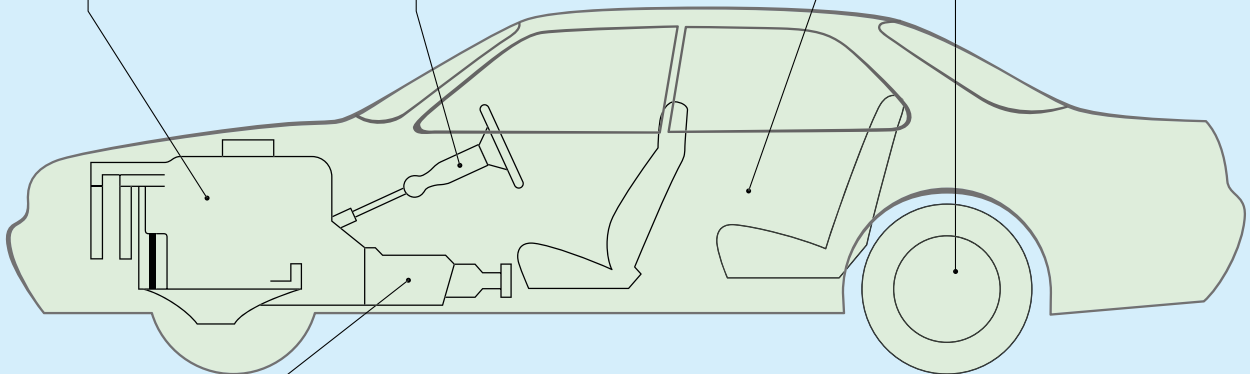
- Power steering rotor cam ring
- Pressure plate
- Rack guide
- etc.

● SEAT AND DOOR PARTS

- Seat lifter cam set
- Door mirror plate clutch
- Striker
- Slider
- etc.

● SUSPENSION AND BRAKE PARTS

- Shock absorber
- Ball joint
- ABS sensor
- etc.



● TRANSMISSION PARTS

- M/T Synchronizer hub
- Synchronizer ring
- Synchronizer key
- Shift fork
- A/T Hub clutch
- Retaining plate
- Pressure plate
- Turbine hub
- Weight governor
- Cam stater T.C.
- Outer race
- etc.

Various sintered parts



● Parts of electric appliances, office machines, agricultural machines and sewing machines, etc.

JIP™ iron powder plays important roles in various aspects in our daily life.

Other than powder metallurgy

- Body warmer
- Deoxidizing material
- Carrier for copier
- Sound insulator
- Chemical reaction material
- Welding
- Gas cutting
- Others



● **BODY WARMER**
Since iron powder easily oxidizes, it is used as the heating element in body warmer.



● **Agriculture** Direct seeding rice using iron coated seeds can save labor cost.



● **CARRIER**
Iron powder is used as carrier for copier.



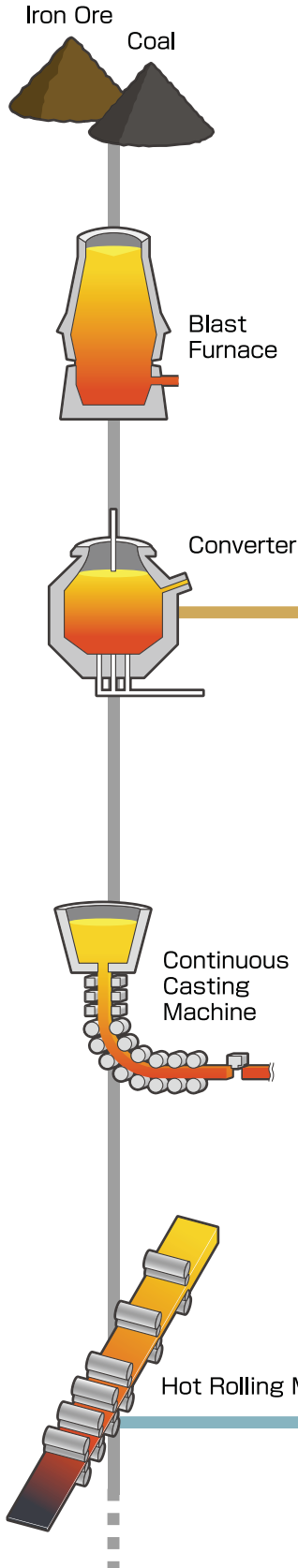
● **DEOXIDIZER**
Because of its oxidation action, iron powder is used as an oxygen absorbent.

● **Gas cutting**
Oxidation heat generated from iron powder is utilized for cutting steel with gas.



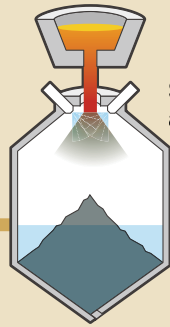
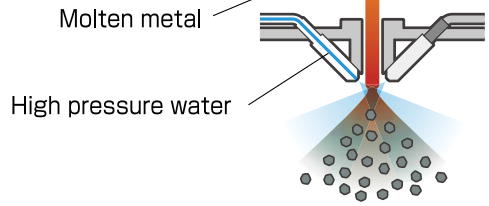
IRON AND STEEL POWDER MANUFACTURING PROCESS

Our high reliability is based on an integrated production control system — from raw materials to shipment

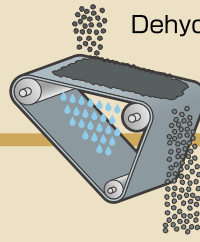


Atomized Steel Powders

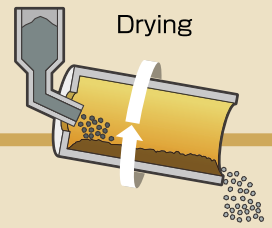
Atomizing Method



Spraying atomization



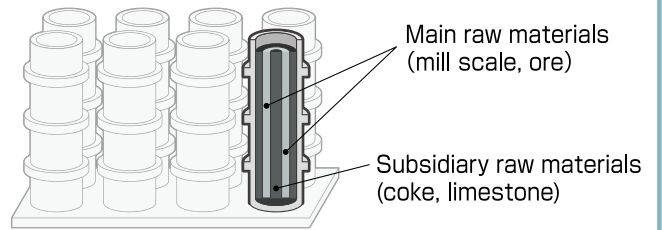
Dehydration



Drying

Reduced Iron Powders

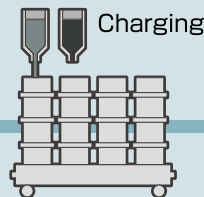
State of raw materials placed in a sagger



main raw materials
(mill scale, ore)

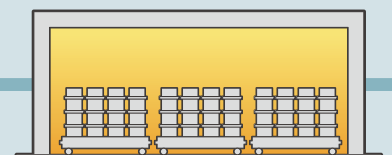


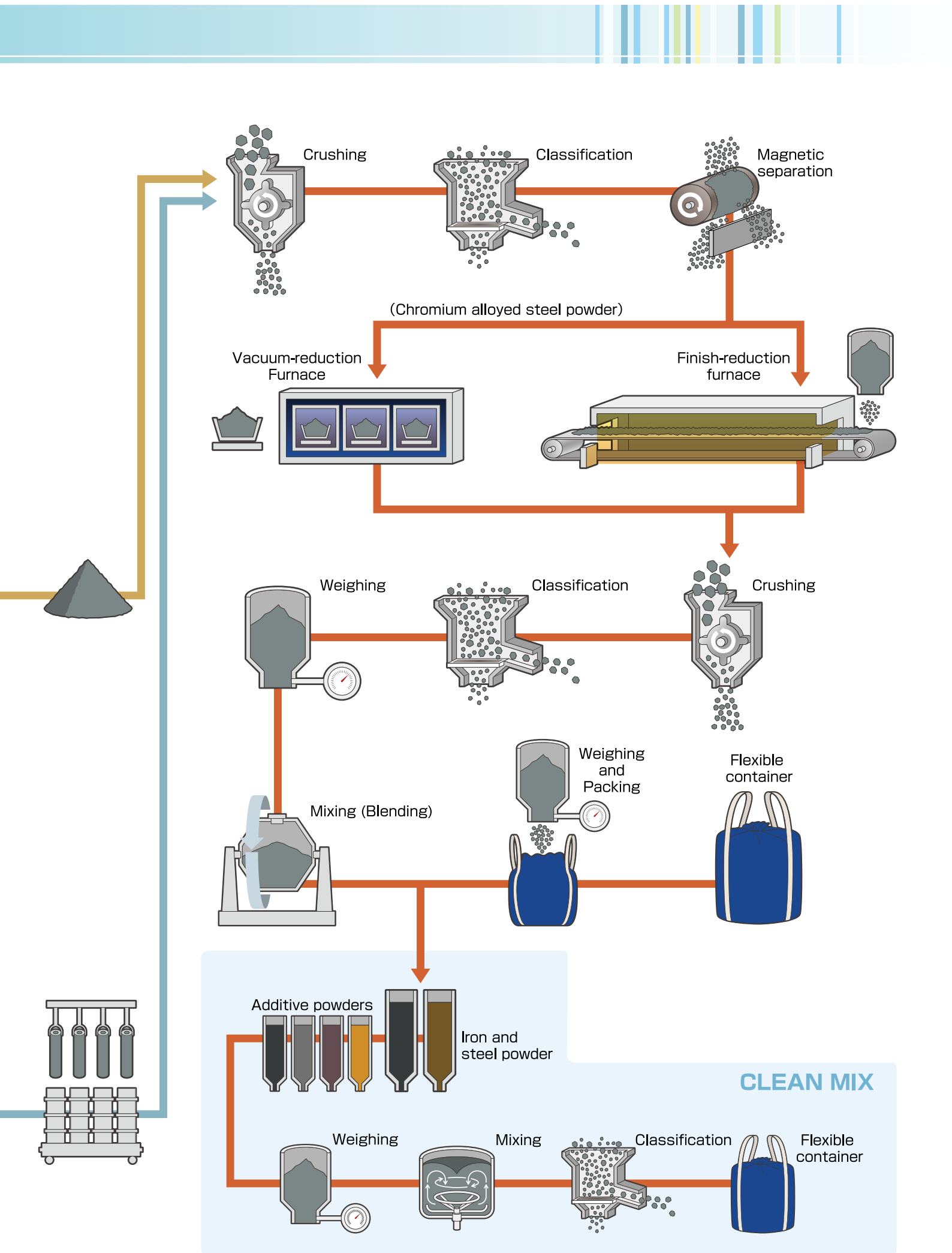
Subsidiary
raw materials
(coke, limestone)



Charging

First reduction





QUALITY CHARACTERISTICS

You can expect superior properties and performance because you select the product according to your purposes and applications.

Quality characteristics of iron and steel powder

| Use purpose | Designation | Chemical composition (%) | | | | | | | | Hydrogen Loss (%) |
|--|-------------|--------------------------|--------|---------|--------|---------------|---------|---------|---------|-------------------|
| | | T. Fe | M. Fe | T. C | Si | Mn | P | S | O | |
| Powder metallurgy | JIP 240M | | | ≤ 0.030 | | ≤ 0.35 | | | | |
| | JIP 255M | | | | | | | | | ≤ 0.30 |
| | JIP 270M | 98.5 ≤ | — | ≤ 0.020 | ≤ 0.15 | ≤ 0.40 | ≤ 0.020 | ≤ 0.020 | — | |
| | JIP 270MS | | | ≤ 0.010 | | | | | | ≤ 0.25 |
| | JIP 255M-90 | | | ≤ 0.020 | | | | | | ≤ 0.30 |
| | JIP 260A | | | | | 0.15~ 0.35 | | | ≤ 0.200 | |
| | JIP 280A | | | | | | ≤ 0.025 | ≤ 0.025 | | |
| | JIP 301A | Bal. | — | ≤ 0.010 | ≤ 0.05 | 0.10~ 0.25 | | | ≤ 0.250 | — |
| | JIP 300A | | | | | ≤ 0.15 | | | | |
| | JIP 304A | | | | | ≤ 0.12 | ≤ 0.015 | ≤ 0.015 | ≤ 0.150 | |
| Friction materials | JIP B-80 | 98.0 ≤ | — | ≤ 0.050 | ≤ 0.15 | ≤ 0.40 | ≤ 0.015 | ≤ 0.020 | — | ≤ 0.50 |
| Magnetic materials | JIP MG270H | 98.5 ≤ | — | ≤ 0.020 | ≤ 0.15 | ≤ 0.40 | ≤ 0.020 | ≤ 0.020 | — | ≤ 0.25 |
| Deoxidation materials | JIP 303A-60 | 99.0 ≤ | — | ≤ 0.020 | ≤ 0.10 | 0.15~ 0.25 | ≤ 0.020 | ≤ 0.020 | ≤ 0.300 | — |
| Welding materials | JIP WH-100 | 98.0 ≤ | — | ≤ 0.100 | ≤ 0.20 | ≤ 0.40 | ≤ 0.020 | ≤ 0.020 | — | — |
| Gas cutting agents | JIP G | 98.0 ≤ | — | ≤ 0.100 | — | — | — | ≤ 0.025 | — | — |
| | JIP 300AG | — | — | — | — | — | — | — | ≤ 0.350 | — |
| Body warmers Chemical reaction agents | JIP K-100T | — | 90.0 ≤ | — | — | — | — | — | — | — |
| | JIP KB-90 | — | 87.0 ≤ | — | — | — | — | — | — | — |
| Chemical reaction agents | JIP 300R | — | — | ≤ 0.250 | ≤ 0.05 | ≤ 0.30 | ≤ 0.025 | ≤ 0.025 | ≤ 1.200 | — |
| | JIP 301SGMR | — | — | — | — | ≤ 0.10 | ≤ 0.020 | ≤ 0.020 | | |
| Sound insulators | JIP S-100 | 70.0 ≤ | — | — | — | — | — | — | — | — |

| Particle size distribution (μm) (%) | | | | | | | | Apparent density (Mg/m^3) | Flow rate (s/50g) | * Green density (Mg/m^3) | * Rattler value (%) |
|--|-------------|-------------|-------------|-------------|-------------|-------------|-----------|---|-------------------|--|---------------------|
| + 250 | + 180 | + 150 | + 106 | + 75 | + 63 | + 45 | - 45 | | | | |
| | | | | | | | | 2.20~2.45 | | $6.60 \leq$ | ≤ 0.80 |
| — | — | ≤ 2.0 | 15.0~35.0 | 20.0~50.0 | | | | 2.45~2.65 | ≤ 35.0 | $6.70 \leq$ | ≤ 1.00 |
| | | | | | ≤ 25.0 | 5.0~30.0 | 5.0~25.0 | 2.60~2.80 | | | ≤ 1.50 |
| | | | | | | | | 2.62~2.82 | ≤ 30.0 | $6.75 \leq$ | |
| — | ≤ 2.0 | ≤ 10.0 | 25.0~45.0 | 15.0~45.0 | | | | 2.47~2.67 | ≤ 35.0 | $6.70 \leq$ | ≤ 1.20 |
| | ≤ 5.0 | | | 15.0~35.0 | 5.0~20.0 | 5.0~25.0 | 5.0~25.0 | 2.55~2.75 | ≤ 35.0 | $6.75 \leq$ | ≤ 0.80 |
| | | | | | | | | 2.70~2.90 | | | ≤ 0.90 |
| — | ≤ 2.0 | ≤ 15.0 | 10.0~30.0 | | | | | 2.80~3.05 | ≤ 30.0 | $6.80 \leq$ | ≤ 1.00 |
| | | | | 10.0~40.0 | ≤ 25.0 | 5.0~30.0 | 10.0~30.0 | 2.85~3.10 | | | ≤ 1.20 |
| — | ≤ 2.0 | 5.0~15.0 | 30.0~55.0 | 15.0~35.0 | ≤ 15.0 | 10.0~25.0 | | 2.20~2.45 | ≤ 40.0 | $6.60 \leq$ | — |
| — | — | ≤ 2.0 | 15.0~35.0 | 20.0~50.0 | ≤ 25.0 | 5.0~30.0 | 5.0~25.0 | 2.62~2.82 | ≤ 30.0 | $6.75 \leq$ | ≤ 1.50 |
| ≤ 1.0 | ≤ 10.0 | — | — | — | — | — | 10.0~30.0 | 2.85~3.05 | ≤ 30.0 | — | — |
| ≤ 40.0 | | | 35.0~80.0 | | 10.0~40.0 | | | — | — | — | — |
| — | ≤ 2.0 | ≤ 15.0 | — | — | — | — | 15.0~35.0 | — | ≤ 35.0 | — | — |
| | | | | | | | | | ≤ 30.0 | | |
| — | ≤ 5.0 | ≤ 10.0 | — | — | — | — | 5.0~40.0 | 2.40~2.80 | — | — | — |
| | | ≤ 2.0 | | | | | | 1.40~2.20 | | | |
| ≤ 2.0 | ≤ 5.0 | ≤ 15.0 | — | — | — | — | 10.0~40.0 | — | — | — | — |
| — | — | ≤ 2.0 | ≤ 10.0 | ≤ 15.0 | ≤ 15.0 | ≤ 25.0 | 50.0~80.0 | — | — | — | — |

* Compacting pressure : 490MPa., 1% Zn-St added

QUALITY CHARACTERISTICS

Quality characteristics of alloyed steel powder for powder metallurgy

| Types | Designation | Chemical composition (%) | | | | | | | | | |
|---|-------------------|--------------------------|-------|---------------|--------|-----------------|---------------|---------------|---------------|---------------|---------------|
| | | T. C | Si | Mn | P | S | Cu | Ni | Cr | Mo | V |
| Partially alloyed steel powder for high strength parts | JIP SIGMALOY 2010 | | | | | | — | 1.80~ 2.20 | | 0.90~ 1.10 | |
| | JIP SIGMALOY 215S | ≤0.010 | ≤0.05 | ≤0.12 | ≤0.015 | ≤0.015 | 1.30~ 1.70 | 1.50~ 2.00 | — | 0.45~ 0.55 | — |
| | JIP SIGMALOY 415S | | | | | | | 4.00~ 4.80 | | | |
| Mo Hybrid alloyed steel powder | JIP AH4515 | ≤0.020 | ≤0.06 | 0.15~ 0.25 | ≤0.030 | ≤0.030 | — | — | — | 0.50~ 0.70 | — |
| Completely alloyed steel powder for high strength parts | JIP 4655S | | ≤0.05 | ≤0.30 | ≤0.020 | | | 0.40~ 0.60 | | 0.45~ 0.65 | |
| | JIP 5MOS | | ≤0.06 | ≤0.25 | | | | | — | 0.50~ 0.70 | |
| | JIP 4MOA | ≤0.020 | | 0.15~ 0.25 | | ≤0.030 | | | | 0.35~ 0.55 | |
| | JIP 5CRA | | | 0.10~ 0.30 | ≤0.030 | | | | 0.40~ 0.60 | 0.1~ 0.3 | — |
| | JIP 4100V | | | 0.60~ 0.90 | | | | | 0.90~ 1.20 | 0.20~ 0.40 | |
| | JIP 20CRV | ≤0.050 | | | | 0.170~ 0.230 | — | — | 1.80~ 2.20 | 0.15~ 0.30 | |
| | JIP 30CRV | ≤0.100 | ≤0.10 | ≤0.30 | | ≤0.030 | | | 2.50~ 3.50 | 0.20~ 0.40 | 0.20~ 0.40 |
| | JIP 25MOA | | | ≤0.15 | ≤0.020 | | | | | 2.00~ 3.00 | |
| | JIP 35MOA | ≤0.020 | | ≤0.20 | ≤0.050 | ≤0.020 | | | | 3.20~ 3.50 | |
| | JIP 50MOA | | | ≤0.15 | | | | | — | 4.50~ 5.50 | — |
| | JIP 65COA | | | ≤0.20 | ≤0.020 | ≤0.030 | 0.10~ 0.30 | 1.40~ 1.80 | | 1.30~ 1.70 | |

| | | Particle size distribution (μm) (%) | | | | | | | | | Apparent density (Mg/m^3) | Flow rate (s/50g) | * Green density (Mg/m^3) |
|---------------|--------------|--|-------------|-------------|---------------|---------------|--------------|---------------|---------------|---------------|---|-------------------------------|--|
| Co | O | + 250 | + 180 | + 150 | + 106 | + 75 | + 63 | + 45 | - 45 | | | | |
| | ≤ 0.120 | | | | 10.0~ 30.0 | 10.0~ 35.0 | 5.0~ 20.0 | 10.0~ 30.0 | 10.0~ 35.0 | 2.90~ 3.10 | | * ³ 7.10 \leq | |
| - | ≤ 0.150 | - | ≤ 2.0 | ≤ 15.0 | - | - | - | - | 5.0~ 35.0 | 2.80~ 3.10 | ≤ 30.0 | * ³ 7.15 \leq | |
| | | | | | 10.0~ 30.0 | 10.0~ 40.0 | ≤ 25.0 | 5.0~ 30.0 | | | | | |
| - | ≤ 0.200 | - | ≤ 2.0 | ≤ 15.0 | - | - | - | - | 10.0~ 30.0 | 2.90~ 3.20 | ≤ 30.0 | * ³ 7.10 \leq | |
| | ≤ 0.150 | | | | | | | | | 2.70~ 3.10 | ≤ 40.0 | | |
| | ≤ 0.200 | - | ≤ 2.0 | ≤ 15.0 | - | - | - | - | 10.0~ 30.0 | 2.90~ 3.20 | ≤ 30.0 | * ³ 7.10 \leq | |
| | ≤ 0.400 | | | | | | | | | | | | |
| - | ≤ 0.250 | ≤ 2.0 | ≤ 25.0 | | 10.0~ 40.0 | 15.0~ 45.0 | ≤ 25.0 | 5.0~ 30.0 | ≤ 25.0 | 2.70~ 2.95 | ≤ 35.0 | * ³ 7.05 \leq | |
| | ≤ 0.300 | | ≤ 10.0 | ≤ 20.0 | 10.0~ 30.0 | 15.0~ 35.0 | ≤ 20.0 | 5.0~ 25.0 | 5.0~ 25.0 | 2.80~ 3.30 | ≤ 30.0 | * ¹ 6.65 \leq | |
| | ≤ 0.250 | | ≤ 5.0 | ≤ 15.0 | 10.0~ 35.0 | 10.0~ 40.0 | ≤ 25.0 | 5.0~ 30.0 | 5.0~ 30.0 | 2.55~ 2.85 | ≤ 35.0 | | |
| | | | | | | | | | | 2.95~ 3.35 | | * ³ 6.90 \leq | |
| | ≤ 0.200 | - | ≤ 2.0 | ≤ 20.0 | | | | | 10.0~ 40.0 | 2.95~ 3.25 | ≤ 30.0 | | |
| | | | | | | | | | | 2.95~ 3.35 | | | |
| 6.00~ 7.00 | ≤ 0.250 | | ≤ 3.0 | ≤ 15.0 | 15.0~ 30.0 | 15.0~ 35.0 | ≤ 20.0 | 5.0~ 25.0 | 15.0~ 30.0 | 2.75~ 3.05 | | * ² 6.70 \leq | |

*1 : Compacting pressure : 490MPa

*2 : Compacting pressure : 588MPa

*3 : Compacting pressure : 686MPa
1% Zn-St added

Characteristics of JIP™ iron and steel powder

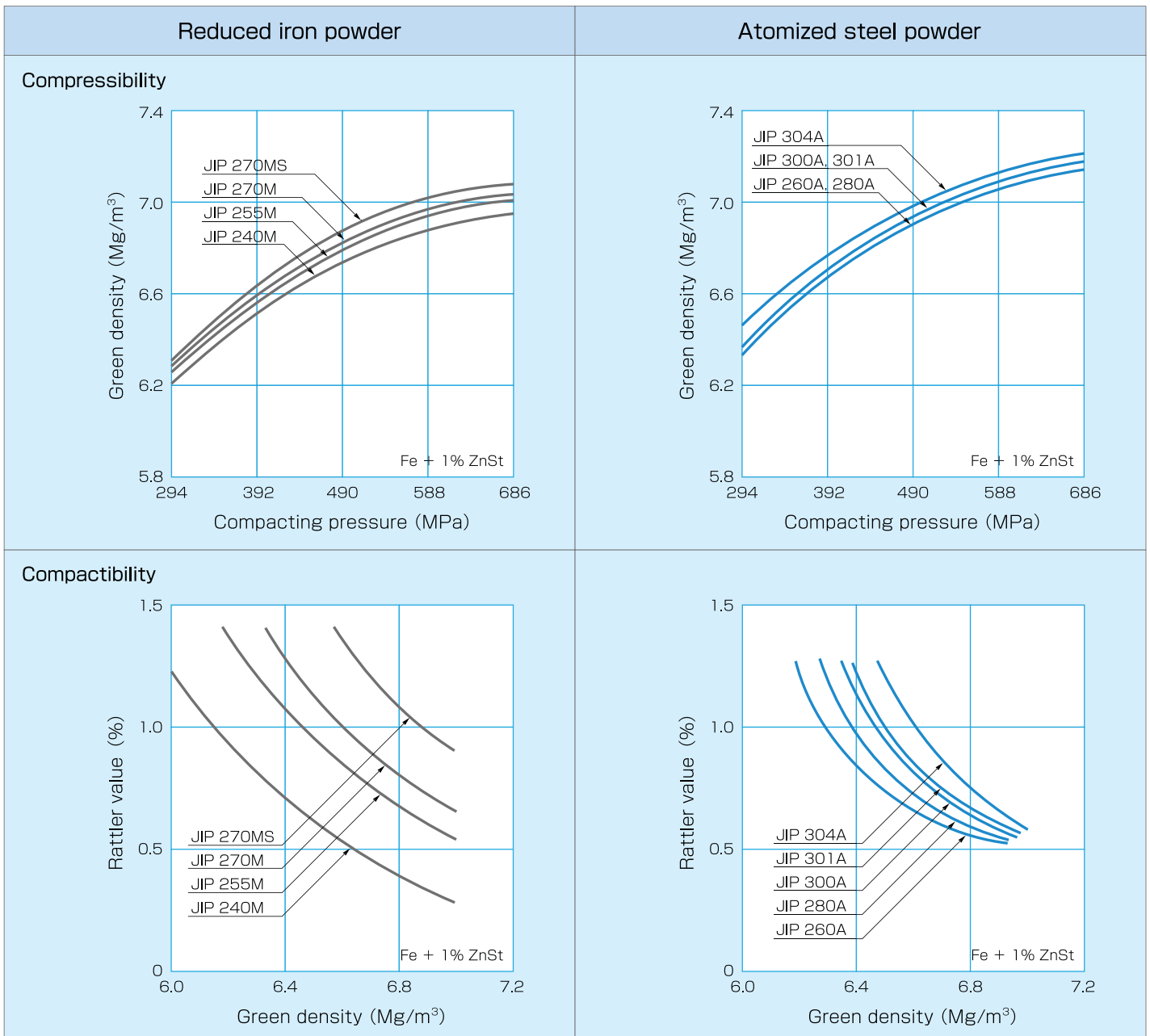
● Properties of green compact

[Compressibility]

- (1) Since JIP™ iron and steel powders, both the atomized steel powders and reduced iron powders, are made from highly pure raw materials and finish-reduced under high purity H₂ atmosphere, they show excellent compressibility.
- (2) The higher the apparent density, the better the compressibility.

[Compactibility]

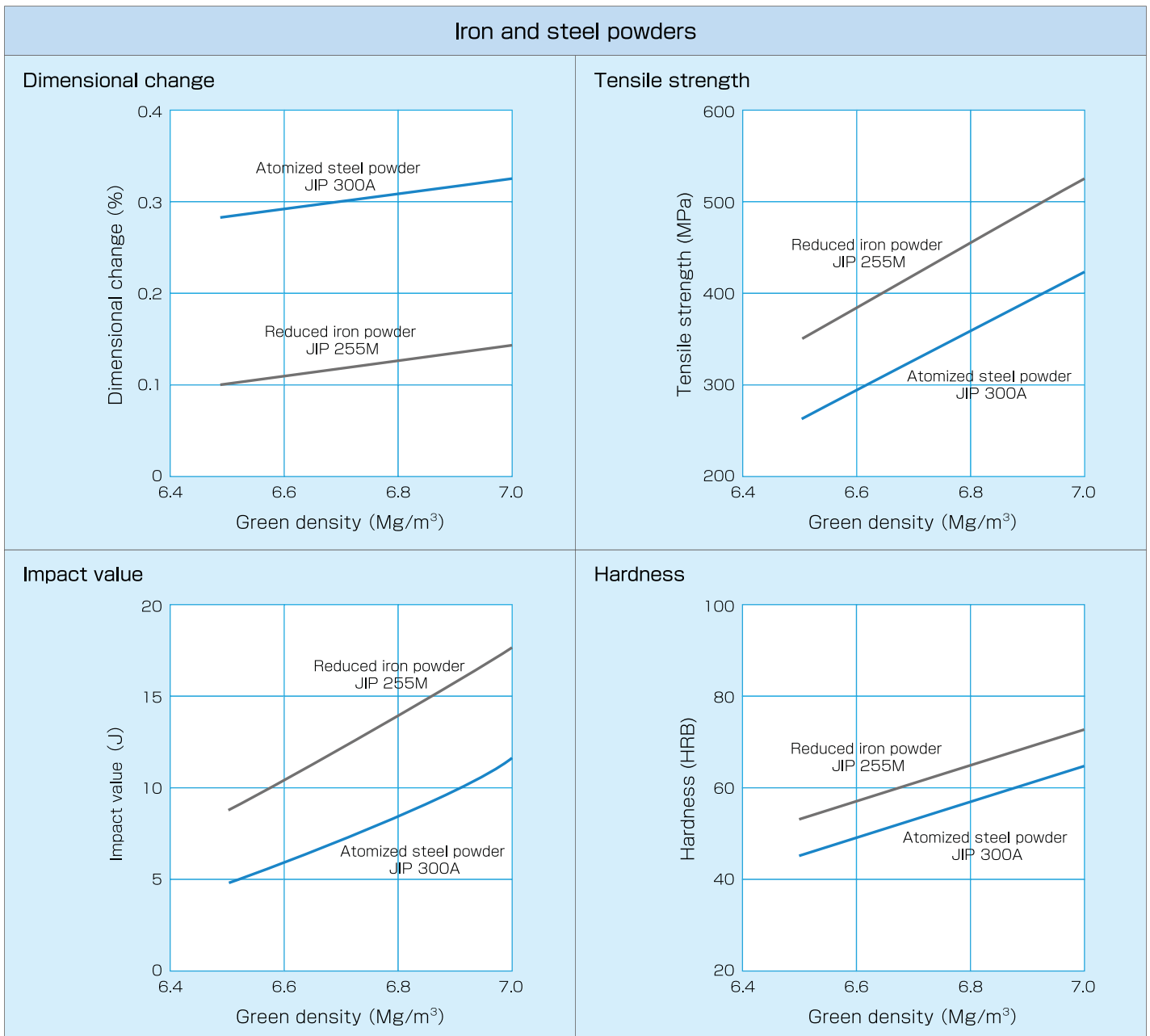
- (1) The compactibility of green compact is usually judged by the Rattler test (edge stability test). Both JIP™ reduced iron powder and atomized steel powder show good compactibility under the test.
- (2) The lower the apparent density, the better the compactibility.



● Properties of sintered products

- (1) JIP™ iron and steel powders exhibit excellent reactivity with a variety of alloying elements, making it possible to produce high-strength sintered products.
- (2) As JIP™ iron and steel powders are manufactured under the strict quality control system, they show extremely low variation in sintered product properties such as dimensional change.
- (3) As for dimensional change during sintering, reduced iron powders tend to shrink more comparing with atomized steel powder. This is one of the great features of JIP™ reduced iron powder.

Composition : Fe-1.5% Cu-0.5% Gr-1 % ZnSt
 Sintering temperature and time : 1130°C×20min
 Sintering atmosphere : Endothermic gas, D.P. 0°C



ALLOYED STEEL POWDER

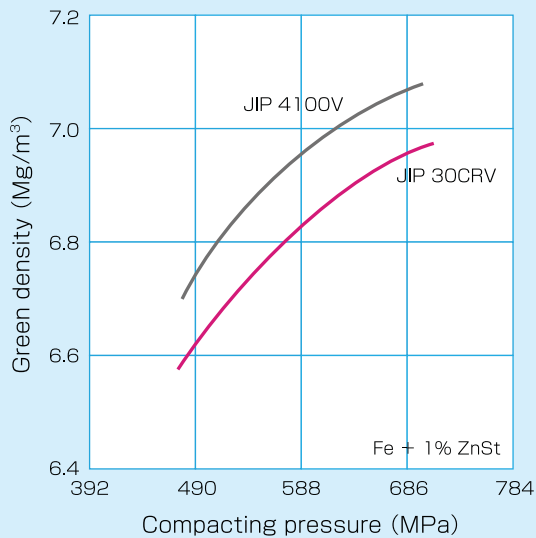
1. Characteristics of Cr alloyed steel powder “JIP™ 4100V, JIP™ 30CRV”

- (1) Being produced by the JFE-developed vacuum reduction process, JIP™ 4100V and JIP™ 30CRV are the steel powders with less oxygen, carbon and nitrogen contents than those of conventional products containing Cr, and thus offer high compressibility.
- (2) Nitrogen, hydrogen and vacuum atmosphere is suitable for sintering.
- (3) They are most idealistic for high strength, wear resistant parts.
- (4) JIP™ 30CRV is suitable for heat and wear resistant parts, and the sintered products exhibit excellent characteristic (high hardness, high tensile strength) in the as-sintered condition.

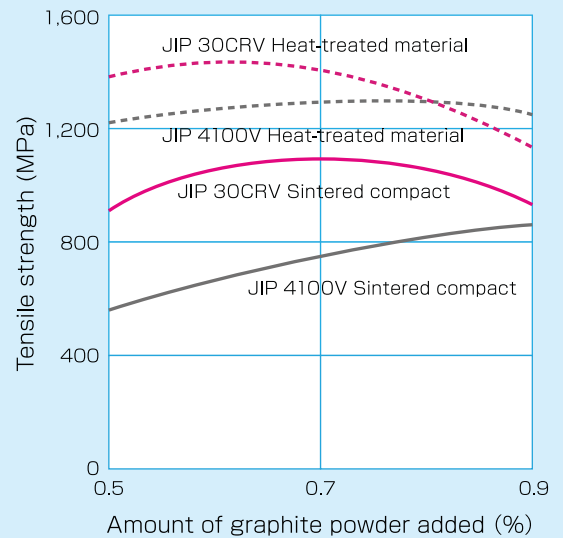
| | |
|---------------------|--|
| Composition | : Fe-X% Cr-1% ZnSt |
| Compacting pressure | : 686MPa |
| Sintering | : 1250°C×60min. in AX gas |
| Quenching | : 4100V : 810°C×30min. O.Q. 30CRV : 850-900°C×30min. O.Q. |
| Tempering | : 4100V : 170°C×90min. A.C. 30CRV : 170°C×30min. A.C. |

JIP™ 4100V, JIP™ 30CRV

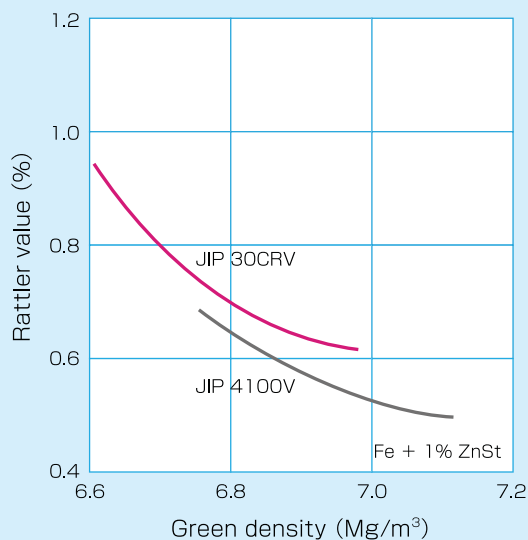
Compressibility



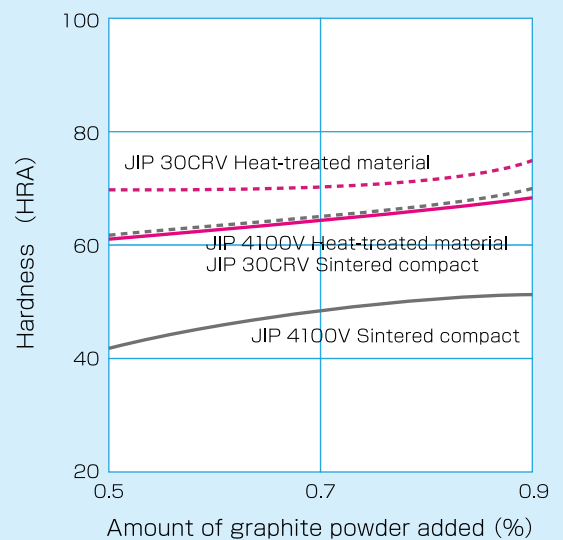
Tensile strength



Compactibility



Hardness



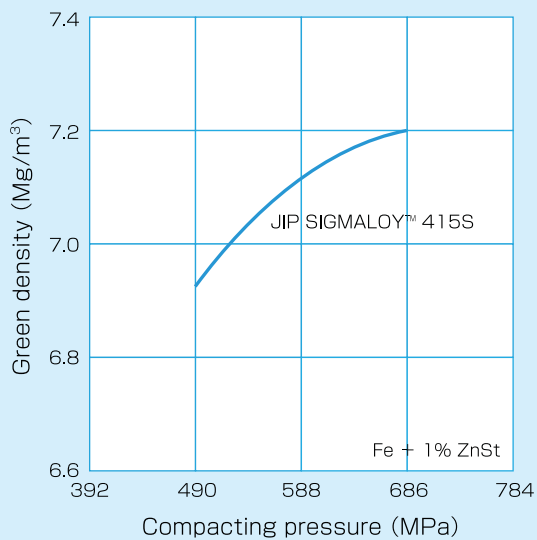
2. Characteristics of Ni-Cu-Mo partially alloyed steel powder “JIP SIGMALOY™ 415S”

- (1) JIP SIGMALOY™ 415S are the partially alloyed steel powders made by metallurgically combining the alloying elements around the pure iron powder particles, and can prevent segregation of alloying elements in sintered compacts.
- (2) In spite that they are partially alloyed with Ni-Cu-Mo, they have very high compressibility.
- (3) As JIP SIGMALOY™ 415S is made by especially promoting the diffusion of Ni at the time of sintering, it exhibits high strength in as-sintered condition at high sintering temperature of 1250°C or more.

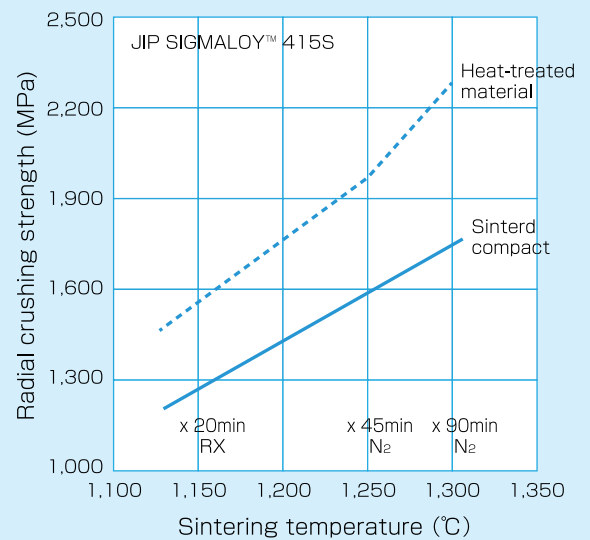
Composition : Fe-0.5% Cr-0.75% ZnSt
 Green density : 7.0Mg/m³
 Quenching : 870°C × 60min. O.Q.
 Tempering : 200°C × 60min. A.C.

JIP SIGMALOY™ 415S

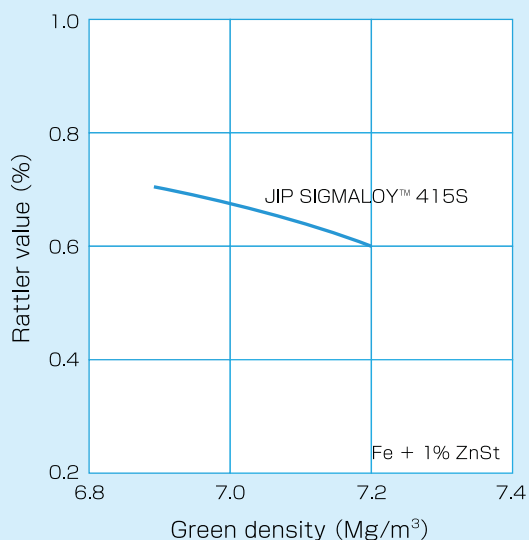
Compressibility



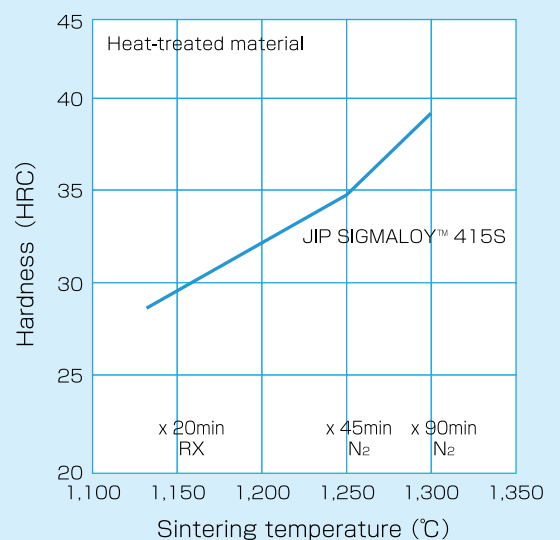
Radial crushing strength



Compactibility



Hardness

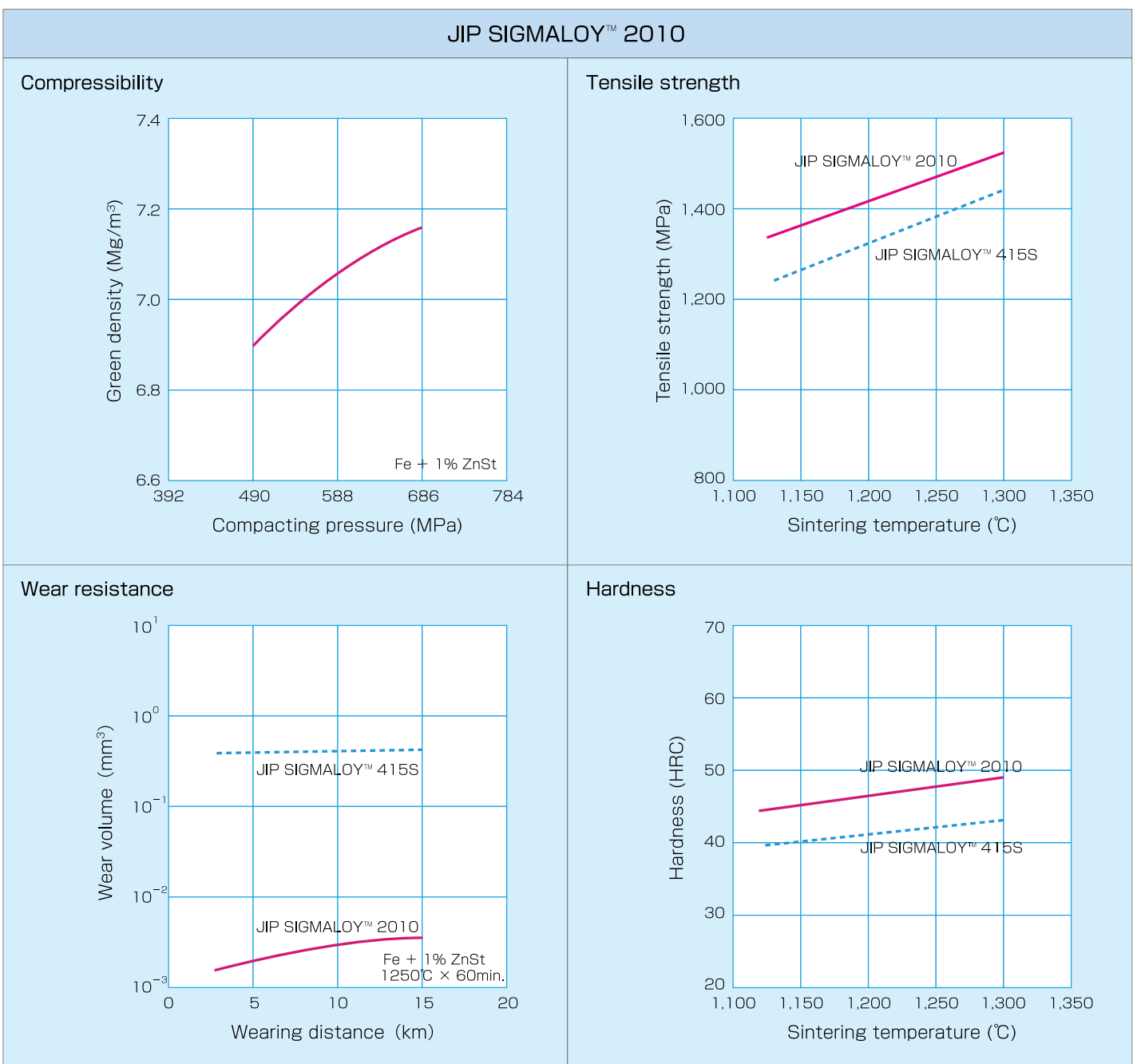


ALLOYED STEEL POWDER

3. Characteristics of Ni-Cu-Mo partially alloyed steel powder “JIP SIGMALOY™ 2010”

- (1) This is partially alloyed steel powder which increases its strength when heat-treated.
- (2) It offers higher strength than JIP SIGMALOY™ 415S under IPIS1H condition.
- (3) It can be easily re-compacted as it is very soft after sintering, and exhibits the highest level of strength at 2P2S1H condition.

| | |
|---------------------|----------------------|
| Composition | : Fe-0.3% Gr-1% ZnSt |
| Compacting pressure | : 686MPa |
| Sintering | : 60min. in AX gas |
| Quenching | : 920°C×150min. O.Q. |
| Tempering | : 180°C×60min. A.C. |



4. Characteristics of Ni-Free alloyed steel powder “JIP™ FM600”

(1) This shows mechanical properties equivalent to 4%Ni alloyed steel powder when sintered with conventional mesh belt sintering furnaces.

(2) It shows a tool chip wear rate only 1/5 times that of 4%Ni alloyed steel powder.

Test sample

FM600 : 4MOA(0.45Mo)-2%Cu-0.8%Gr+0.5%Lub(HDX)

4%Ni : SIGMALOY415S-0.6%Gr+0.8%Lub(ZnSt)

Compacting : 490, 588, 686MPa

Sintering : Mesh belt furnace (1130°C×10min, Endothermic gas)

Turning test condition

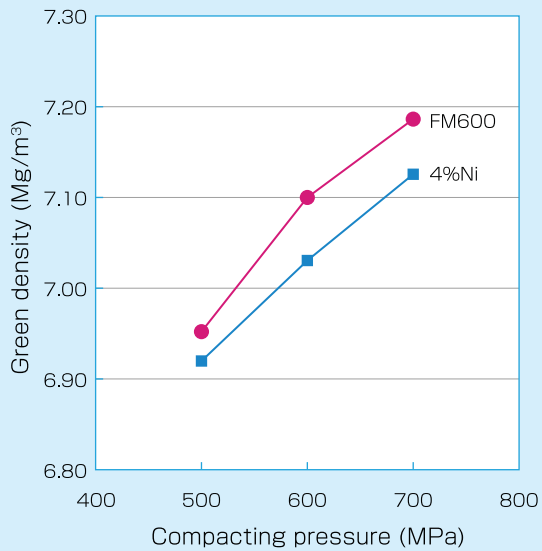
Turning tool chip : Cermet

Feed : 0.1mm/rev without coolant

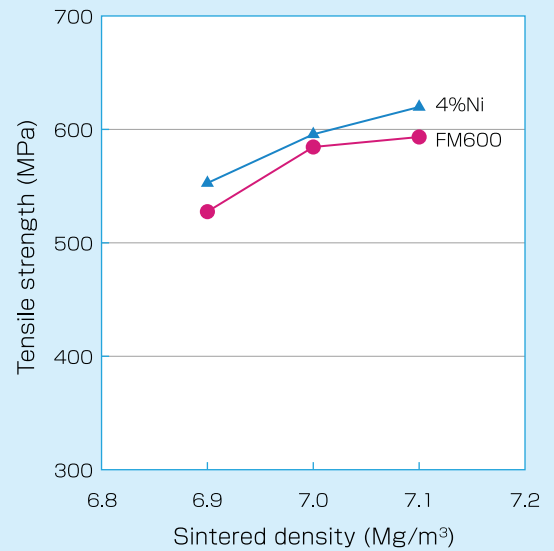
Turning speed : 200m/min

Depth of cut : 0.5mm

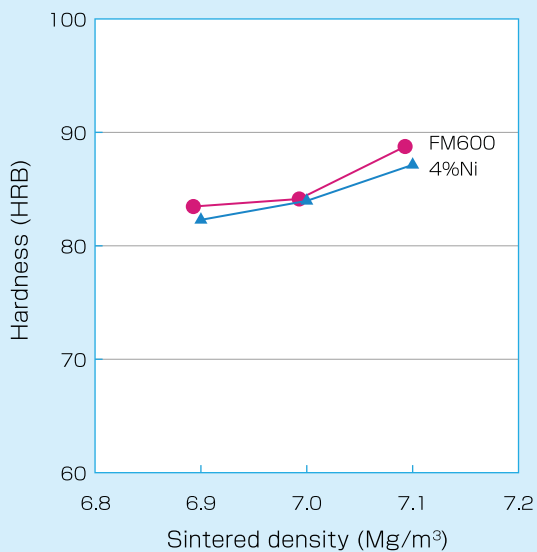
Compressibility



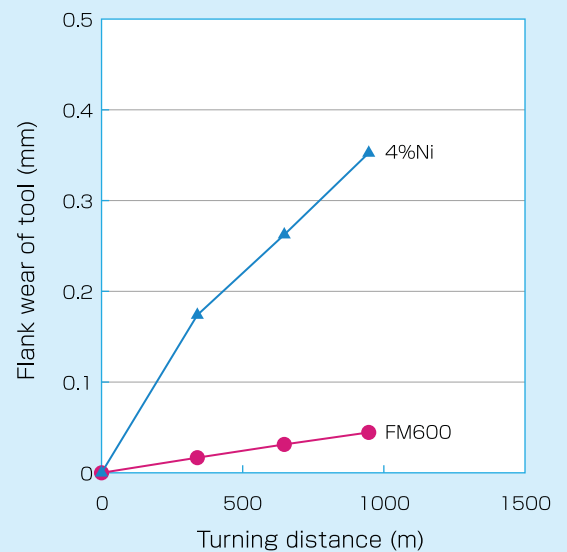
Tensile strength



Hardness



Tool chip wear



ALLOYED STEEL POWDER

5. Characteristics of Ni-Free alloyed steel powder “JIP™ FM1000”

(1) This shows mechanical properties equivalent to 4%Ni alloyed steel powder when sintered with conventional mesh belt sintering furnace then heat-treated.

(2) It shows a tool chip wear rate only 1/5 times that of 4%Ni alloyed steel powder.

Test sample

FM1000 : 4MOA(0.45Mo)-1%Cu-0.5%Gr+0.5%Lub(HDX)

4%Ni : SIGMALOY415S-0.3%Gr+0.8%Lub(ZnSt)

Compacting : 490,588,686MPa

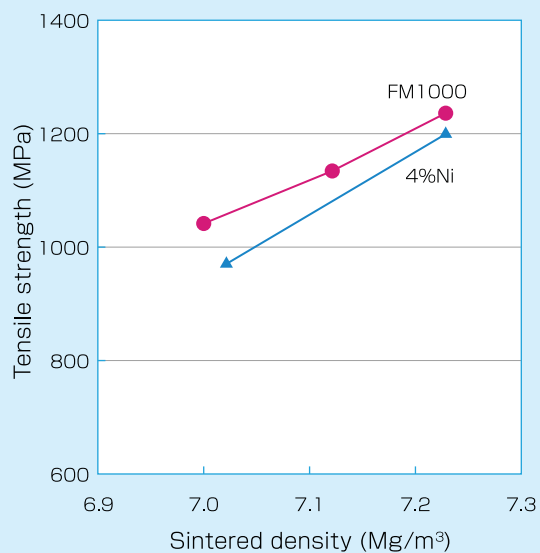
Sintering : mesh belt furnace (1130°C×10min, Endothermic gas)

Heat treatment : Carburizing 900°C×60min C.P. 0.8%

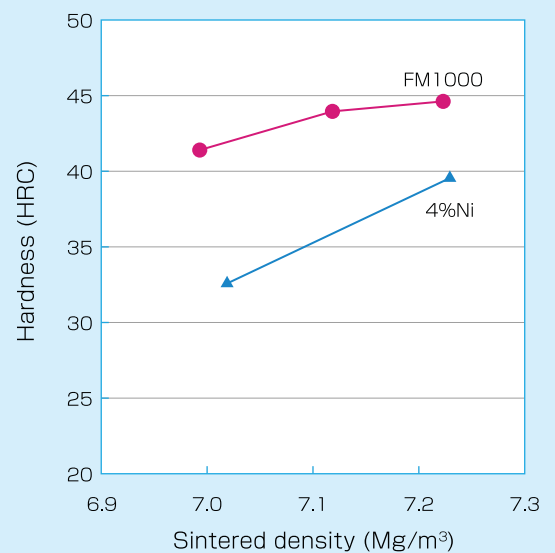
Quenching into 60°C oil

Tempering 180°C×60min

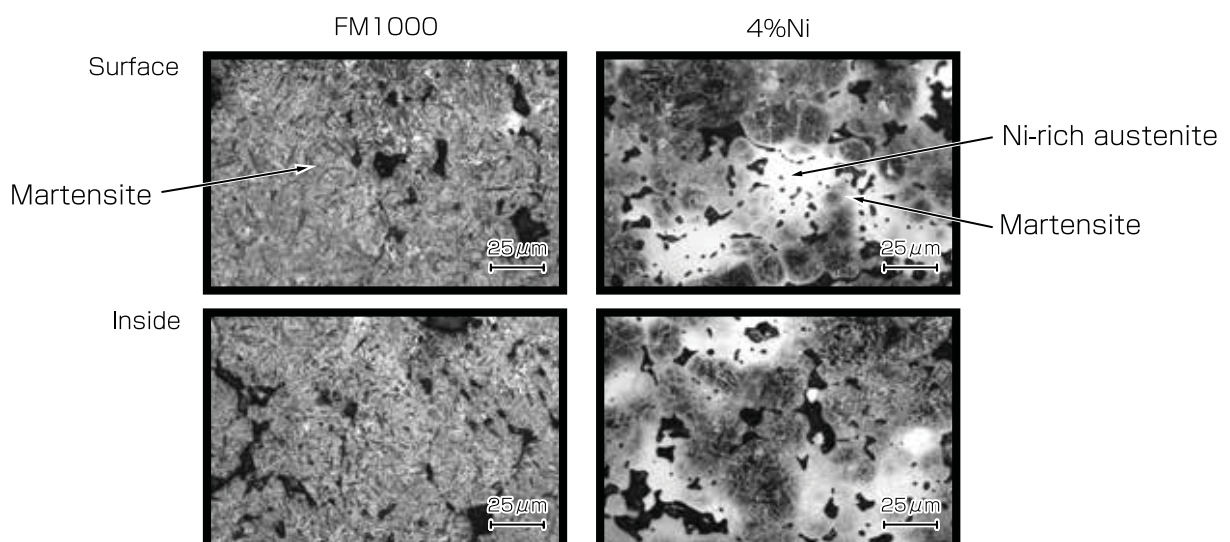
Tensile strength



Hardness



FM1000 shows homogeneous tempered martensite structure



6. Characteristics of Ni-Free alloyed steel powder “JIP™ FM1300”

- (1) This shows mechanical properties equivalent to 4%Ni alloyed steel powder when sintered with high temperature then heat-treated.
- (2) The base steel powder is Mo-hybrid alloyed steel powder “AH4515” (0.45% prealloy+0.15% diffusion bonded) that shows excellent sintering performance.
- (3) It shows higher rolling contact fatigue strength and excellent wear resistance compared with 4%Ni alloyed steel powder.

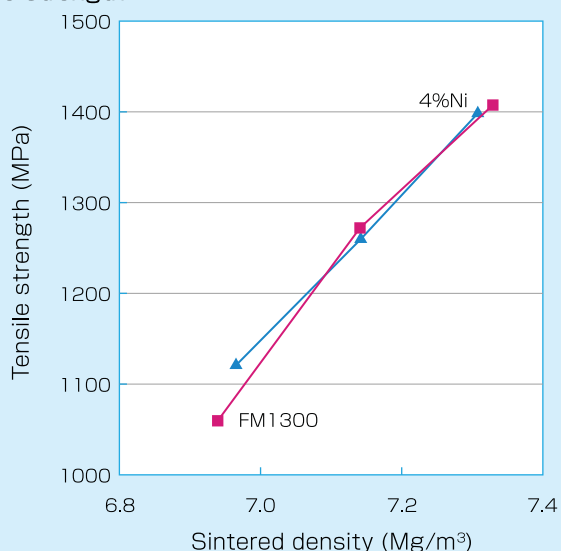
Test sample

FM1300 : AH4515(0.6%Mo)-0.5%Gr+0.5%Lub(HDX)
 4%Ni : SIGMALOY415S-0.3%Gr+0.6%Lub(EBS)
 Green density : 6.8, 7.0, 7.2Mg/m³
 Sintering : 1250°C×60min N₂-10%H₂ gas
 Heat treatment : Carburizing 900°C×60min C.P. 0.8% Quenching into 60°C oil Tempering 180°C×60min

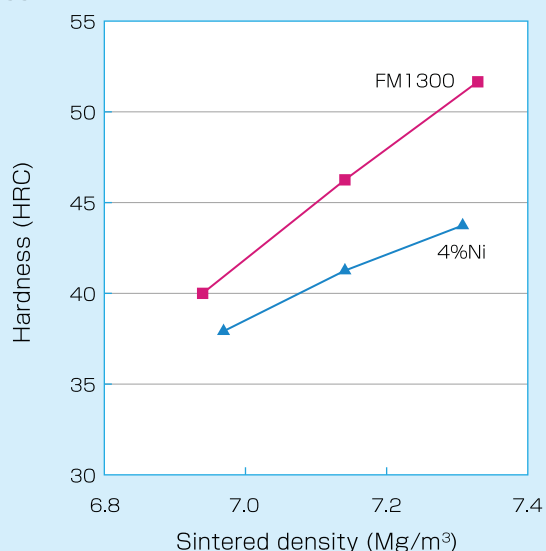
Wear test (Ogoshi-method)

Breaking load : 12.6kgf
 Friction velocity : 4.21m/sec
 Dropping oil : DEXRON III 1 drop/sec

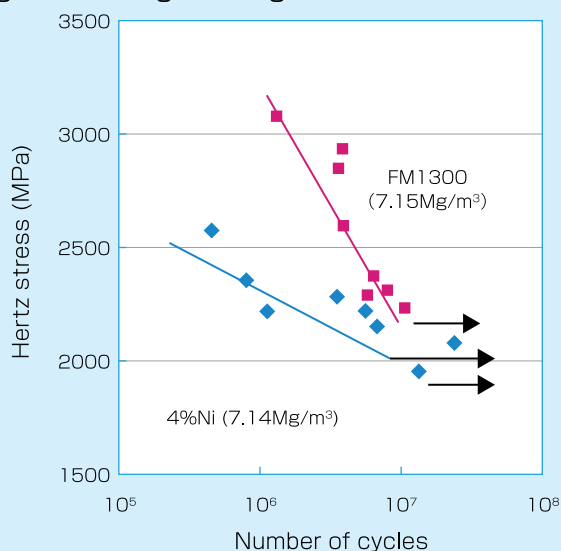
Tensile strength



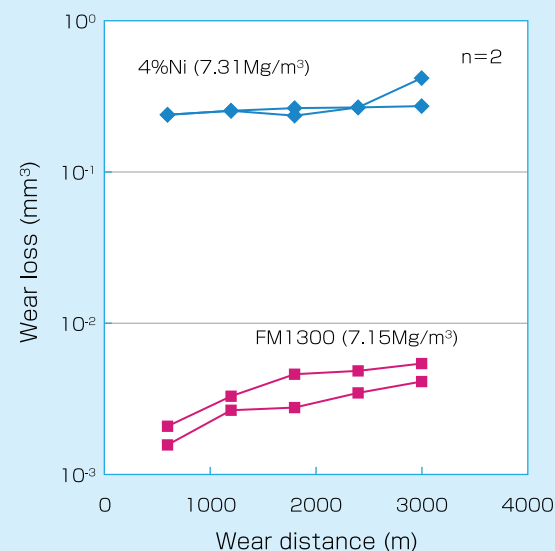
Hardness



Rolling contact fatigue strength



Wear resistance

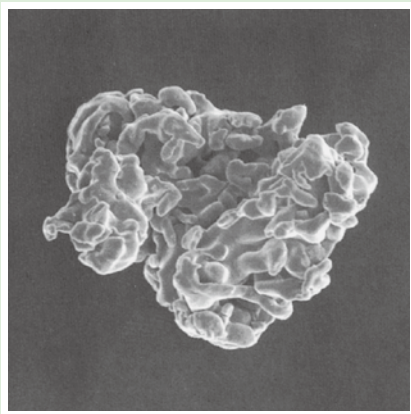


MICROPHOTOGRAPHS

The microscope makes the difference in properties clear.

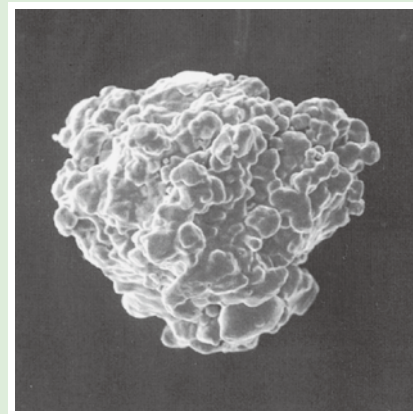
(1) Particle shapes of iron and steel powders (Scanning electron microscopy)

Reduced iron powder



JIP 255M X 200

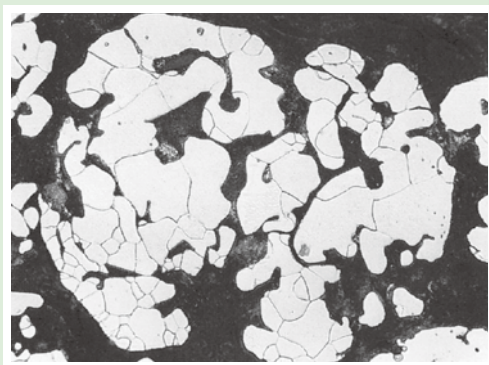
Atomized steel powder



JIP 300A X 200

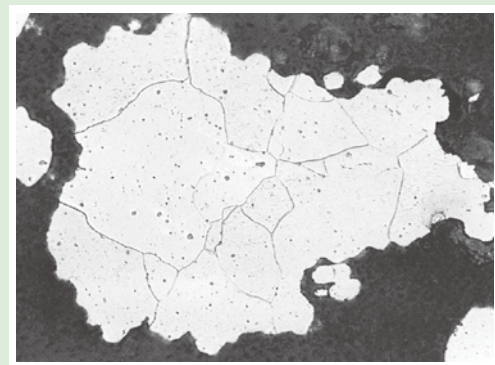
(2) Cross-sectional microstructures of iron and steel powders (Optical microscopy)

Reduced iron powder



JIP 255M X 400

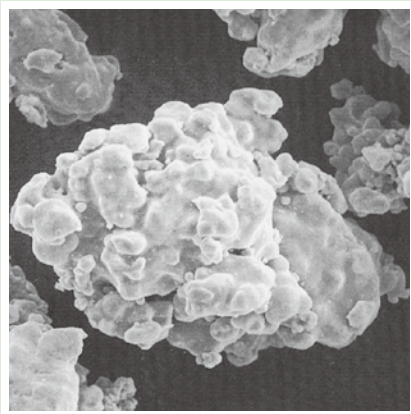
Atomized steel powder



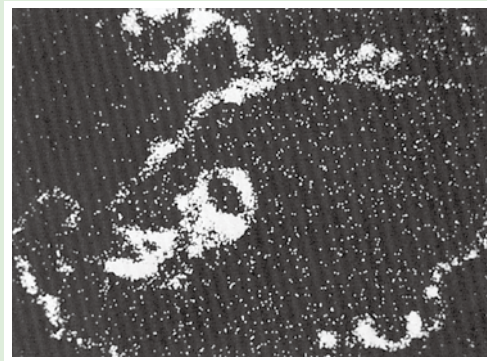
JIP 300A X 400

(3) Particle shape of the partially alloyed steel powder (photomicrographs by scanning electron microscope)

SEM photo of surface
of JIP SIGMALOY™ particles



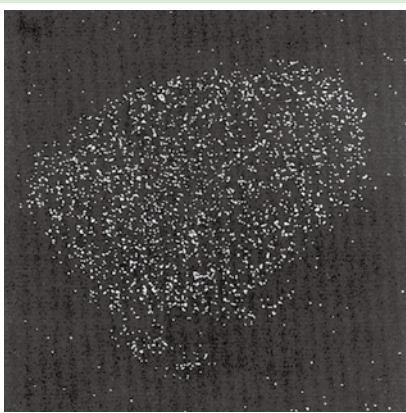
Distribution of Ni in JIP SIGMALOY™



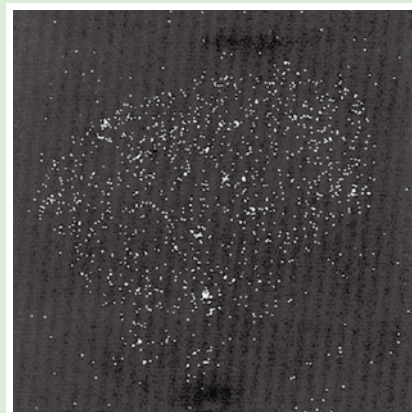
- White dots represent alloying elements.
- The photo shows that the alloying elements are uniformly distributed on the surface of powder particles.

(4) EPMA images of alloyed steel powder (JIP™ 4100V)

Cr



Mn



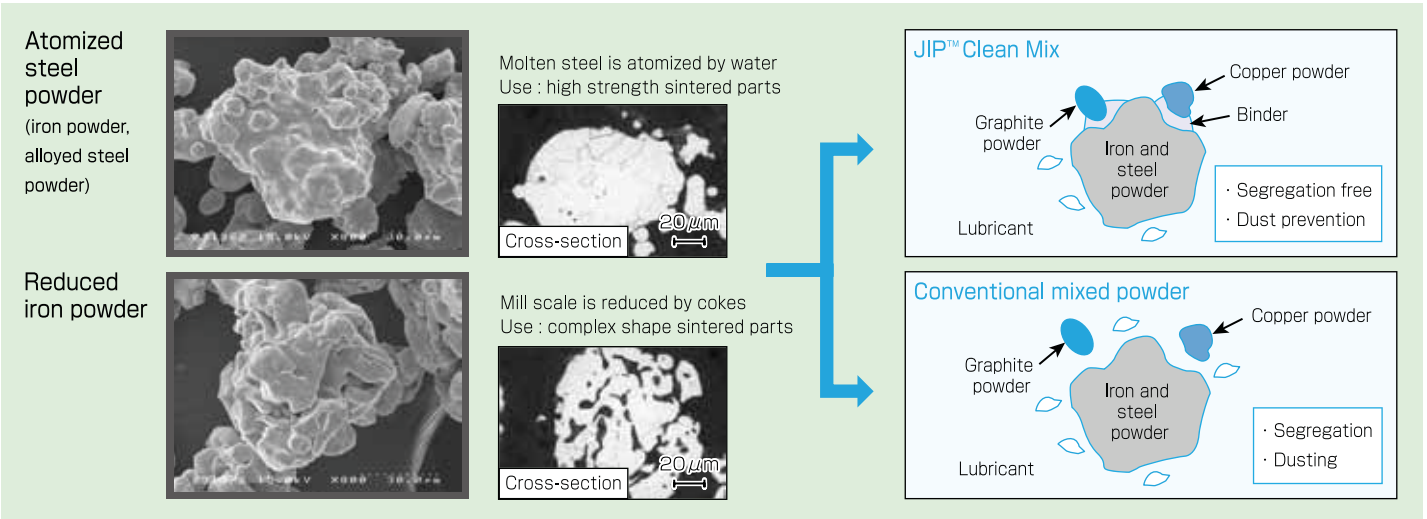
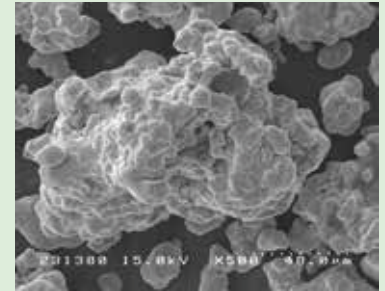
- White dots represent alloying elements.
- The photos shows that the alloying elements are uniformly distributed.

What is “JIP™ Clean Mix”?

JIP™ Clean Mix is new premixed powder that we have developed to prevent segregation. In the ordinary blending method, graphite powder, as well as Ni, Cu, Mo, and other metallic powders, are blended with iron powder. However, in JIP™ Clean Mix, graphite and other additive powders are specially treated to make them adhere to iron powder.

As a result, additives hardly segregate in JIP™ Clean Mix during transportation. In addition, little dust is generated and environmental impact is minimal, and the excellent fluidity improves the productivity of sintered parts. Furthermore, the stable dimensional accuracy reduces changes in dimensions of sintered parts.

Scanning electron microscope image of JIP™ Clean Mix



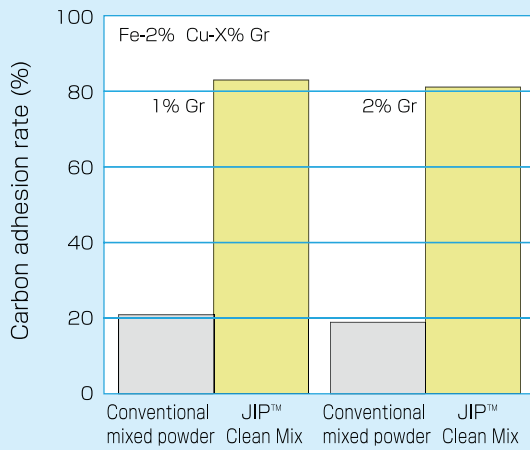
| No | Type | Performance and feature |
|----|--|---|
| 1 | Zinc stearate system | Segregation free of graphite powder |
| 2 | Wax system | Prevention of Zinc-oxide pollution in sintering furnace |
| 3 | Zinc free lubricant | Clean appearance of sintered parts |
| 4 | Cu segregation free | Segregation free of both Graphite powder and Copper powder |
| 5 | Room temperature high density "HDX" | Suitable for high density sintered parts as it's possible to press with only 0.5% lub. |
| 6 | Low ejection force "LX" | Suitable for long shape sintered parts that is high ejection force |
| 7 | Free machining "JFM3" | Good drill machining |
| 8 | Free machining "JFM4" | Good turning machining |
| 9 | Free machining "JFMX" | Good both drill and turning machining |
| 10 | Weight stability "ZERO" | Good fluidity and weight stability of sintered parts |
| 11 | Ni-free alloyed steel powder "FM600", "FM1000", "FM1300" | Low cost and high strength equivalent to 4%Ni |
| 12 | Sinter-hardening "21SX" | For sinter-hardening method |
| 13 | Dimensional stability | Combination of reduced iron powder and Cu segregation free powder shows excellent dimensional stability |

“JIP™ Clean Mix” improves the productivity and environmental preservation.

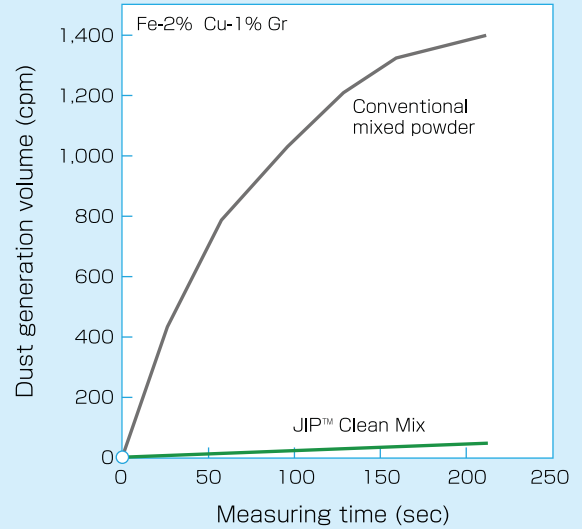
JIP™ Clean Mix

Volume of carbon adhesion

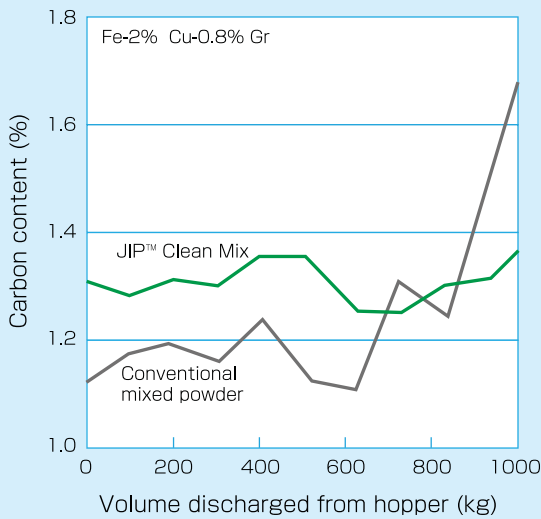
$$\left(\frac{\text{Carbon volume in particle size of } 150\mu\text{m}\sim 75\mu\text{m}}{\text{Total carbon volume in mixed powder}} \right)$$



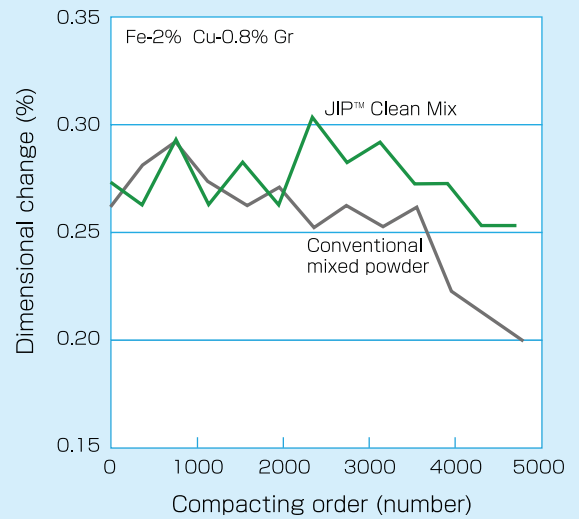
Dust generation volume



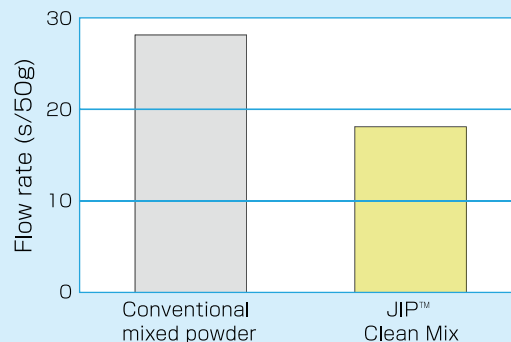
Variation at the time of discharge from hopper



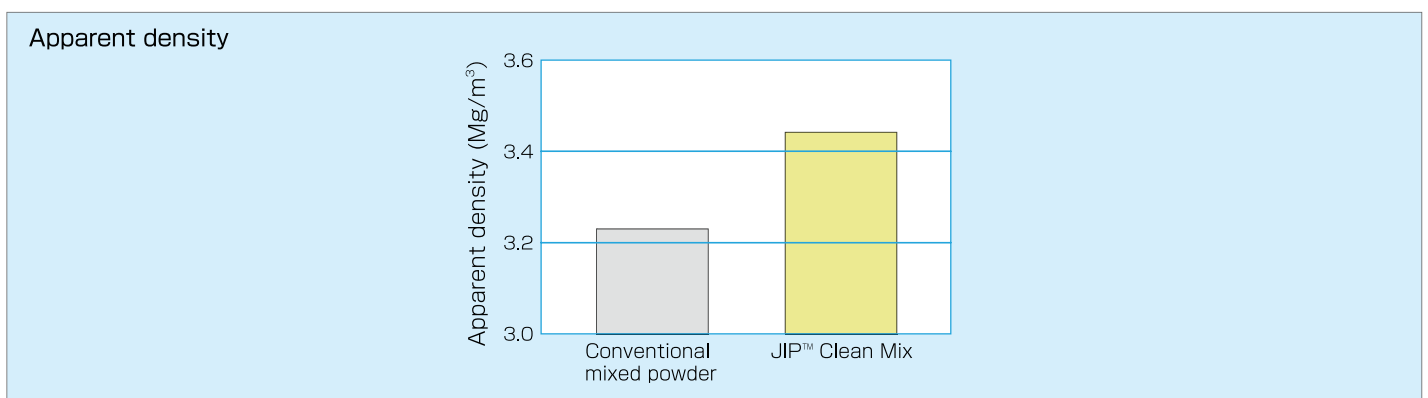
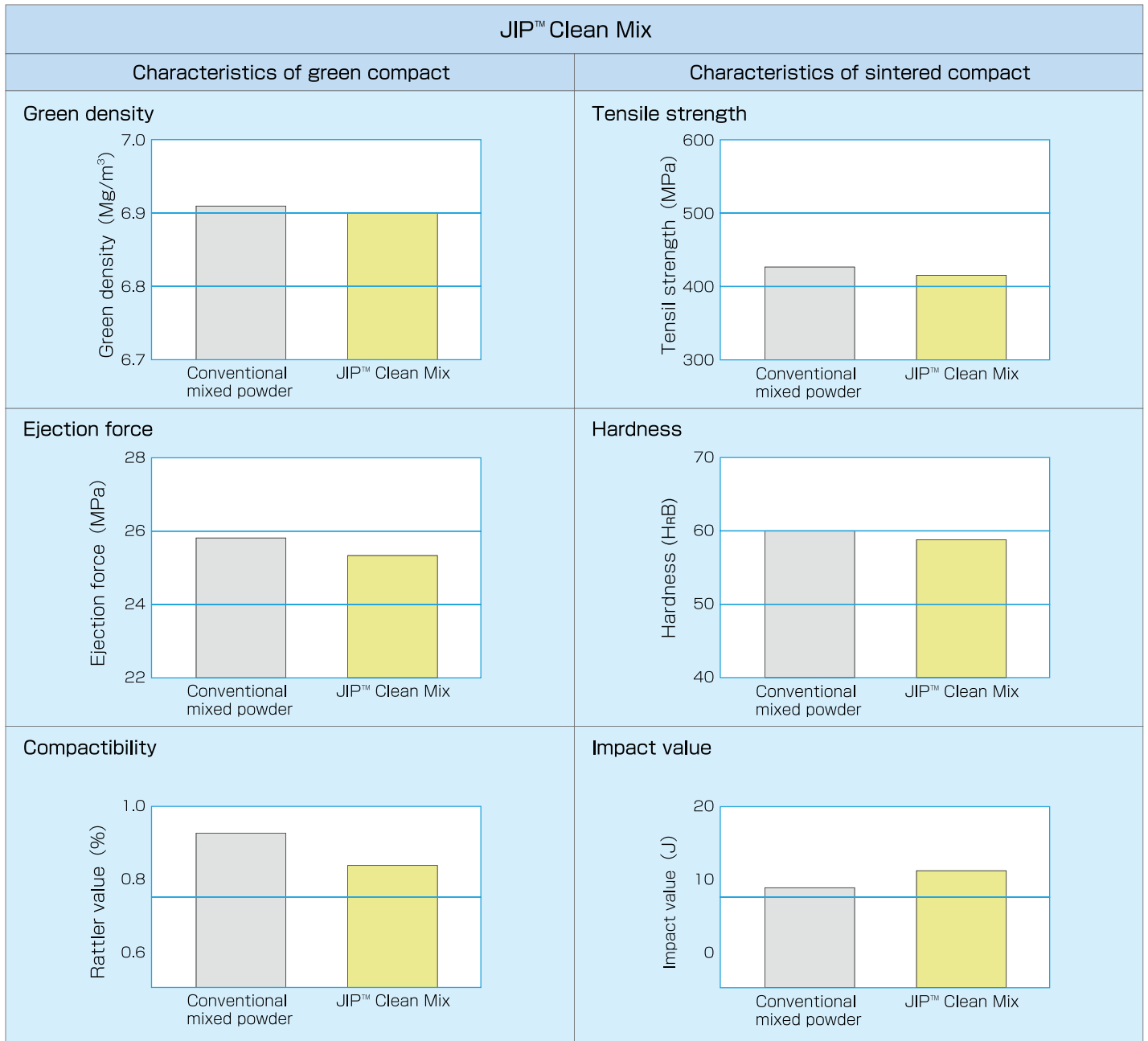
Dimensional change



Fluidity



Other features of “JIP™ Clean Mix”

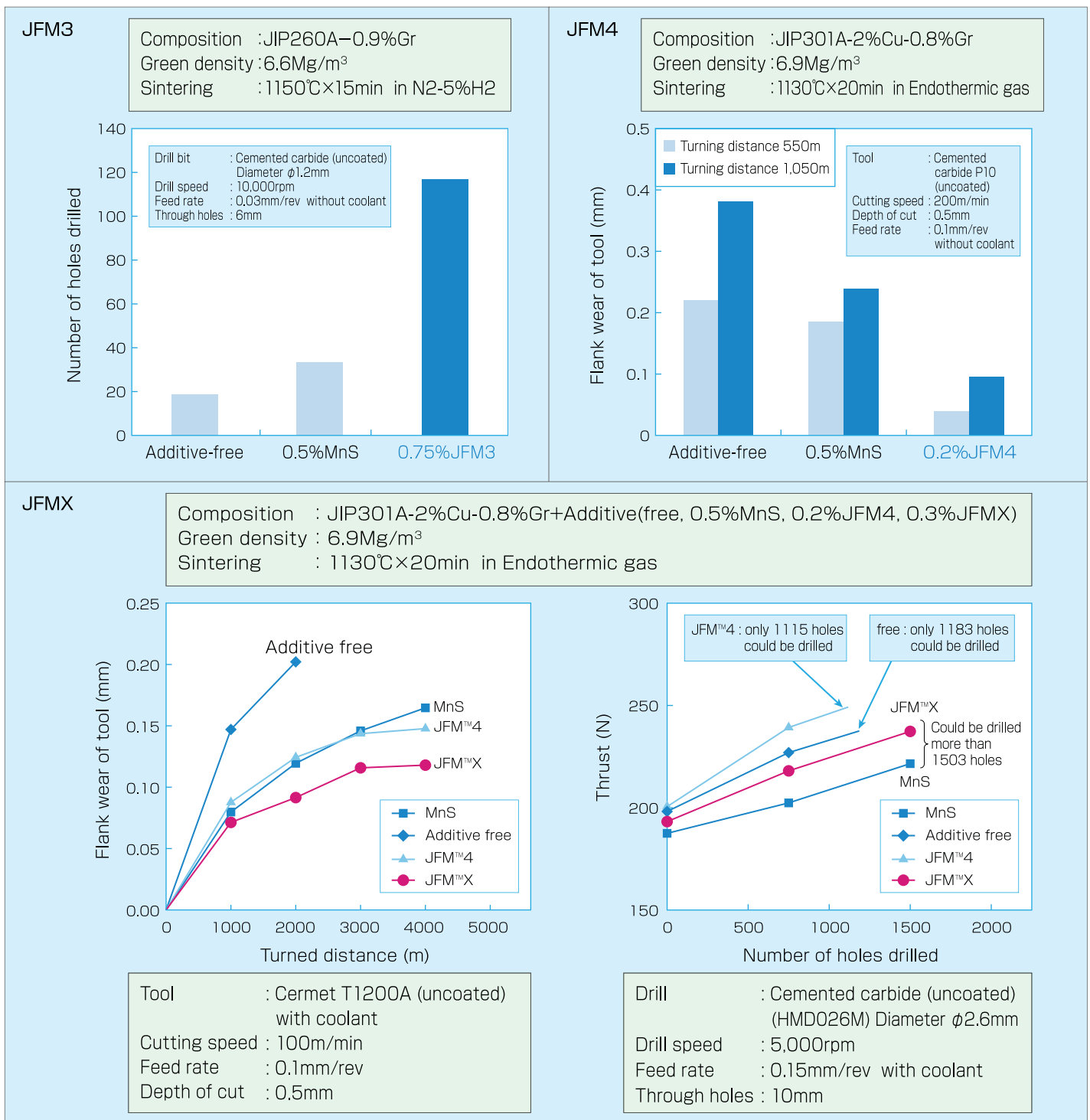


1. Free machining Clean Mix JFM™ series “JFM™3, JFM™4, JFM™X”

JFM™3 : It shows superior drill machinability. Filling pores in the sintered compacts with special additive powders improve to decrease the interrupted cutting, and also promote to become smaller the cutting chips. JFM3 shows 6 times many drilled holes compared with the materials without additives, and also 3 times many drilled holes compared with the materials with MnS.

JFM™4 : It shows superior machinability in the high speed turning over 200m/min. Special additive powders promote to become smaller the cutting chips. Additionally special additive powders are softened by friction heat, then make the protection film on the surface of the tools. The flank wear of the tools shows one-fourth of that of the materials without additives, and one-third of that of the materials with MnS.

JFM™X : It improves the machinability simultaneously in drilling and turning at wide range of cutting speed.



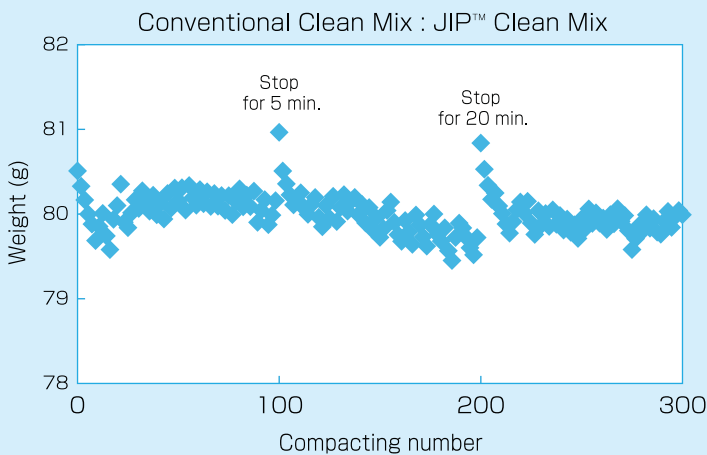
2. JIP™ Clean Mix ZERO shows superior weight and dimensional stability of sintered parts.

It improves weight and dimensional stability of sintered parts by improving filling performance.

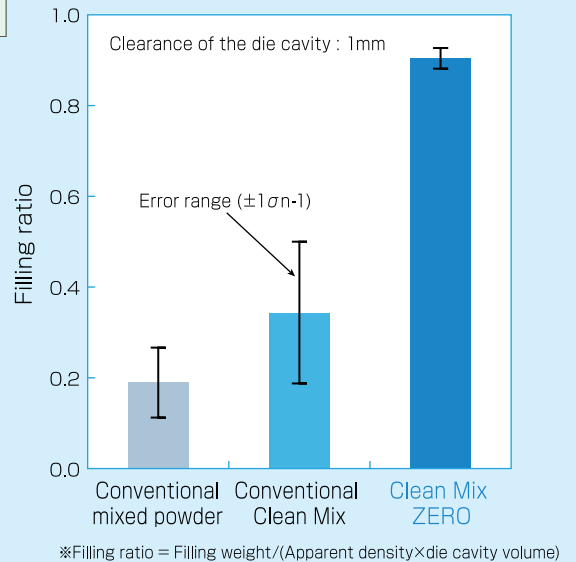
- It decreases variation in weight of green compacts when restarting after press stop.
- It makes it easy to adjusting the compacting conditions, then it makes to decrease numbers of the test compactions.
- It makes it easy to filling the narrow die cavity, then it enables to produce the complex shape sintered parts.
- It contains no metallic soap, so it contributes the clean surface of sintered parts.

Conventional mixed powder : Mixed powder with ZnSt
 Conventional Clean Mix : JIP™ Clean Mix
 Clean Mix ZERO : JIP™ Clean Mix ZERO
 Composition : JIP301A-2%Cu-0.9%Gr+0.8% Lubricant

Variation in weight of green compacts



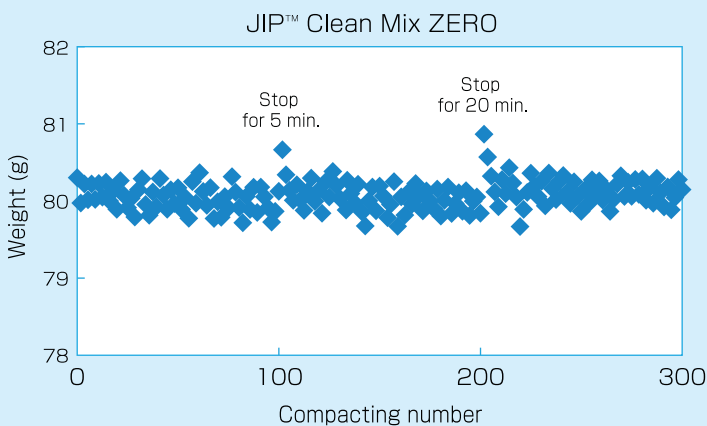
Filling ratio*



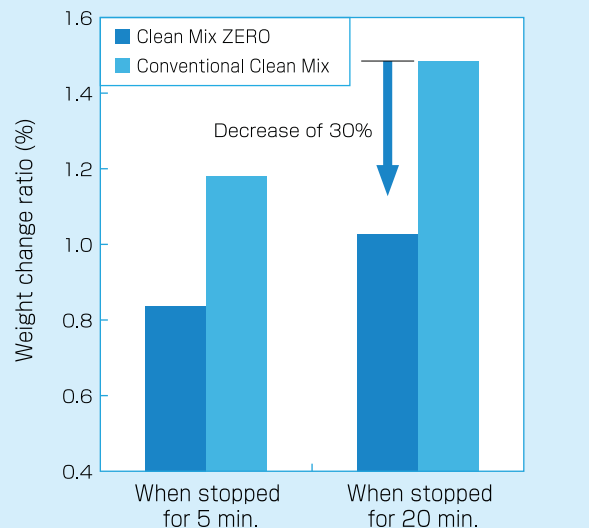
Continuous compacting condition

Test piece : $\phi 30\text{mm} \times \phi 20\text{mm} \times 30\text{mmH}$
 Green density : 6.8Mg/m^3
 Compacting speed : 400 piece/hr

Variation in weight of green compacts



Weight change ratio*



AGRICULTURAL USE PREMIXED IRON POWDER FOR DIRECT SEEDED RICE

Characteristics of S91 premixed iron powder

■ High quality

It's particle size distribution is finer, so it can easily adhere to rice seed surface.

■ Reduction of labor

It doesn't need mixing iron powder and gypsum, as it's homogeneously premixed iron powder and gypsum.※

Net 11kg package is easy to use and to carry by hand.

※ Finishing treatment using gypsum etc. is necessary for coating rice seeds.

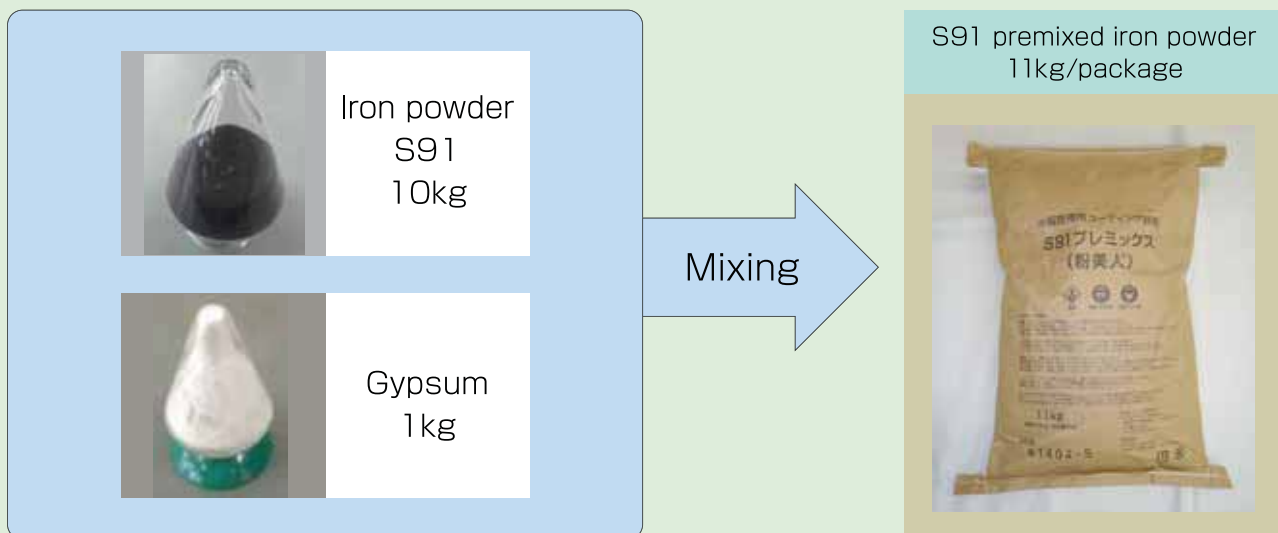
■ Improvement of work environment

It prevents dust, as it hardly adheres to rice seeds after drying.

■ High Safety

Although it's enough fine, it's not the dangerous object in fire law.(※)

※ Public institution proves that it's not applicable to dangerous object in fire law.



Example of using S91 premixed iron powder for rice seeds

| Dry rice seed | 20kg | 300kg(5 sacks of rice) |
|--|----------------------------------|--------------------------------------|
| S91 premixed iron powder <iron powder + gypsum> | 11kg (1 package) <10kg + 1kg> | 165kg(15 packages) <150kg + 15kg> |

※Finishing treatment using gypsum etc. is necessary for coating rice seeds.



PACKING AND MARKING

Packing weight ————— 500kg and 1,000kg flexible containers are provided as standard. The inner bag is made of polyethylene, while the outer bag is made of synthetic film with an outlet at the bottom. The designation, serial No., and weight are marked on the bag.

500kg or 1,000kg flexible container



ORDERING PROCEDURE

Please include the following informations in all orders and inquires for JIP™.

- | | |
|--|--|
| 1. Designation | Green density |
| 2. Specific requirements as to chemical composition, apparent density, flow rate and particle size distribution. | General information on adding elements |
| 3. Quantity | General outline of shape of the end product |
| 4. Detailed information pertaining to intended use-e.g., powder metallurgy, welding, etc. | Required mechanical properties of the sintered compact |
| • For use in powder metallurgy: Bearing or general structural parts | 5. Packaging and marking requirements |
| | 6. Delivery requirements (time and place) |
| | 7. Other important information for producing the ordered product |

PRECAUTIONS FOR USE

- Since iron powder oxidizes, JIP™ iron and steel powders should be used as soon as possible.
- When storing leftover powder, bags should be completely resealed.
- JIP™ iron and steel powders should not be stored in a hot or humid area.

● For further information, please contact our nearest office or send your inquiries directly to:

Iron Powder Sales Dept., Iron Powder Sec. Phone:(81)3-3597-4062,4063,4064,4233 FAX:(81)3-3597-4567

JFE Steel Corporation<http://www.jfe-steel.co.jp/en/>**HEAD OFFICE**

Hibiya Kokusai Building, 2-3 Uchisaiwaicho 2-chome, Chiyodaku, Tokyo 100-0011, Japan Phone: (81)3-3597-3111 Fax: (81)3-3597-4860

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16th Floor, 41, Cheonggyecheon-ro, Jongno-gu, Seoul,
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(Youngpung Building, Seorin-dong)
Phone: (82)2-399-6337 Fax: (82)2-399-6347**BEIJING**JFE Steel Corporation Beijing
1009 Beijing Fortune Building No.5, Dongsanhuan
North Road, Chaoyang District, Beijing, 100004,
P.R.China
Phone: (86)10-6590-9051 Fax: (86)10-6590-9056**SHANGHAI**JFE Consulting (Shanghai) Co., Ltd.
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23rd Floor 6788 Ayala Avenue, Oledan Square,
Makati City, Metro Manila, Philippines
Phone: (63)2-886-7432 Fax: (63)2-886-7315**HO CHI MINH CITY**JFE Steel Vietnam Co., Ltd.
Unit 1704, 17th Floor, MPlaza, 39 Le Duan Street,
Dist 1, HCMC, Vietnam
Phone: (84)28-3825-8576 Fax: (84)28-3825-8562**HANOI**JFE Steel Vietnam Co., Ltd., Hanoi Branch
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Chu Trinh Street, Hoan Kiem Dist., Hanoi, Vietnam
Phone: (84)24-3855-2266 Fax: (84)24-3533-1166**BANGKOK**JFE Steel (Thailand) Ltd.
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Silom, Bangrak, Bangkok 10500, Thailand
Phone: (66)2-636-1886 Fax: (66)2-636-1891**YANGON**JFE Steel (Thailand) Ltd., Yangon Office
Unit 05-01, Union Business Center, Nat Mauk Road,
Bocho Quarter, Bahan Tsp, Yangon, 11201, Myanmar
Phone: (95)1-860-3352**SINGAPORE**JFE Steel Asia Pte. Ltd.
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Phone: (65)6220-1174 Fax: (65)6224-8357**JAKARTA**PT. JFE STEEL INDONESIA
6th Floor Summitmas II, JL Jendral Sudirman Kav.
61-62, Jakarta 12190, Indonesia
Phone: (62)21-522-6405 Fax: (62)21-522-6408**NEW DELHI**JFE Steel India Private Limited
806, 8th Floor, Tower-B, Unitech Signature Towers,
South City-I, NH-8, Gurgaon-122001, Haryana, India
Phone: (91)124-426-4981 Fax: (91)124-426-4982**MUMBAI**JFE Steel India Private Limited, Mumbai Office
603-604, A Wing, 215 Atrium Building, Andheri-Kurla
Road, Andheri (East), Mumbai-400093, Maharashtra,
India
Phone: (91)22-3076-2760 Fax: (91)22-3076-2764**CHENNAI**JFE Steel India Private Limited, Chennai Office
No.86, Ground Floor, Polyhose Towers(SPIC Annexe),
Mount Road, Guindy, Chennai-600032, Tamil Nadu,
India
Phone: (91)44-2230-0285 Fax: (91)44-2230-0287**BRISBANE**JFE Steel Australia Resources Pty Ltd.
Level28, 12 Creek Street, Brisbane QLD 4000
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Phone: (61)7-3229-3855 Fax: (61)7-3229-4377**EUROPE and MIDDLE EAST****LONDON**JFE Steel Europe Limited
15th Floor, The Broadgate Tower, 20 Primrose Street,
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Phone: (44)20-7426-0166 Fax: (44)20-7247-0168**DUBAI**JFE Steel Corporation, Dubai Office
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Phone: (971)4-884-1833 Fax: (971)4-884-1472**NORTH, CENTRAL and SOUTH AMERICA****NEW YORK**JFE Steel America, Inc.
600 Third Avenue, 12th Floor, New York, NY 10016,
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Phone: (1)212-310-9320 Fax: (1)212-308-9292**HOUSTON**JFE Steel America, Inc., Houston Office
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