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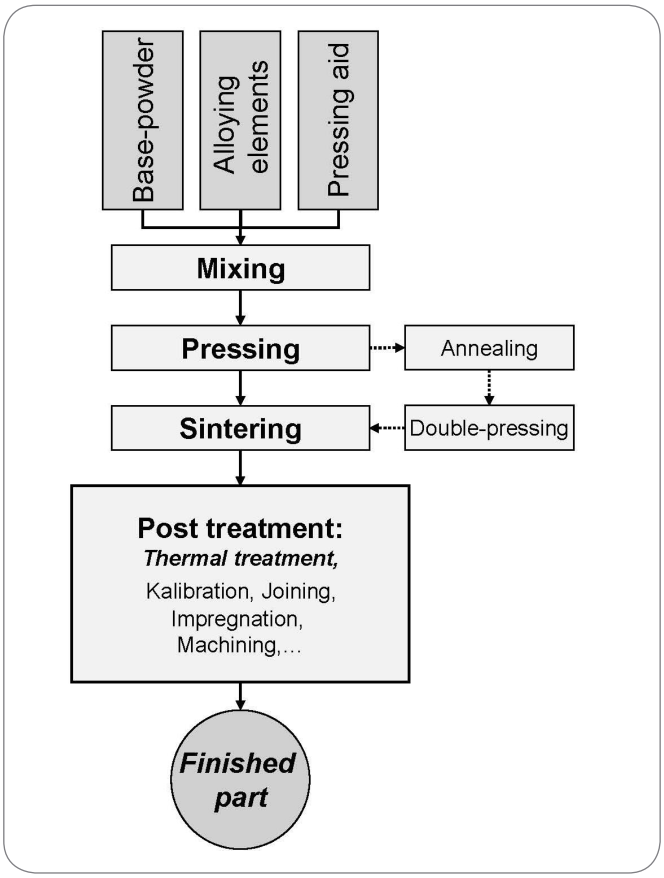
Precision parts made from alloyed sinter metals

New powder as carbon carrier for powder-metallurgy moulding production

In comparison to conventional manufacturing processes, the powder-metallurgy manufacture of complex shaped precision parts by a mixture of powder, pressing and sintering enables savings in the production of both raw materials and energy, and has already taken hold in many fields, most significantly in vehicle manufacture. The application of high-strength sintered steel parts is limited by factors including the tendency of the graphite, which is usually added, to become segregation, and the space requirement of the graphite in moulding, which limits the relative density and hence the mechanical properties.



Flow diagram of PM route

Objective

The current development is characterised by eliminating these problems by the use of a special powder as a carbon carrier.

Approach

In contrast to the current usual method of adding the carbon as a fine, extremely pure and relatively expensive powder, in the solution selected here, it is added as a high carbon content, iron based alloy in powder form, in which the carbon is present as cementite, iron carbide Fe3C. In this way, the carbon is strongly bonded to the iron, and separation effects, like the notorious ‚dusting' during production are thus eliminated. As the, master alloy' particles are similarly sized to the iron power into which they are mixed, the tendency to separate is widely minimised. The great hardness of the cementite containing structure which would otherwise diminish the compressibility is reduced to a harmless level by a special annealing process.

The extensive space requirements of current methods, due to the low density of the graphite (density 2.26 g.cm^{-3}) which above all impedes the compaction of high-density components with a high carbon content, does not arise here. The carbon is added as high-density phase cementite (density

>7.4 $g.cm^{-3}$) and as such it does not take up any extra volume in practical terms.

The master alloy powder can be produced similarly to plain iron by atomising a melt, while the melting temperature required is just above 1150°C instead of >1540°C for pure iron. This significantly reduces energy consumption and plant costs for fire-proof materials.

	Pressure	Sintering temperature °C	Master 2	Master 3
C content %			2.5	3.8
Flow Rate s/50g			28.5	32.0
Filling density			3.46	3.23
Green density	600 MPa		7.07	7.11
Green strength	600 MPa		9.8	10.2
Sintering density g/cm^3	600 MPa	1120	7.13	7.05
	1200 MPa	1120	7.43	7.41
Tensile strength MPa	600 MPa	1120	382	359
	1200 MPa	1120	533	492
Breaking strain	600 MPa	1120	6.2	9
	1200 MPa	1120	9.0	7.7
Hardness HV10	600 MPa	1120	139	125
	1200 MPa	1120	165	153

Properties of two masteralloy powders

Results

The new technology enables the manufacture of sintering parts with high carbon content, but also featuring high relative density, low residual porosity and correspondingly good physical properties, and the dimensional and physical properties are more uniform due to the avoidance of segregation effects.

In the table (to the left) the properties of two masteralloy powders are listed as well as those of resulting sintered steel Fe-0.5%C.

Benefits

For the powder manufacturer:

- Reduced energy consumption for atomisation (approx. 50% lower).
- Use of economical carbon carriers.

For the moulded part manufacturer:

- Higher sintering densities (in particular components with C content >0.5%).
- Stable carbon content (i.e. more uniform geometrical dimensions measurements and mechanical properties).
- More cost effective carbon carriers than graphite (graphite is listed by the EU as a critical raw material).

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