Quality of MIM Parts

Quality is just not the end Properties of the Part

Quality must be Built in to the Process

Every Process Step must be Monitored Statistically for Quality

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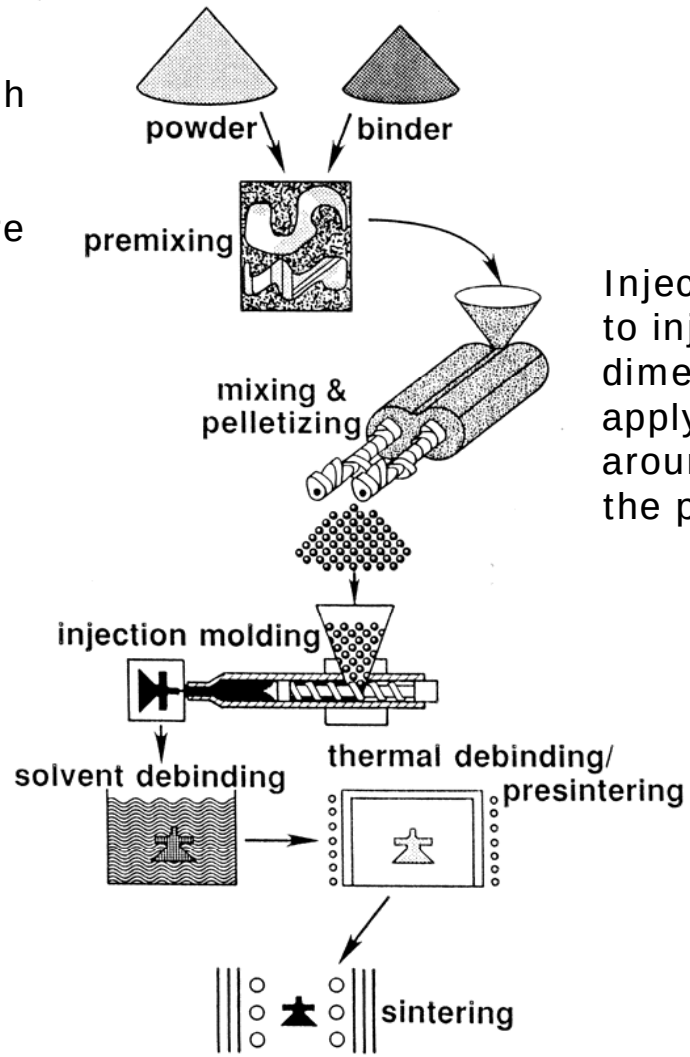
The MIM Process

Mixing

At the mixing stage, both metal powder and the polymeric binder (thermoplastic types) are combined into a homogeneous mixture



Injection Molding

Injection molding machines are used to inject the green part. The mould dimensions are calculated by applying a "shrinkage factor" which is around 15-20% for most material to the part drawing.

Debinding

Debinding is a process whereby the binder is removed from the molded part, leaving behind the metal 'skeleton' that retains the molded shape. This remaining element is known as the 'brown' part.

Sintering

Finally, the brown parts are sintered The metal powder particles will be bonded together and consequently this step provides the strength in the finished product.

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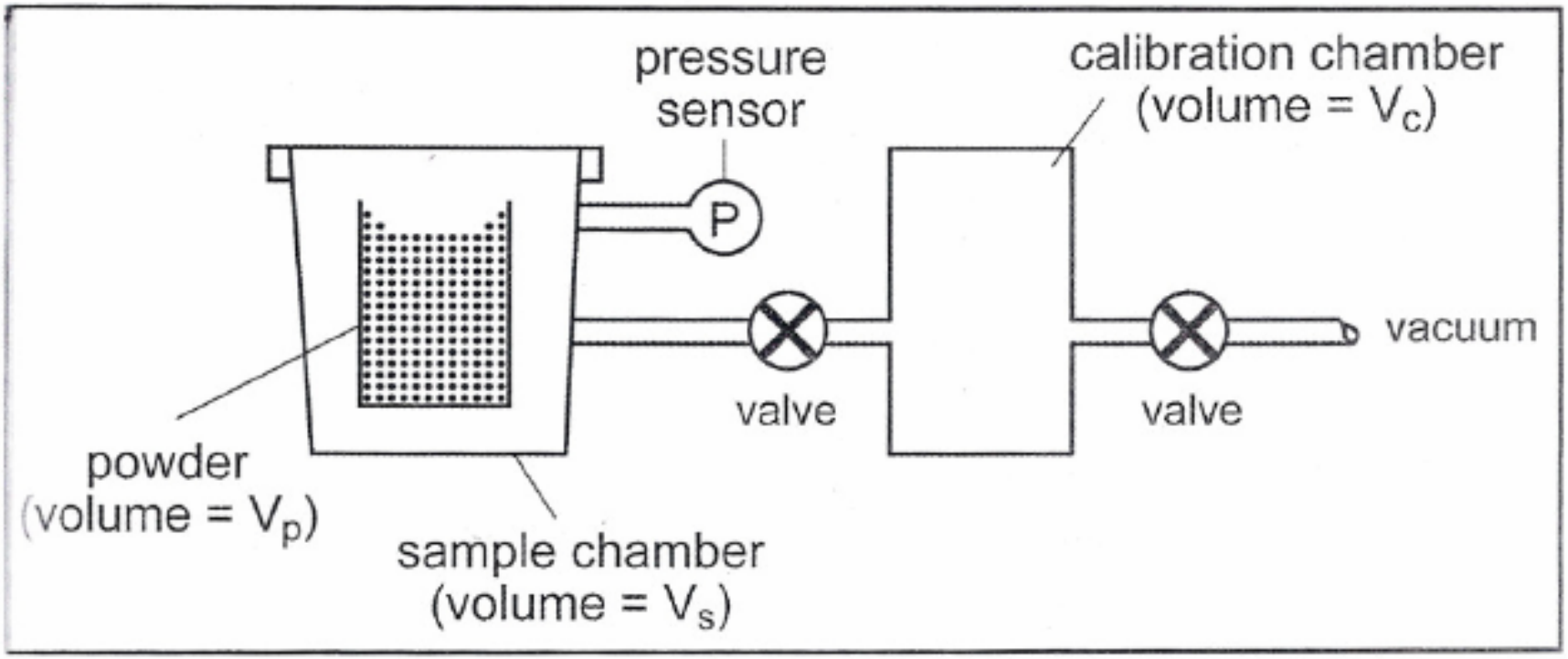
Feedstock

- Powders
- Binders
- Homogeneity after Premixing
- Homogeneity after final Mixing

The Properties to Measure are:

- Density (Pycnometer)
- Melt Flow Index
- Properties of Sintered Parts

Schematic Diagram of a Pycnometer



A schematic diagram of the true volume measurement for a loose powder using a pycnometer. The powder of known mass is placed into the sample chamber, and pressure measurements are made before and after equilibration with an initially evacuated calibration volume.

Molds

- Mold Design and Manufacturing
  - Individual Cavities

Measurements to Monitor Quality for each Cavity:

- Molded Green Part from Optimal Conditions
  - Weight, Density, Part Dimensions
- All Molding Parameters must be Provided.
- Sinter the above Molded Part and Check
  - Weight, Density, Part Dimensions

Injection Molding

- All Injection Molding Parameters must be Monitored and Recorded for Mold Qualification and Daily Molding.

After Molding Check for:

- Density of the Green Part by Pycnometer
- Weight of the Green Part to 3 Decimal Points
- Critical Dimensions by Micrometer or Calipers or Laser/Optical Measuring Device.

Debinding

All Debinding Parameters must be Monitored and Recorded.

Are there Location Effects in the Debinding Equipment?

Has all the Primary Binder (Wax) been Removed? Verify by measuring:

- Weight Loss
- Density (Pycnometer)
- Test by Location to eliminate Location Effects.

Sintering

Monitor and Record all Sintering Parameters

Are there Location Effects? Adjust Sintering Parameters.

Final Quality Checks are done by Measuring:

- Part Weight
- Part Density (Pycnometer)
- Part Dimensions

The MIM Quality Process

Powders

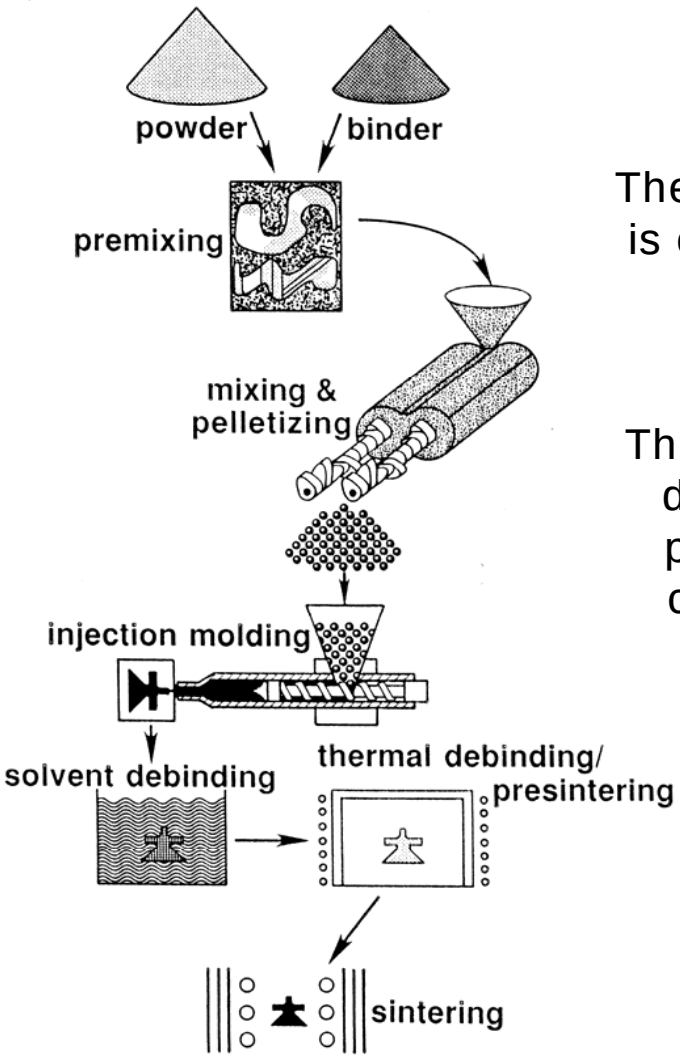
The densities of powders and binders are checked with the pycnometer.

Mixing

After mixing the density of the feedstock is checked with a pycnometer.

Debinding

The density of the debound 'brown' part is measured with the pycnometer and compared to the theoretical brown density.



Molding

The density of the molded part is checked with a pycnometer and compared to the theoretical density of the feedstock.
The part is ground up and the density measured with the pycnometer. This value is compared with that of the feedstock density.

Sintering

The density of the sintered part is measured with a pycnometer.

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Secondary Operations

- This is Part Dependant
- Critical Dimensions
- Finish

Summary and Conclusions

- MIM has a great Potential to Save Manufacturing Costs for making Parts.
- MIM produces Complex Parts with Properties close to Wrought Materials and Quality and Repeatability Superior to Investment Castings.
- MIM involves a lot of Variables that present their own Challenges.
- Quality must be Monitored at Every Step.