Sinter components can be manufactured with various degrees of tolerance – as is the case with machined components. The tolerances are typically classified as geometric tolerances and linear measurements. And geometric tolerances are further divided into independent and dependent elements. Cylindricity, for instance, is an independent element, as the tolerance relates to one element only. Position, on the other hand, is dependent, as the tolerance depends on two or more elements.

Linear measurements can be defined in roughly the same way: a cylinder diameter only relates to the cylinder, while the space between two cylinder diameters depends on both cylinders. As appears from the figure, the lowest tolerances are obtained in connection with sizing of sinter components with independent elements.

Because of dependence, the tolerance between two centres cannot be changed substantially by means of sizing. If, on the other hand, we look at diameter and cylindricity tolerance, we may obtain considerable improvements.
Small tolerances in sinter metal

The sintering technology makes it possible to manufacture components with very small tolerances. Danfoss has experienced how this results in high quality as well as considerable savings.

Components with small tolerances are challenging to manufacture regardless of the production technology. And when it comes to sinter metal, people often assume that powder metallurgy is not suitable for manufacturing components with small tolerances. Basically, the sintering process consists of two stages. First a component is pressed of metal powder, then it is heated to a temperature well under the melting temperature, at which it obtains its final strength. The powerful effect of the heating in combination with the subsequent cooling means that some of the components do not maintain the fine tolerances that they get during the pressing process. After sintering, the components will typically have a tolerance that corresponds to that of most traditionally machined components.

Sizing is the answer

“Many people do not realise that sizing brings the tolerance of a sinter component to the same level as that of a machined component”, says Mogens Jensen, Manager Sales and Technic at FJ Sintermetal. “There is, however, one limitation: if several elements of a component are dependent on each other (see opposite page, the editors), sizing only has a limited effect. But since we know this, we of course try to take it into consideration already in the construction phase”.

“At Danfoss, we have been working with sinter components for a very long time”, explains Brian Holm Andersen, Technical Support Technology, Danfoss Compressors GmbH in Flensburg, Germany. “And we use many types of components - with regard to geometry as well as various types of finish. We have more than 20 years’ experience in the field of sinter components with small tolerances, so we understand the value of sizing sinter components. Over time, we have had very good experience with components manufactured by means of this method with regard to both price and quality”.

A sinter component typically has a porosity of 10-15 per cent, and by using this porosity we are able to repress the sinter component to create both elastic and plastic deformation, and the component is thus sized as it cold forms to the walls of the tool.

“In practice, we have obtained very convincing results through sizing”, explains Henrik Rasmussen, Manager Production Technic at FJ Sintermetal, “in many cases sizing produces the same results as grinding, but sizing is a serial production process, and the process time may be shorter than five seconds, depending on the requirements for the product.”

The following tolerance properties may be obtained by means of sizing:

- Cylindricity down to 8 µm at a diameter of 25 mm
- Height tolerances down to 0.03 mm at a height of 5 mm
- Flatness tolerances down to 5 µm at a surface of 2500 mm
- Parallelism down to 0.035 mm between surfaces of 2500 mm and at a distance of 5 mm
- Perpendicularity of 2 µm at a distance of 5 mm
- Density increase of e.g. 3 per cent, which corresponds to an increase in strength of 10-15 per cent

“Naturally, this all depends on the geometry of the components, and the narrow tolerances not only require the very best equipment. Technicians, tool designers and employees in the production also need to have an efficient dialogue and an extensive know-how,” adds Henrik Rasmussen.