Hot stuff! New sintering press makes high temperatures quick and easy

A fast-heating press from Dr Fritsch uses current resistance to process metal and ceramic powders...

Hot pressing is a well known technique in the metal powder field. It is one of the sintering methods to solidify cold pressed (metal) powders. However, for mass production, free sintering is preferred. With free sintering, the manual work to fill the pressing moulds can be saved, resulting in cheaper final products.

Another competing technology for traditional hot pressing is the high isostatic pressure or HIP process. This process puts Pascal's Law - "pressure is transmitted equally and in all directions through a liquid or a gas" to work to produce high-quality parts. While HIPping also needs preparation of the pre-pressed powder parts, it gives high final density and good structural proportion to the parts. The costs of a HIP press, is however, substantial.

Uni-axial hot pressing is mainly used in the diamond tool business although there are also some other applications.

Here, a green density of only approximately 65 per cent is used because of the abrasive character of the powders. Higher green density would inevitably result in poor tool life of the cold press die. To achieve higher green density, a higher pressing force would be needed. This would mean more friction and - due to the use of diamond grit - more wear, and therefore lower tool life.

This low green density needs substantial stroke length for sintering. Sintering temperatures of 650-1200°C are normally used.

Within hot pressing technology, three distinctly different types of heating can be found in use:

• Inductive heating
• Indirect resistance heating
• Direct resistance heating

Inductive heating technology works by heating with high-frequency coils that can induce temperature rises. The mould is made out of graphite or steel, and pressure is applied by one or two cylinders onto the punches.

The mould is positioned in an induction coil. During sintering a high frequency generator and the induction coil generates heat in the mould.

The advantage is that the pressure and the inductive power are completely independent. Powders with a liquid phase are suitable and low pressures are possible.

Among the disadvantages are the expense of a high-frequency generator and the need for proper alignment. If the mould is placed off centre, the heat distribution is uneven. But the main disadvantage is the dependence of the process on good heat conductability. The magnetic field can penetrate the mould only 0.5mm to 3mm. From there on, the heat has to be "transported" into the mould by the thermal conductivity of the mould material. Even heating is much more difficult if the mould is off-centre. Another potential problem is heating rate. Too high a heat-up rate will therefore result in high temperature differences that can destroy the mould.

With indirect resistance heating technology, the mould is placed in a heating chamber. The chamber is heated by graphite heating elements. These elements are heated by electrical current. The heat is then transferred into the mould by convection.

As the electrical energy heats the heating elements that then heat the mould in a second state, the process is called indirect resistance heating.

Advantages are high achievable temperatures, independence from the conductibility of the mould and independence from heat and pressure. Main disadvantage is the time that it takes to heat up the mould. It takes relatively long to bring the heat from the outside of the mould to the centre and to distribute the heat evenly.

With direct resistance heating, the mould is directly connected to electrical power. The resistance of the mould and the powder part leads to heat that is generated directly in the mould.

This results in very high heating speed. The previous two methods are both somehow related to the physical properties of thermal conductivity. However, with direct resistance heating, the heat is generated where it is needed.

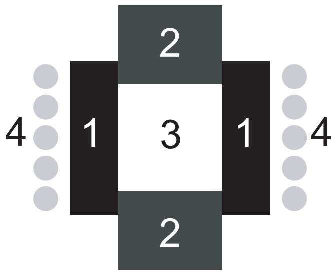
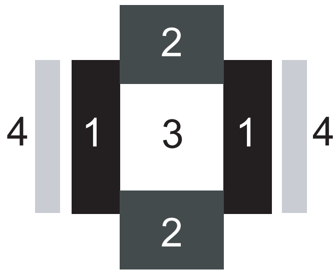


Figure 1. Inductive heating
(1) Ring mould
(2) Top/bottom punch
(3) Powder part
(4) Induction coil

Figure 2. Indirect resistance heating
(1) Ring mould
(2) Top/bottom punch
(3) Powder part
(4) Graphite Heating Element



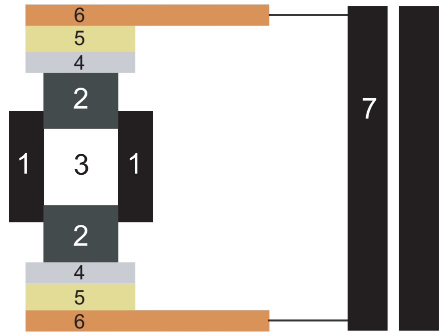


Figure 3. Direct resistance heating

(1) Ring mould
(2) Top / Bottom Punch
(3) Powder Part
(4) Graphite Electrode
(5) Brass Electrode
(6) Copper Plate
(7) Transformer

Up to now, this technology has been used mainly in the metal powder field with typical maximum temperatures of 1400°C.

Using metal powder, the conductivity of the mould is ideal for fast heating of the work-piece. Moulds that have a big diameter and relatively small height can be heated up very fast.

Dr. Fritsch has recently introduced a high-temperature sintering press. This machine has reached 2,400°C and combines high heating rates with high temperatures and precise temperature control. The workpiece is directly measured by means of a pyroscope.

As standard, maximum pressing power is up to 600kN (60 tonnes), heating power is 150kVA at 4.5V to 6V secondary voltage. The machine can operate at vacuum or under protective atmosphere; overpressure can be realised as an option.

The machine has been successfully tested for metal and ceramic workpieces such as boron carbide at temperatures up to 2400°C. An optional magazine is available which can load the workpieces automatically. Up to 54 pieces can be stocked. Process control and off-line programming via PC is also an option. Touch display operation is standard.

The machine is especially suitable for processes that need high heating rates, eg for materials that should not be kept at high temperatures too long or for proceses that require fast heating rates for high productivity.

For further information go to **www.dr-fritsch.de**

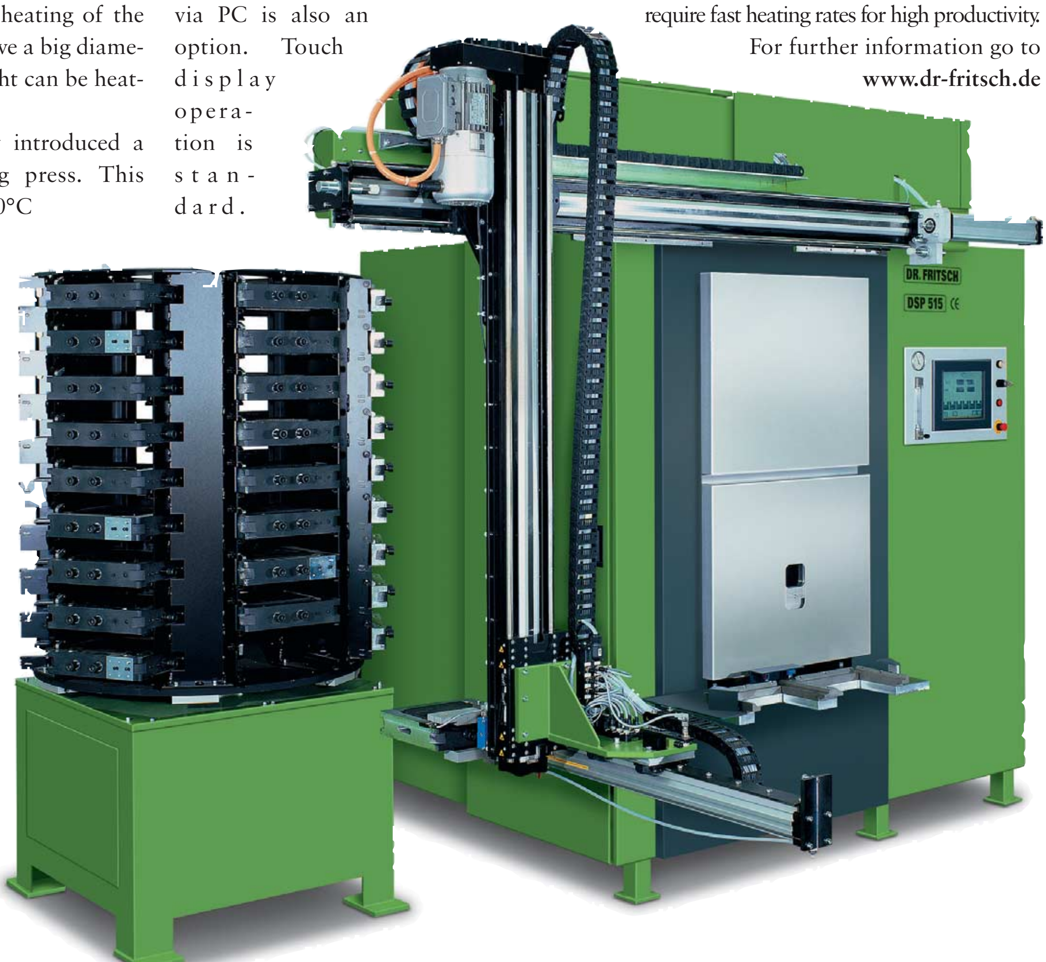


Figure 4. DSP515 with Magazine