Copper alloys and multi-alloy aluminium bronzes

An optimum temperature control does the trick

Shortest cycle time and optimum part quality are the main requirements which have to be met by high-quality injection moulds. The main focus lies on the optimum temperature control of the mould. The following article deals with the role of special copper alloys and multi-alloy aluminium bronzes produced by the Schmelzmetall AG.

The company

Since its foundation in 1959, the main focus of the Schmelzmetall AG has been the development of copper alloys with the best possible properties for this type of alloy.

Today, the Schmelzmetall AG and the whole Schmelzmetall group have become the leading manufacturer of age-hardening, high-performance copper alloys.

Our Hovadur® materials, manufactured with vacuum casting, represent highest quality. This challenging manufacturing process as well as the exclusive usage of purest source materials ensures a high uniformity of our alloys.

Basics

The requirements of the global market are as simple as they are merciless. An optimum quality of the injection moulded part is required, while the cost pressure is continuously increasing.

This can only be achieved by means of the latest moulds, which are able to produce the injection parts in the shortest possible cycle time and feature a reliable production during their total service life. A key factor is the thermal conductivity of the materials used for the cavity forming area. A high thermal conductivity of the used materials ensures a very fast heat distribution and thus a very uniform mould wall temperature. This is a key factor for the quality of the injection parts. The cycle time is mainly determined by the cooling time, the injection temperature and the mould release temperature. The cooling time accounts for approx. 70% of the total cycle time. The resulting thermal requirements are met by the high-quality copper alloys of the Schmelzmetall AG.

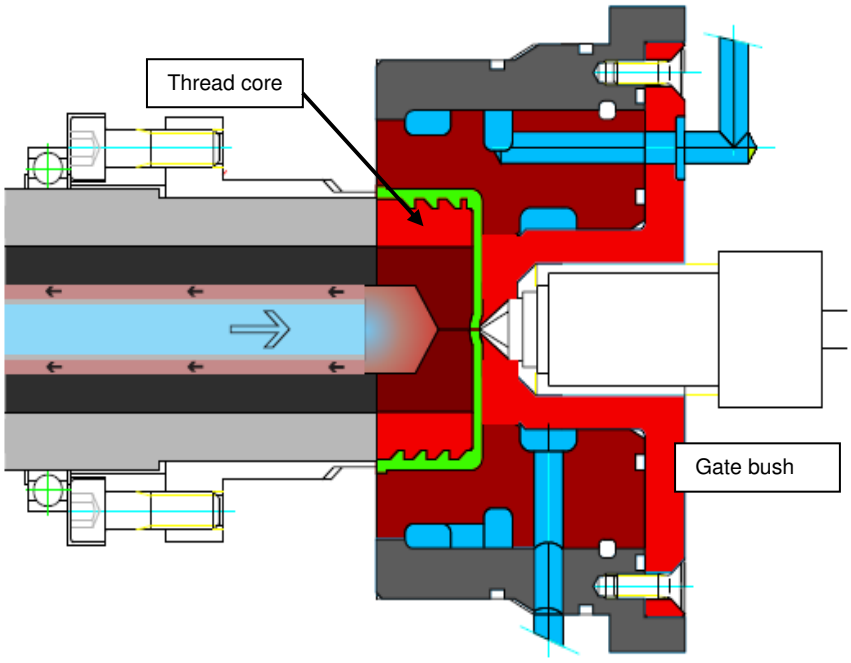
Depending on the intended use, it may be necessary to optimise the sliding or wear properties of the used copper alloy. This can be easily achieved by using suitable coatings.

How to choose a copper alloy

In principle, the various copper alloys of the Hovadur® K and B series of the Schmelzmetall AG are suitable for injection moulds. The alloys of the Hovadur® K series feature good hardness and strength as well as a thermal conductivity which is 10 to 14 times higher than in tool steels. Multi-alloy aluminium bronzes of the Hovadur® B series, however, possess outstanding sliding properties and a three times higher thermal conductivity than tool steels. In addition, they are suitable for die sinking and gas-shielded welding. The answer to the question, which alloy is most suitable, depends on the intended use. High hardness does not always correspond to good wear resistance leading to a long mould life.

The issue of wear

An injection mould has two wear mechanisms which have to be considered: rheological and tribological wear. Rheology describes the wear mechanisms in the cavity. In other words, what influence does the plastic have on the cavity forming components during the injection process. All cavity forming mould



Picture 1: mould for closures

components are subject to this wear at every shot. The tribology allows us to determine the wear on moving mould components. Eventually, there are four wear mechanisms: abrasion, adhesion, corrosion and cavitation. In summary one can say, that out of the four occurring mechanisms, high to highest hardness is necessary only for abrasion wear, in order to achieve a high wear resistance The lower hardness as compared to tool steel is therefore not necessarily a disadvantage, yet the substantially higher thermal conductivity is a significant advantage. In those cases requiring a higher hardness, it is possible to use a suitable coating. In those cases where coatings are not sufficient anymore, compound technologies may be the solution. These are special, mostly metallurgical compounds, using the corresponding Hovadur® alloys in areas requiring a high thermal conductivity, whereas in areas where mechanical wear is an issue, tool steel or highly wear-resistant materials are used.
The following application examples show the possibilities of the Hovadur® alloys used individually or as a compound in injection moulds.

Screw cap mould: Cycle time reduced by 30%
For this kind of moulds - see picture 1 - there are various possibilities to use Hovadur® K alloys and compound solutions. In this area, in addition to the shortest possible cycle time, a long mould life is a key success factor.
By using Hovadur® K350 for the mould insert and Hovadur® K265 for the inner core - see picture 2 - the cycle time could be reduced by 30%. This modification does not have a negative influence on the service life of such moulds. In the second step the threaded core has been executed as system core - see picture 3. The

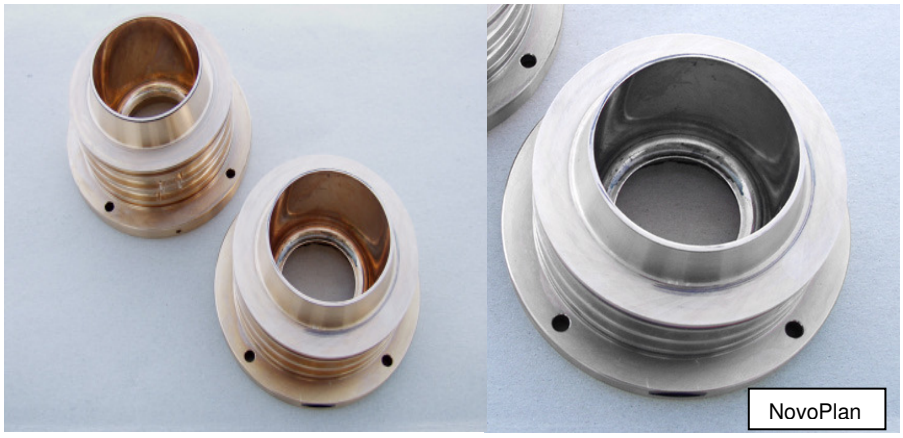
Picture 2: 6-cavity mould

threaded core is made of Hovadur® K265 in the cavity area and of steel 1.2344 in the wear area. This measure resulted in an additional cycle time reduction by 2 seconds. Regarding this 6-fold screw cap mould, this means a cost saving of EUR 12,000 after a running time of two years.


Picture 3: special thread core

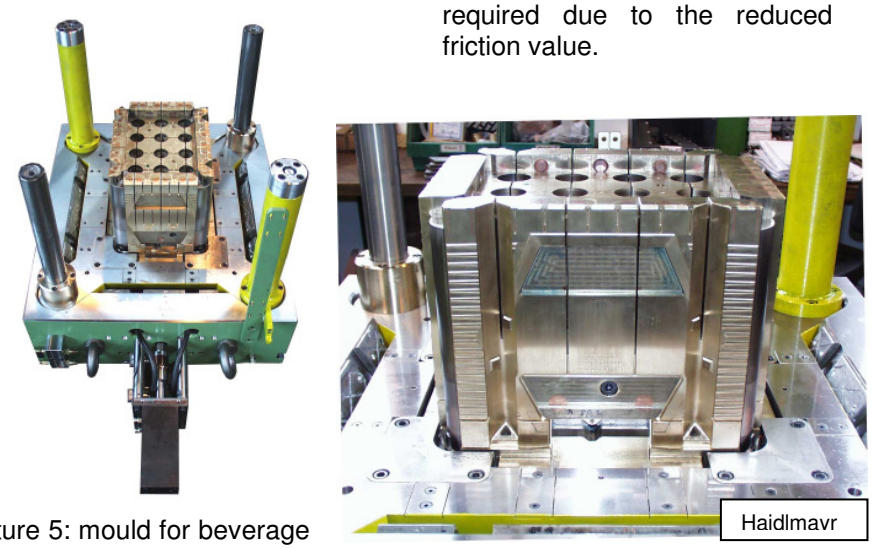
Mould insert for end caps
In moulds for screw caps, whether or not they are used with true threaded cores or with forced mould release cores, and in moulds for end caps to be used for toiletries such as shampoo or washing soap, copper materials have been in use for a long time. Usually they are used in combination with a coating. Thus, inner cores and forced mould release cores are made mainly of Hovadur® K350 with an additional hard electroless nickel coating in the main wear area. We will use the example of a mould insert for end caps made of CB2 for cosmetics or toiletries in order to demonstrate the influence of coatings.

The problem with this insert was the cone, which served as a stripping cone - see picture 4 - and suffered from great wear. By means of a coating, the service life was to be significantly increased without having a too negative influence on the cycle time. Therefore, hard electroless nickel coating was used. The major advantages for the customer were the improvement of production reliability and the increase in productivity.



Picture 4: mould insert, left uncoated, right coated with HCN

Beverage crates
At first, you might ask yourself: what advantages Hovadur® B alloys could possibly have for moulds in this area of use? Apart from good mechanical strength and wear resistance characteristics, good mechanical machinability and good corrosion resistance are required. Looking more closely at these moulds - see picture 5 -, one quickly realises that the plastic must cover a long distance from the injection point.



Picture 5: mould for beverage crate

This requires very good sliding properties which can be found in the materials of the Hovadur® B series. In addition, these materials offer a three times higher thermal conductivity than steel leading also to a significant reduction in cycle time. Materials with even higher thermal conductivity such as Hovadur® K265 would lead to a too fast setting of the plastic. The result: The mould would not be entirely filled. In addition, a higher injection pressure would be required due to the reduced friction value.

Conclusion
In many cases copper alloys of the Hovadur® K and B series can largely contribute to fulfilling the requirements for best quality of injection moulded parts and shortest cycle time. Sometimes, the combination with a suitable coating or a compound solution may be the best possibility. Here, too, the Schmelzmetall AG is the partner of the mould makers and injection moulders.

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