

Deep hole drilling with high pressure MQL

Single flute drilling is the method of choice for the reliable drilling of high-precision and deep holes. In many cases, however, users cannot fall back on single flute drilling because the necessary prerequisites are not fulfilled in the form of a deep hole drilling machine with an oil cooling lubrication. Thanks to adapted tools and a new, high-pressure capable MQL system, botek and Bielomatik have succeeded in

using deep hole drilling tools with small diameters in a reliable process even under unfavorable conditions. Deep hole drilling is considered to be a reliable and cost-effective process that is significantly better than other drilling methods in terms of machining quality. These advantages can be exploited in many applications where often only a small bore centerline deviation is permitted.

In addition, surfaces with very low roughness values may be required, for example if they have to be cleaned afterwards without leaving any residues. Here, deep hole drilling is often the only method that enables such results without subsequent machining of the hole. Optimal conditions for their implementation are a special deep hole drilling machine, deep hole drilling oil with HP additives, coolant pressure of



Picture 1:
The new 1-channel MQL system from Bielomatik, designed for an inlet pressure up to 25 bar
(Picture: Bielomatik Schmiertechnik GmbH, Frickenhausen)

up to 160 or even 200 bar for the smallest diameters as well as an efficient filtering system.

Challenging conditions

Numerous machines now enable production with cooling lubricant pressures of up to 80 bar, in individual cases up to 140 bar. However, machining centers and lathes are often operated with emulsion, which sets limits for deep hole drilling because the lubricating effect on the guide pads of the tools is insufficient. In addition, with small bore diameters, even a pressure of 80 bar can be insufficient due to the small cooling channels of the tools. Also, for users who do not primarily drill deep holes, an investment in special deep hole drilling machines or cooling lubricant systems for higher pressures is usually not worthwhile.



Picture 2a and b:
MQL system plus high pressure plus single flute gundrill plus process design: The chips differ significantly from previously used techniques. When processing high-purity copper, the feed per revolution could be increased by up to 70 % compared to oil.

Last but not least, the use of deep hole drilling oil is not permitted in certain production processes or at some locations. In order to still be able to drill high-precision and deep holes on existing machines, botek and Bielomatik have now combined their know-how.

Process participants coordinated in detail

In the now designed deep hole drilling processes, sufficient lubricant reaches the cutting edge and guide elements of the tool thanks to the MQL-compatible, optimized high-performance solid carbide gundrill type 113-HP-M. A specially adapted cutting edge geometry produces a chip shape adapted to MQL machining even at high feed rates, which prevents the chips from jamming in the chip flute of the single fluted drill.

Bielomatik's MQL system uses aerosol under high pressure to provide the necessary amount of oil for spot lubrication and cooling on the cutting edge and guide pads of the tool. Because the air-oil mixture has a higher compressibility than water-based emulsions, a larger volume flow is achieved, so that the chips can be removed from the bore hole quickly and reliably. Thus now also bore diameters ≤ 2.5 mm can be realized on machines, which do not have a high pressure system with deep hole drilling oil.

Additional cooling effect thanks to high pressure

Like the other process parameters, the MQL pressure provided can be adapted to the respective machining task.

This way, the compressed air and energy consumption can be kept within application-optimized limits. The pressure increase from the level of the house network, approx. 6 bar, to up to 25 bar is achieved by pressure amplifiers, so-called boosters, which are connected upstream of the Bielomatik system. Due to the higher compression and the increased expansion of the MQL aerosol as it exits the tool, an increased cooling effect also occurs, which influences the chip formation.

Feed speed massively increased

For example, this cooling effect leads to significantly shorter chips when machining high-purity copper materials, which are generally very long-chipping

Picture 3:
Particularly short chips were produced with the MQL system under high pressure even when drilling stainless steels. Here like there the explanation: The chips are quenched by the expansion of the air and break clearly better.





Picture 4:
Deep hole drilling of stainless steel on a deep hole drilling machine TBS200

when machining with oil. An effect that decisively supports reliable chip removal. This can be seen concretely in the processing of electrolytic copper and small drill diameters. In a customer application, a 40 mm deep hole with a diameter of 1.5 mm was drilled into this material. The required quality criteria:

A Ra-value of 0.2 μm and a centerline deviation of less than 0.03 mm. With the generation of significantly shorter chips during this machining under high-pressure MQL, it was not only possible to achieve process reliability, but also to increase the feed rate by up to 70 % compared to oil. „We knew that with copper we

had a problem with chip formation,” emphasizes Jürgen Deeg, manager of the testing department at botek. “But we also knew we were in a diameter range where there was not much scope for different tool geometries. The tools are simply too delicate. But now we were able to drive the process parameters upwards. Because with this intervention in the chip formation we suddenly had very small chips”.

Bielomatik Schmiertechnik GmbH

Bielomatik Schmiertechnik, based in Frickenhausen, Germany, is a manufacturer and supplier of lubrication technology systems. In the field of central lubrication technology, its customers include well-known machine manufacturers for the paper, woodworking and textile industries. After the company had also started to develop and manufacture the first minimum quantity lubrication systems for metal cutting in the late 1990s, Bielomatik was the first manufacturer to offer both 1-channel and 2-channel systems for lubricant supply through the spindle. These MQL systems are used particularly in the series production of engines in the automotive industry. Thanks to its many years of experience with 1-channel and 2-channel MQL systems, Bielomatik Schmiertechnik is able to equip a wide variety of processes with the optimum system for batch sizes from 1 upwards. In April 2020, the lubrication technology division was demerged from bielomatik Leuze GmbH + Co KG and sold to the lubrication technology specialist Dropsa based in Milan, Italy. Since then Bielomatik Schmiertechnik has been part of the Dropsa Group. With 16 subsidiaries worldwide in Europe, Asia and America, the group has a broad sales and service network and generates a global turnover of more than 50 million euros with approximately 250 employees annually.

Process limit shifted

Another application that botek and Bielomatik were able to design with process reliability is the deep hole drilling of small diameters into stainless steel. In this process, bore wall surfaces

were created with a roughness that is very close to the qualities achievable under deep hole drilling oil and significantly undercuts the Ra values achieved under emulsion. Here, too, small diameters could be reliably drilled in with single flute gundrills designed for MQL and high-pressure MQL. Once again thanks to particularly short chips. The process limit, which botek and Bielomatik were able to shift in this way, is currently at a diameter of 1.2 mm. Only now, materials such as stainless steel with diameters below 2.5 mm can be deep hole drilled under MQL using single fluted tools. For larger diameters this was already possible with 10 bar. With up to 25 bar this limit has now been significantly lowered.

Next technology step possible

Based on these developments for deep hole drilling with high pressure MQL, botek and Bielomatik are the contact partners for new applications, be it in terms of process design, quality or economy. The degrees of freedom for the user have been increased. It is now up to him to decide how to explore them. Thanks to experienced specialists and application engineers at botek and Bielomatik, users have access to highly qualified contacts to test the possibilities of deep hole drilling under MQL in their company. Not only drilling fast is one of botek's strengths, but also the short term availability of the tools.

To this end, the stock program has been successively expanded in recent years and an express production line has recently been set up for solid carbide gundrills, pilot drills and special tools such as step drills. Good conditions for the user and his next technological step.

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botek is a global deep hole drilling tool supplier with about 800 employees worldwide. The core business comprises internally cooled tools for all deep drilling systems with diameters from 0.5 to 1,500 mm. In addition, solid carbide pilot drills, twist drills in excess lengths, application-specific step drills, reamers, milling cutters as well as PCD-tipped tools are part of the product range of the family-owned company with its head office in Riederich.

A particular strength of botek is the application-orientated design of tools and machining processes by experienced application engineers. Together with 50 sales and support partners worldwide they are quickly on site.

The goal: To find the most economical solution for each customer and to continuously develop it further. True to the company's guiding principle: Always improving!

Picture 5: Tinker further and provide users with information: Project manager Andreas Ruf and Head of testing Jürgen Deeg from botek and development engineer Christoph Shepherd of Bielomatik (from left)

