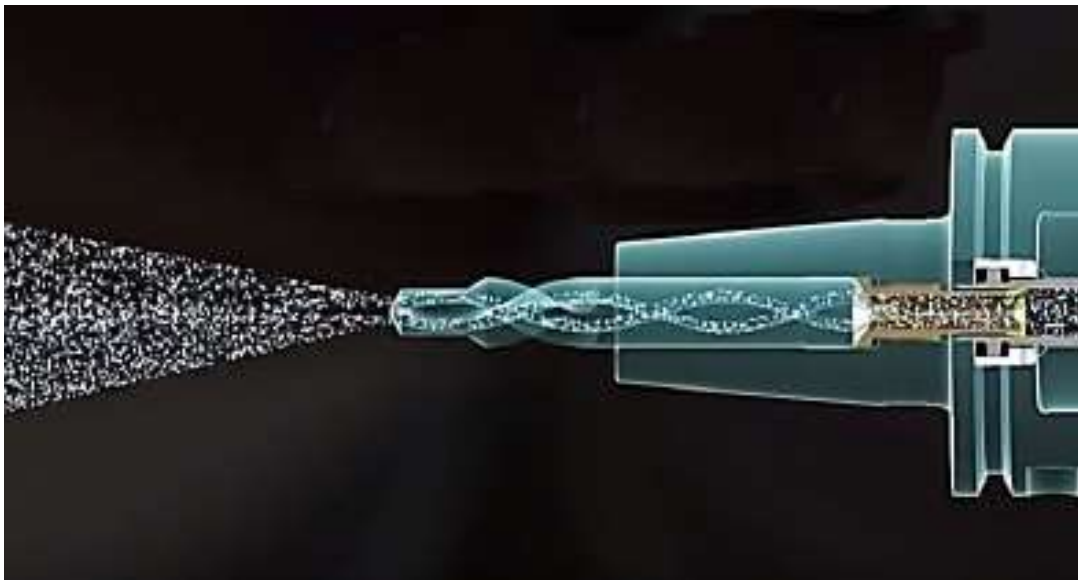


Minimum Quantity Lubrication technology for tools with internal feed



MQL systems for tools lubrication
from inside with lubricant supply through spindles,
revolvers and tool holders
for
machine tools, machining centers, turning centers

in partnership with

HPM Technologie GmbH

- Con riserva di modifiche senza preavviso -

MQL: the modern industrial standard for tools lubrication

Minimum quantity lubrication (MQL) has gained its way into the area of metal cutting machining and has been already proved as the alternative to conventional wet processing in many applications. Unlike conventional wet lubrication systems, which flood the piece with high quantities – circulated - of metalworking fluids, minimum quantity lubrication uses a few milliliters of lubricant per hour in the machining process. Since the beginning of the 2000s the technical, environmental and economic advantages given by the adoption of MQL have convinced many mechanical companies, starting in Germany and Japan, to gradually shift their machining processes from water-mixed metalworking fluids to MQL. Today MQL for internal tools lubrication represents the new industrial standard for more and more manufacturers in different countries and industries such as automotive, aerospace, pneumatic components, ensuring the production of complex pieces in absence of environmental pollution and almost dry.

Suitable applications:

MQL systems can be used for tools lubrication in almost all mechanical processes, both with chip removal as well as in the forming/rolling processes, on any type of modern CNC machine tool, to work different materials with highly reliable lubrication process..

Machine tools:

- Portal milling machines
- Turning and milling centers
- Flexible production systems
- Double spindle machine tools
- Multiple spindle heads
- Transfer machines

Machining:

- Milling
- Turning
- Threading
- Tapping
- Drilling
- Deep hole drilling
- Reaming
- Rolling

Materials:

- Aluminum and its alloys
- Steel and alloy steel
- Cast iron
- Brass
- Titanium

MQL technology is based on continuous supply of extremely small amounts of lubricant to the cutting point. During machining, the lubricating medium significantly reduces the friction between chip and cutting face, thus generating less heat which is largely dissipated via the chips. The use of MQL-compatible tools facilitates quick chip removal. As a result the tool lasts longer, the cutting speed increases, the surface quality improves and the entire machining process is completed in a shorter time and at lower costs.



MQL system advantages

- Minimized lubricant consumption (on average: 20 ml/h)
- No water consumption
- Chips and machined parts nearly dry (no oil soiling)
- Elimination of the metalworking fluid (emulsion) system
- Savings on energy consumption compared to emulsion
- No need to prepare and dispose of used metalworking fluid
- No thermal shock on the tool cutting edge
- Longer tool life
- Higher cutting speed
- Better surface quality
- Perfect execution of deep holes, even with $L / D > 30$
- Complete visibility over the on-going process (no scattering)
- Clean working environment, compliance with health and environmental regulations

Consumption in comparison

Whole oil:

- oil: 10x - 100x liters / hour
- electricity: high

Water-miscible metalworking fluids (emulsions):

- water: 100x - 1.000x liters / hour
- oil (emulsion of 1.000 l/h, mixture from 4% to 7%): 40÷70 liters/hour
- electricity: very high

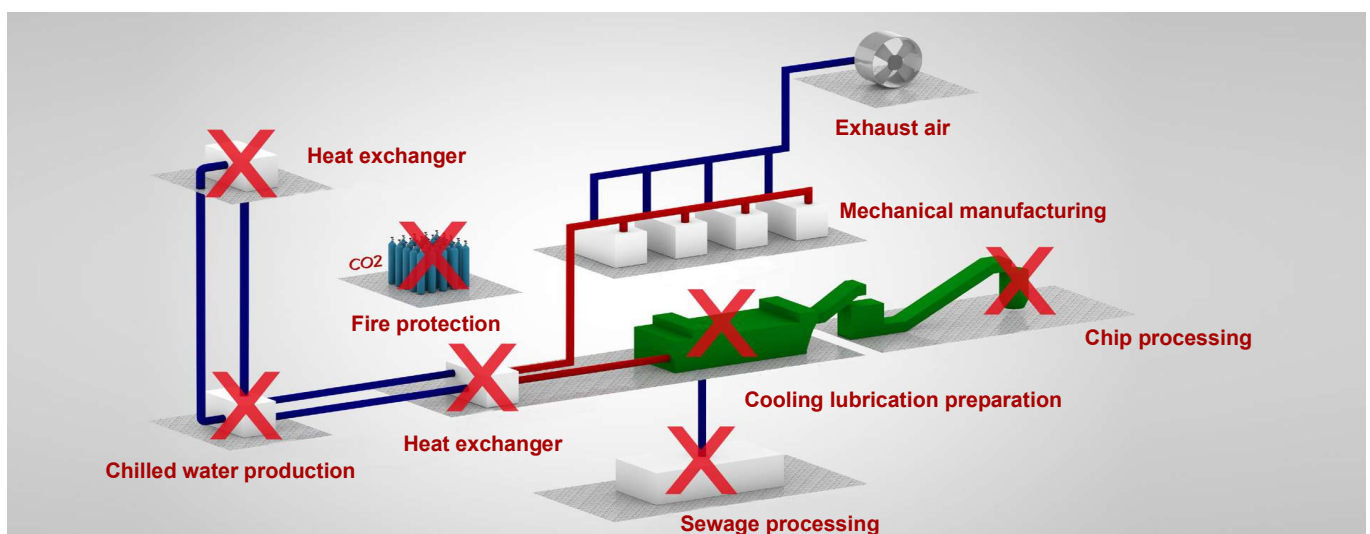
MQL:

- compressed air: 1.000x liters / hour
- oil: 5 to 65 ml / hour (0.005-0.065 liters / hour)
- water: 0 for the process; optional washing at cycle end
- electricity: very low

With MQL, for each individual process (piece) the cost incidence due only to the lubricant consumption (oil) is thousandths of a Euro on average, while the cost incidence due to the tool can be estimated in the range of cents of Euro or more, on average.

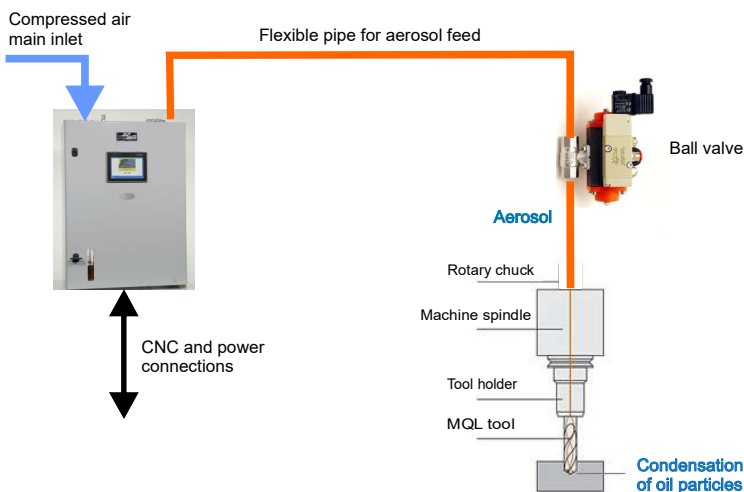
Potential savings with MQL in series production

Dry machining with MQL technology offers enormous savings potentials in series production. The traditional method based on coolant requires several devices, for example to cool and clean the emulsion, process the wet chips, and treat the waste water. All these devices are not needed when using MQL instead.



MQL technology for tool lubrication with internal feed, single channel

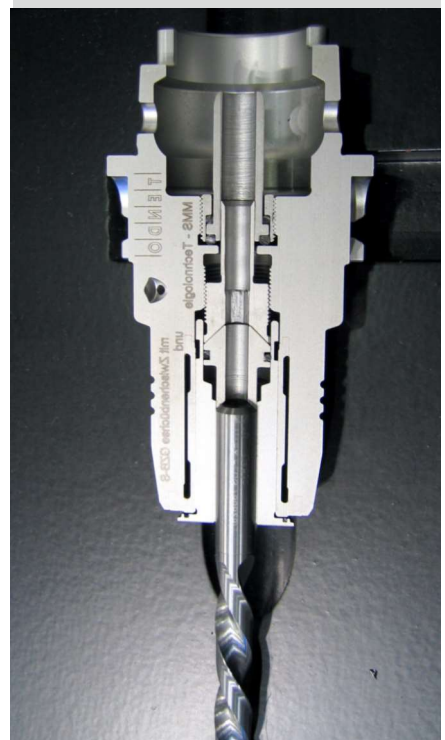
The lubricant medium used for MQL is a very fine mixture of compressed air and micronized oil droplets, sized from 0.1 to 1 micron, defined as “aerosol” and generated inside a specific MQL system. The aerosol is continuously conveyed to the lubrication point, through flexible pipes and channels inside the rotating spindle, the tool holder and the tool. The oil particles get condensed in small droplets right at the exit of the tool, and are precisely addressed to hit the tool cutting edge. The oil lubricates the contact surfaces between tool and work piece, while the high speed air flow helps to evacuate the chips. Minimum quantities of fresh oil are precisely metered and almost entirely consumed during the tool cutting time, giving the advantage to keep dry pieces and chips; oil consumption ranges from 5 to 65 ml/h (tool cutting time); 20 ml/h is the typical value. Lubrication parameters must fulfill different requirements: tools, materials, machines and machining data. Lubrication parameters refer to the absolute volumetric air flow and the relative volumetric oil flow rate (oil quantity) and should be carefully chosen for an optimal process execution. In most cases, tools with small inner channels diameter (<0.5 mm) require high pressure and a slightly oily process, the other way around for large tools/larger channels. The MQL system can be mounted anywhere on the machine tool, even far from the spindle: the micronized oil droplets can be conveyed by the compressed air, notwithstanding unfavorable circumstances, allowing aerosol transportation over long distances, up to 30 meters.



The choice of tools and lubricants suitable for MQL is a key - factor to get maximum benefit from the use of MQL technology.

Tools play an important role in the process: their geometry and finishing influence chips removal and friction, while the internal channels feeding the lubricant must be adapted to the machining operation and allow a high speed aerosol flow which precisely hits the tool cutting edge. A reduced channel diameter in proximity of the cutting area increases the flow speed: without this fundamental feature the aerosol cannot condense properly and oil fog is generated, bringing to increased oil consumption and lower efficiency. The ideal diameter is 1.8 mm, in practice ranging between 0.2 and 2.2 mm.

Lubricants. Only synthetic (or vegetable) oils must be used for MQL, in particular, fatty alcohol for aluminum and EP synthetic esters for steel. Lubricants containing mineral oil components or additives should not be used to avoid the inhibition of micro oil particles generation. In addition, when using MQL for tools lubrication, it is advisable to turn down the use of emulsion as the water-based mix will compromise the achievement of the many benefits of the minimal lubrication.



MQL systems with advanced technology

The MQL systems offered by MWM are based on the advanced technology made available by HPM.

Venturi nozzles controlled by one (or more) **proportional valves** with high reaction speed are used to generate and control high quality aerosol flow under variable production conditions. The electronic control technology patented by MWM makes available a specific **IFX-F sensor**, which measures the percentage of oil contained in the aerosol stream conveyed to the tool, provides a signal to the CNC and guarantees a 100% safe process.

MWM systems have the following main features:

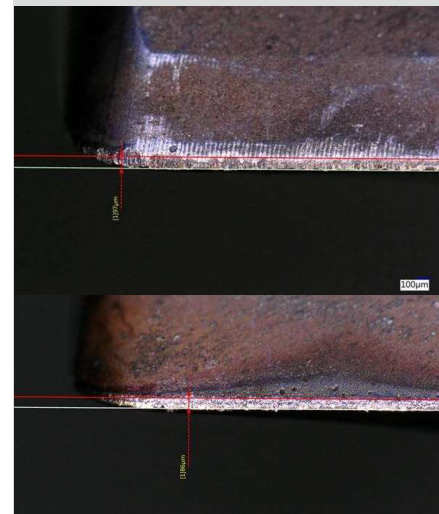
1. **Dynamic aerosol generation** is a key feature to allow a high-level lubrication process with a better performance. Most MQL systems available in the market offer just a static aerosol generation.
2. **Automatic flow control** offers maximum flexibility of use for any type of machining: using both very small tools (eg: \varnothing 1 mm driller) and large tools (eg: \varnothing 25 mm milling tool). The operator can choose between several available lubrication parameters, differentiated in terms of air pressure and/or oil concentration, and associate the most suitable to each tool.
3. **Short response time** allows to shorten the machining process. This important feature assumes great relevance when, in particular, machining centers equipped with automatic tool change are used: the MQL system changes the lubrication parameters in less than 0.1 second.
4. **Process safety and continuous monitoring** guarantee the execution of a reliable process. Ongoing communication with the CNC allows the operator to be constantly informed on the process status.

Each electronic model of LSJ and LS Series includes the main components described below:

The aerosol generating unit consists of a pressurized tank, an oil flow control, one or more aerosol feeders (Venturi) controlled by pilot valves. The oil level in the tank is continuously monitored and transmitted to the machine CNC. Oil refill can be done either manually or automatically by means of a pump driven by the MQL control and connected to an external reservoir tank.

The air flow control system uses electro-pneumatic regulators which adjust the pressure, proportionally to an electrical signal. This technology improves the automatic adjustment of variations in the aerosol supply pressure, without affecting the air supply pressure. Undesired changes of the air pressure can be found on traditional systems equipped with modular solenoid valves, pneumatic, with stepwise pressure regulation (with fixed value). This new technology allows to achieve an optimal aerosol flow control, at any flow rate and pressure level. When compared to traditional MQL technology, HPM's technology highly improves the performance: by prolonging the tool life (up to 25% increase according to comparative research tests), and by reducing oil consumption to a minimum.

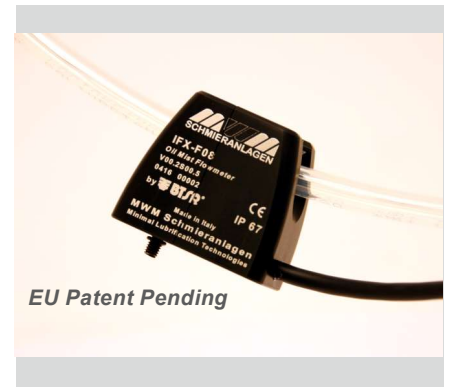
The control box contains all the required control, monitoring and communication electronics. Air pressure and volume oil stream are adjusted to an optimal value, regardless the type and number of tools. Profinet (or Profibus) interface to the machine CNC is included standard.



External accessories

IFX-F sensor for aerosol flow control (oil-mist)

For instant checking of the correct quantity of lubricant sprayed, MWM has developed and patented the first sensor for oil-mist, which guarantees a 100% safe process. The optoelectronic sensor IFX-F provides a digital signal which can be further elaborated as a feedback from the CNC of the machine tool, which controls the MQL system in operation.



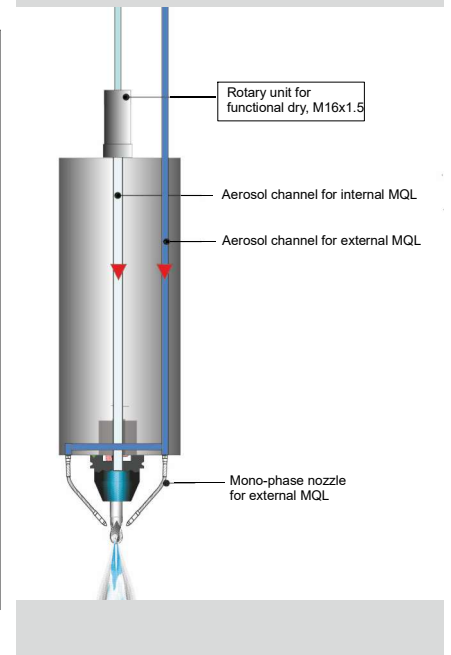
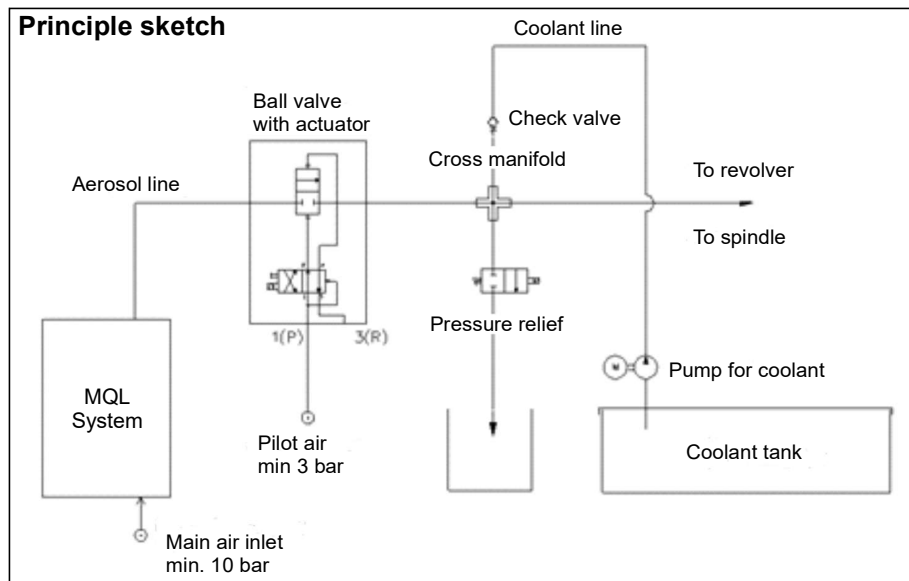
Ball valve for aerosol

For processes with scheduled breaks, i.e. for tool change, a ball valve with full passage must be installed. The ball valve, piloted by the CNC of the machine tool, has the function of intercepting the aerosol flow during work breaks, keeping in pressure the aerosol pipe between the MQL unit and the spindle (or revolver). On machines with automatic tool change, the aerosol feeding process must be quickly carried out, with a very short reaction time (ie: 0.1- 0.2 s). For this reason, the ball valve must be installed as close as possible to the end point, namely in proximity of the spindle (or revolver).



Hybrid systems: MQL + Emulsion

Although such systems are not recommended, when it is necessary to use an MQL system in combination with a traditional coolant (emulsion) system, the circuit which feeds the aerosol to the tool must include a high pressure ball valve to block the aerosol flow while the coolant is used, and a check valve on the coolant circuit. When switching from coolant to aerosol, first it is necessary to deliver only compressed air in order to dry the channels inside the spindle, the tool holder and the tool.



Side nozzles for external MQL

The MQL system is primarily developed for internal lubrication. However, to meet the most different needs the aerosol can also be used for external lubrication. For this purpose, it is necessary to use one (or more) optional single-phase nozzles, positioned next to the tool, and select a suitable lubrication parameter.



MWM systems for internal tool lubrication

MWM delivers MQL systems for internal tool lubrication easy to install and fully equipped with all necessary accessories.

For communication optimization: MQL systems with electronic control and interface for data exchange are available for selecting the lubrication parameters, monitoring the functional status, communicating alarm messages to the machine CNC.

For operational flexibility: MQL systems which can lubricate multiple tools in simultaneous operation when the same parameter can be shared.

For complex machining processes: double MQL systems are also available which simultaneously provide two different tools with different MQL parameters. They fulfil all of the functions available on single MQL units, but can supply two different points of consumption simultaneously and independently of each other, with the ideal amounts of lubricant, i.e. turning centers with two revolvers in simultaneous operation.



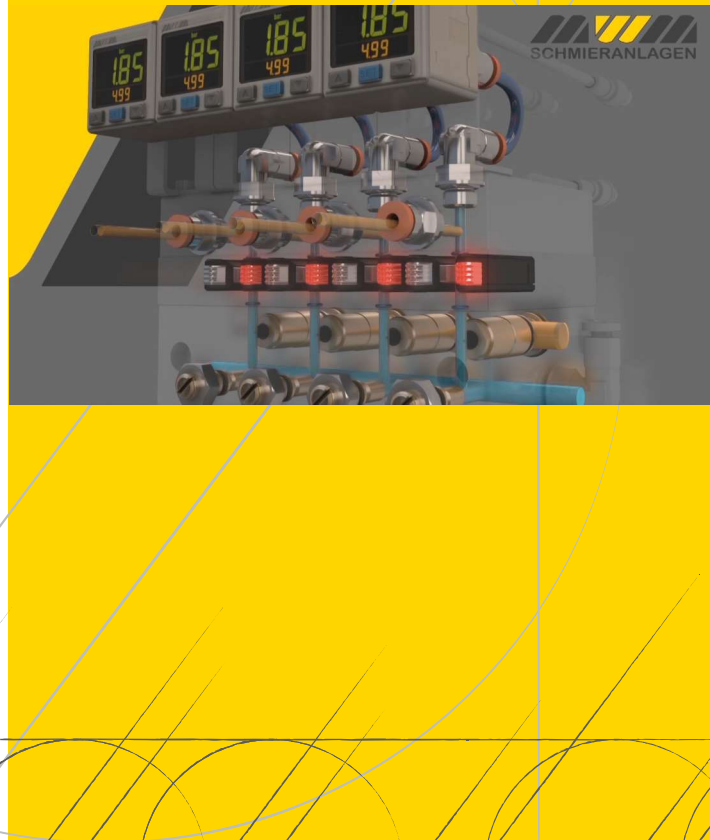
MQL-LS standard system	LSJ-Basic	LSJ-Z01	LSJ-Z01 Plus	LSJ-Z36	LS30	LS35	LS37
Supply air pressure range(bar)	4,5÷16	6÷16	4,5÷10	4,5÷10/16	4,5÷10	4,5÷16	4,5÷16
Oil tank capacity(liters)	2	4	4	4	4	4	4
Automatic oil refill	option	option	option	option	option	option	yes
Response time	—	—	<0,1sec	<0,1sec	<0,1sec	<0,1sec	<0,1sec
Optical sensor IFX-F (oil-mist detector)	option	option	option	option	yes	yes	yes
Air flow control	—	option	option	option	option	option	yes
Data exchange	—	—	PROFINET PROFIBUS	PROFINET PROFIBUS	PROFINET PROFIBUS	PROFINET PROFIBUS	PROFINET PROFIBUS

Most suitable MQL system choice

Whatever the tool or material, MWM experts can define the optimal solution. We can propose MQL systems able to meet any specific requirement, from the simplest to the most complex application.

MWM has developed a complete family of MQL systems at a competitive price. The adoption of the HPM technology allows to develop tailored solutions and achieve the best result, fitting the MQL system to the manufacturing process, to the tools and materials.

For detailed information please contact MWM: an expert technologist will be available to evaluate your manufacturing process and your needs.



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