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Minimum Quantity Lubrication

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ABSTRACT:The enormous reduction in the quantity of lubricant compared to the circulated quantities of conventional metalworking fluid systems is the key feature of MQL. In contrast to conventional flood lubrication, minimum quantity lubrication uses only a few millilitres (ml) of lubrication per hour for the machining process.
Minimum quantity lubrication today uses such precise metering that the lubricant is nearly completely used up. Typical dosage quantities range from 5 ml to 50 ml per process hour(tool cutting time).The extreme reduction in lubricant quantities results in nearly dry work pieces and chips. Losses due to evaporation and wastage, which may be considerable with emulsion lubrication(depending on the work piece being processed), are inconsequential with MQL. This greatly reduces health hazards due to emissions of metalworking fluids on the skin and in the breathed-in air of employees at their workplaces. The cost-inflating factors of conventional flood lubrication are done away with when MQL is used.

KEYWORDS: **MQL, lubrications, dry work etc.**

I. INTRODUCTION

Minimum quantity lubrication (MQL) has increasingly found its way into the area of metal cutting machining and, in many areas, has already been established as an alternative to conventional wet processing. In contrast to flood lubrication, minimum quantity lubrication uses only a few drops of lubrication (approx. 5 ml to 50 ml per hour) in machining. Today, the enormous cost-saving potential resulting from doing almost entirely without metalworking fluids in machining production is recognized and implemented by many companies, primarily in the automotive industry. While in the early 1990s small applications (sawing, drilling) were done "dry", today we are able to produce cylinder heads, crankcases, camshafts and numerous other components made of common materials – such as steel, cast iron and aluminium – using MQL in the framework of highly automated large volume production.

The advantages of this new technology are clear. With respect to occupational safety, MQL offers numerous advantages over water-mixed metalworking fluids. A major advantage is the substantially better compatibility concerning skin care. Minimum quantity lubrication is a total-loss lubrication method rather than the circulated lubrication method used with emulsions. This means using new, clean lubricants that are fatty-alcohol or ester based. Additives against pollution, e.g. biocides and fungicides, are not necessary at all, since microbial growth is possible only in an aqueous phase. The extreme reduction of lubrication quantities results in nearly dry work pieces and chips. This greatly reduces health hazards caused by emissions of metalworking fluids in breathed-in air and on the skin of employees at their workplaces. Metalworking fluids do not spread throughout there around the machine, thus making for a cleaner workplace. Costs generated by conventional flood lubrication (e.g. maintenance, inspection, preparation and disposal of metalworking fluids) are no longer an issue with minimum quantity lubrication process.

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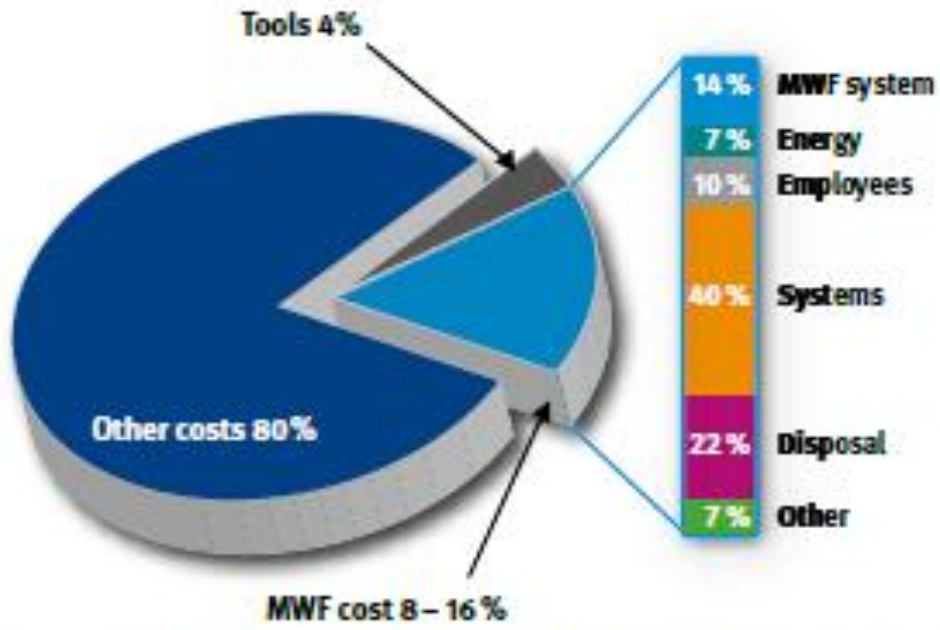

Fig.1 Metal working fluid cost in metal machining

II. PROCESS

A. EXTERNAL FEED FOR STANDARD PROCESSES

MQL systems for external feeds are suitable for retrofitting machine tools because the required spray nozzles can be easily installed on the spindle head. This system is especially suitable for simple standard processes, e.g. sawing, drilling, milling and turning. This type of lubricant supply, however, is limited by the different tool lengths and diameters as well as by limited accessibility to the tool cutting edge, e.g. when deep hole drilling.

Using MQL systems with internal feeds enables precise aerosol supply directly to the contact point through the tool. The lubricant is continually available at the critical points during the entire processing sequence. This makes it possible to drill very deep holes and use very high cutting speeds. Because the medium has to be fed through the machine spindle, converting to this system may be costly.
Some systems can be controlled directly by the machine tool control system; lubrication system settings for the required oil quantity and compressed air values can then be performed automatically when there is a tool change. For these lubrication systems in automated production, setting system parameters manually is not required.

B. Definitions:

A definition of minimum quantity lubrication has not yet been specified in standards and guidelines. Based on numerous publications, the following definition has been established in practice:

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Minimum quantity lubrication (MQL)

An average of not more than 50 ml of lubricant is used per processing hour and tool for the machining process. For certain operations, however, the process may well use more than 150 ml/h for short intervals, e.g. with tools having a diameter of > 40 mm.

A term often used is "minimum quantity cooling lubrication" (MQCL).

Reduced quantity lubrication (RQL)

This refers to reducing the circulation quantity of today's metalworking fluid systems through the targeted supply of lesser quantities of metalworking fluids (up to 2 litres per processing hour). Reduced quantity lubrication is therefore not total-loss lubrication. An example of reduced quantity lubrication is supplying metalworking fluids via shoe-shaped nozzles when grinding; the quantity of metalworking fluid can be reduced by up to 90 % compared to conventional processing

III. KEY COMPONENTS OF MINIMUM QUANTITY LUBRICATION

Every company interested in introducing minimum quantity lubrication asks the question "How can we best implement it in our production processes?" Often initial tests and experiences with this new technology are already available.

For the seamless introduction and implementation of minimum quantity lubrication in the production processes it is vital to have comprehensive information about core elements in advance. Figure 6 shows the core elements for successfully introducing MQL.

FIG.2. CORE ELEMENTS FOR SUCCESSFULLY INTRODUCING MINIMUM QUANTITY LUBRICATION

Reliable process machining is achieved when the lubricant, tool, metering device and machine are all suitable for minimum quantity lubrication and optimally adjusted to each other. The more these elements are compatible with each other the better. It is also important that the conditions be properly applied to the machining process by the qualified machine operator. The individual core elements are described below.

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IV. PRODUCTION PROCESSES WITH MINIMUM QUANTITY LUBRICATION

In addition to cooling and lubricating the machining point, the job of the metalworking fluid in conventional wet processing is to transport the chips away from the cutting zone. Thus, the best suited machining processes for minimum quantity lubrication are primarily those in which lubrication is the most important factor. In **Figure 7** the quantity requirement for metal working fluids is shown as a function of the different machining process

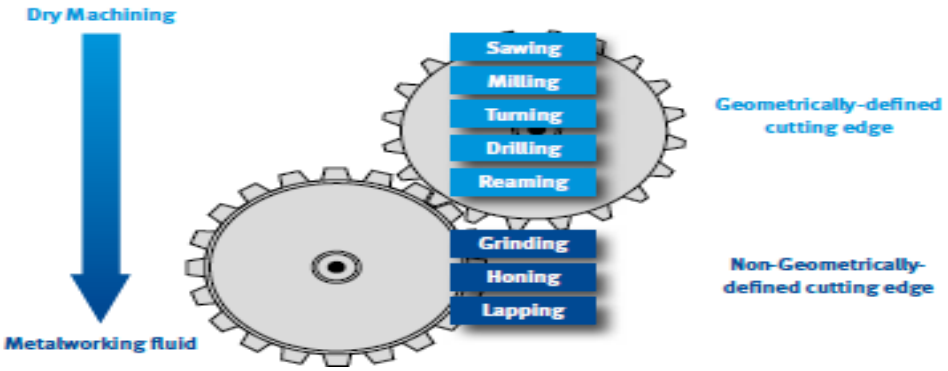

FIG.3. QUANTITY REQUIREMENT FOR METAL WORKING

Processing with geometrically defined cutting edges, such as milling, turning or drilling, can today be easily implemented with minimum quantity lubrication. The implementation is more difficult for processes with increasingly non-geometrically defined tool cutting edges, where the cooling and flushing effect of the metalworking fluid has a considerable influence on the machining process. Processes such as grinding are not yet economically feasible with minimum quantity lubrication.

A continually updated materials-processing matrix from research projects and working groups shows that today there are a great many and diverse areas of application for dry processing and minimum quantity lubrication (see Table 1)

Table 1: Areas of applications of MQL & dry processing

MATERIAL	ALUMINIUM		STEEL		CAST
Process	Cast Alloy	Forged Alloy	High-Alloy Steels, rolling Bearing steel	Free-cutting steel, quenche and tempered steel	GG20-GGG70
DRILLING	MQL	MQL	MQL	DRY	DRY
REAMING	MQL	MQL	MQL	MQL	MQL
MILLING	DRY	MQL	DRY	DRY	DRY
THREAD CUTTING	MQL	MQL	MQL	MQL	MQL
THREAD ROLLING	MQL	MQL	MQL	MQL	MQL

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DEEP DRILLING	MQL	MQL		MQL	MQL
TURNING	MQL/DRY	MQL/DRY	DRY	DRY	DRY
HOBBING			DRY	DRY	DRY
SAWING	MQL	MQL	MQL	MQL	MQL
BROACHING			MQL	MQL/DRY	DRY

VI. CRITERIA TO SELECT MQL LUBRICANT

A. **Smell**
The smell of the lubricant is not inconsequential. Spraying the lubricant can cause the smell to be intensified.

B. **Sprayability**
The lubricant should spray easily and, especially with 1-channel systems, be able to produce a stabile aerosol (oil-air mixture).

C. **Additives**
The additives should be adjusted to the processing requirements, particularly when
Processing non-ferrous metals and difficult-to-cut steels.

D. **Residues on machine parts**
Despite minimum spray amounts and the use of extraction devices, lubricants may leave residues on work pieces and machine parts. The lubricant should not resinate and should be easy to clean off if necessary.

E. **Viscosity range**
Practical experience shows that the best results with lubricants (ester or fatty alcohol) are achieved at a viscosity range of 15 to 50 mm2/s and in some cases up to 100 mm2/s at 40 °C. Upper viscosity limits should be discussed with the MQL system manufacturer (check device suitability for Sprayability). In general the MQL system and lubricant should be compatible with each other.

VII. ADVANTAGES AND LIMITATIONS

Advantages
1. Simple adaptations
2. Low investment costs
3. Little work required to retrofit conventional machine tools
4. Rapid responds characteristics
5. No special tool required

Limitations
1. Limited adjustable options for the nozzle due to different tool lengths and diameter
2. Possible shadowing effects of the spray jet when machining
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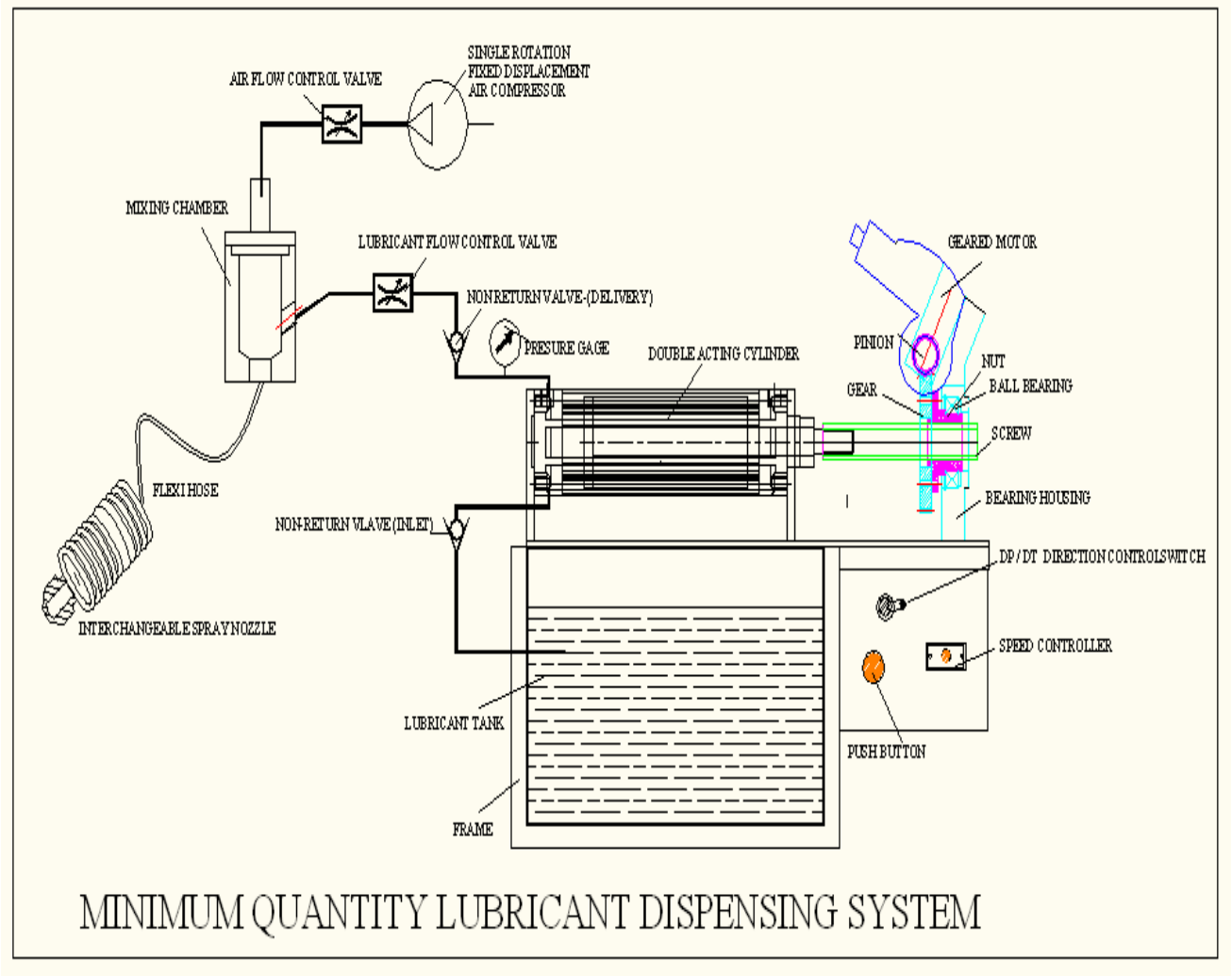

Fig.4. Minimum Quantity lubrication system

VIII. CONCLUSION

Minimum quantity lubrication system is useful for small size production or job. As compare MQL system give great surface finish & Quality of the product. Economic cost also less as compare to other lubrications systems.

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