The MQL HANDBOOK
A guide to machining with Minimum Quantity Lubrication
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**Dedication:** To Wally Boelkins who was championing MQL well before it even had a name, and who wanted to get it all in writing before he retired but found there was always one more person to talk to and one more place to visit.
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What is Minimum Quantity Lubrication?

Introduction

Minimum Quantity Lubrication (MQL) is just what the name implies. MQL uses a very small amount of a fluid to reduce the friction between a cutting tool and the work piece. The exact amount for “minimum” varies depending on who you ask. The German DIN specification puts it up to 50 mL/hour of lubricant (1.7 oz./hour), and, in exceptional cases, up to 150 mL/hour (5 oz./hour). Other studies have put the cap at 500 mL/hour (17 oz./hour). The amount is somewhat subjective and will depend greatly on the materials, processes, and the tools. Some materials have more natural lubricity than others, some processes are better able to get the fluid to the right place, and bigger tools need more lubricant than smaller ones. But as a general rule of thumb, 5 to 80 mL/hour (0.2 to 2.5 oz./hour) on tools less than 40 mm (1.57”) in diameter seems to keep chips dry and gives good results. No matter where you fall in this range, it is much less than the 30,000-60,000 mL/hour (8 to 16 gallons/hour) typically used with flood coolants!

MQL works best in cutting applications such as sawing, milling, turning, and drilling. It is not as effective in abrasive operations such as grinding, honing, and lapping where the fluids are needed to flush the resulting swarf away to avoid gumming.

There are many advantages to using less fluid. From an economic perspective, MQL simply costs less. Many are surprised to learn that the savings are not simply from buying less fluid. Although MQL fluids typically cost substantially more per gallon, less than 1/10,000 of the amount of fluid is used. This makes the cost per machined volume much less. MQL is considered a near-dry process, with less than 2 percent of the fluid adhering to the chips. This is not the same as dry machining where no fluid is used, but both share the
characteristic of needing no reclamation equipment. This eliminates investments into sumps, recyclers, containers, pumps, and filtration devices.

Furthermore, there are no costs for cleaning and drying the chips before their disposal or cleaning the work pieces prior to the next process.

The exact amount of savings will vary by plant, but industry estimates are that from 8 to 16% of total operation costs are related to metalworking fluids (MWF’s)\(^2\) and MQL will substantially cut these costs.

The extreme reduction of fluid greatly reduces health hazards caused by metalworking fluid emissions both into the air and on the skin of employees. When done properly, MQL fluids do not spread throughout the work area. They do not get into the electrical components of the machine nor dissolve the paint off of surfaces. This makes the whole shop cleaner and extends the life of the machines.\(^12\)
Although it may seem counter-intuitive, many shops see substantial increases in tool life. The reasons for this will be explained in the section How does MQL work?, but the increase has been up to 500%! In addition to the improvement in tool life, it usually results in better surface finishes too.

Lastly, in comparison to flood coolant, MQL is better by far for the global environment. Its reduction in waste and its environmentally friendly fluids make it a very eco-friendly process. Of course, all of these relate to each other. What is really exciting about moving to MQL is the virtuous cycle it starts. All the elements work with each other to reinforce the positive results displayed in Figure 2.

The German Ministry of Education and Research (BMBF) did a 3-year project called “Forschung für die Produktion von Morgen” or “Research for Tomorrow’s Production.” In this study, they looked at MQL and other “dry machining processes” (defined as those that leave less than 2% fluid residue on the chip). Fifty-eight studies were done involving several companies and many different materials. The involvement of large companies such as Bosch and Daimler-Chrysler allowed insights gleaned from the study to trickle down to small and medium sized companies who could not afford to do the research themselves. Several of their findings are used in this booklet, and the table in Figure 3 is a sample of the MQL specific results that were found.