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Enhancing Single Channel Minimum Quantity Lubrication through Bypass Controlled Design for Deep Hole Drilling with Small Diameter Tool

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Abstract : Due to significant energy savings, enablement of higher machining speed as well as environmentally friendly features, Minimum Quantity Lubrication (MQL) has been used for many machining processes efficiently. However, in the deep hole drilling field (small tool diameter D < 5 mm) and long tool (length L > 25xD) it is always a bottle neck for a single channel MQL system. The single channel MQL, based on the Venturi principle, faces a lack of enough oil quantity caused by dropped pressure difference during the deep hole drilling process. In this paper, a system concept based on a bypass design has explored its possibility to dynamically reach the required pressure difference between the air inlet and the inside of aerosol generator, so that the deep hole drilling demanded volume of oil can be generated and delivered to tool tips. The system concept has been investigated in static and dynamic laboratory testing. In the static test, the oil volume with and without bypass control were measured. This shows an oil quantity increasing potential up to 1000%. A spray pattern test has demonstrated the differences of aerosol particle size, aerosol distribution and reaction time between single channel and bypass controlled single channel MQL systems. A dynamic trial machining test of deep hole drilling (drill tool D=4.5mm, L= 40xD) has been carried out with the proposed system on a difficult machining material AlSi7Mg. The tool wear along a 100 meter drilling was tracked and analyzed. The result shows that the single channel MQL with a bypass control can overcome the limitation and enhance deep hole drilling with a small tool. The optimized combination of inlet air pressure and bypass control results in a high quality oil delivery to tool tips with a uniform and continuous aerosol flow.

Keywords : deep hole drilling, green production, Minimum Quantity Lubrication (MQL), near dry machining
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