Advances in Sustainable Manufacturing: Microfiltration and Micromachining

Research is presented in two areas where manufacturing is moving toward a more sustainable future. Metalworking fluids (MWFs) are a vital part of the machining industry, used for cooling and lubricating tools and workpieces. However, it is estimated that their use results in 10 million m^3 of oily waste water annually, with much of it classified as hazardous waste. Further, MWF sumps are known to contain bacteria that present significant occupational health risks to workers. Microfiltration is a membrane-based technology that enables contaminated fluids to be recycled while in use and significantly extends their lifespan. However, a major barrier to widespread use of microfiltration in industry is the fouling of microfiltration membrane pores by MWF ingredients and fluid contaminants. The presented research shows probabilistic and computational fluid dynamic modeling efforts and fluid design developments used to mitigate partial blocking as a fouling mechanism.

Micromachining is an emerging technology used to make machining of micro-scale parts viable without the significant energy costs of the CNC machines currently on the market. However, the limitations of micro-tooling technologies lead to increased levels of tool wear and tool failure, necessitating cooling and lubrication. The presented research shows how application of atomized MWFs can significantly reduce tool wear and lead to improved surface finish over both dry and flood cooling.