Experimental Validation of an Aerosol Generation Model for the Grinding Process

Hernan Peña-Diaz

The use of cutting fluids is a common practice in industrial machining operations. These fluids help in lubricating the contact area and in removing excess heat generated in the cutting zone. However, since these fluids have to be impinged upon the cutting zone the subsequent generation of aerosol mists, smoke and gases is unavoidable. These aerosol mists can be harmful to machine operators. It is, therefore, in the best interest of industrial manufacturers to have a good understanding of the mechanisms that generate these aerosols, so that they can accurately assess the health risks in which their employees are involved. Previous work in this area has produced an analytical model that predicts the aerosol generation rate for the grinding process. The objective of the present work is to validate that theoretical model under various experimental conditions of interest and to produce a piece of software based on the theoretical model. The software is intended to be used in an industrial setting where aerosol mists are generated during grinding operations in order to quickly assess the aerosol concentration levels that can be reached under known process conditions.

The grinding process has been modeled as shown in figure 1. This particular process is a cylindrical grinding operation. Under these conditions, four primary mechanisms have been identified for the formation of aerosols. The first one has been named “Airblast Splash”. Aerosols generated in this manner are created by the direct impingement of the cutting fluid on the grinding wheel and workpiece. The grinding wheel’s high speed of rotation creates a strong air belt around it, which will directly influence aerosol generation. The splashing effect of the cutting fluid over the grinding wheel is believed to be the primary contributor to the total aerosol generation.

The second mode of aerosol generation occurs when a portion of the impinged cutting fluid passes through the gap between the grinding wheel and the workpiece. This gap is created because the porous grains in the grinding wheel are somewhat separated and permit the passage of fluid through the space between them. This portion of the total cutting fluid does most of the heat removal in the cutting zone. The third mode of aerosol generation occurs by spin-off from the workpiece. This refers to droplets that break off from the liquid layer that is created over the rotating workpiece. The last mode of aerosol generation is the evaporation of cutting fluid due to the high temperatures in the cutting zone.

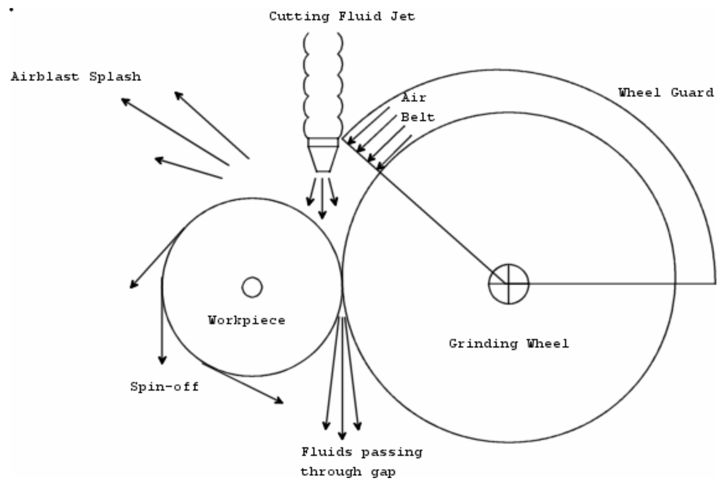

Figure 1 – Schematic of the cylindrical grinding process used to develop the theoretical model

There are several variables that will directly influence the resulting aerosol generation rate. The type of cutting fluid used, the size, velocity and roughness of the grinding wheel, the size and velocity of the workpiece, the type of nozzle used to dispense the cutting fluid, the proximity of the nozzle to the grinding wheel and the flow rate of the cutting fluid are just a few of the many parameters that are involved in this process. The five most significant parameters over which direct control can be achieved have been selected for the experimental validation. A mixed level factorial experiment will be conducted to estimate the effects of each of these individual parameters on the creation of aerosols during the grinding operation. Finally, the theoretical model prediction will be directly compared with experimental data to establish its accuracy and validity.

Hernan Peña-Diaz is pursuing a Master’s degree in Mechanical Engineering. He is currently working on research in the experimental validation of atomization models for industrial machining operations. He received his BSME degree from the University of Puerto Rico in 1997 and started graduate studies at Georgia Tech in the fall of 2000.

For more information, please contact *Hernan Peña-Diaz* directly at: gte563w@prism.gatech.edu