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## Modeling of wire vibration in wire electrical discharge machining process

Sameh Shawky Habib  
Benha University, Egypt

Wire electrical discharge machining (WEDM) is extensively used in machining of conductive materials when producing precision products. WEDM has higher capability for cutting complex shapes with high precision for very hard materials. During the WEDM process, the wire behaves like a metal string, straightened by two axial pulling forces and deformed laterally by a sum of forces from the discharge process. Major forces acting on the wire can be classified into three categories. The first is a tensile force, pulling the wire from both sides in axial direction and keeping it straight. The second is the dielectric flushing force that comes from circulation of the dielectric fluid in the machining area. The third category consists of forces of different kinds resulting from sparking and discharging. The large amplitude of wire vibration leads to large kerf widths, low shape accuracies, rough machined surfaces, low cutting speeds and high risk of wire breakage. Such tendencies for poor machining performance due to wire instability behavior appear with thinner wires. In this study, direct observation using high-speed camera investigated the movements of tungsten wire electrode during fine wire EDM process. Also, a mathematical model correlating the interactive and higher order influences of various parameters affecting wire vibration during the WEDM process through response surface methodology (RSM) were investigated. The adequacy of the above proposed model has been tested using analysis of variance (ANOVA). Optimal combination of these parameters has been obtained to minimize wire vibration.

[sameh.abadir@feng.bu.edu.eg](mailto:sameh.abadir@feng.bu.edu.eg)

## An example of roll pass design optimisation

Sead Spuzic and Kazem Abhary  
The University of South Australia, Australia

Hot rolling is amongst the most widely used manufacturing techniques. However, rolling mills are major resource consumers, and thus urgent rationalisations in the relevant industrial systems are required. Roll pass design (RPD) is a principal factor that determines process efficiency, product quality and resource consumption. Therefore it is important to optimise RPD including the selection of roll materials. New avenues for optimising RPD are to be found by extracting knowledge buried in the vast of industrial records. For this algorithms are developed that enable the generation of structured RPD databases. This novel structure is characterised by intelligently constructed hierarchy and universality of numerically defined variables. In addition, it allows for optimised invariance of the matrix components on the irrelevant features of the analysed rolling series. The variable hierarchy and matrix invariance enables extracting important RPD patterns relevant to the specific assortments of analysed rolling mill, and for comparing these patterns to more generic databases. Extracted statistical functions are then used for nonlinear optimisation of RPD parameters. An example of design of the leader oval groove for rolling wire rod is presented along with discussion of general mathematical aspects.

[Sead.Spuzic@unisa.edu.au](mailto:Sead.Spuzic@unisa.edu.au)