

Uncertainty Evaluation of Erosion Volume Measurement Using Coordinate Measuring Machine

Authors : Mohamed Dhouibi, Bogdan Stirbu, Chabotier André, Marc Pirlot

Abstract : Internal barrel wear is a major factor affecting the performance of small caliber guns in their different life phases. Wear analysis is, therefore, a very important process for understanding how wear occurs, where it takes place, and how it spreads with the aim on improving the accuracy and effectiveness of small caliber weapons. This paper discusses the measurement and analysis of combustion chamber wear for a small-caliber gun using a Coordinate Measuring Machine (CMM). Initially, two different NATO small caliber guns: 5.56x45mm and 7.62x51mm, are considered. A Micura Zeiss Coordinate Measuring Machine (CMM) equipped with the VAST XTR gold high-end sensor is used to measure the inner profile of the two guns every 300-shot cycle. The CMM parameters, such as (i) the measuring force, (ii) the measured points, (iii) the time of masking, and (iv) the scanning velocity, are investigated. In order to ensure minimum measurement error, a statistical analysis is adopted to select the reliable CMM parameters combination. Next, two measurement strategies are developed to capture the shape and the volume of each gun chamber. Thus, a task-specific measurement uncertainty (TSMU) analysis is carried out for each measurement plan. Different approaches of TSMU evaluation have been proposed in the literature. This paper discusses two different techniques. The first is the substitution method described in ISO 15530 part 3. This approach is based on the use of calibrated workpieces with similar shape and size as the measured part. The second is the Monte Carlo simulation method presented in ISO 15530 part 4. Uncertainty evaluation software (UES), also known as the Virtual Coordinate Measuring Machine (VCMM), is utilized in this technique to perform a point-by-point simulation of the measurements. To conclude, a comparison between both approaches is performed. Finally, the results of the measurements are verified through calibrated gauges of several dimensions specially designed for the two barrels. On this basis, an experimental database is developed for further analysis aiming to quantify the relationship between the volume of wear and the muzzle velocity of small caliber guns.

Keywords : coordinate measuring machine, measurement uncertainty, erosion and wear volume, small caliber guns

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