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Estimating cone rotation speeds from roller cone bit vibration

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Abstract: Real-time diagnosis of bit wear while drilling has been a fundamental interest for drilling engineers. It has been inferred from previous studies that the degree of tooth wear for a roller cone bit might be correlated with the increases of cone rotation speeds during drilling. This implies that monitoring cone rotation speeds could be an effective diagnostic method of tooth wear for roller cone bits. However, there is no practical means to directly measure cone rotation speeds in the field so far.

Instead of direct measurement, the author developed an estimation method of cone rotation speeds from roller cone bit vibration data. The method is an application of signal detection from random data using cross-correlation function. An estimate of cone rotation speed can be obtained as an inverse problem solution by maximizing the cross-correlation between measured bit vibration and a vibration time history simulated using bit dynamics model for a single cone expressed as a function of cone rotation speed.

Validation of the method was made by applying the estimation procedure to experimentally measured vibration data for 8-1/2" milled tooth bits. The developed method could simultaneously estimate the rotation speeds for all of the three cones with considerably high accuracy in various drilling conditions.

Key words: drilling, roller cone bit, tooth wear diagnosis, cone rotation speed, vibration, cross-correlation

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