HARDMETALS PERFORMANCE EVALUATION BASED ON TESTING THE TRANSITIONS IN THEIR WEAR CHARACTERISTICS

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ABSTRACT

This paper described an integrated testing method for hardmetals abrasion resistance and fracture toughness joint evaluation. Fracture toughness is one of the two major materials properties to take into consideration when designing mining tools made of hardmetals (WC – Co cemented carbides). This is due to the fact that abrasive wear and brittle fracture lead to high replacement cost and extended downtime for worn tools. In mining and drilling processes, involving impact and rubbing contact between the tools and rock, the perfect ratio between the two somehow conflicting mechanical properties of cemented carbide rock – bit materials namely wear resistance and fracture toughness remains unknown. During the course of this tribological investigation the attention was focused on the transition from the initial unstable stage of wear to the steady stage of wear (Fig. 1).

![Graphical interpretation of wear indicators such as Wv, ΔWv, and Wv based on experimental data with hardmetal WC 5 tested with alumina as an abradant.](image1)

In the unstable stage the predominant cause of mass loss was hardmetal fracture at the cutting – edges of the specimens. In the second steady stage the wear was controlled by microabrasion mechanisms in which wear depends linearly on time and a little or no fracture occurs except for a separate carbide grains fragmentation. Accurate determination of the transition for every grade tested was possible thanks to the peculiar shape of the specimens in the form of triangular bar with three leading edges and thanks to the procedure of the bar mass loss control in series of sequentially following tests (Fig. 2).

![Schematic diagram of tribotester: 1-drill chuck, 2-drive shaft, 3-cylindrical chamber, 4-thermocouple, 5-torque indicator, 6-thrust bearing, 7-velocity indicator, 8-displacement indicator, 9-recorder, 10-specimen-bar (dimensions in mm).](image2)

Based on experimentally defined wear transitions the fracture toughness and wear resistance factors were calculated using the following empirical equation [1]:

\[ K_{CWR} = \beta \left( \frac{E}{H} \left( \frac{1}{s} \right) (EI \cdot F_N)^{1/2} \right) \]

The presented wear resistance testing integrated with fracture toughness assessment has some potential experimental advantage. This is so when it is used in hardmetals development programme to rank materials in terms of abrasion resistance and fracture toughness. Particularly these materials for which standard wear testing methods (e.g. ASTM B611) or conventional toughness test methods (e.g. Palmqvist/Vickers indentation fracture toughness test) are not suitable or too expensive.

REFERENCES