

Lubrication and Tool-wear in the Turning of Hard Powdered Metals

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Background

A current target and need in the auto industry is to achieve improved tool life in machining powered metal valve seats for an engine block. The tools required are specialized and expensive, and extending the service life of the tools will have significant economic impact within the industry. Quaker Chemical Corp. would like a recommendation of three water based metalworking fluids i.e. Quakeral 381SD, Microcut 240T, and Microcut 3680 that were used to machine M2-Steel (M2) and High Nickel (HN) valve seats.

Project Overview

To evaluate the three metalworking fluids, two performance data were collected and analyzed. Tool-wear on the inserts and surface finish of the valve seats were measured after the machining operations and statistical analysis was utilized to evaluate the performance.

Result

Tool Wear Analysis

ANOVA and Tukey's tests with 0.05 as critical value were conducted to test the significant differences in the amount of tool wear between three types of metalworking fluids on two different valve seats. During Microcut 240T experiment for M2-steel, the failure of the cutting inserts were occurred in early cuts. Hence, for M2-steel, the statistical analysis was only conducted for Microcut 3680 and Quakeral 381 SD. The summary can be seen below

	ANOVA		M3680-Q381SD		M240T-Q381SD	M3680-M240T
	M2	HN	M2	HN	HN	HN
Rake Face	0.01	0.12	(-0.001,-0.0005)	(-0.004,0.0006)	(-0.003,0.0014)	(-0.003,0.002)
Minor Cutting Edge	0.05	0.00	(-0.0003,0.000005)	(-0.0006,-0.0003)	(-0.0006,-0.0003)	(-0.0002,0.0001)
Major Cutting Edge	0.01	0.33	(-0.001,-0.0006)	(-0.003,0.001)	(-0.003,0.001)	(-0.002, 0.002)

The number listed in red showed significant differences in tool wear performance because the p-value is less than 0.05 and the Confidence Interval has no zero in the interval. Based on the ANOVA test, the rank of the metalworking fluids on tool-wear performance (from the best) are as follows: M2 (M3680-Q381SD-M240T) and High Nickel (M3680 or M240T – Q381SD).

Surface Finish

The same statistical analysis was conducted to test the surface finish performance on three types of metalworking fluid. The summary of the result is listed below

	ANOVA	Confidence Interval of the difference between		
	P-Value	M240T-Q381	M3680-Q381	M3680-M240T
M2	0.251	(-53.179, 21.858)	(-35.869, 39.169)	(-20.208, 54.829)
High Nickel	0.309	(-7.953, 17.861)	(-7.759, 18.055)	(-12.713, 13.101)

The ANOVA and Tukey's test result showed that there are no significant differences for surface finish performance in between three types of metalworking fluid for both M2 and High Nickel. For both type of valve seats, the P-value are greater than 0.05 and all the confidence interval contained zero on the interval.

Conclusion

With the completion of data collection on the two performance measures, statistical analysis and human judgment was used to evaluate the three metalworking fluids that were provided by Quaker Chemical Corp. Due to no significant difference in surface finish, the metalworking fluids were ranked according to tool-wear rates. The most suitable metalworking fluid to machine the high nickel valve seats are M3680 and M240T, followed by Q381. To machine M2-Steel valve seats, the most suitable metalworking fluid is M3680, followed by Q381, then M240T.