outokumpu
high performance stainless steel

North American Version
Imperial Units

A Machining Comparison between Outokumpu PRODEC® and Standard Stainless Bar

Background

Outokumpu's PRODEC® Type 304 and Type 316 stainless steels were developed to provide improved machinability over conventional products while meeting all requirements of the standard grade equivalents. While a significant improvement has been demonstrated in laboratory development tests and in commercial applications, the question has often been raised as to how PRODEC bar compares to a premium product such as Carpenter Project 70® stainless steel bar when evaluated under identical conditions. This report provides the results of machining tests conducted to answer this question.

Procedure

Machinability testing was conducted under the contracted services of IAMS/Metcut, Cincinnati, Ohio. Three representative PRODEC three inch round bars were compared to three inch round bars produced by Slater, Daido, and Carpenter Technology Corporation. The certified chemical analysis and mechanical properties of these bars are provided in Tables 1 and 2.

The test procedure consisted of single point turning without lubricant at varying speeds while holding feed constant at 0.015 inches per revolution at a 0.050 inch depth of cut. These conditions simulated a semi-roughing operation

Chemical Composition of Bars Used in Machining Test, wt. pct.

Table 1

Manufacturer	Grade	Heat	C	N	Mn	P	S	Si	Ni	Cr	Mo	Cu	Co
Daido	T304	96712	0.050	0.080	1.67	0.034	0.028	0.32	8.40	18.77	0.19	0.34	—
Slater	T304	95638	0.060	0.050	1.27	0.036	0.027	0.48	8.61	18.70	0.49	0.36	0.10
Carpenter Technology	Project 70 T304	21709	0.018	0.086	1.69	0.032	0.024	0.61	8.20	18.36	0.55	0.53	—
Outokumpu	PRODEC T304	A302816	0.035	0.028	1.00	0.026	0.017	0.75	8.60	18.53	0.46	0.41	0.19
Outokumpu	PRODEC T304	BUB88700-P	0.040	0.079	0.94	0.03	0.027	0.68	8.60	18.40	0.50	0.32	0.14
Outokumpu	PRODEC T316	CUB2153-P	0.036	0.048	1.49	0.031	0.024	0.61	10.70	17.40	2.06	0.38	0.35

Mechanical Properties of Bars Used in Machining Test

Table 2

Manufacturer	Grade	Heat	Y.S. (ksi)	U.T.S. (ksi)	El. Pct.	R.A. Pct.	HB
Daido	T304	96712	41.7	91.0	60.0	72.0	172
Slater	T304	95638	43.1	90.4	59.4	74.1	183
Carpenter Technology	Project 70 T304	21709	47.8	88.5	59.0	79.0	175
Outokumpu	PRODEC T304	A302816	42.2	87.4	57.0	74.0	163
Outokumpu	PRODEC T304	BUB88700-P	50.4	91.6	54.0	74.0	163
Outokumpu	PRODEC T316	CUB2153-P	42.3	84.6	53.0	71.0	155

for carbide tooling. The tooling consisted of Kennametal KC 850 grade carbide SNMP 432 style inserts. The evaluations were made by periodically measuring the flank wear throughout each test to develop a wear curve for each material at each of four different cutting speeds. The materials could then be compared using a set of curves plotting the cutting time required to reach a given flank wear versus cutting speed. The basic wear data are given in Table 3A-3C, and tool life versus cutting speed curves for a 0.015 inch flank wear are given in Figures 1 through 3.*

Results

The results show that the three PRODEC bars fall into a distinctly higher performance category than the three competitive bars. These two distinct groups of machining performance are shown in Figure 1. All the PRODEC bars significantly outperformed even the best of the competitive bars, all of which were quite similar. The superiority of PRODEC is shown more distinctly in Figure 2 where only the average for the three competitive bars is shown. The PRODEC bars provide a tool life advantage of approximately 100%, about thirty minutes versus fifteen minutes at a cutting speed of 600 sfm, or provide increased productivity of about 25% at, for example, a fifteen minute tool life. The Carpenter Project 70 bar did not display any machining advantage over the other competitive bars as can be seen in Figure 1, and so the advantage of PRODEC over Project 70 is again in the order of 100% better tool life or 25% better productivity, as shown in Figure 3.

Conclusion

This machinability comparison shows that PRODEC Type 304 and Type 316 stainless bars have the capability of significantly outperforming standard and premium stainless bar products. While this conclusion is based on only one set of machining conditions there is no reason to think that this superiority will not hold for other conditions. PRODEC can offer both improved tool life and productivity, either individually or in combination. Machine shops using PRODEC should explore both of these advantages to determine a combination that is optimal for their specific requirements.

Tool Life Data for PRODEC® and Competitive Stainless Steel Bars — Table 3A

Tool Life — Minutes to Reach 0.05 inch Flank Wear — Table 3A

Speed (sfm)	All Competition	Daido	Carpenter Technology	Slater	PRODEC (0.017 Pct. Sulfur)	PRODEC (0.027 Pct. Sulfur)	PRODEC 316
500	35.5	—	37.0	34.0	—	43.0	—
600	15.3	14.0	16.5	15.5	30.0	36.0	29.0
700	7.7	6.5	8.0	8.5	16.5	19.5	22.5
800	3.0	1.0	3.0	5.0	8.0	8.0	12.0

Tool Life — Minutes to Reach 0.10 inch Flank Wear — Table 3B

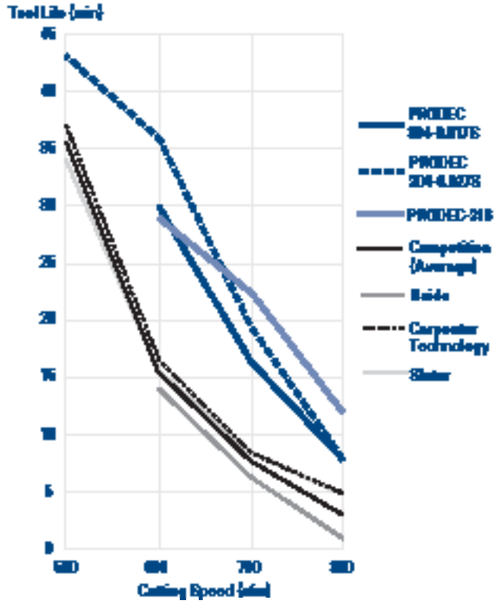
Speed (sfm)	All Competition	Daido	Carpenter Technology	Slater	PRODEC (0.017 Pct. Sulfur)	PRODEC (0.027 Pct. Sulfur)	PRODEC 316
500	26.0	—	28.5	23.5	—	38.5	—
600	11.6	8.8	13.0	13.0	30.0	26.5	16.5
700	5.1	4.4	4.5	6.5	16.5	16.0	7.0
800	2.4	0.6	2.0	4.5	8.0	8.0	2.5

Tool Life — Minutes to Reach 0.005 inch Flank Wear — Table 3C

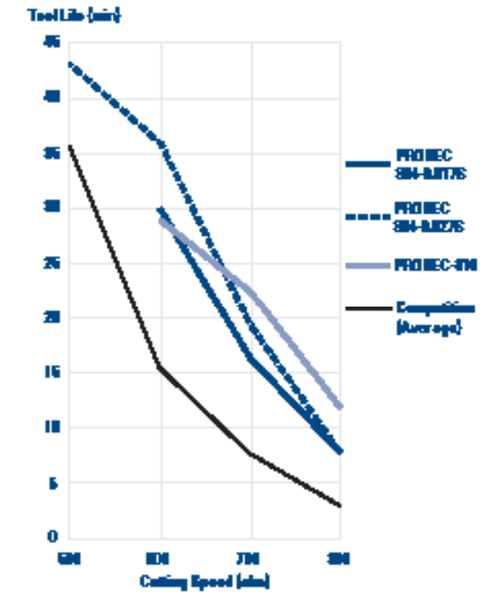
Speed (sfm)	All Competition	Daido	Carpenter Technology	Slater	PRODEC (0.017 Pct. Sulfur)	PRODEC (0.027 Pct. Sulfur)	PRODEC 316
500	12.5	—	17.0	8.0	—	22.0	—
600	5.5	3.8	7.5	6.0	9.0	8.0	16.5
700	2.9	2.3	2.0	4.5	7.5	7.0	6.5
800	1.4	0.7	1.5	2.0	2.5	5.0	2.5

*Data shown are typical and should not be interpreted as minimum or maximum values in any application. Information may vary from that published and is subject to change without notice. Ideal parameters are established by a complex interaction of machine characteristics, tooling, cutting fluids, personnel, and part design. Data must be interpreted by user in light of these relationships.

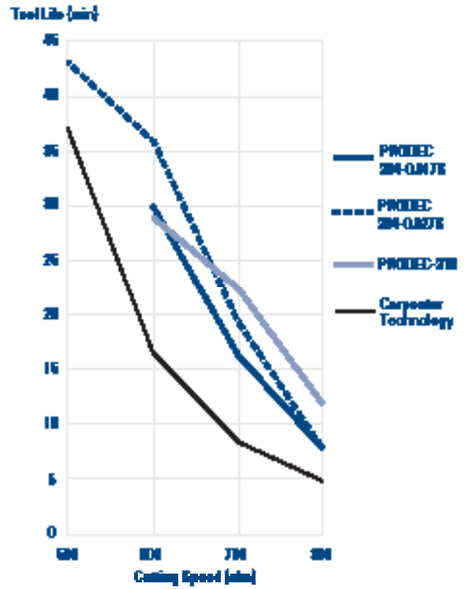
Tool Life for PRODEC® and Competitive Type 304 Stainless Bars at 0.015 inch Flank Wear — Figure 1



Tool Life for PRODEC® and Competitive Type 304 Stainless Bars at 0.015 inch Flank Wear — Figure 2



Tool Life for PRODEC® and Competitive Type 304 Stainless Bars at 0.015 inch Flank Wear — Figure 3



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to create long lasting solutions for the tools
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