

# 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

**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<br>Technology | Project 70<br>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.<br>(ksi) | U.T.S.<br>(ksi) | El.<br>Pct. | R.A.<br>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<br>Technology | Project 70<br>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 |

simulated a semi-roughing operation 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

**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.

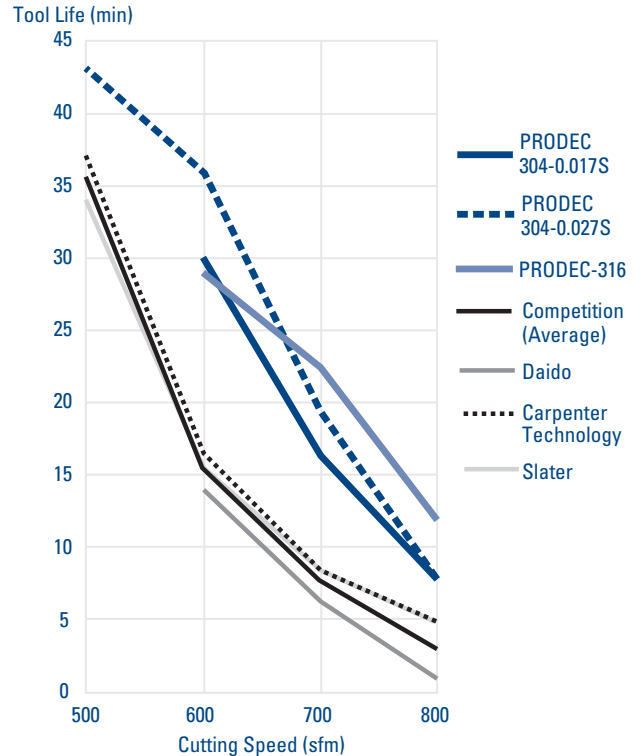
groups of machining performance are shown in Figure 1. All the PRODEC bars significantly outperformed even the best of the competitive bars, all of which were quite similar. The superiority of PRODEC is shown more distinctly in Figure 2 where only the average for the three competitive bars is shown. 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.

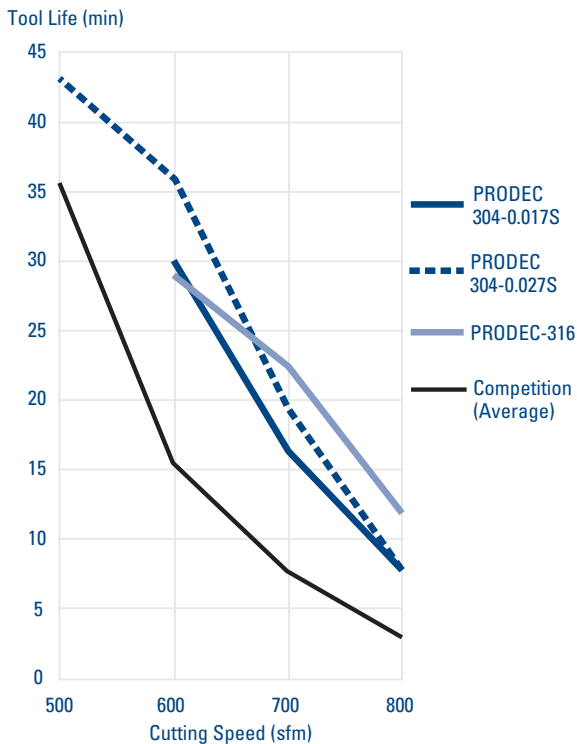
**Tool Life for PRODEC® and Competitive Type 304 Stainless Bars at 0.015 inch Flank Wear**

Figure 1



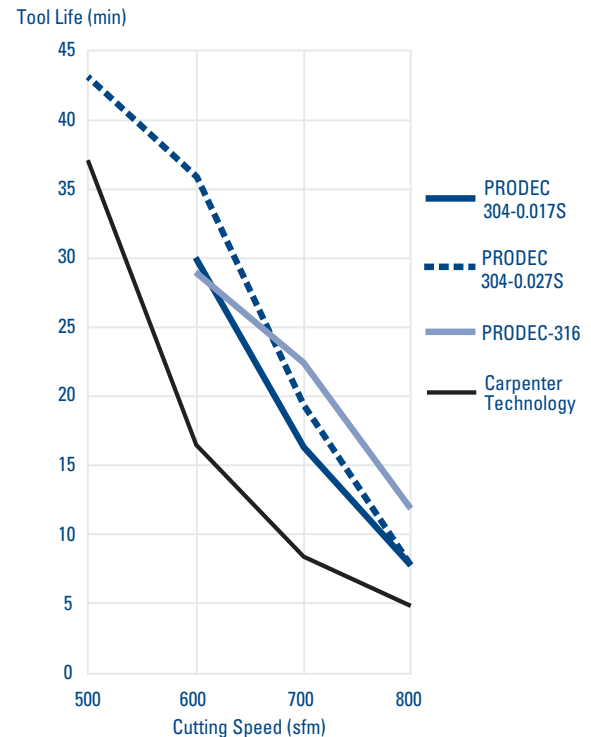
**Tool Life for PRODEC® and Competitive Type 304 Stainless Bars at 0.015 inch Flank Wear**

Figure 2



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

Figure 3



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.

*This report was prepared for Outokumpu  
by TMR Stainless, Pittsburgh, PA.*

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*What makes Outokumpu special is total customer focus – all the way, from R&D to delivery. You have the idea. We offer world-class stainless steel, technical know-how and support. We activate your ideas.*



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