

# Speeds and Feeds



| ISO | VDI 3323 | Material Description                         | Composition / Structure / Heat Treatment       |                     | HB      | HRC | SFM<br>(ft/min) | Countersink Diameter |             |             |             |             |             |             |             |             |
|-----|----------|----------------------------------------------|------------------------------------------------|---------------------|---------|-----|-----------------|----------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
|     |          |                                              |                                                |                     |         |     |                 | IPR(inch/rev)        |             |             |             |             |             |             |             |             |
|     |          |                                              |                                                |                     |         |     |                 | METRIC               | 5           | 10          | 15          | 20          | 25          | 30          | 40          | 50          |
|     |          |                                              |                                                |                     |         |     | DECIMAL         | .1969                | .3937       | .5906       | .7874       | .9843       | 1.1811      | 1.5748      | 1.9685      |             |
| P   | 1        | Non-alloy steel                              | About 0.15% C                                  | Annealed            | 125     |     | 66              | FEED                 | .0047-.0063 | .0063-.0079 | .0079-.0091 | .0091-.0102 | .0102-.0114 | .0114-.013  | .013-.0146  | .0146-.0161 |
| P   | 2        |                                              | About 0.45% C                                  | Annealed            | 190     | 13  | 66              | FEED                 | .0047-.0063 | .0063-.0079 | .0079-.0091 | .0091-.0102 | .0102-.0114 | .0114-.013  | .013-.0146  | .0146-.0161 |
| P   | 3        |                                              | About 0.45% C                                  | Quenched & tempered | 250     | 25  | 43              | FEED                 | .0039-.0055 | .0055-.0071 | .0071-.0083 | .0083-.0094 | .0094-.0106 | .0106-.0122 | .0122-.0138 | .0138-.0154 |
| P   | 4        |                                              | About 0.75% C                                  | Annealed            | 270     | 28  | 33              | FEED                 | .0024-.0039 | .0039-.0055 | .0055-.0067 | .0067-.0083 | .0083-.0094 | .0094-.0106 | .0106-.0122 | .0122-.0138 |
| P   | 5        |                                              | About 0.75% C                                  | Quenched & tempered | 300     | 32  | 33              | FEED                 | .0024-.0039 | .0039-.0055 | .0055-.0067 | .0067-.0083 | .0083-.0094 | .0094-.0106 | .0106-.0122 | .0122-.0138 |
| P   | 6        | Low alloy steel                              |                                                | Annealed            | 180     | 10  |                 |                      |             |             |             |             |             |             |             |             |
| P   | 7        |                                              |                                                | Quenched & tempered | 275     | 29  |                 |                      |             |             |             |             |             |             |             |             |
| P   | 8        |                                              |                                                | Quenched & tempered | 300     | 32  |                 |                      |             |             |             |             |             |             |             |             |
| P   | 9        |                                              |                                                | Quenched & tempered | 350     | 38  |                 |                      |             |             |             |             |             |             |             |             |
| P   | 10       | High alloyed steel, and tool steel           |                                                | Annealed            | 200     | 15  |                 |                      |             |             |             |             |             |             |             |             |
| P   | 11       |                                              |                                                | Quenched & Tempered | 325     | 35  |                 |                      |             |             |             |             |             |             |             |             |
| M   | 12       | Stainless steel                              | Ferritic / Martensitic                         | Annealed            | 200     | 15  | 20              | FEED                 | .0024-.0031 | .0024-.0031 | .0031-.0039 | .0031-.0039 | .0039-.0047 | .0039-.0047 | .0047-.0059 | .0047-.0059 |
| M   | 13       |                                              | Martensitic                                    | Quenched & Tempered | 240     | 23  | 16              | FEED                 | .0024-.0031 | .0024-.0031 | .0031-.0039 | .0031-.0039 | .0039-.0047 | .0039-.0047 | .0047-.0059 | .0047-.0059 |
| M   | 14       |                                              |                                                | Austenitic          | 180     | 10  | 13              | FEED                 | .0024-.0031 | .0024-.0031 | .0031-.0039 | .0031-.0039 | .0039-.0047 | .0039-.0047 | .0047-.0059 | .0047-.0059 |
|     |          | Duplex                                       |                                                |                     | 180     | 10  |                 |                      |             |             |             |             |             |             |             |             |
| K   | 15       | Grey cast iron                               | Pearlitic / ferritic                           |                     | 180     | 10  | 72              | FEED                 | .0035-.0043 | .0043-.0051 | .0051-.0063 | .0063-.0075 | .0075-.0087 | .0087-.0098 | .0098-.011  | .011-.0126  |
| K   | 16       |                                              | Pearlitic (Martensitic)                        |                     | 260     | 26  | 56              | FEED                 | .0031-.0039 | .0039-.0047 | .0047-.0059 | .0059-.0071 | .0071-.0083 | .0083-.0094 | .0094-.0106 | .0106-.0122 |
| K   | 17       | Nodular cast iron                            | Ferritic                                       |                     | 160     | 3   | 56              | FEED                 | .0035-.0043 | .0043-.0051 | .0051-.0063 | .0063-.0075 | .0075-.0087 | .0087-.0098 | .0098-.011  | .011-.0126  |
| K   | 18       |                                              | Pearlitic                                      |                     | 250     | 25  | 49              | FEED                 | .0031-.0039 | .0039-.0047 | .0047-.0059 | .0059-.0071 | .0071-.0083 | .0083-.0094 | .0094-.0106 | .0106-.0122 |
| K   | 19       | Malleable cast iron                          | Ferritic                                       |                     | 130     |     | 56              | FEED                 | .0035-.0043 | .0043-.0051 | .0051-.0063 | .0063-.0075 | .0075-.0087 | .0087-.0098 | .0098-.011  | .011-.0126  |
| K   | 20       |                                              | Pearlitic                                      |                     | 230     | 21  | 49              | FEED                 | .0031-.0039 | .0039-.0047 | .0047-.0059 | .0059-.0071 | .0071-.0083 | .0083-.0094 | .0094-.0106 | .0106-.0122 |
| N   | 21       | Aluminum-wrought alloy                       | Not Curable                                    |                     | 60      |     | 138             | FEED                 | .0059-.0071 | .0071-.0083 | .0083-.0094 | .0094-.0106 | .0106-.0122 | .0122-.0138 | .0138-.0157 | .0157-.0177 |
| N   | 22       |                                              | Curable                                        | Hardened            | 100     |     | 138             | FEED                 | .0059-.0071 | .0071-.0083 | .0083-.0094 | .0094-.0106 | .0106-.0122 | .0122-.0138 | .0138-.0157 | .0157-.0177 |
| N   | 23       | Aluminum-cast, alloyed                       | ≤ 12% Si, Not Curable                          |                     | 75      |     | 128             | FEED                 | .0059-.0071 | .0071-.0083 | .0083-.0094 | .0094-.0106 | .0106-.0122 | .0122-.0138 | .0138-.0157 | .0157-.0177 |
| N   | 24       |                                              | ≤ 12% Si, Curable                              | Hardened            | 90      |     | 121             | FEED                 | .0047-.0059 | .0059-.0071 | .0071-.0083 | .0083-.0094 | .0094-.011  | .011-.0122  | .0122-.0146 | .0146-.0165 |
| N   | 25       |                                              | > 12% Si, Not Curable                          |                     | 130     |     | 115             | FEED                 | .0059-.0071 | .0071-.0083 | .0083-.0094 | .0094-.0106 | .0106-.0122 | .0122-.0138 | .0138-.0157 | .0157-.0177 |
| N   | 26       | Copper and Copper Alloys<br>(Bronze / Brass) | Cutting Alloys, PB>1%                          |                     | 110     |     | 92              | FEED                 | .0047-.0059 | .0059-.0071 | .0071-.0083 | .0083-.0094 | .0094-.011  | .011-.0122  | .0122-.0146 | .0146-.0165 |
| N   | 27       |                                              | CuZn, CuSnZn (Brass)                           |                     | 90      |     | 82              | FEED                 | .0047-.0059 | .0059-.0071 | .0071-.0083 | .0083-.0094 | .0094-.011  | .011-.0122  | .0122-.0146 | .0146-.0165 |
| N   | 28       |                                              | CuSn, lead-free copper and electrolytic copper |                     | 100     |     | 49              | FEED                 | .0047-.0059 | .0059-.0071 | .0071-.0083 | .0083-.0094 | .0094-.011  | .011-.0122  | .0122-.0146 | .0146-.0165 |
| N   | -        | High strngth Bronze                          |                                                |                     |         |     |                 |                      |             |             |             |             |             |             |             |             |
| N   | 29       | Non Metallic Materials                       | Duroplastic, Fiber Reinforced Plastic          |                     |         |     |                 |                      |             |             |             |             |             |             |             |             |
| N   | 30       |                                              | Rubber, Wood, etc.                             |                     |         |     |                 |                      |             |             |             |             |             |             |             |             |
| N   | -        | CFRP, Graphite Composite                     |                                                |                     |         |     |                 |                      |             |             |             |             |             |             |             |             |
| S   | 31       | Heat Resistant Super Alloys                  | Fe Based                                       | Annealed            | 200     | 15  |                 |                      |             |             |             |             |             |             |             |             |
| S   | 32       |                                              |                                                | Cured               | 280     | 30  |                 |                      |             |             |             |             |             |             |             |             |
| S   | 33       |                                              | Ni or Co Based                                 | Annealed            | 250     | 25  |                 |                      |             |             |             |             |             |             |             |             |
| S   | 34       |                                              |                                                | Cured               | 350     | 38  |                 |                      |             |             |             |             |             |             |             |             |
| S   | 35       |                                              |                                                | Cast                | 320     | 34  |                 |                      |             |             |             |             |             |             |             |             |
| S   | 36       | Titanium Alloys                              | Pure Titanium                                  |                     | 400 Rm  |     |                 |                      |             |             |             |             |             |             |             |             |
| S   | 37       |                                              | Alpha + Beta Alloys                            | Hardened            | 1050 Rm |     |                 |                      |             |             |             |             |             |             |             |             |
| H   | 38       | Hardened steel                               |                                                | Hardened            | 550     | 55  |                 |                      |             |             |             |             |             |             |             |             |
| H   | 39       |                                              |                                                | Hardened            | 630     | 60  |                 |                      |             |             |             |             |             |             |             |             |
| H   | 40       | Chilled Cast Iron                            |                                                | Cast                | 400     | 42  |                 |                      |             |             |             |             |             |             |             |             |
| H   | 41       | Hardened Cast Iron                           |                                                | Hardened            | 550     | 55  |                 |                      |             |             |             |             |             |             |             |             |

# Speeds and Feeds



**Penetration Rate  
(in/min)**

$$v_f = f_n \cdot n$$

**Feed Per Revolution  
(in/rev)**

$$f_n = \frac{v_f}{n}$$

**Cutting Speed  
(ft/min)**

$$v_c = \frac{\pi \cdot D_{tool} \cdot n}{12}$$

**Spindle Speed  
(rev/min)**

$$n = \frac{v_c \cdot 12}{\pi \cdot D_{tool}}$$

**Material Removal Rate  
(in<sup>3</sup>/min)**

$$MRR = D_{tool} \cdot f_n \cdot v_c \cdot 3$$

Inch

| Symbol     | Definition            | Unit                        |
|------------|-----------------------|-----------------------------|
| $v_f$      | Penetration rate      | <i>in/min</i>               |
| $f_n$      | Feed per revolution   | <i>in/rev</i>               |
| $v_c$      | Cutting speed         | <i>ft/min (SFM)</i>         |
| $n$        | Spindle speed         | <i>rev/min (RPM)</i>        |
| $D_{tool}$ | Tool cutting diameter | <i>in</i>                   |
| $MRR$      | Material removal rate | <i>(in<sup>3</sup>/min)</i> |