

# FRICITION LOSSES FOR VISCOUS LIQUIDS

| GPM   | PIPE SIZE | Viscosity, SSU |        |        |        |        |       |       |       |       |       |       |       |      |      |      |       |        |  |
|-------|-----------|----------------|--------|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|------|------|------|-------|--------|--|
|       |           | 32             | 50     | 100    | 200    | 400    | 600   | 800   | 1000  | 2000  | 3000  | 4000  | 5000  | 6000 | 7000 | 8000 | 9,000 | 10,000 |  |
| 1 1/2 | 3/8       | 0.033          | 0.050  | 0.14   | 0.28   | 0.60   | 0.87  | 1.2   | 1.5   | 3.3   | 4.5   | 6.0   | 7.5   | 8.8  |      |      |       |        |  |
|       | 1/2       | 0.013          | 0.020  | 0.055  | 0.11   | 0.24   | 0.35  | 0.47  | 0.60  | 1.3   | 1.8   | 2.4   | 3.0   | 3.5  | 4.2  | 5.0  | 5.4   | 6.0    |  |
|       | 3/4       | 0.0038         | 0.0065 | 0.018  | 0.038  | 0.080  | 0.12  | 0.16  | 0.20  | 0.40  | 0.60  | 0.80  | 1.0   | 1.2  | 1.4  | 1.6  | 1.8   | 2.0    |  |
|       | 1         | 0.0010         | 0.0025 | 0.0070 | 0.015  | 0.030  | 0.045 | 0.060 | 0.075 | 0.15  | 0.23  | 0.30  | 0.36  | 0.45 | 0.52 | 0.60 | 0.67  | 0.73   |  |
| 3 1/2 | 1/2       | 0.060          | 0.10   | 0.13   | 0.27   | 0.56   | 0.85  | 1.1   | 1.4   | 2.8   | 4.3   | 5.6   | 7.0   | 8.5  | 9.8  |      |       |        |  |
|       | 3/4       | 0.014          | 0.015  | 0.044  | 0.090  | 0.18   | 0.28  | 0.36  | 0.45  | 0.90  | 1.4   | 1.9   | 2.3   | 2.8  | 3.2  | 3.7  | 4.1   | 4.6    |  |
|       | 1         | 0.0045         | 0.0060 | 0.016  | 0.035  | 0.070  | 0.10  | 0.13  | 0.18  | 0.35  | 0.50  | 0.70  | 0.85  | 1.0  | 1.2  | 1.3  | 1.6   | 1.8    |  |
|       | 1 1/4     | 0.0011         | 0.0020 | 0.0055 | 0.011  | 0.023  | 0.035 | 0.046 | 0.059 | 0.12  | 0.17  | 0.24  | 0.29  | 0.34 | 0.40 | 0.46 | 0.52  | 0.59   |  |
| 5     | 1/4       | 0.029          | 0.045  | 0.060  | 0.13   | 0.26   | 0.40  | 0.52  | 0.65  | 1.3   | 2.0   | 2.6   | 3.2   | 4.0  | 4.5  | 5.2  | 6.0   | 6.5    |  |
|       | 1         | 0.009          | 0.0092 | 0.018  | 0.050  | 0.10   | 0.15  | 0.20  | 0.25  | 0.50  | 0.72  | 1.0   | 1.3   | 1.5  | 1.8  | 2.0  | 2.2   | 2.5    |  |
|       | 1 1/4     | 0.0022         | 0.0028 | 0.0079 | 0.016  | 0.033  | 0.050 | 0.066 | 0.083 | 0.17  | 0.25  | 0.33  | 0.41  | 0.50 | 0.56 | 0.66 | 0.72  | 0.83   |  |
|       | 1 1/2     | 0.0012         | 0.0015 | 0.0041 | 0.0090 | 0.018  | 0.027 | 0.036 | 0.045 | 0.090 | 0.13  | 0.18  | 0.23  | 0.27 | 0.32 | 0.36 | 0.40  | 0.45   |  |
| 7     | 1/4       | 0.055          | 0.075  | 0.090  | 0.18   | 0.36   | 0.55  | 0.73  | 0.90  | 1.8   | 2.8   | 3.6   | 4.5   | 5.5  | 6.2  | 7.3  | 8.1   | 9.0    |  |
|       | 1         | 0.16           | 0.025  | 0.032  | 0.070  | 0.14   | 0.21  | 0.28  | 0.35  | 0.70  | 1.1   | 1.4   | 1.8   | 2.1  | 2.5  | 2.8  | 3.1   | 3.5    |  |
|       | 1 1/4     | 0.004          | 0.009  | 0.011  | 0.023  | 0.046  | 0.070 | 0.092 | 0.11  | 0.23  | 0.35  | 0.46  | 0.60  | 0.70 | 0.80 | 0.92 | 1.0   | 1.1    |  |
|       | 1 1/2     | 0.0019         | 0.0021 | 0.0060 | 0.013  | 0.025  | 0.038 | 0.050 | 0.062 | 0.13  | 0.19  | 0.25  | 0.31  | 0.37 | 0.45 | 0.50 | 0.55  | 0.62   |  |
| 10    | 1/4       | 0.10           | 0.14   | 0.14   | 0.26   | 0.52   | 0.80  | 1.1   | 1.3   | 2.6   | 4.0   | 5.2   | 6.4   | 8.0  | 9.0  |      |       |        |  |
|       | 1         | 0.030          | 0.045  | 0.047  | 0.10   | 0.20   | 0.30  | 0.40  | 0.50  | 1.0   | 1.5   | 2.0   | 2.5   | 3.0  | 3.5  | 4.0  | 4.5   | 5.0    |  |
|       | 1 1/4     | 0.0080         | 0.013  | 0.016  | 0.033  | 0.066  | 0.10  | 0.13  | 0.17  | 0.34  | 0.50  | 0.68  | 0.85  | 1.0  | 1.2  | 1.3  | 1.5   | 1.7    |  |
|       | 1 1/2     | 0.0035         | 0.0055 | 0.0085 | 0.018  | 0.036  | 0.053 | 0.071 | 0.090 | 0.18  | 0.27  | 0.35  | 0.45  | 0.54 | 0.62 | 0.71 | 0.81  | 0.90   |  |
| 15    | 1         | 0.064          | 0.092  | 0.14   | 0.15   | 0.30   | 0.45  | 0.60  | 0.75  | 1.5   | 2.3   | 3.0   | 3.8   | 4.5  | 5.2  | 6.0  | 7.0   | 7.5    |  |
|       | 1 1/4     | 0.016          | 0.025  | 0.025  | 0.050  | 0.10   | 0.15  | 0.20  | 0.25  | 0.50  | 0.75  | 1.0   | 1.3   | 1.5  | 1.8  | 2.0  | 2.3   | 2.5    |  |
|       | 1 1/2     | 0.0075         | 0.011  | 0.013  | 0.026  | 0.052  | 0.080 | 0.11  | 0.13  | 0.28  | 0.40  | 0.52  | 0.66  | 0.80 | 0.92 | 1.1  | 1.2   | 1.3    |  |
|       | 2         | 0.0022         | 0.0036 | 0.0047 | 0.010  | 0.020  | 0.030 | 0.040 | 0.050 | 0.10  | 0.15  | 0.20  | 0.23  | 0.30 | 0.35 | 0.40 | 0.45  | 0.50   |  |
| 18    | 1         | 0.090          | 0.12   | 0.17   | 0.18   | 0.36   | 0.54  | 0.70  | 0.90  | 1.8   | 2.7   | 3.6   | 4.5   | 5.4  | 6.1  | 7.0  | 8.0   | 9.0    |  |
|       | 1 1/4     | 0.023          | 0.030  | 0.033  | 0.060  | 0.12   | 0.18  | 0.24  | 0.30  | 0.60  | 0.90  | 1.2   | 1.5   | 1.8  | 2.1  | 2.4  | 2.8   | 3.0    |  |
|       | 1 1/2     | 0.011          | 0.016  | 0.016  | 0.032  | 0.064  | 0.098 | 0.130 | 0.16  | 0.32  | 0.49  | 0.64  | 0.82  | 0.98 | 1.1  | 1.3  | 1.5   | 1.6    |  |
|       | 2         | 0.0031         | 0.0050 | 0.0056 | 0.012  | 0.024  | 0.036 | 0.050 | 0.060 | 0.12  | 0.18  | 0.24  | 0.30  | 0.36 | 0.42 | 0.50 | 0.55  | 0.60   |  |
| 20    | 1         | 0.11           | 0.15   | 0.20   | 0.28   | 0.4    | 0.60  | 0.80  | 1.0   | 2.0   | 3.0   | 4.0   | 5.0   | 6.0  | 7.0  | 8.0  | 9.0   | 10.0   |  |
|       | 1 1/4     | 0.028          | 0.040  | 0.060  | 0.065  | 0.13   | 0.20  | 0.26  | 0.32  | 0.65  | 1.0   | 1.3   | 1.6   | 2.0  | 2.3  | 2.6  | 3.0   | 3.2    |  |
|       | 1 1/2     | 0.013          | 0.018  | 0.019  | 0.036  | 0.071  | 0.11  | 0.15  | 0.18  | 0.36  | 0.53  | 0.70  | 0.80  | 1.1  | 1.3  | 1.5  | 1.7   | 1.8    |  |
|       | 2         | 0.0039         | 0.0058 | 0.0061 | 0.013  | 0.026  | 0.040 | 0.054 | 0.067 | 0.13  | 0.20  | 0.27  | 0.34  | 0.40 | 0.48 | 0.54 | 0.60  | 0.67   |  |
| 25    | 1 1/4     | 0.042          | 0.060  | 0.075  | 0.080  | 0.16   | 0.25  | 0.34  | 0.42  | 0.82  | 1.3   | 1.6   | 2.1   | 2.5  | 2.9  | 3.4  | 3.7   | 4.2    |  |
|       | 1 1/2     | 0.02           | 0.029  | 0.035  | 0.045  | 0.090  | 0.13  | 0.18  | 0.23  | 0.45  | 0.67  | 0.90  | 1.1   | 1.3  | 1.6  | 1.8  | 2.0   | 2.3    |  |
|       | 2         | 0.0058         | 0.0083 | 0.0085 | 0.017  | 0.033  | 0.050 | 0.069 | 0.083 | 0.17  | 0.25  | 0.33  | 0.42  | 0.50 | 0.60 | 0.69 | 0.78  | 0.83   |  |
|       | 2 1/2     | 0.0025         | 0.0036 | 0.0038 | 0.0080 | 0.016  | 0.025 | 0.032 | 0.038 | 0.080 | 0.14  | 0.16  | 0.20  | 0.25 | 0.29 | 0.32 | 0.36  | 0.38   |  |
| 30    | 1 1/4     | 0.060          | 0.083  | 0.10   | 0.10   | 0.2    | 0.30  | 0.40  | 0.50  | 1.0   | 1.5   | 2.0   | 2.5   | 3.0  | 3.5  | 4.0  | 4.5   | 5.0    |  |
|       | 1 1/2     | 0.027          | 0.040  | 0.045  | 0.054  | 0.11   | 0.16  | 0.210 | 0.28  | 0.52  | 0.80  | 1.1   | 1.4   | 1.6  | 1.9  | 2.1  | 2.4   | 2.8    |  |
|       | 2         | 0.0080         | 0.012  | 0.016  | 0.020  | 0.040  | 0.060 | 0.080 | 0.10  | 0.20  | 0.30  | 0.40  | 0.50  | 0.60 | 0.70 | 0.80 | 0.90  | 1.0    |  |
|       | 2 1/2     | 0.0034         | 0.0047 | 0.0048 | 0.0095 | 0.019  | 0.30  | 0.038 | 0.047 | 0.098 | 0.15  | 0.19  | 0.24  | 0.30 | 0.35 | 0.38 | 0.44  | 0.47   |  |
| 35    | 1 1/4     | 0.080          | 0.11   | 0.13   | 0.13   | 0.23   | 0.35  | 0.46  | 0.59  | 1.1   | 1.8   | 2.3   | 2.9   | 3.5  | 4.0  | 4.6  | 5.2   | 5.9    |  |
|       | 1 1/2     | 0.037          | 0.052  | 0.065  | 0.065  | 0.13   | 0.19  | 0.25  | 0.32  | 0.62  | 0.94  | 1.3   | 1.6   | 1.9  | 2.3  | 2.5  | 2.8   | 3.2    |  |
|       | 2         | 0.011          | 0.015  | 0.020  | 0.023  | 0.046  | 0.070 | 0.094 | 0.12  | 0.23  | 0.35  | 0.46  | 0.59  | 0.70 | 0.81 | 0.94 | 1.1   | 1.2    |  |
|       | 2 1/2     | 0.0045         | 0.0065 | 0.009  | 0.011  | 0.023  | 0.035 | 0.045 | 0.056 | 0.11  | 0.17  | 0.22  | 0.28  | 0.35 | 0.40 | 0.45 | 0.51  | 0.56   |  |
| 40    | 1 1/2     | 0.047          | 0.066  | 0.078  | 0.080  | 0.15   | 0.220 | 0.29  | 0.36  | 0.72  | 1.1   | 1.5   | 1.8   | 2.2  | 2.5  | 2.9  | 3.2   | 3.6    |  |
|       | 2         | 0.013          | 0.020  | 0.024  | 0.026  | 0.053  | 0.080 | 0.110 | 0.13  | 0.3   | 0.40  | 0.53  | 0.68  | 0.80 | 0.92 | 1.1  | 1.2   | 1.3    |  |
|       | 2 1/2     | 0.0056         | 0.0084 | 0.011  | 0.013  | 0.025  | 0.039 | 0.050 | 0.064 | 0.13  | 0.19  | 0.25  | 0.31  | 0.39 | 0.45 | 0.50 | 0.58  | 0.64   |  |
|       | 3         | 0.0020         | 0.0025 | 0.0025 | 0.0053 | 0.011  | 0.016 | 0.022 | 0.027 | 0.06  | 0.082 | 0.11  | 0.13  | 0.16 | 0.20 | 0.22 | 0.25  | 0.27   |  |
| 50    | 1 1/2     | 0.072          | 0.097  | 0.10   | 0.10   | 0.18   | 0.28  | 0.36  | 0.46  | 0.90  | 1.4   | 1.8   | 2.3   | 2.8  | 3.2  | 3.6  | 4.0   | 4.6    |  |
|       | 2         | 0.020          | 0.029  | 0.033  | 0.033  | 0.067  | 0.10  | 0.13  | 0.17  | 0.34  | 0.50  | 0.68  | 0.83  | 1.0  | 1.1  | 1.3  | 1.5   | 1.7    |  |
|       | 2 1/2     | 0.0085         | 0.012  | 0.016  | 0.016  | 0.032  | 0.050 | 0.064 | 0.080 | 0.16  | 0.24  | 0.32  | 0.40  | 0.50 | 0.59 | 0.64 | 0.72  | 0.80   |  |
|       | 3         | 0.0030         | 0.0045 | 0.0060 | 0.0068 | 0.014  | 0.020 | 0.028 | 0.035 | 0.070 | 0.10  | 0.13  | 0.17  | 0.20 | 0.24 | 0.28 | 0.31  | 0.35   |  |
| 60    | 1 1/2     | 0.10           | 0.14   | 0.16   | 0.16   | 0.22   | 0.32  | 0.43  | 0.54  | 1.0   | 1.6   | 2.2   | 2.8   | 3.2  | 3.8  | 4.3  | 4.9   | 5.4    |  |
|       | 2         | 0.029          | 0.040  | 0.044  | 0.044  | 0.080  | 0.12  | 0.16  | 0.20  | 0.40  | 0.60  | 0.80  | 1.0   | 1.2  | 1.4  | 1.6  | 1.8   | 2.0    |  |
|       | 2 1/2     | 0.012          | 0.017  | 0.022  | 0.019  | 0.038  | 0.059 | 0.078 | 0.097 | 0.19  | 0.29  | 0.38  | 0.49  | 0.59 | 0.70 | 0.78 | 0.88  | 0.97   |  |
|       | 3         | 0.0040         | 0.0060 | 0.0080 | 0.0080 | 0.017  | 0.025 | 0.32  | 0.040 | 0.081 | 0.13  | 0.16  | 0.20  | 0.25 | 0.28 | 0.32 | 0.37  | 0.40   |  |
| 80    | 2         | 0.068          | 0.068  | 0.086  | 0.093  | 0.10   | 0.16  | 0.22  | 0.28  | 0.52  | 0.80  | 1.0   | 1.3   | 1.6  | 1.9  | 2.2  | 2.5   | 2.8    |  |
|       | 2 1/2     | 0.020          | 0.028  | 0.037  | 0.045  | 0.050  | 0.079 | 0.10  | 0.13  | 0.26  | 0.39  | 0.50  | 0.65  | 0.79 | 0.90 | 1.0  | 1.1   | 1.3    |  |
|       | 3         | 0.0070         | 0.010  | 0.012  | 0.012  | 0.022  | 0.032 | 0.044 | 0.054 | 0.11  | 0.17  | 0.22  | 0.28  | 0.32 | 0.37 | 0.44 | 0.50  | 0.54   |  |
|       | 4         | 0.0018         | 0.0027 | 0.0030 | 0.0035 | 0.0072 | 0.011 | 0.015 | 0.018 | 0.036 | 0.06  | 0.074 | 0.091 | 0.11 | 0.13 | 0.15 | 0.17  | 0.18   |  |
| 90    | 2         | 0.063          | 0.082  | 0.10   | 0.11   | 0.12   | 0.18  | 0.25  | 0.30  | 0.60  | 0.90  | 1.2   | 1.5   | 1.8  | 2.2  | 2.5  | 2.8   | 3.0    |  |
|       | 2 1/2     | 0.025          | 0.035  | 0.045  | 0.052  | 0.058  | 0.089 | 0.11  | 0.14  | 0.29  | 0.44  | 0.58  | 0.73  | 0.89 | 1.   |      |       |        |  |