# Appendix A: Conversion Factors Between Metric, API, and US Measures

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<th>Multiply by</th>
<th>to find</th>
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<th>to find</th>
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<tbody>
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<td>acres</td>
<td>hectares</td>
<td>cubic centimeters</td>
<td>$3.531 \times 10^3$ cu ft</td>
</tr>
<tr>
<td>&quot;</td>
<td>sq ft</td>
<td>&quot;</td>
<td>$6.102 \times 10^{-2}$ cu in.</td>
</tr>
<tr>
<td>acre-feet</td>
<td>m$^2$</td>
<td>&quot;</td>
<td>$10^4$ m$^3$</td>
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<tr>
<td>&quot;</td>
<td>bbl$^b$</td>
<td>&quot;</td>
<td>$2.642 \times 10^4$ gal</td>
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<tr>
<td>&quot;</td>
<td>cu ft</td>
<td>&quot;</td>
<td>3-Oct liters</td>
</tr>
<tr>
<td>atmospheres</td>
<td>gal</td>
<td>&quot;</td>
<td>$6.2897 \times 10^6$ bbl$^b$</td>
</tr>
<tr>
<td>&quot;</td>
<td>cm Hg</td>
<td>cubic feet</td>
<td>$0.1781$ bbl$^a$</td>
</tr>
<tr>
<td>&quot;</td>
<td>in. Hg</td>
<td>&quot;</td>
<td>$2.832 \times 10^4$ cc$^b$</td>
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<tr>
<td>&quot;</td>
<td>ft of water</td>
<td>&quot;</td>
<td>$7.481$ gal</td>
</tr>
<tr>
<td>&quot;</td>
<td>kg/cm$^3$</td>
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<tr>
<td>barrels (API)</td>
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<td>acre-ft</td>
<td>&quot;</td>
<td>$28.32$ liters</td>
</tr>
<tr>
<td>&quot;</td>
<td>cc$^b$</td>
<td>cubic feet/day</td>
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<tr>
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<td>cu ft</td>
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<td>$1.18 \times 10^{-3}$ c m/hr</td>
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<td>&quot;</td>
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<td>&quot;</td>
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<td>cu ft/D</td>
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<td>gal/min</td>
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<td>&quot;</td>
<td>m$^3$/d</td>
<td>cubic inches</td>
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<td>cu ft/min</td>
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<td>$1.639 \times 10^{-3}$ m$^3$</td>
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<tr>
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<td>gal/min</td>
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<td>$4.329 \times 10^3$ gal</td>
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<td>bars</td>
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<td>atm</td>
<td>cubic meters</td>
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<td>kg/cm$^3$</td>
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<td>$106$ cc$^b$</td>
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<td>to find</td>
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<td>to find</td>
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<tr>
<td>------------</td>
<td>---------</td>
<td>------------</td>
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<td>14.5 psi</td>
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<tr>
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<td>35.31 cu ft</td>
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<td>0.293 W-hr</td>
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<td>103 liters</td>
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<td>0.01 m</td>
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<tr>
<td>&quot;</td>
<td>10 mm</td>
<td>&quot;</td>
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<td>cm of mercury</td>
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<td>0.4461 ft H₂O</td>
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<td>12 in</td>
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<tr>
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<td>hectares</td>
<td>2.471 acres</td>
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<td>1,076 X 10^3 sq ft</td>
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<td>feet of water</td>
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<td>0.01 km²</td>
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<td>5.086 X 10^{-3} m/min</td>
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<td>0.01667 ft/min</td>
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<td>feet/minute</td>
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<td>foot-pounds</td>
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<td>&quot;</td>
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<td>gallons (U.S.)</td>
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<td>3.785 cc³</td>
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<td>0.002538 kg/cm³</td>
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<td>0.1337 cu ft</td>
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<td>2.205 lb</td>
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<tr>
<td>&quot;</td>
<td>3.785 liters</td>
<td>&quot;</td>
<td>1.102 X 10³ tons (short)</td>
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<td>90.84 liters/hr</td>
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### Appendices: Production Logging—Charts and Tables

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<th>Multiply</th>
<th>by</th>
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<td>min</td>
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<td>m$^3$</td>
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<td>mile</td>
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<td>2.471 X $10^4$</td>
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<td>1,550</td>
<td>sq in.</td>
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<td>°K (abs)</td>
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<td>°R (abs)</td>
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<td>1.8</td>
<td>°F</td>
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<td>km</td>
<td>°Cent/100 meters</td>
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<td>°F/100 ft</td>
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<td>°C/100 ft</td>
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<td>3.281 X $10^3$</td>
<td>ft</td>
<td>&quot;</td>
<td>2,205</td>
<td>lb</td>
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<td>0.03937</td>
<td>in.</td>
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<td>2,000</td>
<td>lb (short)</td>
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<td>6.944 X $10^4$</td>
<td>days</td>
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<td>6.895 X $10^6$</td>
<td>viscosity, lb-s/sq in.</td>
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<td>1.667 X $10^3$</td>
<td>hrs</td>
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<td>4.78 X $10^6$</td>
<td>viscosity, cp</td>
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<tr>
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<td>7.000</td>
<td>grains</td>
<td>&quot;</td>
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<td>&quot;</td>
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<tr>
<td>&quot;</td>
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<td>kg</td>
<td>&quot;</td>
<td>10$^3$</td>
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$^a$ Fahrenheit, $^b$ cubic centimeter, $^c$ commercial centigrade.
Volume Capacity of Pipes

Gallons per 1,000 ft = 40.3 × (ID in inches)^2
Cubic feet per 1,000 ft = 5.454 × (ID in inches)^2
Barrels per 1,000 ft = 0.9714 × (ID in inches)^2
Gallons per mile = 215.4240 × (ID in inches)^2
Barrels per mile = 5.1291 × (ID in inches)^2

Velocity

Feet per minute = 0.127324 (cubic feet per day)/(ID in inches)^2
Feet per minute = 1,029.42 (barrels per minute)/(ID in inches)^2
Feet per second = 0.4085 (gallons per minute)/(ID in inches)^2

Tank Volumes

Barrels per foot in round tank = (diameter, in feet)^2/7.14
Barrels per inch in round tank = (diameter, in feet)^2/85.7
Barrels per inch in square tank = 0.0143 (length, in feet) × (width, in feet)
Cubic feet per inch in square tank = 0.0833 (length, in feet) × (width, in feet)

Oil Gravity

\[
sp.\text{gr.}@60^\circ F = \frac{141.5}{131.5 + \text{API gravity}}
\]

\[
\text{API gravity} = \frac{141.5}{sp.\text{gr.}@60^\circ F - 131.5}
\]
Gas Gravity

\[
\text{Gas specific gravity} = \frac{\text{Density of gas at sc (g/cc)}}{0.00122} = \frac{\text{Density of gas at sc (lb/cuft)}}{0.0762}
\]

\[
\text{Gas specific gravity} = \frac{\text{density of gas}}{\text{density of air at same temp. and press.}} \\
\text{molecular weight of gas} \\
28.966
\]

The metric symbol, cc, for cubic centimeters has been replaced by the SI symbol cm³, but it is still widely used.

The symbol sc (standard conditions) = 60 °F (15.56 °C) and 14.7 psia (one atmosphere).
Appendix B: Average Fluid Velocity Versus Tubing Size

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<tr>
<th>Description</th>
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<tr>
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<td>10 m³/hr</td>
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<tr>
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<tr>
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<td>1000 cu ft/D</td>
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</tr>
<tr>
<td>3½ (73.0)</td>
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</tr>
<tr>
<td>4 (101.6)</td>
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</tr>
<tr>
<td>5 (127.0)</td>
<td>7.00</td>
</tr>
<tr>
<td>6 (152.4)</td>
<td>9.20</td>
</tr>
<tr>
<td>8 (203.2)</td>
<td>10.20</td>
</tr>
<tr>
<td>10 (254.0)</td>
<td>12.70</td>
</tr>
<tr>
<td>2 (50.8)</td>
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</tr>
<tr>
<td>4 (101.6)</td>
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*API upset tubing*

<table>
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<th>cm/s</th>
<th>m/min</th>
<th>cm/s</th>
<th>ft/min</th>
<th>cm/s</th>
<th>m/min</th>
<th>cm/s</th>
<th>ft/min</th>
<th>cm/s</th>
<th>m/min</th>
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<th>ft/min</th>
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# Appendix C: Average Fluid Velocity Versus Casing Size

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<th>10 m³/hr</th>
<th>1000 m³/d</th>
<th>1000 cu ft/D</th>
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### Appendix C (continued)

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<td>1.49</td>
<td>2.95</td>
<td>0.255</td>
<td>0.424</td>
<td>0.835</td>
</tr>
<tr>
<td>1/16</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>16 (406.4)</td>
<td>55.00</td>
<td>15.376</td>
<td>390.6</td>
<td>0.92</td>
<td>1.54</td>
<td>3.02</td>
<td>1.39</td>
<td>2.32</td>
<td>4.56</td>
<td>0.58</td>
<td>0.86</td>
<td>1.90</td>
<td>0.164</td>
<td>0.274</td>
<td>0.559</td>
</tr>
<tr>
<td>32 (640)</td>
<td>65.00</td>
<td>15.250</td>
<td>387.4</td>
<td>0.93</td>
<td>1.56</td>
<td>3.07</td>
<td>1.41</td>
<td>2.36</td>
<td>4.63</td>
<td>0.59</td>
<td>0.91</td>
<td>1.92</td>
<td>0.167</td>
<td>0.278</td>
<td>0.548</td>
</tr>
<tr>
<td>64 (1,280)</td>
<td>75.00</td>
<td>15.124</td>
<td>384.2</td>
<td>0.95</td>
<td>1.59</td>
<td>3.13</td>
<td>1.44</td>
<td>2.40</td>
<td>4.72</td>
<td>0.60</td>
<td>0.99</td>
<td>1.96</td>
<td>0.170</td>
<td>0.283</td>
<td>0.557</td>
</tr>
<tr>
<td>128 (2,560)</td>
<td>84.00</td>
<td>15.010</td>
<td>381.3</td>
<td>0.97</td>
<td>1.62</td>
<td>3.17</td>
<td>1.46</td>
<td>2.44</td>
<td>4.79</td>
<td>0.61</td>
<td>1.02</td>
<td>1.99</td>
<td>0.172</td>
<td>0.287</td>
<td>0.565</td>
</tr>
<tr>
<td>20 (508.0)</td>
<td>94.00</td>
<td>19.124</td>
<td>485.8</td>
<td>0.60</td>
<td>1.00</td>
<td>1.95</td>
<td>0.90</td>
<td>1.50</td>
<td>2.96</td>
<td>0.37</td>
<td>0.62</td>
<td>1.23</td>
<td>0.106</td>
<td>0.177</td>
<td>0.348</td>
</tr>
</tbody>
</table>
Appendix D: Average Fluid Velocity

When a production logging tool is present in the casing or tubing, the average fluid velocity in the tool/pipe annulus may be determined from the following charts.

WITH NO PL TOOL IN FLOW STREAM

FLOW RATE IN BARRELS/DAY

AVG. FLUID VELOCITY IN FEET/MINUTE

WITH 1½-IN. PL TOOL IN FLOW STREAM
WITH 2¼-IN. PL TOOL IN FLOW STREAM

FLOW RATE IN BARRELS/ DAY

AVERAGE FLUID VELOCITY IN FEET/ MINUTE
Appendix E: Quick Guide to Biphasic Flow Interpretation

PVT Data

Compute $\rho_{hwf}$ and $\rho_{lwf}$
Compute $q_{hwf}$ and $q_{lwf}$
Estimate $V_s$
Compute $A = \pi \left[ \left( \frac{\text{CasingID}}{2} \right)^2 - \left( \frac{\text{ToolID}}{2} \right)^2 \right]$

At each level between perforations
Compute $y_h = \frac{\rho_m - \rho_l}{\rho_h - \rho_l}$
Compute $q_h = y_h q_t - (1-y_h)AV_s l$
Compute $q_l = q_t - q_h$

Where: $h$ is for heavy phase
$l$ is for light phase
$m$ is for mixture

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