## Practical formulae, graphs and conversion tables

### UNIT OF MEASUREMENT CONVERSION TABLE

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>S.I. UNIT</th>
<th>SYMBOL</th>
<th>OTHER UNITS</th>
<th>SYMBOL</th>
<th>EQUIVALENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MASS</td>
<td>kilogram</td>
<td>[kg]</td>
<td>Pound</td>
<td>[lb]</td>
<td>1 [lb] = 0.4536 [kg]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ounce</td>
<td>[oz]</td>
<td>1 [oz] = 0.02335 [kg]</td>
</tr>
<tr>
<td>LENGTH</td>
<td>millimeter [10^3 m]</td>
<td>[mm]</td>
<td>Inch</td>
<td>[in] or [&quot;]</td>
<td>1 [in] = 25.40 [mm]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Foot</td>
<td>[foot]</td>
<td>1 [foot] = 304.8 [mm]</td>
</tr>
<tr>
<td>AREA</td>
<td>square centimeter [10^4 m^2]</td>
<td>[cm^2]</td>
<td>Square inch</td>
<td>[sq in]</td>
<td>1 [sq in] = 6.4516 [cm^2]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Square foot</td>
<td>[sq ft]</td>
<td>1 [sq ft] = 929.034 [cm^2]</td>
</tr>
<tr>
<td>CAPACITY</td>
<td>cubic centimeter [10^4 m^3]</td>
<td>[cm^3]</td>
<td>Liter</td>
<td>[l]</td>
<td>1 [l] = 1000 [cm^3]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cubic foot</td>
<td>[cu ft]</td>
<td>1 [cu ft] = 28317 [cm^3]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>UK gallon</td>
<td>[Imp gal]</td>
<td>1 [Imp gal] = 4546 [cm^3]</td>
</tr>
<tr>
<td>FLOW RATE</td>
<td>liter per minute</td>
<td>[l/min]</td>
<td>Cubic foot per minute</td>
<td>[cu ft/min]</td>
<td>1 [cu ft/min] = 28.32 [l/min]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gallon (UK) per minute</td>
<td>[Imp gal/min]</td>
<td>1 [Imp gal/min] = 4.5456 [l/min]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gallon (US) per minute</td>
<td>[US gal/min]</td>
<td>1 [US gal/min] = 3.7848 [l/min]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pound force</td>
<td>[lbf]</td>
<td>1 [lbf] = 4.448 [N]</td>
</tr>
<tr>
<td>PRESSURE</td>
<td>bar [10^5 N/m^2]</td>
<td>[bar]</td>
<td>Pascal [1 N/m^2]</td>
<td>[Pa]</td>
<td>1 [Pa] = 10^5 [bar]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Atmosphere</td>
<td>[atm]</td>
<td>1 [atm] = 1.0132 [bar]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Kilogram force/cm^2</td>
<td>[kgf/cm^2]</td>
<td>1 [kgf/cm^2] = 0.9806 [bar]</td>
</tr>
<tr>
<td>POWER</td>
<td>kilowatt [1000 W]</td>
<td>[kW]</td>
<td>Kilowatt per meter second</td>
<td>[kgf • m/s]</td>
<td>1 [kgf • m/s] = 9.803•10^3 [kW]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Metric horse power</td>
<td>[CV]</td>
<td>1 [CV] = 0.7355 [kW]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Horse power</td>
<td>[HP]</td>
<td>1 [HP] = 0.7457 [kW]</td>
</tr>
<tr>
<td>KINETIC VISCOITY</td>
<td>centistoke [10^-6 m^2/s]</td>
<td>[cSt]</td>
<td>Square meter per second</td>
<td>[m^2/s]</td>
<td>1 [m^2/s] = 10^9 [cSt]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Engler degree</td>
<td>[°E]</td>
<td>1 [°E] = 7.598 [cSt]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fahrenheit</td>
<td>[°F]</td>
<td>1 [°F] = 1.8 [°C] + 32</td>
</tr>
<tr>
<td>MOMENTUM (TORQUE)</td>
<td>Newton per meter</td>
<td>[Nm]</td>
<td>Kilogram force per meter</td>
<td>[kgf • m]</td>
<td>1 [kgf • m] = 0.102 Nm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pound force per inch</td>
<td>[lbf • in]</td>
<td>1 [lbf • in] = 0.113 Nm</td>
</tr>
</tbody>
</table>

* See diagrams of section [8]
Example: A pump is operating at 2000 rpm with a displacement of 100 cm³/rev at 40 bar, calculate the flow rate and the power consumption (Q = 200 l/min; Power = 13.33 kW).

Nota: All datas, graphs and diagrams do not take into account the efficiency.

2.4 Main formulae

Pumps:
- power consumption [kW]: \( \frac{Q \cdot P}{612 \cdot \eta} \)
- required shaft torque [Nm]: \( \frac{v \cdot P}{20 \pi \cdot \eta} = \frac{v \cdot P}{62.8 \cdot \eta} \)

Motors:
- power delivered [kW]: \( \frac{Q \cdot P}{612 \cdot \eta} \)
- shaft torque produced [Nm]: \( \frac{v \cdot P \cdot \eta}{20 \pi} = \frac{v \cdot P \cdot \eta}{62.8} \)
- power supplied [kW]: \( \frac{n \cdot [Nm]}{9545} \)

LEGENDA:

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Unit</th>
<th>Symbols</th>
<th>Quantity</th>
<th>Unit</th>
<th>Symbols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement</td>
<td>cm³</td>
<td>V</td>
<td>Flow rate</td>
<td>l/min</td>
<td>Q</td>
</tr>
<tr>
<td>Angular speed</td>
<td>rpm</td>
<td>n</td>
<td>Efficiency</td>
<td>-</td>
<td>( \eta )</td>
</tr>
<tr>
<td>Pressure</td>
<td>bar</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3 CYLINDER'S NOMOGRAPHS

3.1 CYLINDER FORCE

3.2 CYLINDER SPEED

4 CONVERSION DIAGRAMS

4.1 Capacity

4.2 Torque

4.3 Kinematic viscosity
CHARACTERISTIC CURVES FOR CALIBRATED ORIFICES' SELECTION

Orifice's diameters ø [mm]