PD Flowmeter Sizing Guide

Introduction

Use this guide to evaluate the Flow Technology positive displacement flowmeter performance on your application. It provides the flow rate range, pressure drop information, and typical calibration curves for each flowmeter size. The following steps illustrate how to specify a flowmeter using these charts:

1. ***Collect Application Information*** - Complete a Flow Technology Application Form. Information about flow rates, fluid viscosity, and available pressure is required when reviewing the charts.
2. ***Convert Units*** (If necessary) - Many common conversion factors are provided on Page 20, if it is necessary to convert the application information to the same units as those on the Operating Range and Pressure Drop charts.
3. ***Choose the Flowmeter Size*** - Using the Operating Range and Pressure Drop charts, select a flowmeter size with a recommended flow rate range that covers the application's flow rate requirements.
4. ***Check the Pressure Drop*** - Once a flowmeter size has been chosen, use the fluid viscosity to determine the maximum pressure drop across the meter. The pressure drop can be approximated by looking at the graph, or calculated more closely by using the pressure drop equations adjacent to the graph. If the pressure drop is too high for the application, choose the next larger flowmeter size and reevaluate the pressure drop.
5. ***Evaluate the Flowmeter Performance*** - After a flowmeter size with an acceptable pressure drop has been selected, review the Typical Calibration Curves for that flowmeter. Descriptions and diagrams on using the Typical Calibration Curves to evaluate flowmeter performance are on pages 2 and 3.

Review the individual Flow Technology flowmeter product sheets to determine which type of flowmeter is appropriate for the application.

Call Flow Technology at 1-800-528-4225, with questions about flowmeter performance or assistance with specifying a flowmeter for your application.

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General Flowmeter Specifications

(Refer to individual product sheets for complete specifications)

Turndown Ratio:

(Ratios based on maximum rated flow)
10:1 standard on low viscosity fluids
100:1 standard on medium viscosity fluids
Up to 1000:1 on high viscosity fluids

Reference Accuracy:

±0.05% of rate (repeatability)

Note: Each flowmeter is individually calibrated on a ballistic calibrator in the flow lab on a liquid representing the specific application.

Linearity:

±0.5% of rate over upper 80% of full span, typical.

Up to ±0.1% of rate over full turndown range with enhanced signal conditioning.

Using Typical Calibration Curves

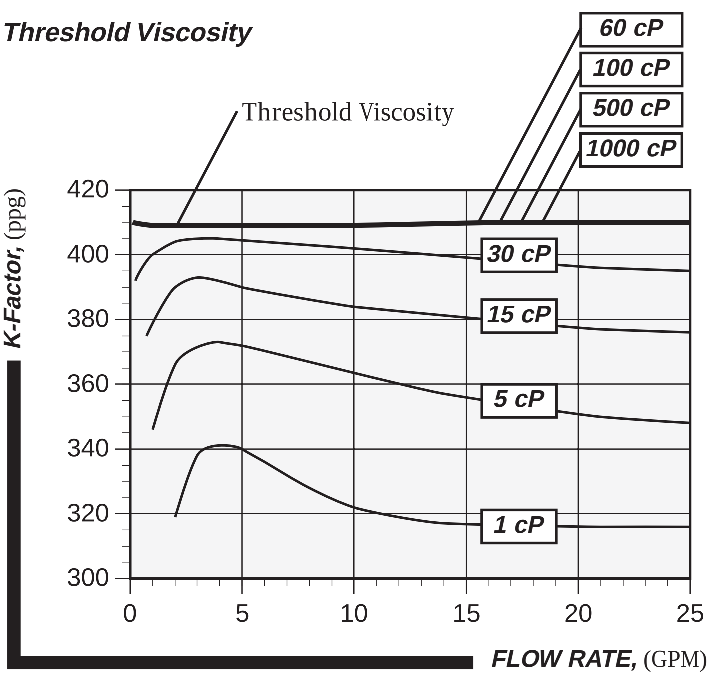
After choosing a flowmeter size with the Operating Range and Pressure Drop graphs, use the Typical Calibration Curves to estimate the flowmeter's performance on the application.

1. ***Find Appropriate Curve*** - Select the Typical Calibration Curves diagram for the chosen flowmeter size. Find the calibration curve with the viscosity that most closely matches the application fluid. If the application fluid has a viscosity higher than those listed, use the curve with the highest viscosity.
2. ***Mark Flow Rate Range*** - Mark the high, low, and normal flow rates for the application on the curve that matches the fluid viscosity. If the flow rate range covers only the lower end of a calibration curve below the threshold viscosity, then a smaller flowmeter size may fit the application.
3. ***Evaluate the Flowmeter Performance*** - Use the diagrams at the bottom of this page and page 3 to evaluate Threshold Viscosity, Marginal Applications, using a Single K-Factor, and using Linearization. If the estimated flowmeter performance is not satisfactory, review the Operating Range and Pressure Drop graphs for other flowmeter sizes that might handle the application better.
4. ***Evaluate Other Application Requirements*** - The Typical Calibration Curves can also be used to estimate the frequency output and the resolution of the flowmeter (Refer to descriptions on each Typical Calibration Curves page).

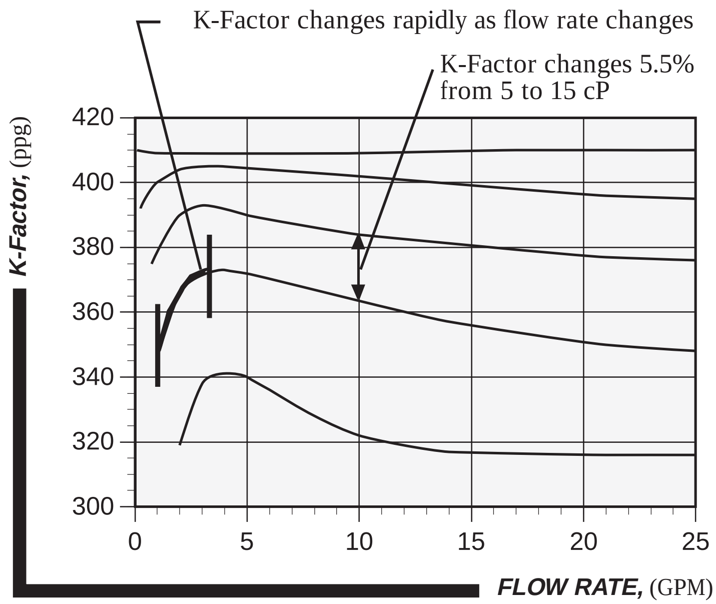
Call Flow Technology at 1-800-528-4225, with questions about flowmeter performance or assistance with specifying a flowmeter for your application.

Using Typical Calibration Curves

Threshold Viscosity



Marginal Applications



Threshold Viscosity - If the viscosity of the fluid being measured is equal to or greater than the Threshold Viscosity (the top curve on the Typical Calibration Curves), then the application will have a very linear calibration curve that is not affected by viscosity changes*. At the Threshold Viscosity the K-Factor values remain constant. Therefore, all fluids at or above the Threshold Viscosity will have nearly identical** K-Factor calibration curves. Since the calibration curve is very linear, a single K-Factor can be used over a 100:1 turndown. Linearization may be required for flow ranges that exceed a 100:1 turndown.

* As long as viscosity does not drop below threshold.

** When test conditions are identical.

Rapidly Changing K-Factor - If the application is on the steeply sloped section of the calibration curve, the flowmeter size selected may be too large. A smaller size should be evaluated. In this section of the curve, the K-Factor changes rapidly as the flow rate changes. If this flowmeter size must be used, then linearization should be used. In addition, the viscosity and temperature should be closely controlled.

Changing Viscosity - The accuracy of the flowmeter can be significantly reduced, if the viscosity varies below the threshold viscosity. As the viscosity increases, the amount of error introduced by changing viscosities decreases.

Viscosity Types

To properly evaluate flowmeter performance, the viscosity of the liquid at the application flow rate and temperature must be known. The viscosity, commonly known as the thickness, is a measure of how much a liquid resists deformation when a force is applied. There are four types of liquid behavior relating to viscosity.

Newtonian - The viscosity of Newtonian liquids remains constant regardless of the force applied to it. Water is a Newtonian liquid.

Non-Newtonian - The viscosity of non-Newtonian fluids drops as the force applied and the resulting velocity both increase. Ketchup is an example of a non-Newtonian fluid. Ketchup's high viscosity prevents in from flowing very fast at first, but as its flow rate increases, it becomes much thinner and flows even faster.

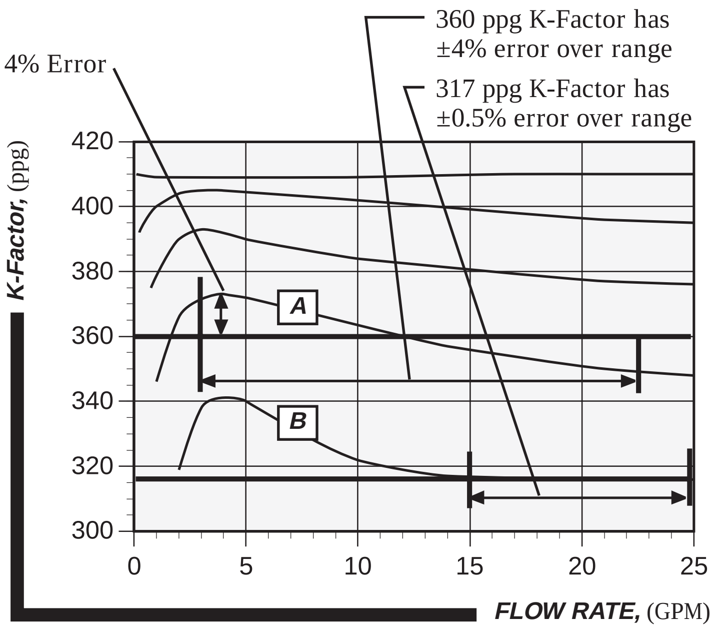
Plastic - Plastic liquids have a high static or rest viscosity, but once in motion the viscosity drops to a lower value and remains constant. Some latex adhesives and caulking compounds exhibit plastic behavior.

Thixotropic - Like plastic liquids, thixotropic liquids have a very high static (rest) viscosity that becomes much thinner once they are in motion. However, the viscosity continues to change as the flow rate increases. Most thixotropic liquids contain solids that contribute to its changing viscosity.

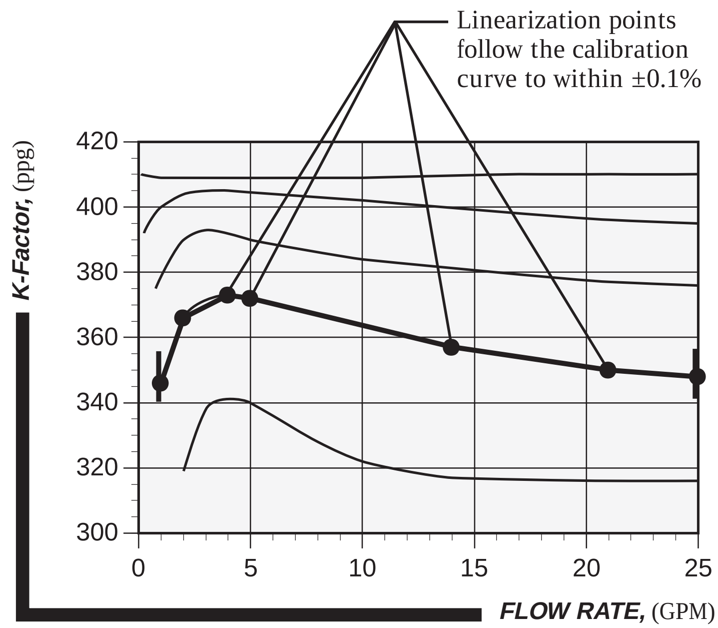
The Pressure Drop and Typical Calibration Curves in this publication are based on tests of Flow Technology flowmeters on Newtonian liquids at 75° F. This guide uses centipoise (cP), a measure of absolute or dynamic viscosity.

Using Typical Calibration Curves

Single K-Factor



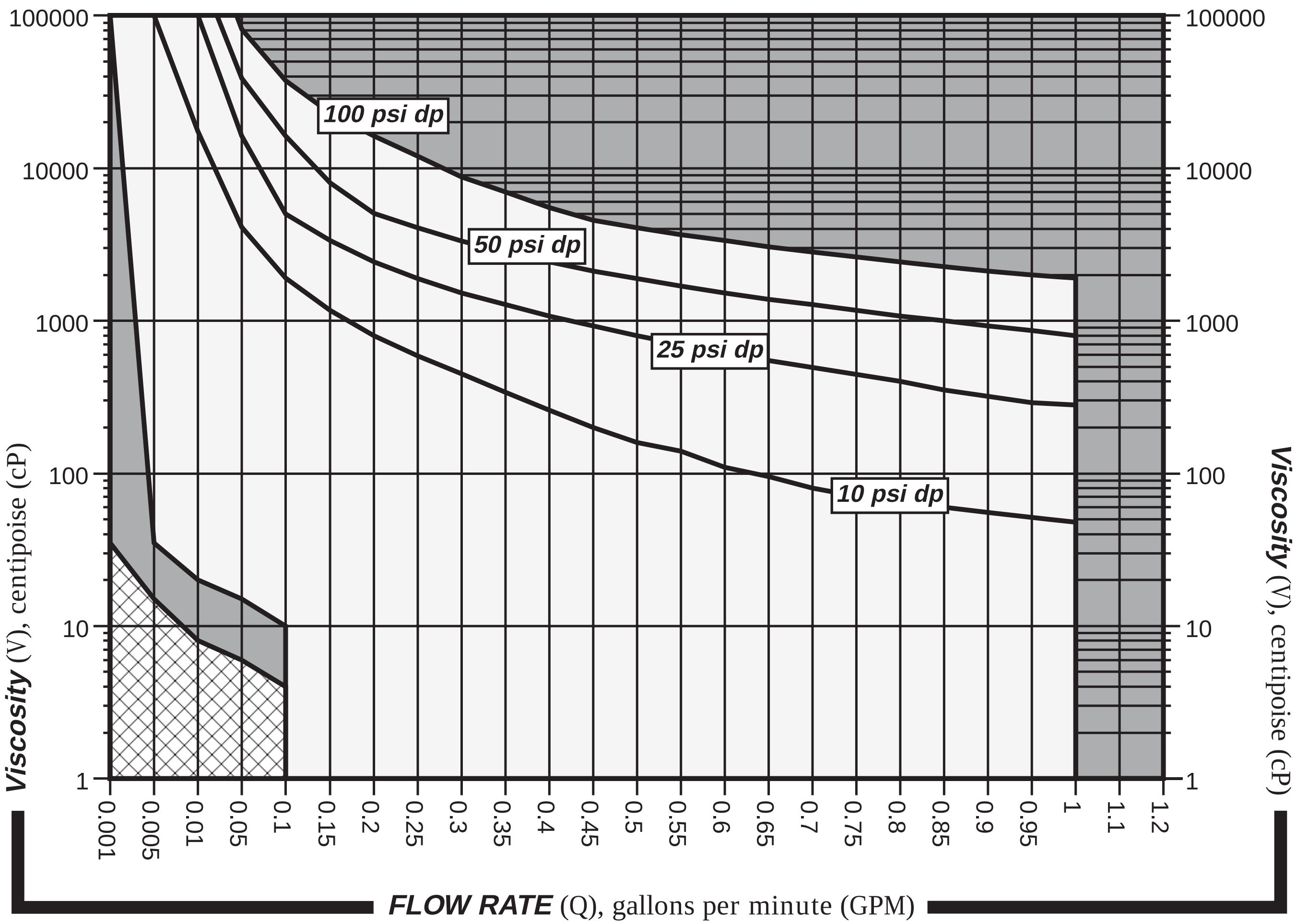
Linearization



Single K-Factor - A single K-Factor may be used on many applications. Above the threshold viscosity, a single K-Factor will typically deliver ±0.5% accuracy over a 100:1 turndown. On applications below the threshold viscosity, the flow range, the curve shape, and the acceptable error must be evaluated before using a single K-Factor. The diagram above shows a 360 ppg K-Factor being used on curve A. The slope of the curve produces an error of ±4% over a 3 to 22 GPM flow range. Linearization should be considered for this application. If the flow range can be narrowed to a flatter section of the calibration curve, a single K-Factor can be used. On curve B, a 317 ppg K-Factor provides ±0.6% accuracy over 15 to 25 GPM.

Linearization - When a single K-Factor cannot follow a calibration curve closely, linearization can be used. Instrumentation equipped with linearization have linearization points programmed into them, so that they can change the K-Factor as the flow rate changes. Data from the calibration curve is used to enter a K-Factor and a pulse frequency at each flow rate point where the curve shape changes. Up to 20 linearization points can be used to track the flow rate to within a ±0.1% accuracy.

Size 01 Flowmeter Operating Range and Pressure Drop



Recommended Operating Range - To get a closer pressure drop estimate, see Presure Drop Calculation information. Review the Typical Calibration Curves below to determine if Linearization will be needed.

Marginal, Consult Factory - Special modifications to the flowmeter or specialized electronics may be required. A different flowmeter size might be better suited for the application.

Not Recommended - Flow measurement in this range is only done on highly specialized applications that require modifications to the flowmeter and/ or specialized electronics.

Pressure Drop (dp) Calculation: Size 01

The pressure drop or differential pressure across a Flow Technology flowmeter is equal to the flow rate times a pressure drop factor. The pressure drop factor is a function of fluid viscosity and meter size. Choose the appropriate equation for the pressure drop factor, calculate it, then use it to determine the pressure drop across the flowmeter.

Pressure Drop (dp) = Q x Fp

Flow Rate *(GPM)*

Pressure Drop Factor

1 to 100 cP:
Fp = 3.12 + (0.1440 x V)

100 to 5000 cP:
Fp = 12.96 + (0.046 x V)

5000 to 100000 cP:
Fp = 126.96 + (0.023 x V)

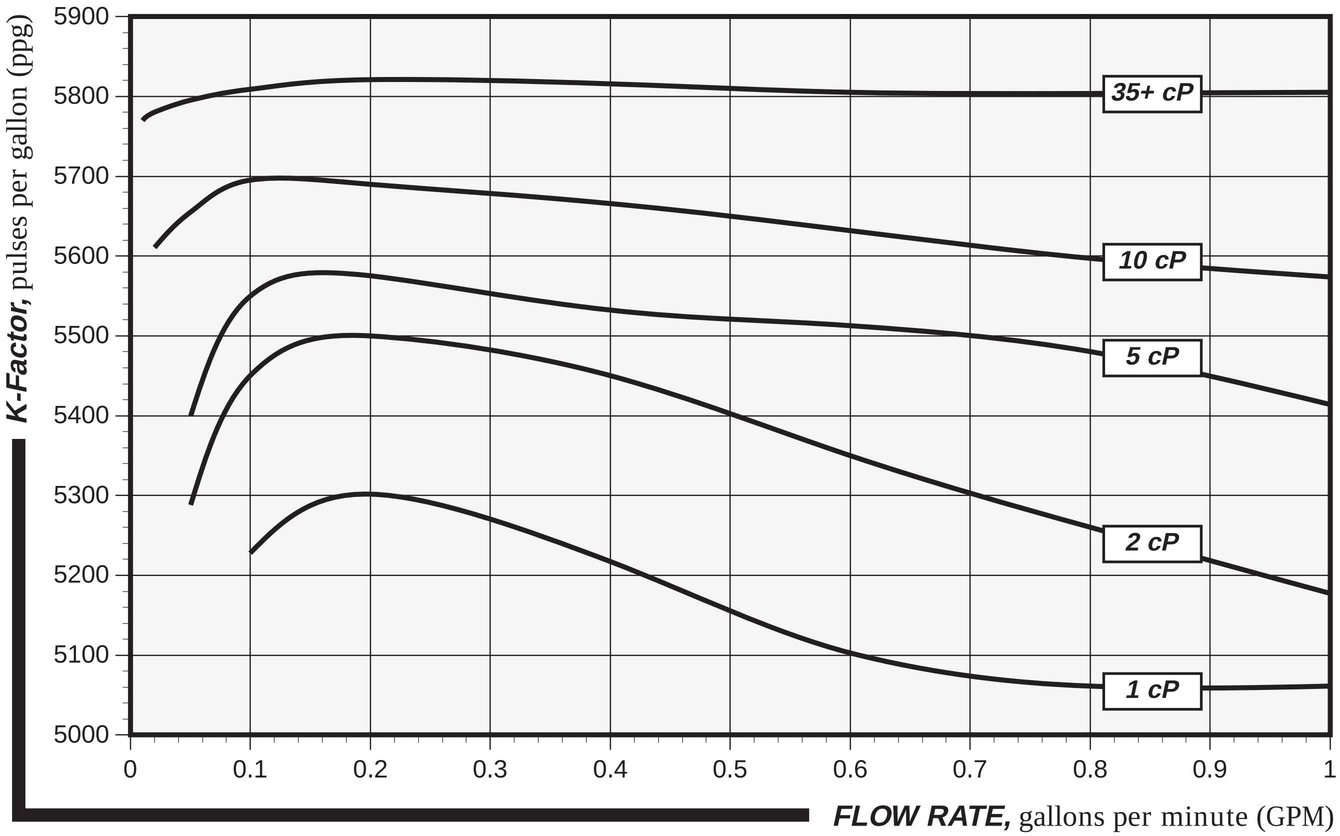
dp - Differential Pressure across flowmeter, pounds per square inch (psi).

Q - Flow rate in gallons per minute (GPM).

Fp - Pressure drop factor. It is calculated using the viscosity of the liquid.

V - Viscosity, centipoise (cP).

Size 01 Flowmeter Typical Calibration Curves



Typical Calibration Curves:
Each curve above represents a different fluid viscosity on a typical Flow Technology flowmeter calibration. The viscosity is given in units of centipoise (***cP***).

Note: The curves shown above represent typical calibrations on a standard Flow Technology flowmeter with standard impellers. Calibration results will vary depending on the flowmeter configuration. Enhancements to the flowmeter and/or the instrumentation allow the performance to be optimized for specific applications.

Fluids below 35 cP - Typical K-Factors and curve shapes are shown for several fluids with viscosities below 35 cP. They demonstrate how different viscosities can have a significant affect on the K-Factor. Electronics with linearization can be used to follow these curves to within ±0.1% over the full turndown of the flowmeter.

Fluids at or above 35 cP - At 35 cP the calibration curve becomes very linear. Higher viscosities will continue to draw very linear curves and the K-Factor value will typically remain at or slightly above 5825 ppg.

Use the Typical Calibration Curves to:

Evaluate Linearization Needs

Linearization needs will vary depending on the application and accuracy requirements.

Below 35 cP - Find the viscosity curve closest to the fluid being measured. If the section of the curve covered by the flow rate range is very flat, linearization may not be needed. However, if the curve is at a steep angle or if it changes shape in the flow rate range, linearization will probably be required.

Above 35 cP - Linearization should not be needed unless rates below 0.12 GPM are being measured.

Estimate Frequency Output

When sending a signal to a PLC, the pulse frequency may be required. Use the following equation to determine the frequency (Hz) at a given flow rate (GPM) and K-Factor (ppg):

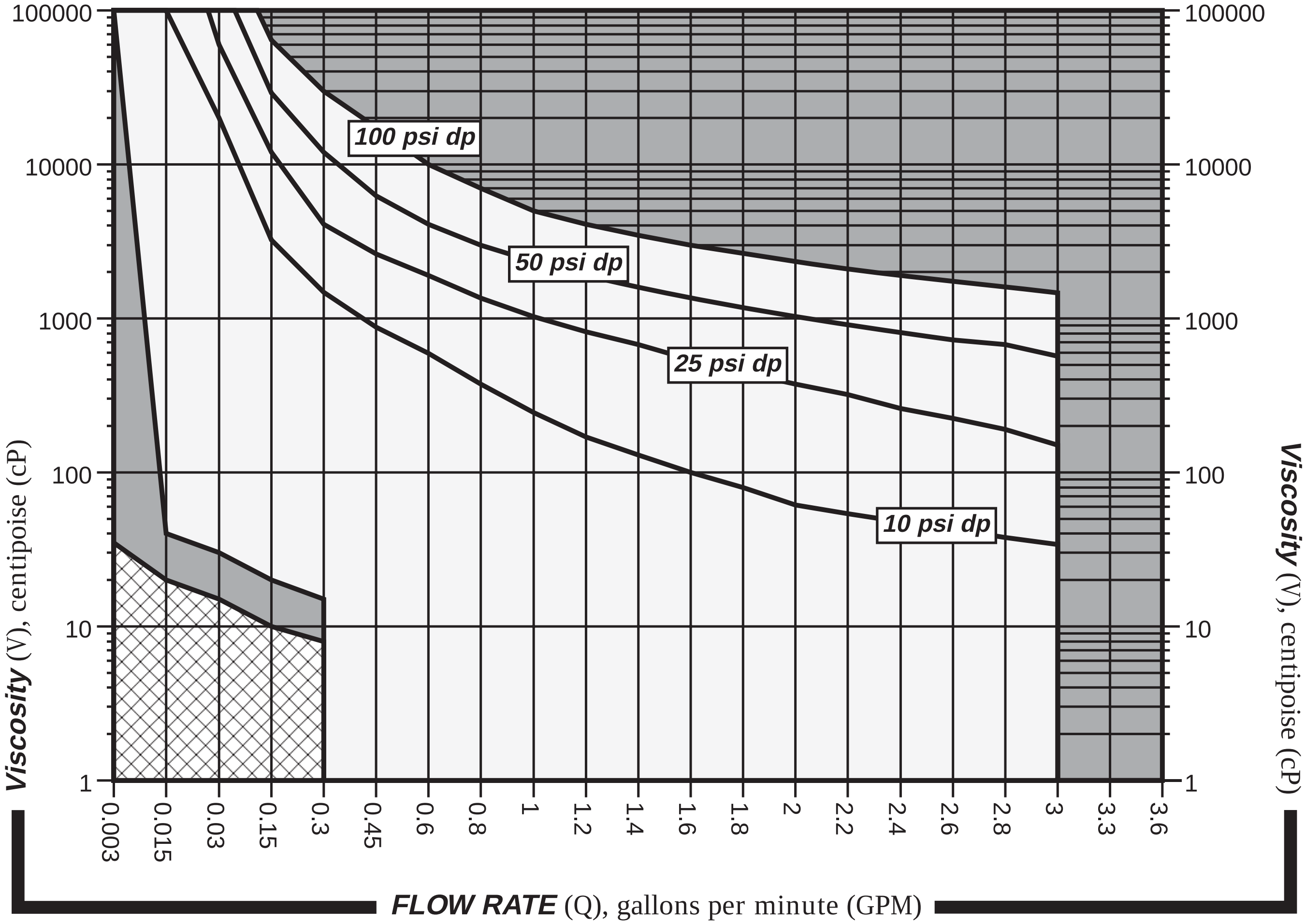
$$F\ (\text{Hz}) = \frac{\text{K-Factor x Flow Rate}}{\text{60 (sec/min)}}$$

Determine the Resolution

The resolution (R) of the flowmeter is the amount of fluid each pulse represents.

$$R\ (\text{Gal/pulse}) = \frac{1}{\text{K-Factor (ppg)}}$$

Size 02 Flowmeter Operating Range and Pressure Drop



Recommended Operating Range - To get a closer pressure drop estimate, see Presure Drop Calculation information. Review the Typical Calibration Curves below to determine if Linearization will be needed.

Marginal, Consult Factory - Special modifications to the flowmeter or specialized electronics may be required. A different flowmeter size might be better suited for the application.

Not Recommended, Try Smaller Size - See previous pages for information on smaller flowmeter sizes.

Pressure Drop (dp) Calculation: Size 02

The pressure drop or differential pressure across a Flow Technology flowmeter is equal to the flow rate times a pressure drop factor. The pressure drop factor is a function of fluid viscosity and meter size. Choose the appropriate equation for the pressure drop factor, calculate it, then use it to determine the pressure drop across the flowmeter.

Pressure Drop (dp) = Q x Fp

Flow Rate *(GPM)*

Pressure Drop Factor

1 to 100 cP:
Fp = 1.30 + (0.060 x V)

100 to 5000 cP:
Fp = 5.40 + (0.0190 x V)

5000 to 100000 cP:
Fp = 52.90 + (0.0095 x V)

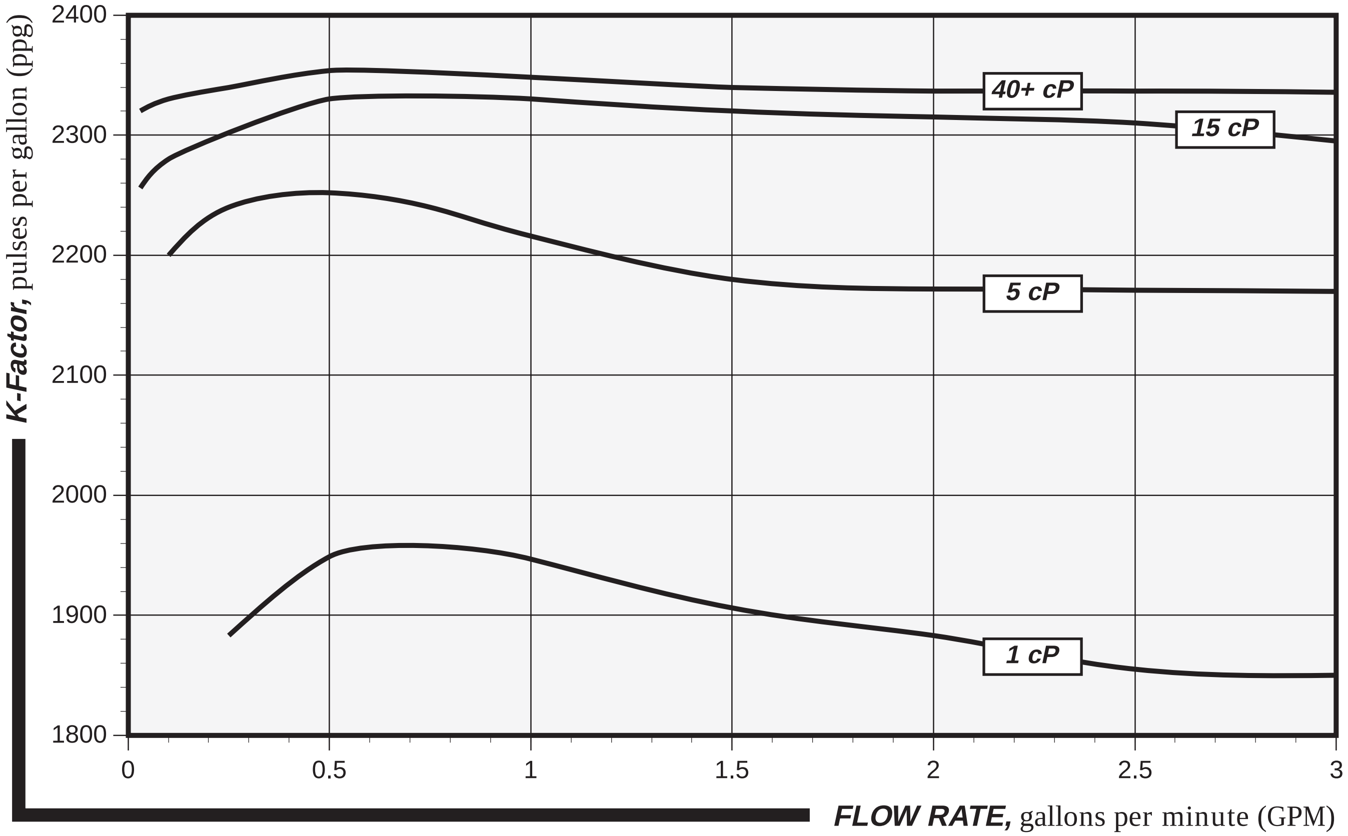
dp - Differential Pressure across flowmeter, pounds per square inch (psi).

Q - Flow rate in gallons per minute (GPM).

Fp - Pressure drop factor. It is calculated using the viscosity of the liquid.

V - Viscosity, centipoise (cP).

Size 02 Flowmeter Typical Calibration Curves



Typical Calibration Curves:
Each curve above represents a different fluid viscosity on a typical Flow Technology flowmeter calibration. The viscosity is given in units of centipoise (***cP***).

Note: The curves shown above represent typical calibrations on a standard Flow Technology flowmeter with standard impellers. Calibration results will vary depending on the flowmeter configuration. Enhancements to the flowmeter and/or the instrumentation allow the performance to be optimized for specific applications.

Fluids below 40 cP - Typical K-Factors and curve shapes are shown for several fluids with viscosities below 40 cP. They demonstrate how different viscosities can have a significant affect on the K-Factor. Electronics with linearization can be used to follow these curves to within ±0.1% over the full turndown of the flowmeter.

Fluids at or above 40 cP - At 40 cP the calibration curve becomes very linear. Higher viscosities will continue to draw very linear curves and the K-Factor value will typically remain at or slightly above 2350 ppg.

Use the Typical Calibration Curves to:

Evaluate Linearization Needs
Linearization needs will vary depending on the application and accuracy requirements.

Below 40 cP - Find the viscosity curve closest to the fluid being measured. If the section of the curve covered by the flow rate range is very flat, linearization may not be needed. However, if the curve is at a steep angle or if it changes shape in the flow rate range, linearization will probably be required.

Above 40 cP - Linearization should not be needed unless rates below 0.5 GPM are being measured.

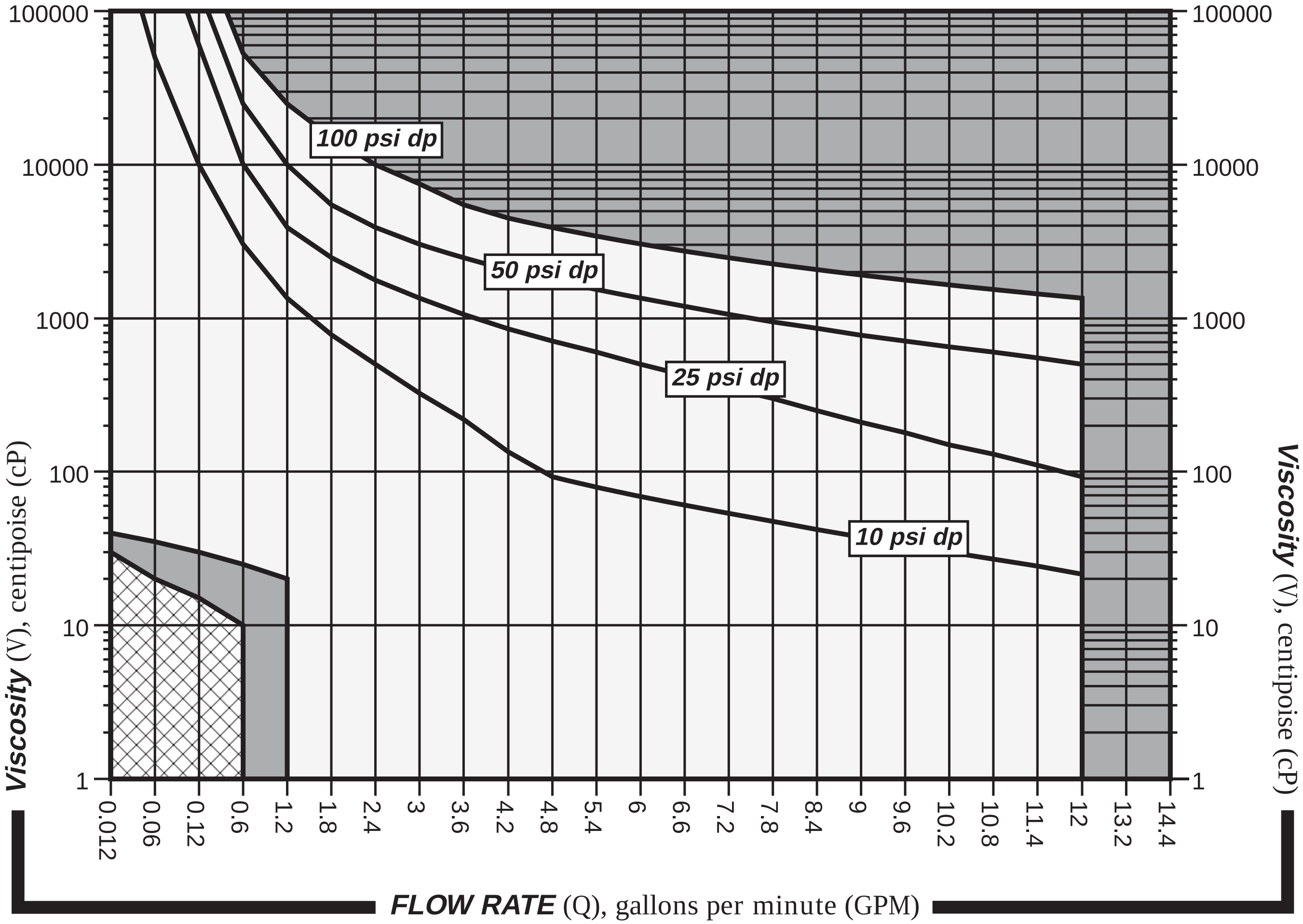
Estimate Frequency Output
When sending a signal to a PLC, the pulse frequency may be required. Use the following equation to determine the frequency (Hz) at a given flow rate (GPM) and K-Factor (ppg):

$$F\ (\text{Hz}) = \frac{\text{K-Factor x Flow Rate}}{60\ (\text{sec/min})}$$

Determine the Resolution
The resolution (R) of the flowmeter is the amount of fluid each pulse represents.

$$R\ (\text{Gal/pulse}) = \frac{1}{\text{K-Factor (ppg)}}$$

Size 05 Flowmeter Operating Range and Pressure Drop



Recommended Operating Range - To get a closer pressure drop estimate, see Presure Drop Calculation information. Review the Typical Calibration Curves below to determine if Linearization will be needed.

Marginal, Consult Factory - Special modifications to the flowmeter or specialized electronics may be required. A different flowmeter size might be better suited for the application.

Not Recommended, Try Smaller Size - See previous pages for information on smaller flowmeter sizes.

Pressure Drop (dp) Calculation: Size 05

The pressure drop or differential pressure across a Flow Technology flowmeter is equal to the flow rate times a pressure drop factor. The pressure drop factor is a function of fluid viscosity and meter size. Choose the appropriate equation for the pressure drop factor, calculate it, then use it to determine the pressure drop across the flowmeter.

Pressure Drop (dp) = Q x Fp

Flow Rate *(GPM)*

Pressure Drop Factor

1 to 100 cP:
$Fp = 0.45 + (0.0176 \times V)$

100 to 5000 cP:
$Fp = 1.72 + (0.0049 \times V)$

5000 to 100000 cP:
$Fp = 11.72 + (0.0029 \times V)$

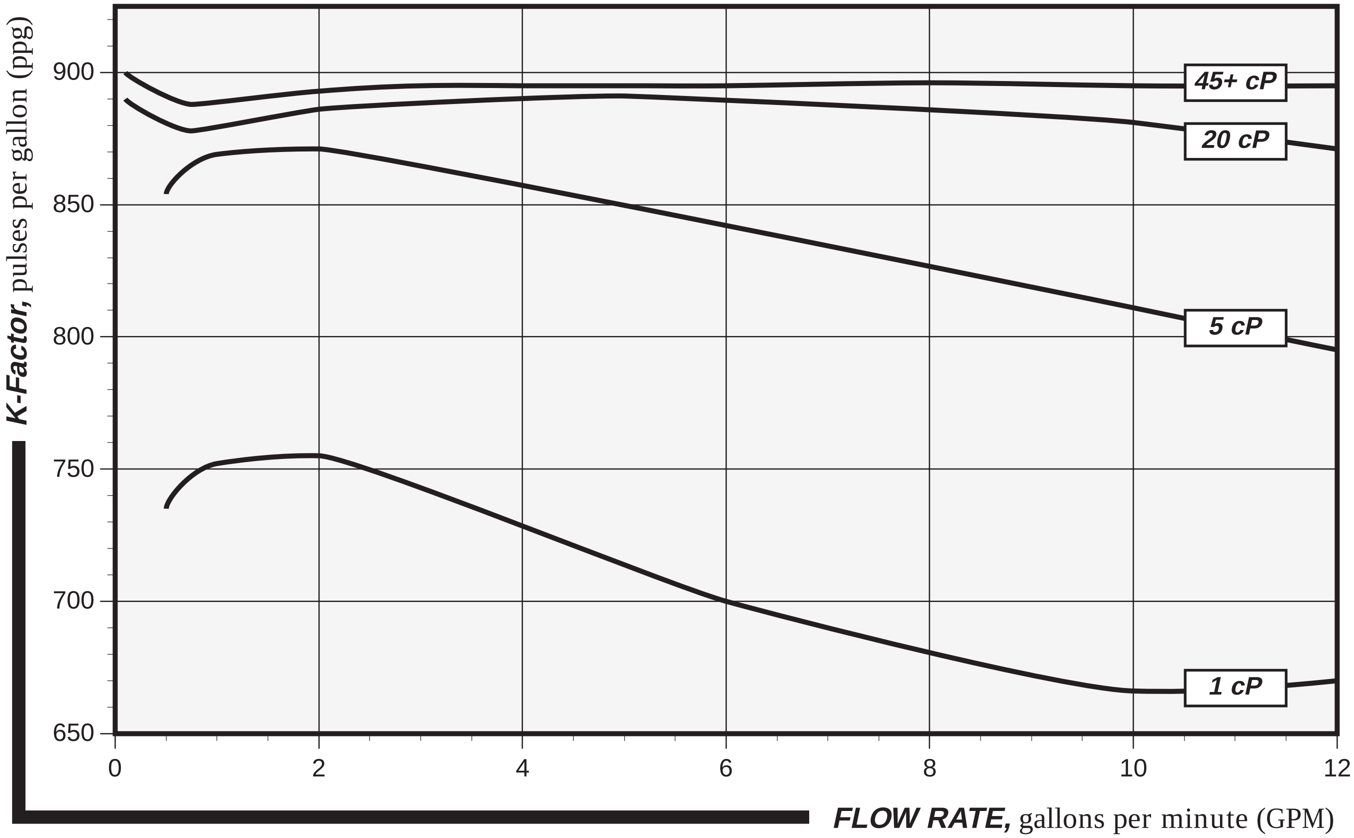
dp - Differential Pressure across flowmeter, pounds per square inch (psi).

Q - Flow rate in gallons per minute (GPM).

Fp - Pressure drop factor. It is calculated using the viscosity of the liquid.

V - Viscosity, centipoise (cP).

Size 05 Flowmeter Typical Calibration Curves



Typical Calibration Curves:
Each curve above represents a different fluid viscosity on a typical Flow Technology flowmeter calibration. The viscosity is given in units of centipoise (***cP***).

Note: The curves shown above represent typical calibrations on a standard Flow Technology flowmeter with standard impellers. Calibration results will vary depending on the flowmeter configuration. Enhancements to the flowmeter and/or the instrumentation allow the performance to be optimized for specific applications.

Fluids below 45 cP - Typical K-Factors and curve shapes are shown for several fluids with viscosities below 45 cP. They demonstrate how different viscosities can have a significant affect on the K-Factor. Electronics with linearization can be used to follow these curves to within ±0.1% over the full turndown of the flowmeter.

Fluids at or above 45 cP - At 45 cP the calibration curve becomes very linear. Higher viscosities will continue to draw very linear curves and the K-Factor value will typically remain at or slightly above 895 ppg.

Use the Typical Calibration Curves to:

Evaluate Linearization Needs

Linearization needs will vary depending on the application and accuracy requirements.

Below 45 cP - Find the viscosity curve closest to the fluid being measured. If the section of the curve covered by the flow rate range is very flat, linearization may not be needed. However, if the curve is at a steep angle or if it changes shape in the flow rate range, linearization will probably be required.

Above 45 cP - Linearization should not be needed unless rates below 0.12 GPM are being measured.

Estimate Frequency Output

When sending a signal to a PLC, the pulse frequency may be required. Use the following equation to determine the frequency (Hz) at a given flow rate (GPM) and K-Factor (ppg):

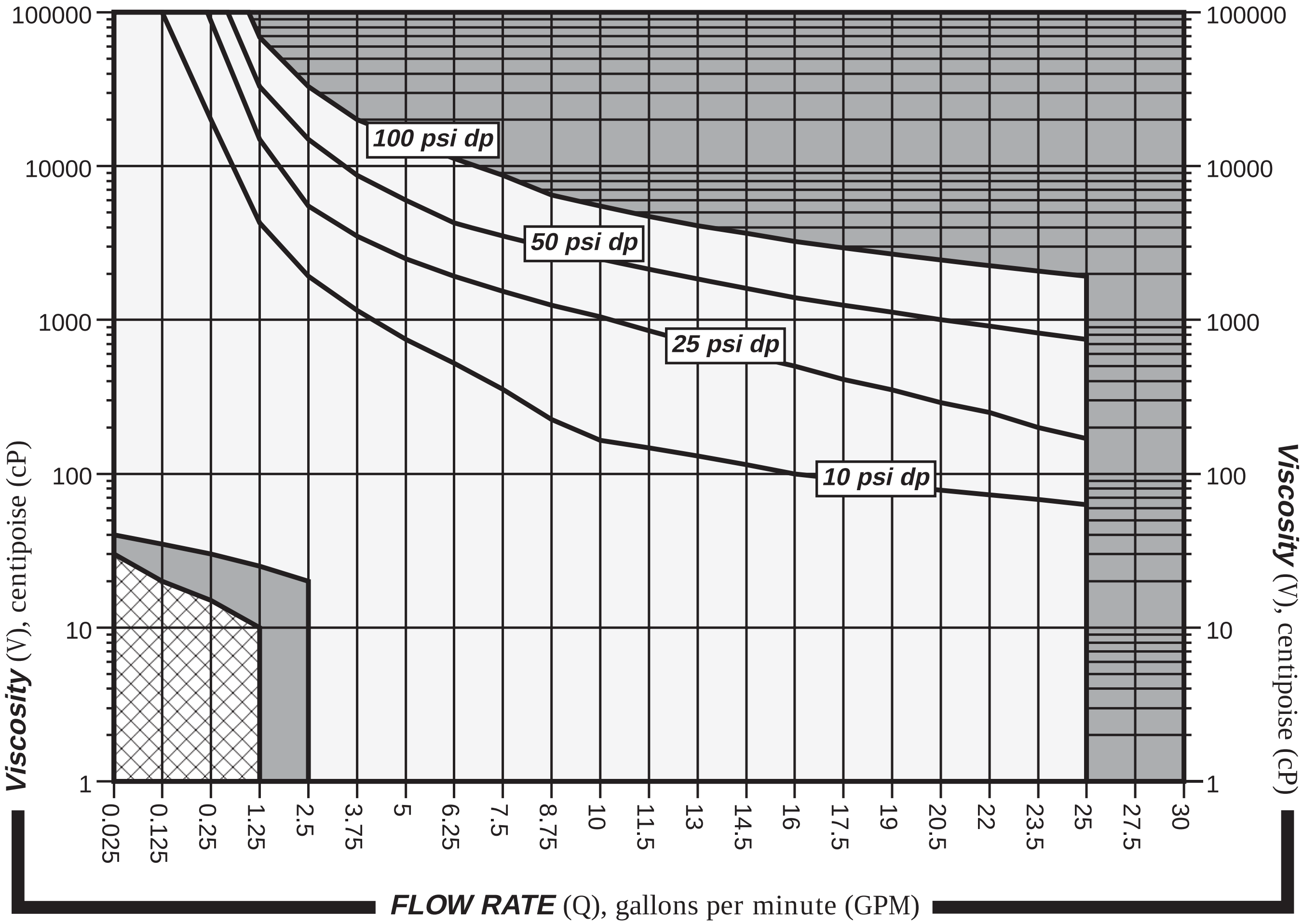
$$F\text{ (Hz)}= \frac{\text{K-Factor x Flow Rate}}{\text{60 (sec/min)}}$$

Determine the Resolution

The resolution (R) of the flowmeter is the amount of fluid each pulse represents.

$$R\text{ (Gal/pulse)}= \frac{1}{\text{K-Factor (ppg)}}$$

Size 10 Flowmeter Operating Range and Pressure Drop



Recommended Operating Range - To get a closer pressure drop estimate, see Presure Drop Calculation information. Review the Typical Calibration Curves below to determine if Linearization will be needed.

Marginal, Consult Factory - Special modifications to the flowmeter or specialized electronics may be required. A different flowmeter size might be better suited for the application.

Not Recommended, Try Smaller Size - See previous pages for information on smaller flowmeter sizes.

Pressure Drop (dp) Calculation: Size 10

The pressure drop or differential pressure across a Flow Technology flowmeter is equal to the flow rate times a pressure drop factor. The pressure drop factor is a function of fluid viscosity and meter size. Choose the appropriate equation for the pressure drop factor, calculate it, then use it to determine the pressure drop across the flowmeter.

Pressure Drop (dp) = Q x Fp

Flow Rate (GPM)

Pressure Drop Factor

1 to 100 cP:
Fp = 0.30 + (0.0059 x V)

100 to 5000 cP:
Fp = 0.72 + (0.0017 x V)

5000 to 100000 cP:
Fp = 3.720 + (0.0011 x V)

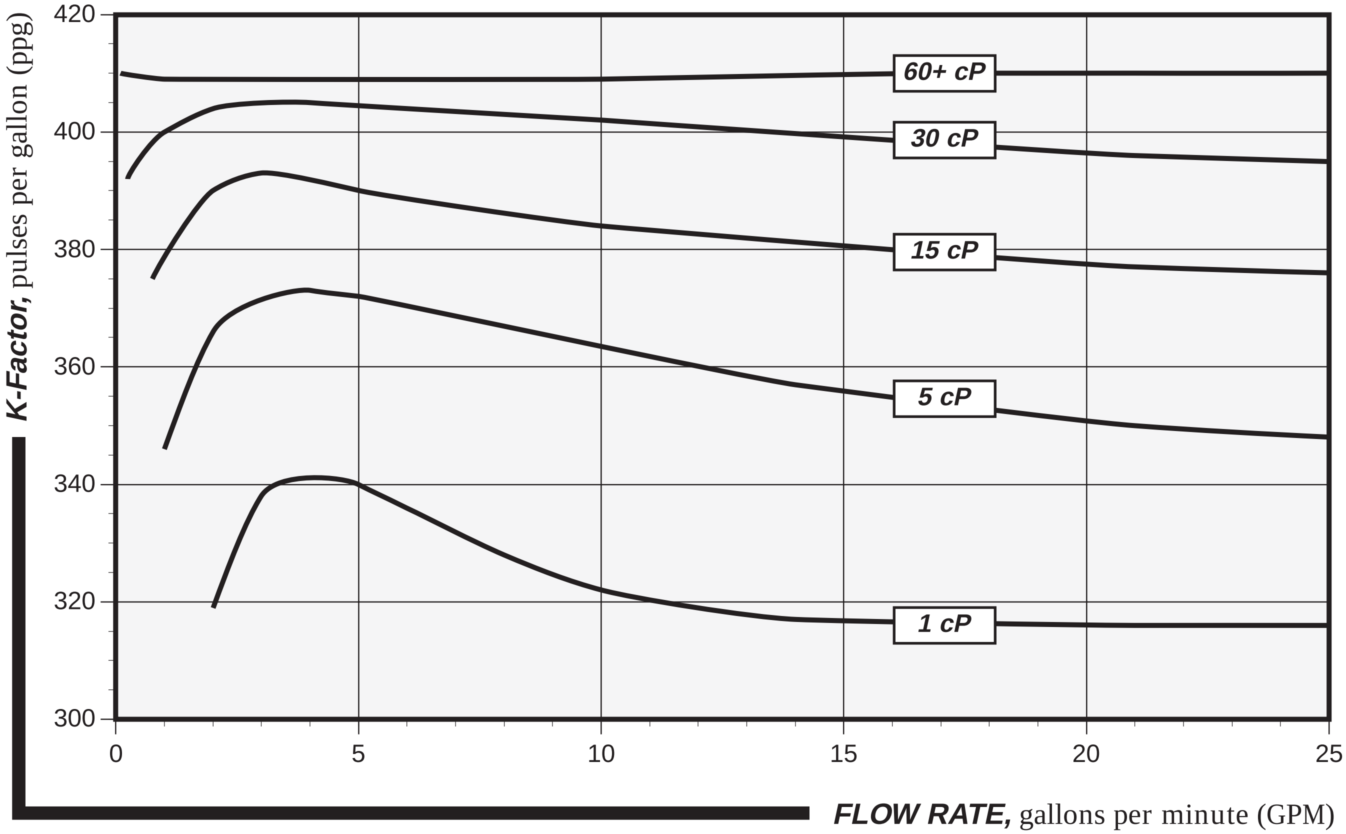
dp - Differential Pressure across flowmeter, pounds per square inch (psi).

Q - Flow rate in gallons per minute (GPM).

Fp - Pressure drop factor. It is calculated using the viscosity of the liquid.

V - Viscosity, centipoise (cP).

Size 10 Flowmeter Typical Calibration Curves



Typical Calibration Curves:
Each curve above represents a different fluid viscosity on a typical Flow Technology flowmeter calibration. The viscosity is given in units of centipoise (***cP***).

Note: The curves shown above represent typical calibrations on a standard Flow Technology flowmeter with standard impellers. Calibration results will vary depending on the flowmeter configuration. Enhancements to the flowmeter and/or the instrumentation allow the performance to be optimized for specific applications.

Fluids below 60 cP - Typical K-Factors and curve shapes are shown for several fluids with viscosities below 60 cP. They demonstrate how different viscosities can have a significant affect on the K-Factor. Electronics with linearization can be used to follow these curves to within ±0.1% over the full turndown of the flowmeter.

Fluids at or above 60 cP - At 60 cP the calibration curve becomes very linear. Higher viscosities will continue to draw very linear curves and the K-Factor value will typically remain at or slightly above 410 ppg.

Use the Typical Calibration Curves to:

Evaluate Linearization Needs
Linearization needs will vary depending on the application and accuracy requirements.

Below 60 cP - Find the viscosity curve closest to the fluid being measured. If the section of the curve covered by the flow rate range is very flat, linearization may not be needed. However, if the curve is at a steep angle or if it changes shape in the flow rate range, linearization will probably be required.

Above 60 cP - Linearization should not be needed unless rates below 0.25 GPM are being measured.

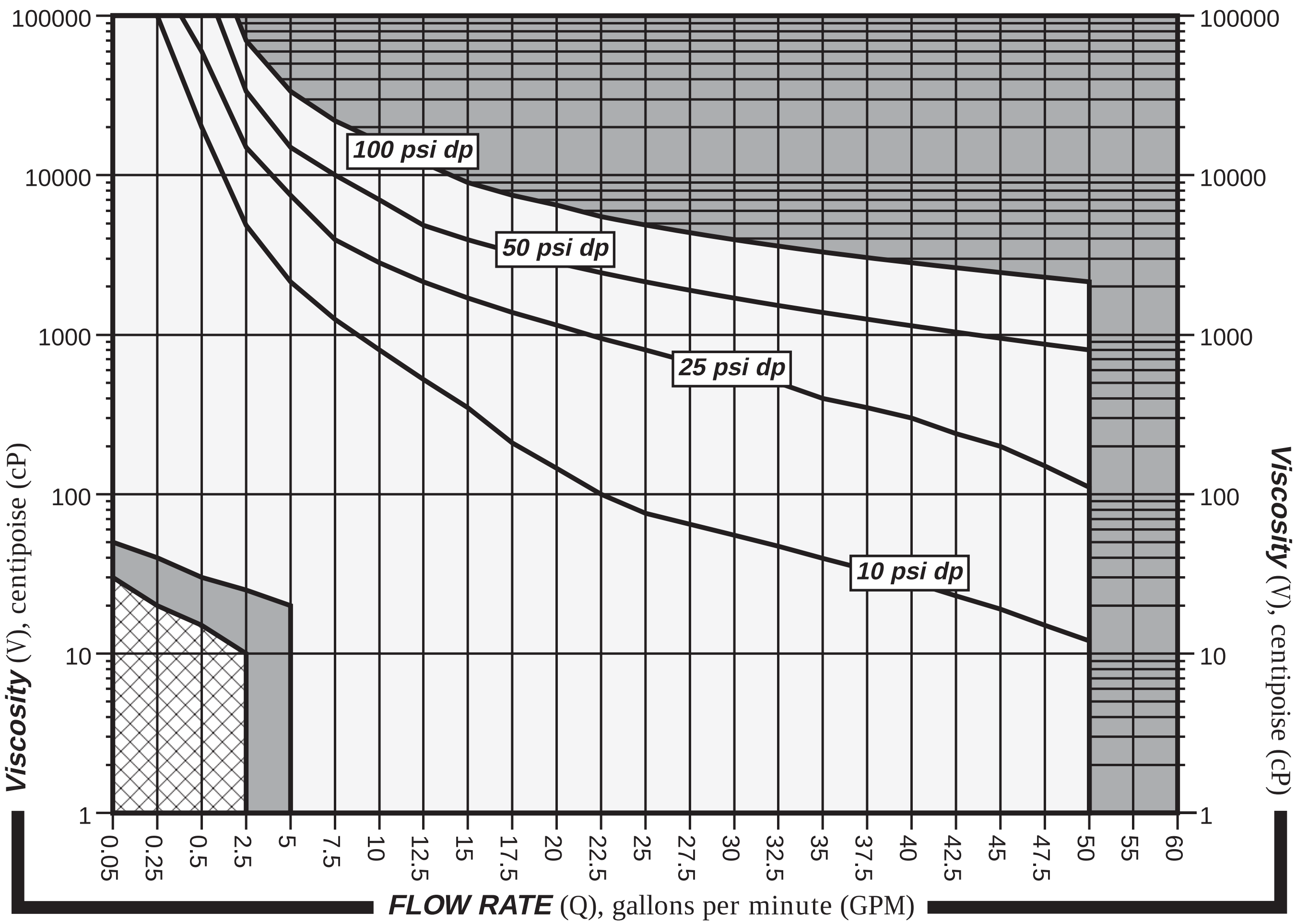
Estimate Frequency Output
When sending a signal to a PLC, the pulse frequency may be required. Use the following equation to determine the frequency (Hz) at a given flow rate (GPM) and K-Factor (ppg):

$$F\ (\text{Hz}) = \frac{\text{K- Factor x Flow Rate}}{60\ (\text{sec/min})}$$

Determine the Resolution
The resolution (R) of the flowmeter is the amount of fluid each pulse represents.

$$R\ (\text{Gal/pulse}) = \frac{1}{\text{K-Factor (ppg)}}$$

Size 15 Flowmeter Operating Range and Pressure Drop



Recommended Operating Range - To get a closer pressure drop estimate, see Presure Drop Calculation information. Review the Typical Calibration Curves below to determine if Linearization will be needed.

Marginal, Consult Factory - Special modifications to the flowmeter or specialized electronics may be required. A different flowmeter size might be better suited for the application.

Not Recommended, Try Smaller Size - See previous pages for information on smaller flowmeter sizes.

Pressure Drop (dp) Calculation: Size 15

The pressure drop or differential pressure across a Flow Technology flowmeter is equal to the flow rate times a pressure drop factor. The pressure drop factor is a function of fluid viscosity and meter size. Choose the appropriate equation for the pressure drop factor, calculate it, then use it to determine the pressure drop across the flowmeter.

Pressure Drop (dp) = Q x Fp

Flow Rate *(GPM)*

Pressure Drop Factor

1 to 100 cP:
Fp = 0.163 + (0.0031 x V)

100 to 5000 cP:
Fp = 0.408 + (0.0007 x V)

5000 to 100000 cP:
Fp = 1.323 + (0.00055 x V)

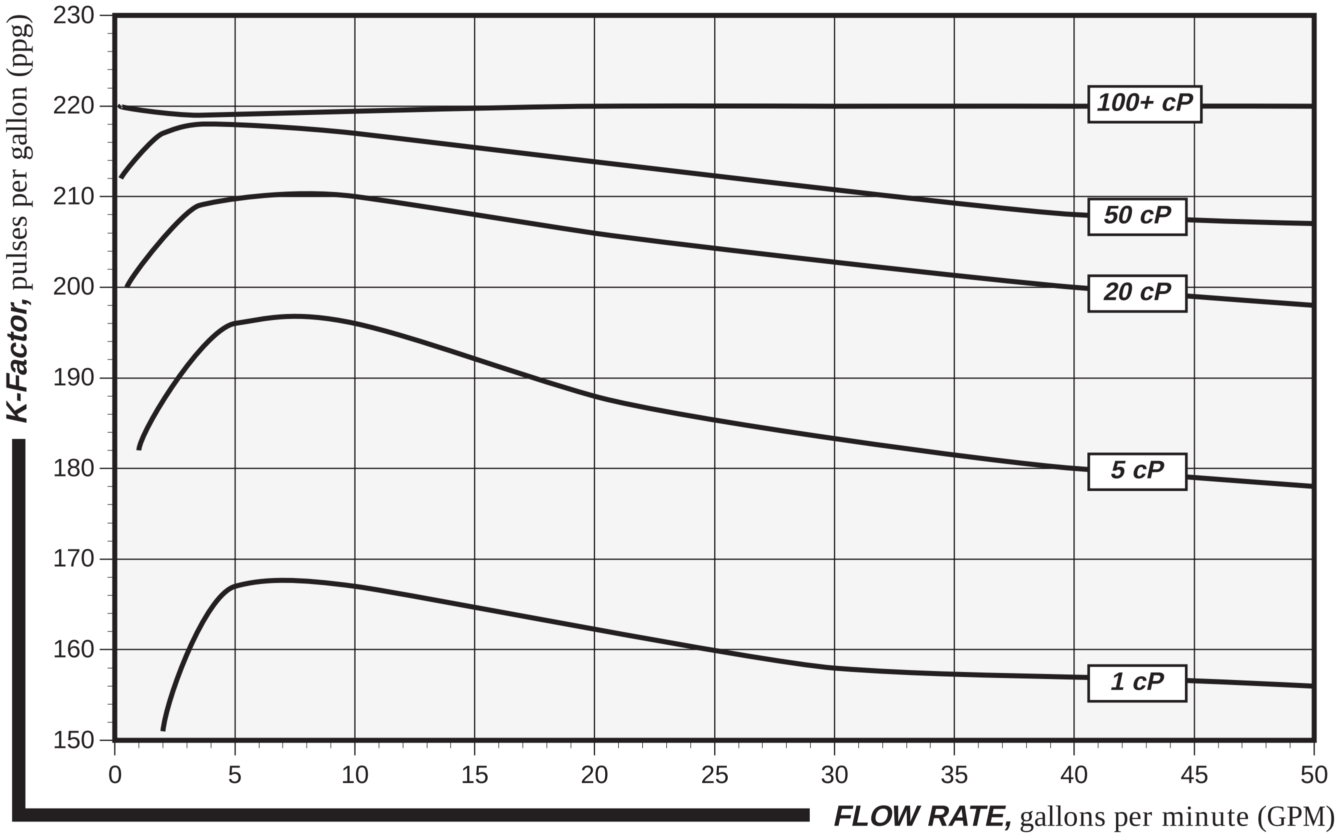
dp - Differential Pressure across flowmeter, pounds per square inch (psi).

Q - Flow rate in gallons per minute (GPM).

Fp - Pressure drop factor. It is calculated using the viscosity of the liquid.

V - Viscosity, centipoise (cP).

Size 15 Flowmeter Typical Calibration Curves



Typical Calibration Curves:
Each curve above represents a different fluid viscosity on a typical Flow Technology flowmeter calibration. The viscosity is given in units of centipoise (***cP***).

Note: The curves shown above represent typical calibrations on a standard Flow Technology flowmeter with standard impellers. Calibration results will vary depending on the flowmeter configuration. Enhancements to the flowmeter and/or the instrumentation allow the performance to be optimized for specific applications.

Fluids below 100 cP - Typical K-Factors and curve shapes are shown for several fluids with viscosities below 100 cP. They demonstrate how different viscosities can have a significant affect on the K-Factor. Electronics with linearization can be used to follow these curves to within ±0.1% over the full turndown of the flowmeter.

Fluids at or above 100 cP - At 100 cP the calibration curve becomes very linear. Higher viscosities will continue to draw very linear curves and the K-Factor value will typically remain at or slightly above 220 ppg.

Use the Typical Calibration Curves to:

Evaluate Linearization Needs

Linearization needs will vary depending on the application and accuracy requirements.

Below 100 cP - Find the viscosity curve closest to the fluid being measured. If the section of the curve covered by the flow rate range is very flat, linearization may not be needed. However, if the curve is at a steep angle or if it changes shape in the flow rate range, linearization will probably be required.

Above 100 cP - Linearization should not be needed unless rates below 6 GPM are being measured.

Estimate Frequency Output

When sending a signal to a PLC, the pulse frequency may be required. Use the following equation to determine the frequency (Hz) at a given flow rate (GPM) and K-Factor (ppg):

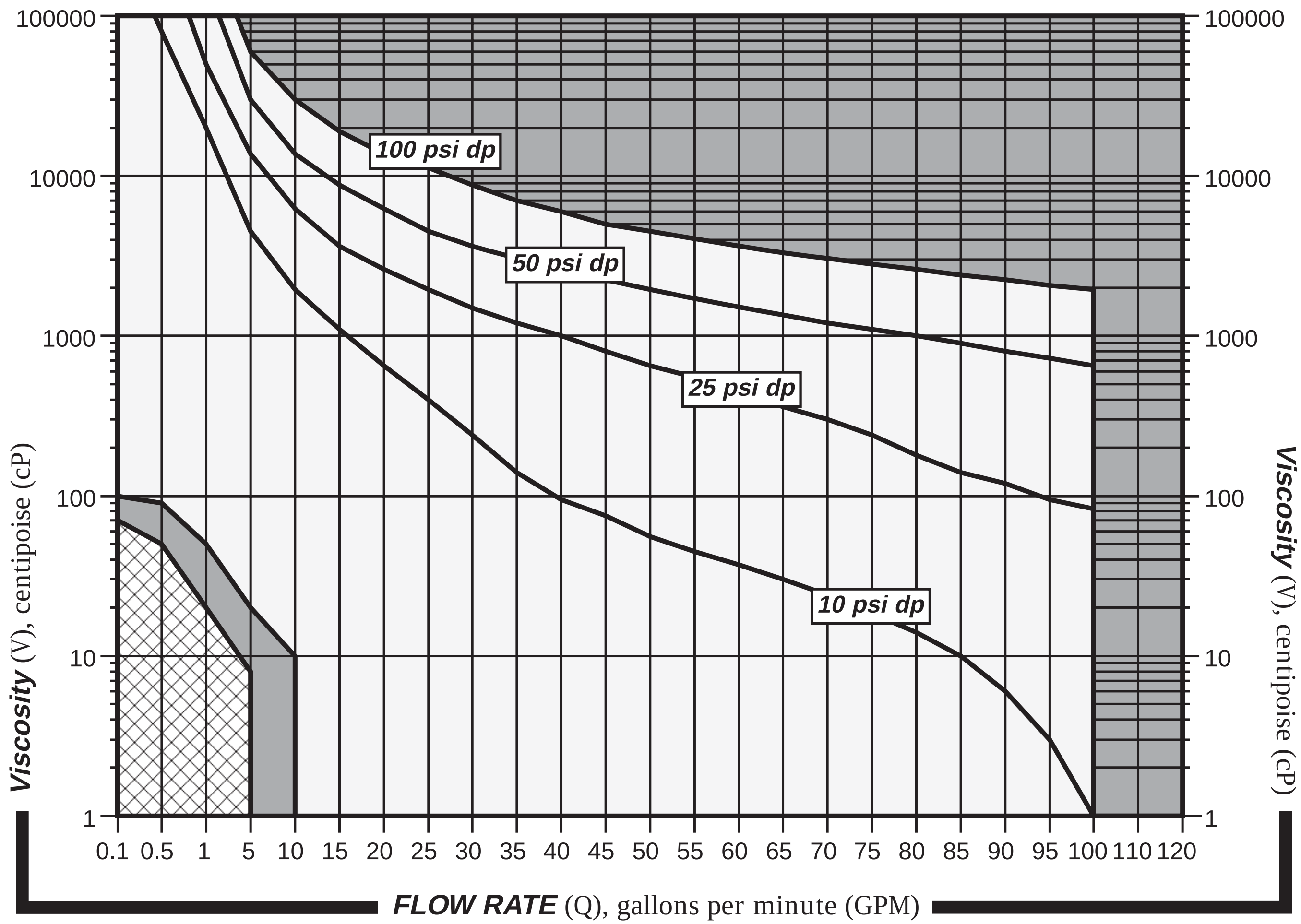
$$F\ (\text{Hz}) = \frac{\text{K-Factor x Flow Rate}}{\text{60 (sec/min)}}$$

Determine the Resolution

The resolution (R) of the flowmeter is the amount of fluid each pulse represents.

$$R\ (\text{Gal/pulse}) = \frac{1}{\text{K-Factor (ppg)}}$$

Size 20 Flowmeter Operating Range and Pressure Drop



Recommended Operating Range - To get a closer pressure drop estimate, see Presure Drop Calculation information. Review the Typical Calibration Curves below to determine if Linearization will be needed.

Marginal, Consult Factory - Special modifications to the flowmeter or specialized electronics may be required. A different flowmeter size might be better suited for the application.

Not Recommended, Try Smaller Size - See previous pages for information on smaller flowmeter sizes.

Pressure Drop (dp) Calculation: Size 20

The pressure drop or differential pressure across a Flow Technology flowmeter is equal to the flow rate times a pressure drop factor. The pressure drop factor is a function of fluid viscosity and meter size. Choose the appropriate equation for the pressure drop factor, calculate it, then use it to determine the pressure drop across the flowmeter.

Pressure Drop (dp) = Q x Fp

Flow Rate *(GPM)*

Pressure Drop Factor

1 to 100 cP:
Fp = 0.100 + (0.0018 x V)

100 to 5000 cP:
Fp = 0.240 + (0.00039 x V)

5000 to 100000 cP:
Fp = 0.580 + (0.00032 x V)

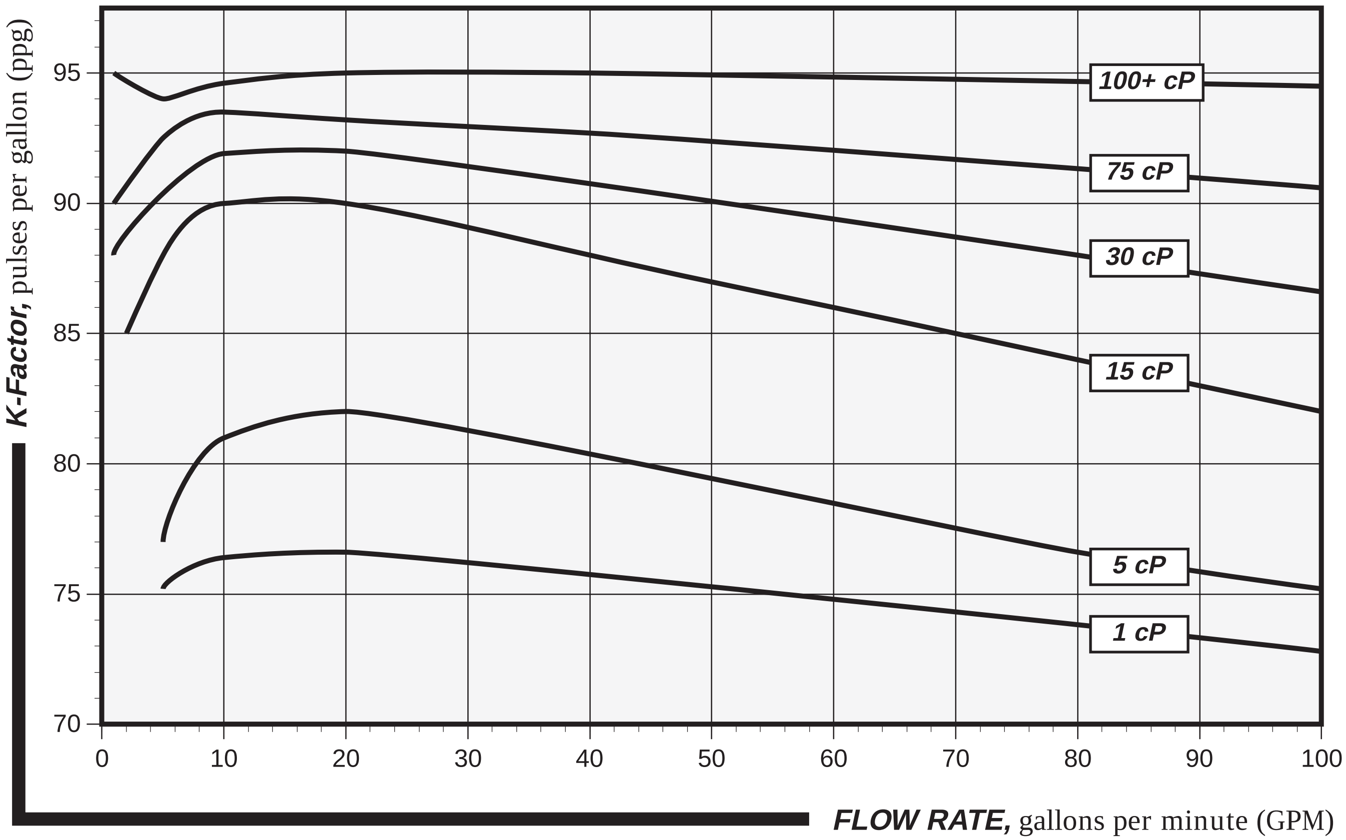
dp - Differential Pressure across flowmeter, pounds per square inch (psi).

Q - Flow rate in gallons per minute (GPM).

Fp - Pressure drop factor. It is calculated using the viscosity of the liquid.

V - Viscosity, centipoise (cP).

Size 20 Flowmeter Typical Calibration Curves



Typical Calibration Curves:
Each curve above represents a different fluid viscosity on a typical Flow Technology flowmeter calibration. The viscosity is given in units of centipoise (***cP***).

Note: The curves shown above represent typical calibrations on a standard Flow Technology flowmeter with standard impellers. Calibration results will vary depending on the flowmeter configuration. Enhancements to the flowmeter and/or the instrumentation allow the performance to be optimized for specific applications.

Fluids below 100 cP - Typical K-Factors and curve shapes are shown for several fluids with viscosities below 100 cP. They demonstrate how different viscosities can have a significant affect on the K-Factor. Electronics with linearization can be used to follow these curves to within ±0.1% over the full turndown of the flowmeter.

Fluids at or above 100 cP - At 100 cP the calibration curve becomes very linear. Higher viscosities will continue to draw very linear curves and the K-Factor value will typically remain at or slightly above 95 ppg.

Use the Typical Calibration Curves to:

Evaluate Linearization Needs
Linearization needs will vary depending on the application and accuracy requirements.

Below 100 cP - Find the viscosity curve closest to the fluid being measured. If the section of the curve covered by the flow rate range is very flat, linearization may not be needed. However, if the curve is at a steep angle or if it changes shape in the flow rate range, linearization will probably be required.

Above 100 cP - Linearization should not be needed unless rates below 6 GPM are being measured.

Estimate Frequency Output
When sending a signal to a PLC, the pulse frequency may be required. Use the following equation to determine the frequency (Hz) at a given flow rate (GPM) and K-Factor (ppg):

$$\text{F (Hz)} = \frac{\text{K-Factor x Flow Rate}}{\text{60 (sec/min)}}$$

Determine the Resolution
The resolution (R) of the flowmeter is the amount of fluid each pulse represents.

$$\text{R (Gal/pulse)} = \frac{1}{\text{K-Factor (ppg)}}$$

Common Conversions and Calculations

Volume

To Convert	Into	Multiply By
Barrels (U.S.)	gallons	31.5
barrels (oil)	gallons (oil)	42.0
cubic cms	gal (U.S. liq.)	0.0002642
cubic cms	liters	0.001
cubic inches	gallons	0.004329
cubic meters	cu cms	100000
cubic meters	liters	1000.0
gallons	cu cms	3785.0
gallons	cu inches	231.0
gallons	liters	3.785
liters	cu cm	1000.0
liters	cu meters	0.001
liters	gal (U.S. liq.)	0.2642
ounces	(fluid) liters	0.02957
pint	gal (U.S. liq.)	0.125

Flow Rate

To Convert	Into	Multiply By
gallons/min	cu ft/sec	0.002228
gallons/min	liters/sec	0.06308
gallons/min	cu ft/hr	8.0208
liters/min	cu ft/sec	0.0005886
liters/min	gallons/sec	0.004403

Pressure

To Convert	Into	Multiply By
atmosphere	psi	14.696
bar	psi	14.504
kilopascal	psi	0.14504
pascal (Pa)	psi	0.000145
psi	atmosphere	0.06804
psi	kgs/sq m.	703.1
psi	kPa	6.895

Length

To Convert	Into	Multiply By
centimeters	inches	0.3937
feet	meters	0.3048
inches	centimeters	2.540
meters	feet	3.281
micron	inches	3.937×10^{-5}

Temperature

To Convert	Use
Celsius into °F	(°C x 1.8) + 32
Fahrenheit into °C	(°F - 32)/1.8

Mass

To Convert	Into	Multiply By
grams	kilograms	0.001
grams	milligrams	1000
kilograms	pounds	2.205
ounces	pounds	0.0625
pounds	kilograms	0.4536
pounds	ounces	16.0
tons (long)	kilograms	1016.0
tons (long)	pounds	2240.0
tons (metric)	kilograms	1000.0
tons (metric)	pounds	2205

Miscellaneous

To Convert	Into	Multiply By
gals of water	lbs of water	8.3453
grams/liter	lbs/cu ft	0.062427
parts/million	grains/U.S. gal	0.0584
parts/million	lbs/million gal	8.345
poise	Gram/cm. sec.	1.00
lbs of water	cu feet	0.01602
lbs of water	gallons	0.1198
lbs water/min	cu ft/sec	0.0002670

Viscosity Conversions

cP = centistokes x SG

$$cP = (0.22 \times ssu \times SG) - \frac{(180 \times SG)}{ssu}$$

cP = centipoise
SG = Specific Gravity
ssu = Saybolt second units

Pressure Drop in Pipes for Laminar Flow

Use the following equation to calculate the pressure drop per 100 feet of pipe (ΔP_{100}). This only applies to laminar flows. If the Reynolds number for a flow is 2000 or less, it is considered laminar.

$$\Delta P_{100} = 0.0273 \frac{\mu Q}{d^4}$$

ΔP_{100} = Pressure drop per 100 feet of pipe
μ = Absolute (dynamic) viscosity, in centipoise (cP)
Q = Rate of flow, in gallons per minute
d = Internal diameter of pipe, in inches

Weight per Gallon of a Liquid

If the specific gravity (S) of a liquid is known, then its weight can be calculated using the following equation:

Weight of liquid (lbs/gallon) = SG x 8.345 (lbs/gallon)

SG = Specific gravity of a liquid at a specified temperature relative to water at standard temperature (60° F).

Patented Design

Flow Technology flowmeters are manufactured under one or more of the following U.S. Patents: 4641522, 4815318, 4911010, 4996888, 5027653 Other patents pending

Local Representative:

FTI FLOW TECHNOLOGY™

ISO 9001 REGISTERED

8930 S. Beck Avenue, Ste 107, Tempe, Arizona 85284 USA
Tel: (480) 240-3400 • Fax: (480) 240-3401 • Toll Free: 1-800-528-4225
E-mail: ftimarket@ftimeters.com • Web: www.ftimeters.com

DB 65112 Rev E