INTRODUCTION

Macnaught’s Positive Displacement Flow Meters are suitable for a wide range of industrial applications including fuel and oil distribution, corrosive chemical, solvent measurement and high pressure applications to name a few.

Macnaught offers Positive Displacement Flow Meters featuring Oval Gear technology. The measuring principle includes two high precision toothed oval gears, which are driven by the flow of the medium and mesh with each other: in presence of a flow, defined volumes of fluid are transported through the meter for each rotation of oval gears pair. As the flow rate increases, so does the rotational speed of the rotors. The number of gear rotations is a measure of the amount of fluid that has passed through the meter; each rotation is detected by a sensor and the volume is calculated using a conversion factor (K factor).

Figure 1: Macnaught Positive Displacement Flow Meter operation.

A key distinction of positive displacement flow meters is that they offer direct measurement of the volumetric flow rate. Positive displacement flow meters are frequently specified as they offer high accuracy and repeatability. They readily provide measurement accuracy within +/-0.5% of the true value.

Additionally, positive displacement flow meters require no power to drive the gear operation with no special fluid conditioning (e.g. straight lengths of pipe) and are capable of handling high pressure, large flow variations and plant equipment vibration due to their robust design.

Advantages:

- High accuracy and repeatability
- Suitable for viscous fluids
- Cost-effective
- Accuracy unaffected by changes in viscosity
- Requires minimal maintenance
- Ease of installation
- Exceptional turn-down ratio

Precision engineering and manufacturing methods are used by Macnaught using cutting edge CNC machining technology and mill certified materials to deliver highly repeatable accuracy and durability. All critical components are machined in-house with astute quality control monitoring the production process continuously.*

NOTE: This catalogue is intended to provide general guidance on Macnaught’s Positive Displacement Flow Meters. In order to select the most appropriate meter for your needs, please seek expert advice which is available free-of-charge from Macnaught’s Technical Support Team.
As a result of over 50 years experience with Positive Displacement Flow Meter technology, Macnaught offers two comprehensive ranges that cater for the ever changing market needs. The latest innovation with the MX-SERIES range to the original M-SERIES range, Macnaught flow meters are designed to insist upon durability, reliability and excellence.

The **MX-SERIES** is the latest innovation featuring:
- High precision billet construction for enhanced material integrity and process reliability
- Programmable digital display and Pulse output options
- Unique bayonet assembly for added versatility and flexibility

The **M-SERIES** is Macnaught's original range of meters featuring:
- Established design and cast construction for proven performance
- Mechanical and pulse output options

**Figure 2**: Summary of the key features of Macnaught's Positive Displacement Flow Meters

<table>
<thead>
<tr>
<th></th>
<th>MX-SERIES</th>
<th>M-SERIES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Meter Body</strong></td>
<td>Billet construction*</td>
<td>Cast construction**</td>
</tr>
<tr>
<td></td>
<td>Stainless Steel</td>
<td>Stainless Steel</td>
</tr>
<tr>
<td></td>
<td>Aluminium</td>
<td>Aluminium</td>
</tr>
<tr>
<td><strong>Rotor</strong></td>
<td>PPS (Hastelloy or Stainless Steel)</td>
<td>Aluminium (Carbon Bushing)</td>
</tr>
<tr>
<td></td>
<td>316 Stainless Steel (Carbon Bushing)</td>
<td>PPS</td>
</tr>
<tr>
<td><strong>Output</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mechanical</strong></td>
<td>Standard Output</td>
<td>Standard Mechanical Register</td>
</tr>
<tr>
<td></td>
<td>Intrinsically Safe Pulse</td>
<td>Heavy Duty Mechanical Register</td>
</tr>
<tr>
<td></td>
<td>High Temp. Explosion Proof (EXD)</td>
<td></td>
</tr>
<tr>
<td><strong>Electrical</strong></td>
<td>Standard Pulse</td>
<td>Standard Pulse</td>
</tr>
<tr>
<td></td>
<td>4 - 20 mA output</td>
<td></td>
</tr>
<tr>
<td><strong>Digital Display</strong></td>
<td>Full programmable Meter Mount Digital Displays (PR &amp; ER)</td>
<td>Full programmable Meter Mount Digital Displays (DR - CR025 only)</td>
</tr>
<tr>
<td></td>
<td>Remote-mountable Digital Displays (PR &amp; ER)</td>
<td>Remote-mount Digital Display (PR &amp; ER)</td>
</tr>
</tbody>
</table>

*Billet construction across the MX meters up to 2"*  
*M-SERIES all cast with the exception of the MH High Pressure Flow Meters (these are of billet construction)*
INTRODUCTION

METER SELECTION GUIDE

Correct specification of the appropriate meter is necessary to achieve desired accuracy and suitable data output, as well as to ensure safety in each application. While for most applications, the specification of the appropriate meter will be straightforward, using the specification process outlined below, for some applications there may be additional technical considerations which need to be assessed on a case-by-case basis. In all circumstances we recommend that you consult with Macnaught’s Technical Support Team to select the most appropriate meter for your needs.

The following steps are provided as general guidelines to assist with correct meter specification. However, to ensure accuracy of specification in relation to your application, we recommend seeking expert advice before making the final selection of the appropriate meter. Please note that Macnaught’s Technical Support Team is available free-of-charge to assist in the specification and identification of a suitable meter.

Flow Meter Size

Macnaught Positive Displacement Flow Meters are available in a range of sizes that are engineered to provide high accuracy across a wide turn down ratio. Figure 3 assists in interpreting your process flow rate, which is an important determinant to the accuracy of your meter. The size of meter should be selected for maximum coverage for your operating flow rates. As shown in Figure 4, the accuracy of the meter is optimal near the mid-range of the meter flow range. In some instances the required flow rates can fall across two meter options, e.g. if the required flow rate is 1 GPM both the MX09 & the MX12 are suitable, in such cases it is recommended to select the meter where the flow range is within the upper 50% of the meter’s flow range limits, i.e. the MX09 is preferred.

Figure 3: Macnaught Positive Displacement Flow Meters flow rate range selection chart

Figure 4: Impact of viscosity and flow range on meter accuracy

NOTE: The above graphs are based on generic industry-sourced data. The graphs are intended to be used for illustrative purposes only and may not be directly applicable to your specific applications. Please seek expert advice from Macnaught’s Technical Support Team before final selection.

IMPORTANT: Do not use the above data for product selection.
Macnaught standard ‘single point’ calibration is carried out at mid-flow range where the individual K-factor is assigned to the meter.

Identifying the correct meter size for the operating flow rates will ensure the longevity of the meter and deliver optimal accuracy during its operation. For instances where operation is necessary outside the designated mid flow range of the meter, it is recommended that an optional ‘multi-point’ calibration is performed which will help ensure maximum accuracy is achieved. We recommend consulting Macnaught’s Technical Support Team before final selection.

### Chemical Compatibility

To determine the most appropriate materials combination for each application it is essential that the wetted components of the meter assembly are confirmed for chemical compatibility. Macnaught meters are available in standard materials configurations, as shown on the quick reference table below (figure 5): common fluid types are listed and the recommended materials combination for each of them is indicated. For a more comprehensive chemical compatibility guide, please refer to Appendix E on page 79.

The chemical compatibility guides referred to above are intended to provide general guidance on chemical compatibility. It is highly recommended that the data is checked on a case-by-case basis, as individual process variations in chemical concentration and temperatures from those of the reference data can influence compatibility. We advise seeking expert advice from Macnaught’s Technical Support Team to confirm the materials selection.

**Figure 5: Quick reference chemical compatibility guide**

<table>
<thead>
<tr>
<th>BODY</th>
<th>PPS</th>
<th>AL</th>
<th>SS</th>
<th>AL</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROTOR</td>
<td>PPS</td>
<td>PPS</td>
<td>PPS/SS</td>
<td>SS</td>
</tr>
<tr>
<td>SEALS</td>
<td>FFKM</td>
<td>FKM</td>
<td>FEP</td>
<td>FEP</td>
</tr>
</tbody>
</table>

- Avgas - Jet Fuel
- Diesel Fuel
- Ethylene Glycol
- Gasoline, Unleaded
- Kerosene
- Adblue®
- Ammonia, anhydrous
- Citric Acid
- Methyl Ethyl Ketone
- Acetone
- Ethanol
- Hexane
- Methanol
- Toluene
- Phosphoric Acid
- Potassium Hydroxide
- Sodium Hydroxide
- Sulphuric Acid
- Water

*Refer to Appendix E - Chemical Compatibility Guide for general guidance on suitability

NOTE: This chart is intended to provide general guidance on chemical compatibility and should not be used for product selection. The chart is based on industry data and may not be directly applicable to your specific applications. Macnaught does not accept liability for chemical compatibility outside of the accuracy of the wetted component list. Please consult Macnaught’s Technical Support Team before final selection.
Temperature & Pressure Rating

All Macnaught flow meters are designed to be completely safe under normal operating conditions. However, to ensure user’s safety, it is very important to select a flow meter that will operate within the process pressure and temperature conditions at all times.

Allowances should be made for any potential ‘spikes’ in pressure (e.g. as a result of sudden valve closures or as the pump initially starts). If the system pressure is expected to reach the meters maximum rating it may be necessary to incorporate a pressure relief valve into the system. Macnaught's Technical Support Team is available to provide advice in this regard.

There are a number of factors which influence the pressure and temperature ratings of a flow meter during operation:

- Presence of flanged ports causes a reduction of the pressure rating
- Other modifications to the materials properties

Temperature rating:

- Operational parameters such as the limitations of an attached LCD register and batteries
- Coefficient of thermal expansion or
- Other modifications to the materials properties,

When factors combine, the individual effects could amplify and pose a safety risk. We therefore recommend seeking expert advice from Macnaught's Technical Support Team before final selection of the appropriate meter.

Rotor Type

While Macnaught Positive Displacement Flow Meters are capable of processing a very wide range of fluid viscosities, the viscosity of fluids still need to be considered to aid the selection process. This value should always be taken at the applications operating temperature and flow rate. Note that typical fluid technical data sheets are not usually stated at operating conditions, so further research may be required to determine this information.

In cases where the fluid is non-Newtonian, additional allowances may be required to compensate for changes to viscosity between static and dynamic situations.

The higher the fluids viscosity the greater the pressure drop it will cause. As shown in Figure 7, the maximum flow rate will need to be reduced as the viscosity increases. Please contact Macnaught if your require further assistance. Alternatively, as shown in Figure 6, Macnaught offers High Viscosity (HV) rotors that have been modified to alleviate this pressure drop and still offer extended flow ranges. As a general rule if the viscosity is >1000cP it is recommended to use HV rotors, but it is also important to look for notes on minimum viscosity as this can also affect the meters minimum flow rate.
**Figure 6:** Benefit of High Viscosity Rotors used to reduce pressure loss impact

![Graph showing the benefit of high viscosity rotors on reducing pressure loss](image)

**Figure 7:** Impact of viscosity on pressure loss for a range of flow rates

![Graph showing the impact of viscosity on pressure loss](image)

**Note:** Flow as % of maximum capacity

For viscosities greater than 1000cP High Viscosity rotors are required

**INTRODUCTION**

*NOTE: The above graphs are based on generic industry-sourced data. The graphs are intended to be used for illustrative purposes only and may not be directly applicable to your specific applications. Please seek expert advice from Macnaught’s Technical Support Team before final selection.*

**IMPORTANT:** Do not use the above data for product selection.
OPERATING GUIDELINES

While oval gear flow meters provide exceptional accuracy, reliability and a cost effective solution, there are some considerations for their usage. For example they should not be used to measure fluids with particles or air pockets in them and adequate filtration needs to be installed upstream of the meter. Inside the meter are moving components, so as good practice a routine inspection may be required. The frequency of the inspection should be based on the operating conditions; these will include the maximum flow rate, viscosity and the fluids lubricating properties. If the meter is used with a lubricating fluid, such as oil, and is well within the maximum flow range, then the meter will operate of many years maintenance free.

Installation Guidelines

1. It is recommended that when setting up pipe work for meter installations a bypass line be included in the design. This provides the facility for a meter to be removed for maintenance without interrupting production.

2. Use thread sealant on all pipe threads.

3. For pump applications ensure pipe work has the appropriate working pressure rating to match the pressure output of the pump. Check specified Meter Technical Data section for further details.

4. Install a wire mesh strainer, Y or basket type (refer to pg.68 for Y strainer options) as close as possible to the inlet side of the meter.

5. For M-series meters ensure that the meter is installed so that the flow of the liquid is in the direction of the arrows (if applicable) embossed on the meter body.

6. The meter can be installed in any orientation as long as the meter shafts are in a horizontal plane. (Refer to Figure 9 below for correct installation). The register assembly may be orientated to suit the individual. Note: Incorrect installation can cause premature wear of meter components.

7. Do not over-tighten meter connections. It is important that after initial installation you fill the line slowly, high speed air purge could cause damage to the rotors.

8. Test the system for leaks.

9. Check the strainer for swarf or foreign material after the first 1 hour of operation. Check the strainer for swarf or foreign material periodically, particularly if the flow rate decrease.

Figure 9: Meter orientation for register assembly