ISA-RP16.5-1961

Approved June 30, 1961

Recommended Practice

Installation, Operation, and Maintenance Instructions for Glass Tube Variable Area Meters (Rotameters)

ISA-RP16.5 — Installation, Operation Maintenance Instructions for Glass Tube Variable Area Meters (Rotameters)

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Preface

This recommended Practice has been prepared as a part of the service of ISA toward a goal of uniformity in the field of instrumentation. To be of real value this report should be subject to periodic review. Toward this end the Society welcomes all comments and criticisms, and asks that they be addressed to the Standards and Practices Board Secretary, ISA, 67 Alexander Drive, P.O. Box 12277, Research Triangle Park, North Carolina 27709, e-mail: standards@isa.org.

This report was prepared by the 8D-RP16 Committee of the Production Processes Standards Division on Variable Area Meters.

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The assistance of those who aided in the preparation of this Recommended Practice by answering questionnaires, offering suggestions, and in other ways is gratefully acknowledged.

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1 Purpose

This Recommended Practice is intended to provide a useful guide for the general considerations important to the installation, operation and maintenance of glass tube variable area meters (rotameters).

2 History and development

The need for this Recommended Practice was established by a survey of instrument users sent out initially in September, 1954, to about two-hundred-and-fifty meter users and manufacturers.

3 Scope

This Recommended Practice covers the general considerations important to the installation, operation and maintenance of meters to obtain the most reliable results.

Terminology, dimensions and safety practices have been covered in ISA-RP 16.1.2.3. Nomenclature and terminology for extension devices are included in ISA-RP 16.4. Calibration is included in ISA-RP 16.6.

4 Unpacking the instrument

4.1 Care should be exercised when unpacking the instrument. The instrument should be carefully inspected to determine that no damage has occurred during the shipment.

Depending upon the size of the rotameter, larger metering floats are packed separately and should not be discarded as packing material. Metering floats which have been packed separately should be carefully unpacked. Protective coating or tape on metering edge should not be removed until just prior to installation. Inspection for damage should be made immediately.

5 Preparation of the instrument for installation

5.1 The end fittings and metering tube should be inspected to make sure that they are free of any foreign matter and if necessary, should be cleaned with a tube brush or a soft swab on the end of a wooden dowel. Remove tape and/or protective coating from metering float, and inspect its surface for burrs or scratches. All parts of the meter should be inspected visually for assurance meter will function properly.

6 Installation

6.1 The rotameter must be installed in a vertical position with the piping aligned and supported properly to prevent any stresses being transmitted to the meter. The inlet connection is always referred to the smallest tapered end of the metering tube, or the lowest numerical scale graduation and is located at the bottom. Connecting pipelines should be the same size, but in no case, more than or less than one pipe size different than meter connection size.

The metering float should be inserted into the metering tube with the correct end up so that the float is read at the proper position with reference to the scale. Plumb-bob type floats are read at the largest uppermost diameter. Ball floats are read from mid-position of the ball. Other types of metering floats are also read at the uppermost largest diameter. In any case, the manufacturer's instructions should be checked to verify the correct position of the metering float. When inserting the float, care should be exercised to prevent tube breakage. Ball floats can be guided into the top of the metering tube by using a paper funnel. Avoid dropping metering floats other than the ball type through the outlet end fittings since this could cause tube breakage. Large metering floats usually have a tapped hole in the top to which a rod may be fitted to lower it into the metering tube. Smaller metering floats may be guided into the metering tube using the lower float stop.

The detachable scale should be aligned so that its reference mark and zero line on the metering tube coincide. If not, make the necessary adjustments. This step is not necessary if the scale is etched on the metering tube.

It is recommended that all glass tube rotameter installations incorporate the use of a by-pass arrangement for either liquid or gas service as illustrate in Fig. RP16.5.1. The use of a by-pass arrangement with unions (or flanges) and valves as illustrated in Figure RP16.5.1 permits flushing of new lines by-passing the rotameter, and permits the by-passing of flow when it is necessary to remove the instrument for maintenance. It also assists in maintaining stable start-up for gas service. This is described under "Start-Up" procedure.

For flashing liquids, the by-pass arrangement valving is as shown in Fig. RP16.5.1 with valve No. 1 on the downstream side of the meter being a throttling valve. Valve No. 2 (block valve) on the upstream side of the meter must be operated in the fully open position so as not to introduce excess pressure drop which may cause the liquid to flash.

For non-flashing liquids, the recommended by-pass arrangement valving is shown in fig RP16.5.1 with valve No. 1 in the downstream side of the meter being a throttling valve. Under certain conditions, when it is desired to protect the meter from full line pressure, or where pressure shock (water hammer) might exist, valve No. 2 could be made a throttling valve.

For gas service, the by-pass arrangement is as shown in Fig. RP16.5.1 with valve No. 1 on the downstream side of the meter being a throttling valve for stable operation. Where the by-pass arrangement cannot be incorporated for gas service, the rotameter must be installed with the throttling valve on the downstream side as shown in Fig. RP16.5.2 for stable operation. The maximum distance "L" of the throttling valve from the outlet of the rotameter can be determined from the nomograph contained in Fig. RP16.5.3. Installation according to this data will reduce or eliminate the phenomena known a "float bounce."

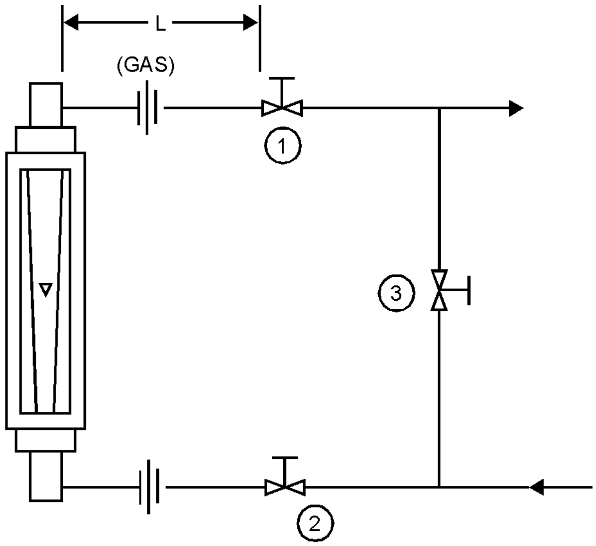


Figure RP16.5.1 — Liquid or gas service

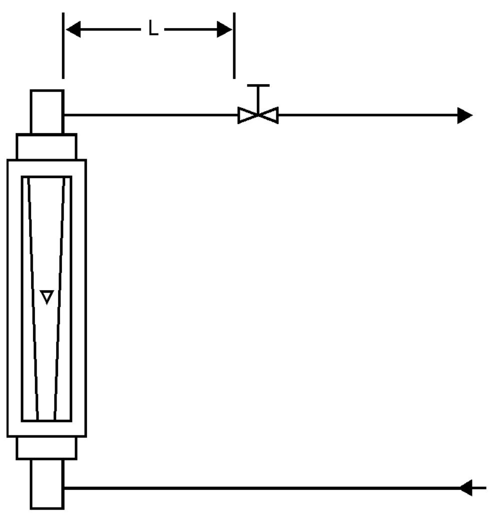


Figure RP16.5.2 — Gas service

7 Start-up with by-pass arrangement

7.1 In order to prevent metering tube breakage or damage to the metering float, a by-pass arrangement should be used as follows:

1) Throttling Valve No. 1 should be closed.

2) Block Valve No. 2 should be closed.

3) Open Equalizing Valve No. 3 sufficiently to bring pressure up to operating pressure.

4) Open Block Valve No. 2 gradually to full open.

5) Open Throttling Valve No. 1 gradually to approximately 1/2 turn.

6) Once stability is maintained, equalizing Valve No. 3 should be closed and further throttling of flow may be done by throttling Valve No. 1.

8 Water hammer

In the installation of glass tube rotameters for liquid service, consideration should be given to possible damage from water hammer. Water hammer is a series of pressure shocks created by a sudden checking of the flow of liquid in a pipe, such as through the quick closing of a valve. The action, by stopping the flow, generates kinetic energy in the column of liquid by compressing the fluid and stretching the walls of the pipe. A wave of increased pressure beginning at the valve is transmitted back through the pipe at a constant magnitude and velocity. When the pressure wave has traveled upstream to a larger part of the pipe or vessel, it reverses itself and a wave of normal pressure progresses back to the valve. While the pressure surge appears first directly at the valve and lasts longest at this point, the actual pressure peak is transmitted through the entire system.

The best method of preventing water hammer is to eliminate quick-acting devices in the fluid stream, or to install surge chambers or accumulators in the system as close to the surge initiating device as possible. However, the resultant pressure peak can be calculated and selection of a rotameter capable of withstanding this pressure is possible.

The peak pressure generated by water hammer can be calculated by the following formula: (1)

$$P = P_s + 64V$$

Where

P = Maximum surge pressure generated under condition of water hammer (p.s.i.).

P_s = Normal operating pressure (p.s.i.g.).

V = Fluid velocity at normal operating flow (feet per sec.).

Example — A rotameter system with a 6 g.p.m. rate of flow in a 3/4" (Schedule 40) pipe (fluid velocity 3.61 ft. per sec.) and a normal operating pressure of 50 p.s.i.g.

$$P = 50 + 64 \times 3.61$$

$$P = 281 \text{ p.s.i.}$$

9 Maintenance

9.1 If leaking occurs at either end of the glass metering tube, the pressure in the meter should be released, then the gland bolts should be tightened uniformly. In order to prevent metering tube breakage by over-tightening gland bolts, a portable polariscope may be used to indicate excessive stresses.

A periodical visual inspection should be made of the rotameter. All metering tube packing and gaskets should be replaced if necessary. It is important that the metering tube and float be inspected for deterioration of surfaces. Refer to manufacturer for dimensional and weight tolerance of the metering float.

When it is necessary to replace metering tube or packing, reference must be made to manufacturer's maintenance instructions for correct procedure.

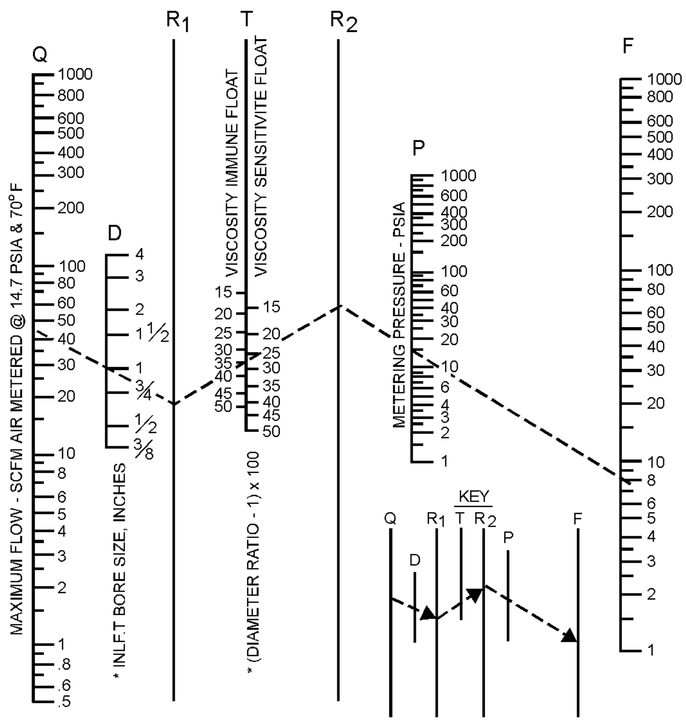
The following are considered normal spare parts:

1) Metering tube
2) Packing
3) Gaskets
4) Metering float
5) Window glass

When ordering the above spare parts, complete information must be supplied, giving serial number, size of meter, metering tube, metering float, and materials of construction.

10 Reference

Mangin, H.V., ISA Journal, Vol 6. No. 11 - Nov. 1959



NOTE: MAXIMUM ALLOWABLE DOWNSTREAM PIPING IS MEASURED FROM METER OUTLET TO DOWNSTREAM THROTTLING VALVE AND IS BASED ON INLET FLOAT STOP POSITIONED AT 10% OF MAXIMUM FLOW. THE MAXIMUM ALLOWABLE DOWNSTREAM PIPING LENGTH IN INCHES (L) IS THE PRODUCT OF FACTOR F AND THE SQUARE OF THE RATIO OF THE INLET BORE SIZE (D) AND THE PIPE I.D.

$$L = F\left(\frac{D}{\text{PIPE I.D.}}\right)^2$$

ACTUAL INSIDE DIA. STEEL PIPE, INCHES		
NOMINAL PIPE SIZE	SCH 40	SCH 80
3/8	.493	.423
1/2	.622	.546
3/4	.824	.742
1	1.049	.957
1 1/2	1.610	1.500
2	2.067	1.939
2 1/2	2.469	2.323
3	3.068	2.900
4	4.026	3.826

EXAMPLE: METER HAS 1" TUBE, 3/4" SCH. 40 PIPING, TO MEASURE 45 SCFM OF GAS AT 14.7 PSIA. DETERMINE MAXIMUM ALLOWABLE PIPING LENGTH TO DOWNSTREAM THROTTLING VALVE. DIAMETER RATIO OF TUBE IS 35, FLOAT IS VISCOSITY IMMUNE.

1. FROM NOMOGRAPH; D = 1, F = 8

2. $L = F\left(\frac{D}{\text{PIPE I.D.}}\right)^2 = 8\left(\frac{1}{.824}\right)^2 = 11\frac{3}{4}$ INCHES

* DETERMINED FROM TUBE NOMENCLATURE
(REFER TO ISA - RP 16.1.2.3 PRA 5.3)

e.g. - 1 - 35 - G - 10

Figure RP16.5.3 — Float bounce piping limitations for variable area meters on gas service

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