Sight Flow Indicators HANDBOOK

Selection and application of sight flow indicators in process applications

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L.J. Star Incorporated provides an extensive line of process observation equipment — sightglasses, lights, sanitary fittings, and level gage instrumentation. Product lines include Metaglas® Safety Sight Windows, Lumiglas® Explosion Proof Lights and Cameras, Visual Flow Indicators, Sight Ports, Sanitary Clamps, Magnetic Level Gages and Gage Glass. Metaglas is the #1 selling fused sightglass, proven in thousands of installations around the world. Unlike some other sightglasses, it meets stringent DIN 7079 and DIN 7080 quality standards, and it is approved for USP Type I use. For additional information, or to request third-party documentation of standards compliance and product performance claims, contact L.J. Star Incorporated, P.O. Box 1116, Twinsburg, OH 44087. Phone: 330-405-3040. Fax: 330-405-3070. Email: view@ljstar.com. Website: www.ljstar.com.

Introduction to Sight Flow Indicators

The ability to see what is happening inside a pipe can be invaluable to process operators. Despite technological advances, no sensor can equal the human eye which has more than 94 million photo receptors.

Process observation equipment falls into two major categories: sight glasses, also called sight glass windows, which are used on process vessels, and sight flow indicators, which are used in process pipelines. This handbook covers sight flow indicators. (For information on sight glass windows, see our *Chemical and Pharmaceutical Sight Glass Application Handbook*.)

A sight flow indicator is a device installed in a pipe to provide a visual means of verifying liquid flow for direction and approximate rate. Simple and low-cost, it also allows operators to observe the color and clarity of process fluids through a window.

The basic description of a sight flow indicator is a body with one or more viewing windows, usually with gaskets, and a way to mount the indicator to the pipeline, such as flanged, threaded, or sanitary clamp connections. Depending on the manufacturer, sight flow indicators are available to fit standard pipe sizes ranging from ¼-inch to 16-inches and carry ANSI pressure ratings.

In contrast to the electronic sensors used to monitor the flow and other characteristics of a process media, sight flow indicators allow direct observation and cannot give a false reading, lose power, or fail to read. On the other hand, electronic sensors can provide precise measurements and can be integrated into an automated control system. Even in these situations, sight flow indicators are used in conjunction with electronic sensors, in order to provide a simple means of confirming a reading. What's more, sight flow indicators are comparatively inexpensive and easy to install, making it possible to have confirmation at many points throughout a processing system.

Applications

Sight flow indicators may be applied to almost every phase of process media movement, whether the media is liquid, gas or powder. Operators can see the approximate rate of flow, direction of flow, and condition of the process media, without interrupting process flow.

- In the processing of bulk solids such as plastic resins, inorganic powders, and food product, sight flow indicators enable operators to view blending and confirm the free flow of materials.
- Sight flow indicators enable personnel to inspect pipelines for residue, scale, and foreign matter, especially during cleaning routines.
- For pipes carrying steam, sight flow indicators enable personnel to be alerted to the presence of condensate and take steps to eliminate it.
- A chemical processing system often involves a number of pipelines used to move liquid product though cooling lines, filters, and transfer/pumping lines. Sight flow indicators enable operators to observe line conditions for signs of clogging or blinding filters.
- In discrete manufacturing, machines depend on adequate lubrication for their smooth operation. Sight flow indicators are used on equipment so that maintenance personnel can detect the absence of oil and to inspect the color of the oil which may indicate it needs to be changed.

Specifying

The specification of a sight flow indicator includes selecting the body material, gasket material, type of glass, window design, and mounting type. The first step is to define the process to be observed, including temperature, pressure, the physical characteristics of the process media, the direction of flow (horizontal left or right, vertical up or down), and whether the process has sanitary requirements. These factors will lead to the second step: selecting the appropriate type of sight flow indicator. The final step is to define the type of material needed in the body, gaskets, and glass.

Types of Sight Flow Indicators

Unlike sight glass windows that don't have indicating mechanisms, sight flow indicators may have passive components that are set in motion by the flow in order to indicate flow direction or intensity. If the flow indicator has indication components, a certain level of flow is required to set them in motion. Flow indicators without indication components are used where observing the characteristics of a process fluid is more important than verifying flow. Because indication components complicate cleaning in hygienic systems, they are rarely used in sanitary applications.

In addition, some flow indicators, called "flow meters", have a calibrated scale that provides a rough measurement of flow to an observing operator.

Flow indicators can be custom made for large diameter pipes. A cost-saving alternative is to install a standard diameter flow indicator on a smaller pipe running in parallel.

360° View Flow Indicator

Also called full view, cylindrical- or tube-style flow indicator, this type of flow indicator passes fluid through a glass cylinder that is visible from all angles. This allows ample ambient light to illuminate the flow. It is ideal for observation of process fluid for clarity, color, foam, and other conditions, and for the presence of moisture. Often designs feature impact-deterrent shields or sheaths made of plastic. This style of flow indicator is suited for lower-pressure systems with moderate flow rates. These indicators must be installed on pipes where there is minimal mechanical strain.

An alternative design has a metal shield or sheath with windows. This adds strength to the indicator and protects it from moderate mechanical strain.

360° view flow indicators may be fitted with glass marked with a calibrated scale and used for level indication.

View-through flow indicator

This type of flow indicator has two opposing windows so that an operator can see the intervening flow of fluid lighted from behind, either by ambient light or with an attached luminaire. Unlike 360-degree full-view flow indicators, this design is suited for ANSI pressure classes, high temperature, and harsh fluid applications. This type may be ordered with Teflon® lining of the metal body for corrosive service.

Mount types include flange, threaded, butt-weld, socket-weld and clamp. Sizes depend on the manufacturer but generally range from ¼ inch diameters to 16 inch diameters, with larger units available as special order. Stock models are available in pressure ratings ranging from 20 to 3000 psi.

This style covers the widest range of applications and may be fitted with indication devices such as flappers, flutters, drip tubes, balls, and rotors.

For either full-view or view-through sight flow indicators, occasionally a standard model will not match the exact needs of the application. For unusual sizes and unusually demanding applications, suppliers offer custom sight flow indicators or modifications of standard units.

Flapper flow indicator

Flow indicators may be fitted with a hinged flapper or flag visible through the sight glass. The flapper is deflected toward the flow direction. Because the position of the flapper changes in relationship to the force of flow, it provides operators with an approximate gauge of flow. This style is best applied on horizontal pipelines, but it may also be employed in vertical pipelines with upward flow. It is ideal for use with transparent solutions and gases which cannot be observed directly, and for dark, nearly opaque fluids in which flow is difficult to observe.

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Visual flow meters

Flapper-style sight flow indicators are available in which the flapper has a reset spring. The force of the spring is overcome by the relative flow of the process fluid. A graduated scale is marked on the glass so that the flow volume is indicated. In simple applications this may be used as an alternative to an expensive flow meter.

Some sight flow indicators use a weighted flapper or flag that indicates the volume of flow by its position on a calibrated scale marked on the sight glass. These flow meters are factory-set for a specific flow of water at 20°C for a given diameter of pipe. Therefore they are not useful for non-water applications.

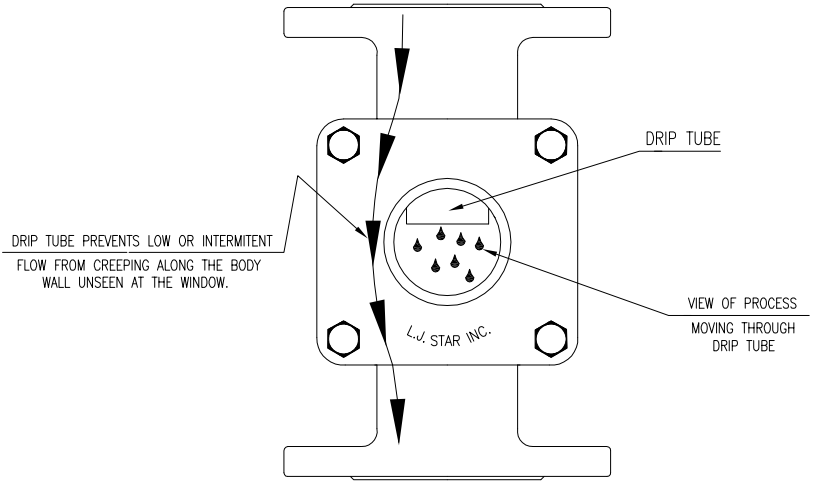
Visual flow meters work with one direction flow only.

Rotary flow indicator

Flow indicators may be fitted with rotors or impellers that are turned by the flow of liquid or gas. The rotors are mounted in the window view so operators can observe the direction and approximate speed of flow. This is particularly useful for clear gases and fluids, but the rotor is visible with dark fluids as well. This indicator operates in any position and with any direction of flow. Rotor-style flow indicators should not be used if the flow rate is very low, because the rotating device or propeller may not turn.

Drip indicator

Drip indicators may be models designed for drip observation or conventional flow indicators installed with a drip tube. Drips and low-volume intermittent flows may be observed in applications such as distillation. Because gravity is utilized, drip indicators are normally applied in vertical pipes with a downward flow. Nevertheless there are some applications where horizontal installation is possible.



Ball Flow Indicator

Flow moves a ball from the bottom of the indicator housing to a position at the top of the sight window. The ball is visible through the window so that flow may be observed easily at a glance. The suspension of the ball by the fluid indicates the presence of flow. Because gravity returns the ball to its rest position, this style of indicator must be applied in vertical pipes with upward flow. Generally this is used with slow moving fluids or gases, and not with high-rate or turbulent flows.

There is another style of ball flow indicator in which the flow of process fluid or gas causes a ball to oscillate in a glass dome. When the flow stops, the ball drops out of sight. This style must be installed in a horizontal position. It is especially useful for fast moving fluids and gases.

Plastic ball flow indicators are also available, some with calibrated scale markings that indicate relative flow, but plastic indicators are not recommended for use in process applications.

Where space or system design characteristics make straight-line sight flow indicators unusable, 90-degree models are available.

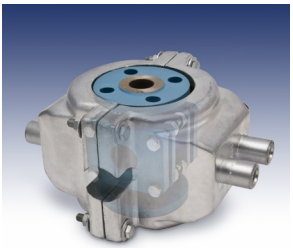
Flutter Indicator

The mechanisms for standard flappers and rotors cannot be Teflon® coated, so for observing gases and liquids in Teflon-lined flow indicators a flutter style indicator is a good choice. The movement of a thin ribbon of tough, non-reactive material such as Teflon may be observed though the sight glass window. The intensity of the flutter indicates the relative speed of the flow. Usually it is mounted inside the sight flow indicator in such a way that it can be used for flows in a single direction only. Because the ribbon has so little mass, it is moved easily; therefore flutter indicators are ideal for low-speed process flow and light process media.

Accessories

Steam Jackets

Steam heated jackets are available to cover view-through flow indicators. Only the sight glass window is not covered. The jackets prevent cool spots in a process and increase the viscosity of fluids.



Cameras

Sight ports may be fitted with video cameras that allow remote monitoring as well as recording. For hazardous environments, explosion-proof versions are available.

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Lighting

Lights, also called luminaires, may be added to view-through and full-view style sight flow indicators. Generally these lights mount externally using a bracket, or the luminaire fits directly into a sanitary fitting for one-piece mounting right onto the ferrule or cover flange. For hazardous environments, explosion-proof versions are available. Illumination is provided by a halogen bulb, fluorescent bulb or LEDs. In addition, fiber optic cable may be used to transmit light from the light source to the sight glass, which is desirable in tight spaces and when the bulb must be located away from the sight glass because of vibration. More information about applying lighting to sight glass applications is provided in the L.J. Star application handbook, *Understanding and Specifying Sight Glass Lighting.*

Washers and Wipers

Material such as foam, solids, and condensation may stick to the inside of a sight glass and obscure the view. For these applications, spray washers and wipers that clean the inner surface of the glass are available. In bulk material processing, solids may stick to sight glass windows and obscure the view. Here as well, spray washers and wipers may be helpful. Wiper blades are most often made of an elastomeric material. The wiper is usually operated manually by twisting a handle or knob. Because the mechanism is of a standard length, a wiper may not be available to fit unusually thick window or double glass flow indicators. Motorized wipers are also available, including explosion proof versions. These can be controlled locally or via remote control.

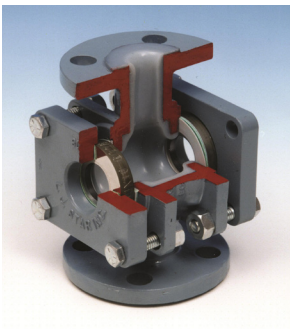
Construction

Metal

View-through flow indicators usually have cast-metal bodies. Commonly used body materials include carbon steel, iron, bronze, and stainless steel. The formulas of stainless steel offered may be 316, 304, Alloy 20, Hastelloy®, Inconel, and Monel. PVC is also used, although for industrial and chemical processing it is rarely used. Not all styles and models are available in all materials.

Linings

In situations where the process medium will react with metal, the indicator body may be made corrosion resistant by adding a lining of Teflon®, FRP or other non-reactive material. In addition, lower-cost body materials such as carbon steel may be made suitable for an application by adding such a lining. This approach is most often used to achieve cost savings compared to using indicator bodies made of more expensive alloys.



Gaskets

Gaskets are available in a wide range of materials, and their selection should be matched to the requirements of the application, including operating temperature and compatibility with the medium handled. Common material choices include neoprene, Gylon® (PTFE), Teflon with an elastomer insert, butyl, Buna-N, silicone, fluorocarbon, and graphite.

For hygienic applications, sight flow indicators O-ring seals are available. These often mount to the pipe ferrule using clamps. The sight glass windows are attached to the body in a similar fashion.

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Glass

Soda lime glass and borosilicate glass are commonly used in sight flow indicators. Quartz glass, also known as fused silica, and sapphire are used only for special applications. Although acrylic and Lexan lenses are available, they are rarely used in industrial applications because of their limited corrosion resistance and temperature range.

In addition to the type of glass (its chemical composition) used, any glass may be strengthened by annealing or tempering.

Soda lime glass is common glass dating back to the ancient Egyptians. It is usable in operating temperatures up to 300˚F (150˚C), although in the case of alkaline media only up to 212˚F (100˚C).

Borosilicate glass differs from soda lime glass in that some of the silica is replaced by boron oxide. It was developed in 1893 by a German scientist who found that adding boron salt resulted in glass having improved resistance to thermal shock, chemical corrosion and higher temperature capabilities (600˚F). "Pyrex," a trademark of Corning, is a brand of borosilicate glass.

Fused silica is made from fusing quartz crystals at high heat. Because no doping agents are added, this pure form of glass has superior temperature and thermal shock capabilities. It is specified for operating temperatures up to 1000˚C. It is more expensive than other types of glass and not as strong nor as durable as annealed borosilicate glass. Kel-F or PFA shields can be used to protect the glass from materials that could erode or etch the glass.

Sight glass lenses are available as plain glass disks that are bolted to the indicator body with intervening gaskets, or as sight glass windows in which the glass is fused to a metal frame during manufacture. Such fused glass designs are polished so that there is no crevice between the glass and metal.

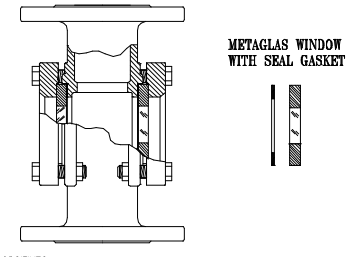
There are many advantages to fused-glass sight glass windows. The metal frame prevents overtorque or uneven bolt compression from affecting the sight glass. Fused sight glasses can be reused, but plain glass should be replaced after maintenance because it is exposed to mounting stresses that may chip or weaken the glass.

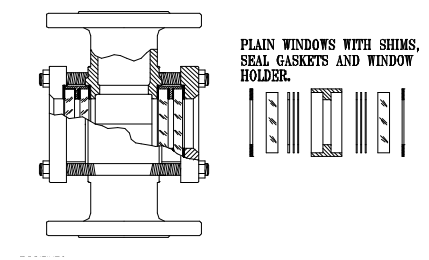
The biggest advantage of a sight glass fused to a metal frame is strength. The metal ring holds the glass in concentric compression that overcomes the tensile forces that could otherwise break the glass. Like cement, glass is strong

under compression but fragile under tensile stress. Compression gives glass amazing strength. In fact, under high compression the glass become slightly elastic, able to flex under pressure and continue service when it is chipped or scratched. Glass strength is critical for worker safety, because glass fails catastrophically with explosive force.

Some people request sight flow indicators having dual glasses for reasons of safety and reliability. Depending on the manufacturer, such designs involve either a lens made of multiple layers of glass or independent lenses that are separately sealed. Such designs offer redundancy and reduce the effect of thermal gradients across the glass. However, the glass strength should be calculated only on the inner glass lens, not on the combination of glass lenses. Hydrostatic testing can verify the strength of the inner glass only, so the pressure rating is based on the inner glass only.

A safer and more reliable sight flow indicator is achieved by using a single fused-glass sight glass. Because the metal frame holds the glass in compression, the glass will have more strength and safety than a dual or double glass design. If the fused-glass window is made with borosilicate glass, then it will also be more resistant to thermal shock. Moreover, because it has fewer components than a double-glass design, it is less costly and easier to maintain.





Preventing Sight Glass Failures

Improper installation can contribute to sight glass failure. Examples are over-tightening and uneven torqueing which produce bending loads on the glass and can potentially result in cracking. A common cause of failure is trapped debris that causes a bending moment, such as from gaskets that become baked onto the flanges and portions are left behind when removed.

Some low-quality sight flow indicators may not have flat and parallel surfaces as a result of poor or low tolerance manufacturing. This also may result in a bending load on the glass.

It is not uncommon for a sight glass to be used as a handy place to rest a wrench or other tool. This may scratch the glass, creating a source for breaks to originate, also known as stress concentrations. Even though a bending load is required to open these cracks, they significantly reduce the pressure capabilities of the glass.

Thermal shock is a sudden, drastic change in temperature that causes one side of the glass to expand or contract differently from the other side. This can occur when a cold sight glass experiences a sudden increase in temperature at process startup, or when a hot sight glass is suddenly cooled during an external washdown of equipment.

Of course, over-pressurization can cause a sight flow indicator to fail. A properly specified unit should have an ample safety margin.

Lastly, degradation of the glass over time can lead to failure. Chemicals, and even water, will corrode glass. There are several chemical resistance charts that illustrate the loss of weight of glass when exposed to various chemicals. Another source of degradation is the continuous friction from an abrasive product against the glass.

Installation and Maintenance Tips

Maintenance

Sight flow indicators are relatively simple devices that require little to no maintenance, assuming that the proper model is selected for the application and that its installation was done properly.

- If dirty glasses are disassembled for cleaning, their seals should be replaced at the same time. If the glass is a plain disc of glass (not fused to a metal frame) then the glass should be replaced as well. Fused-glass sight glasses are reusable.
- Clean glass using commercial glass cleaners. Never use wire brushes, metal scrapers or harsh abrasives.

- Do not clean glass while equipment is in operation. Cold water on a hot sight glass could cause the glass to fail from thermal shock.

Inspection

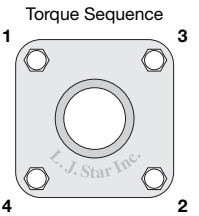
- Sight glasses should be regularly inspected for damage. To examine for scratches, shine a very bright concentrated light source at an angle of about 45°. Anything that glistens should be inspected closely.
- Scratches that catch the fingernail and any star or crescent-shaped marks that glisten are cause for replacement. Sight glasses that appear cloudy or roughened after cleaning should be replaced.
- Also inspect sight glass frames/flanges for corrosion buildup.

Installation

- Never use glass that is scratched, chipped or otherwise damaged. Glass seating surfaces must be flat within 0.005″ with a smooth finish. Flanges must be rigid. Do not allow the glass to contact metal when assembling. Gaskets must be new, clean and smooth. Use gaskets of the same diameter and fit them concentrically.

Bolting

- Never tighten bolts on a sight glass while equipment is in operation. Follow a regular tightening sequence to ensure even loading of glass. Allow a maximum difference of 1.5 ft/lbs between bolts during tightening. Tighten only enough to produce a positive seal against the process pressure.
- Bolts may need tightening after initial cycling of vessel. Never tighten bolts when the sight glass is hot.



L.J. Star is a leading expert in the application of sight flow indicators and sight glasses. The broad product line includes:

- Sight flow indicators
- Fused sight glass windows
- Gauge glass and sight glass
- Luminaires
- Sight glass cameras
- Sanitary fittings
- Sanitary bubble traps
- Magnetic level gauges

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