

# Guide for the selection, Installation and Maintenance of Pipe Line Strainers

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## **PREFACE**

Experience has proven the need for strainers in the protection of pumps, compressors, turbines, meters, automatic valves, sprinkler heads, burner nozzles, steam traps and other pipeline equipment.

This guide has been established as a technical reference for project engineers and managers responsible for specifying and using pipeline strainers. While strainers remain a relatively low cost item, when specified, properly, the protection they provide is invaluable. It is the intent of this guide to provide the background and information necessary to make knowledgeable and sound engineering decisions in the specification of pipeline strainers.

The Pipe Line Strainer Section of the Fluid Controls Institute Inc acknowledges and appreciates the assistance of those people who have made the creation and updating of this technical resource possible.

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## CHAPTER 1

### Definition

A pipe line strainer is a device which provides a means of mechanically removing solids from a flowing fluid by utilizing a perforated, mesh or wedge wire straining element. The most common range of strainer particle retention is 1 inch to 40 micron (.00156 inch).

### Purpose

Strainers are employed in pipe lines to protect downstream mechanical equipment such as condensers, heat exchangers, pumps, compressor, meters, spray nozzles, turbines, steam traps, etc. from the detrimental effect of sediment, rust, pipe scale or other extraneous debris.

### Types of Strainers

Two frequently specified strainer are the “Y” strainer and the basket strainer. While there is primarily one type of “Y” strainer (Fig. 1A), there are several variations of basket strainers. (Fig 1B through 1E).

Vertical piping, frequently found at pump inlets, necessitates the use of a “Y” strainer or a tee

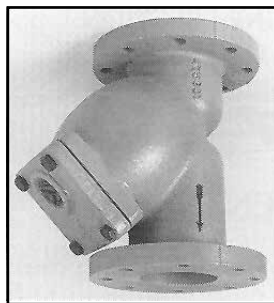


Fig. 1A

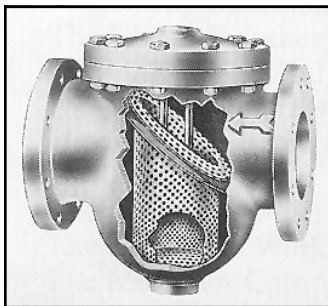


Fig. 1B

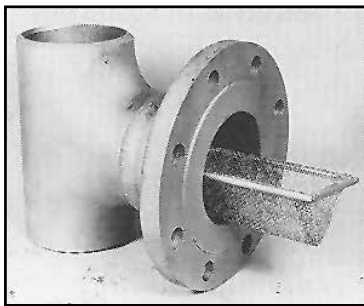


Fig. 1C

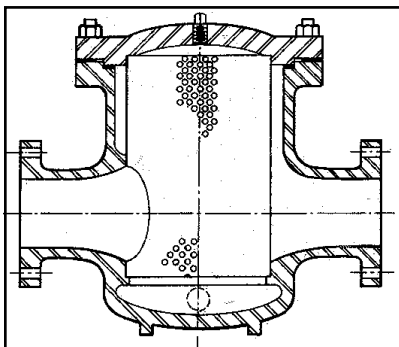


Fig. 1D

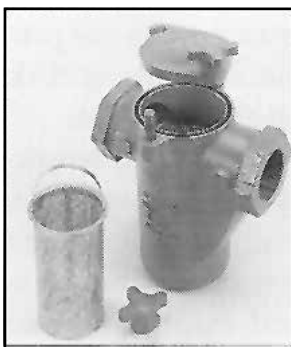


Fig. 1E

type basket strainer. Most basket strainers are intended for horizontal or slightly inclined piping. “Y” strainers and tee type basket strainers, on the other hand, can be used in horizontal as well as vertical (downward) piping. Special attention must be given, however, to maintaining the position of the debris collection chamber

and the drain (blowdown) connection in their lowest position. (Fig. 2). A “Y” strainer in vertical piping must be placed with its screen in the downward position to trap the sediment in the debris collection chamber.

Tee type strainers, suction diffusers and several variations of fabricated basket strainers can also be used in a right angle flow application. (Fig. 3).

“Y” strainers and most

variations of basket strainers can be self-cleaning. With the addition of a blowdown valve and some modification of the straining element of a basket strainer, the element can be flushed out by opening and closing the blowdown valve. This can be done without flow shut down or disassembling any piping.

In sizes above 4” , a single basket strainer will generally create less pressure drop than a “Y” type. Basket strainers are normally installed in a horizontal pipe with the cover over the basket at the top. Cleaning of the strainer generally simple and no draining is required. Cover flanges for basket strainers are relatively easy to remove and servicing is simplified. Replacement of covers on “Y” -type strainers is facilitated by some manufacturers through the use of studs, rather than bolts, which help to align the cover during the replacement operation. Hinged covers and screen licking devices can also make servicing easier.

There seems to be a general misconception among engineers and contractors concerning “Y” strainers and basket strainers used in steam service. In many instances, basket and “Y” strainers will perform comparably in steam service. It is essential in ordering strainers for steam service that the manufacturer be so advised. As mentioned above, the housings may be furnished without a bottom, allowing the accumulate debris to blown out by opening the blowdown valve. (Fig. 4).

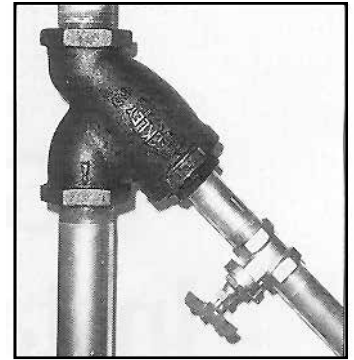


Fig. 2

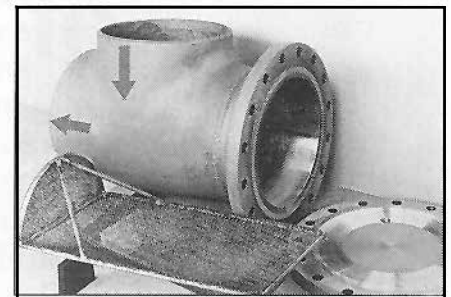


Fig. 3

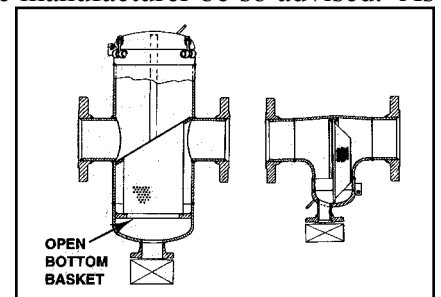


Fig. 4

While there are some high pressure applications for basket strainers, (Fig. 5), due to the required thickness and subsequent high cost, basket strainers are not normally constructed for pressures above 1,500 psi. "Y" strainers, on the other hand, are readily available for working pressures up to 6,000 psi and higher. In addition to "Y" and basket types, other strainers are available such as duplex/twin, geometric, washdown/backflushing, automatic self cleaning, plate or expanded cross section type, scraper, and magnetic screen types. Descriptions of these as well as miscellaneous options available with them, follow.

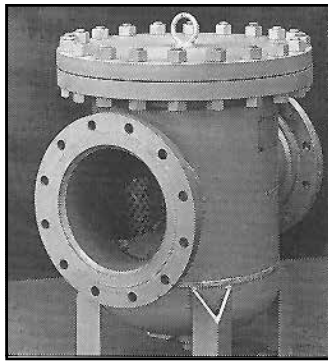


Fig. 5

### Duplex/Twin Strainers

For applications where continuous operation is required and the line cannot be disassembled for cleanout, duplex or twin basket strainers can be used. Refer also to Automatic Strainers, Page 5, for continuous service applications. Examples are fuel oil strainers for industrial or marine oil burners, lubricating lines on board ships, cooling towers, continuously running chemical operations, and many industrial water intake and service lines.

When one basket becomes full, the flow is switched to the other basket. The first basket is removed, cleaned and replaced. For smaller sizes the "plug" - type duplex basket strainer (Fig. 6) is generally used since it is less costly to make and simpler to operate and maintain than other types. It is basically a plug valve with two integral basket wells into which flow can be diverted by rotating the plug. In larger sizes the plug design becomes unwieldy, and an individual valving arrangement is used (Fig. 7). Here, flow is shifted from one basket to the other by integral sliding gate valves. These strainers are frequently furnished with an interlocking chain-drive mechanism so the two valves work in unison (one basket compartment opens while the other is being valved off). This prevents accidental

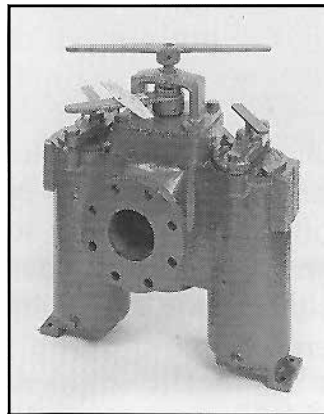


Fig. 6

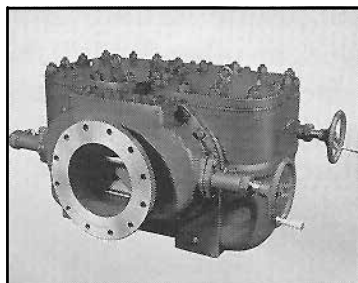


Fig. 7

shutoff of the line.

This type strainer can be furnished with individual globe valves instead of gate valves. Globe valves give more positive shutoff, but since these strainers are not normally used for high pressures they are generally not needed. The globe-valve-type duplex strainer is usually more expensive than the gate-valve type.

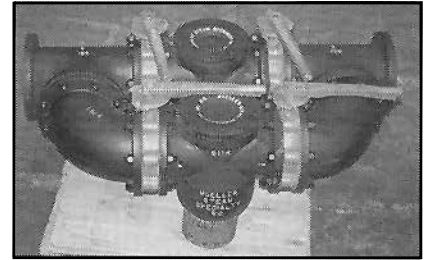


Fig. 8

Twin strainers, two single basket strainers connected in parallel with individual control valves are also available (Fig. 8). Where continuous operation is required, however, a duplex strainer is generally preferred. It occupies less space and is a "one-piece unit". However, because of the more circuitous path the liquid must take through a duplex strainer, pressure drop is higher than through the equivalent size single basket strainer.

### Geometric (Temporary) Strainers

(Fig. 9A through 9C)

Where cost is of prime importance, a geometric strainer may be installed between flanges in a pipe line. Variations of geometric strainers include cone (Fig. 9A), truncated cone (Fig. 9B) and flat geometries (Fig. 9C). The design considerations with these types of strainers are:

- 1) They have a lower net open area than basket strainers.
- 2) The pipe line must be disassembled to inspect, clean or remove these strainers.
- 3) Structural strength can be difficult to achieve, particularly in larger sizes, and in the case of wire mesh. While these strainers were once called temporary or startup strainers, more frequently than not, they are now left in the line during operation. As with all types of strainers,

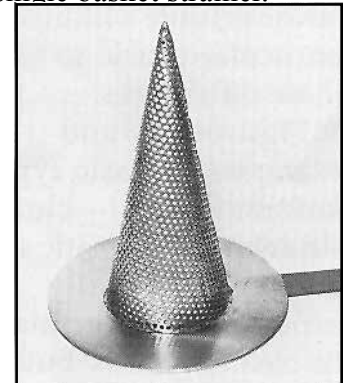


Fig. 9A

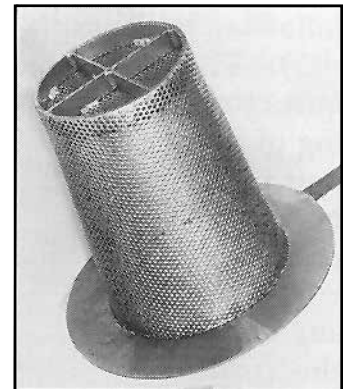


Fig. 9B

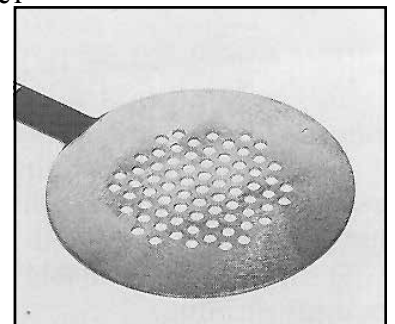


Fig. 9C

periodic maintenance must be carried out to ensure efficient operation.

***Washdown, Manual, Fixed or Rotary Spray, Back-Flushing Strainers (Figure 10)***

These strainers are fitted with side inlets or other devices for the introduction of high velocity liquid (the same as being strained - usually water). The turbulence created back-flushes the strainer basket and opening a drain valve evacuates the debris.

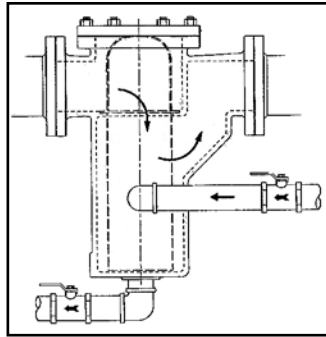


Fig. 10

***Automatic Self-Cleaning Strainers***

An automatic self-cleaning strainer is a unit which goes through a complete cleaning cycle, using some of the fluid flowing through the strainer to flush out the collected debris, with little or no attention by the plant personnel. There are numerous styles of automatic strainers produced and each has its desirable features; however, only a limited discussion is presented in this particular article to discuss these differences.

Figures 11 and 12 are examples of basic types of automatic self-cleaning strainers. Automatic strainers are normally more expensive than the manually cleaned units but their extra cost can often be justified for one or more of the following reasons:

1) The frequency of cleaning of a manual unit and the cost of labor for doing this.

2) If there is any danger that the strainer or the equipment that it is protecting may be damaged by the strainer not being cleaned when required.

3) The strainer is necessarily located in a place where it is not readily accessible for cleaning.

4) Plugging of the strainer is unpredictable due to a variable loading rate such that manual cleaning cannot be properly scheduled.

5) Insufficient available personnel to perform the

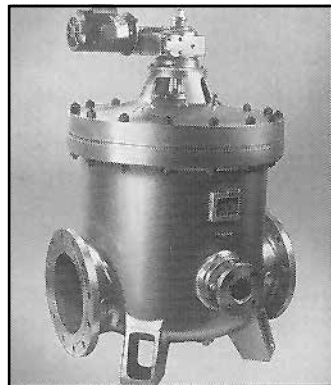


Fig. 11

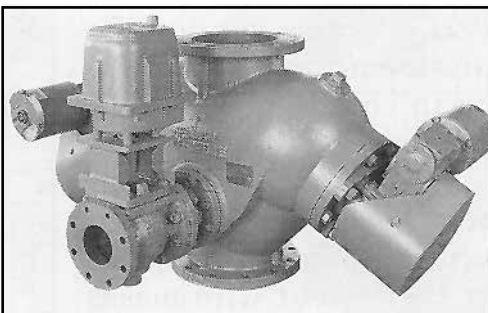


Fig. 12

manual cleaning.

There are many types of automatic and semi-automatic controls for the strainer and among these are:

1) Differential pressure switch which senses the pressure drop through the strainer and initiates a cleaning cycle at a preset pressure differential.

2) Timer which initiates cleaning cycle of strainer at preset intervals of time.

3) Pushbutton start for which an operator pushes a button to initiate a cleaning cycle (semi-automatic).

4) Differential pressure switch alarms which signal the operator that the strainer needs cleaning (semi-automatic).

5) Any combination of the above controls.

All of the above control systems are normally used with strainers that clean intermittently. Some automatic strainers also clean continuously so that a control to initiate the cleaning cycle is not required.

For intermittent cleaning strainers, the differential pressure switch control is normally preferred, because it will initiate a cleaning cycle when required regardless of strainer plugging rate. If a fairly constant strainer plugging rate occurs, the timer control can be utilized. Also, if the strainer may go through long periods of slow plugging during which it may not clean, a timer control may be desired to make certain the strainer operates periodically to keep it from binding. Normally, because of its automatic cleaning characteristic, an automatic strainer is cleaner for longer periods of time, than a manually cleaned strainer.

When used in process or inplant service water systems, it is not normally necessary to prescreen the liquids handled by self-cleaning strainers. It is essential, however, that any self-cleaning strainer be protected from logs, long sticks, and heavy concentrations of large fish when the strainer is installed in intake systems where water is being taken from a river, lake or other surface water source. When very fine process straining is desired, two self-cleaning strainers in series - one coarse and one fine - should be considered.

Automatic strainers are most commonly used on water service, the primary reason being the difficulty of disposing of the fluid which flushes the debris from the strainer. However, most automatic strainers can work on other fluids if the fluid can be disposed of satisfactorily. Many successful applications have been made with such fluids as black liquor, white water, starch, fuel oils (including Bunker C), lubricating oils, machine coolants, gasoline, ammonia flushing liquor, caustic solutions and cooking oils.

***Plate or Expanded Cross Section Strainers (Fig. 13)***

Where short face-to-face dimensions are essential, the plate strainer may be used (a flat geometric strainer is also an option). Only low net open areas are available with this type of strainer. In addition, operating pressure

drops are normally higher and maximum allowable pressure drops lower than with other types of strainers.

#### **Scraper Strainers (Fig. 14)**

For systems that require continuous operation, and or where large quantities of extraneous matter are contained in the fluid, scraper strainers are quite effective. This type of strainer has either a blade of brush-type rotor that can be hand-operated or motor-driven. The scraper strainer can be equipped to accomplish automatic blowdown of refuse rejected by to screen rotor combination.

#### **Magnetic Strainers (Fig. 15)**

An effective solution to the problem of excessive and premature wear of pump seals and wear rings has been the magnetic screen assembly. A standard strainer is fitted with magnets which are removable for cleaning. These magnets are so spaced and arranged as to create a magnetic field around the interior or the screen and attract find ferrous particle which could damage downstream equipment.

Engineers have specified this type of strainer in pilot jobs and, after evaluation, have standardized this specification for all pump strainers, magnets can be incorporated in almost any of the "Y", basket or geometric type strainers.

#### **Special Application Strainers**

##### **A. High Differential Strainers**

There is an increasing demand for strainers with screens which can withstand full line pressure when clogged. While the types of strainers already discussed can be structurally enhanced to

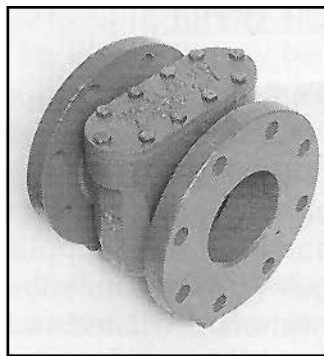


Fig. 13

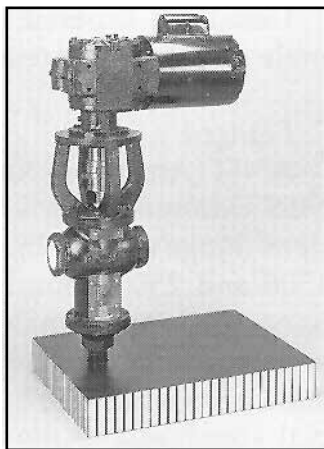


Fig. 14

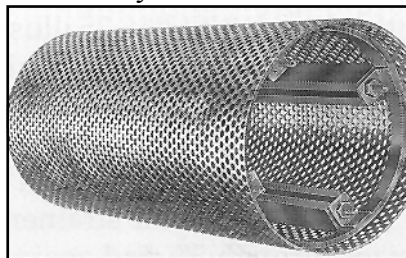


Fig. 15

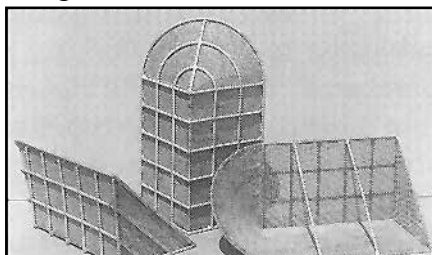


Fig. 16A

withstand fairly high pressure when clogged. While the types of strainers already discussed can structurally enhanced to withstand fairly high pressures cases where extremely high differentials exist may call for special design. These screens are frequently constructed of very heavy wire mesh or heavy plate with each hole drilled. Seams are butt welded to ensure complete structural integrity. A few manufactures can supply these strainers over a wide range of pressure requirements.

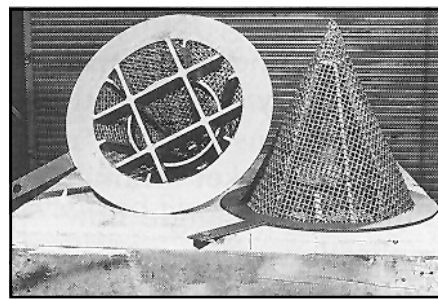


Fig. 16B

##### **B. Micronic Strainers**

Strainers are available with extremely fine wire mesh which will remove particles as fine as 5 microns. These strainers, though expensive, are more economical than the disposable cartridge-type filters in that the straining elements can be cleaned and reused. Corrosion resistance is also better in most cases. Baskets must be supplied with a gasket, "O" ring, or close tolerance metal-to-metal seal to eliminate bypassing. Oil separation can be accomplished with cotton or fiber-filled screens. Water can be separated from gasoline using a fine mesh. Bronze or stainless steel wool-packed straining elements also serve certain filter requirements.

##### **C. High Capacity (Volume) Basket Strainers**

These strainers are designed for viscous fluids, gasoline and fuel oil service where fine straining has to be combined with a large basket which will not clog after extended periods. A gasketed seat or close tolerance metal-to-metal fit for the baskets insures that no bypassing of fine particles will occur.

##### **Miscellaneous Strainer Options**

Strainers can be incorporated into a piping system in a variety of ways. Mechanical equipment can incorporate a strainer in the body. This can be economical and can reduce pipe connections and labor (Fig. 17).

In some cases a strainer is required at the inlet of a pump or meter

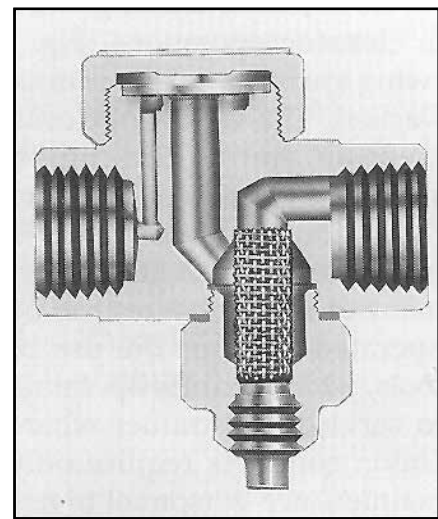


Fig. 17

which is extremely close to the ground. An offset strainer (Fig. 18) with a high inlet and low outlet will satisfy this need. Other designs may use a tee type basket strainer (Fig. 3) in an angle flow application.

Quite frequently line sizes are reduced following a strainer prior to temperature control valves or heating and cooling coils (Fig. 19). A reducing strainer can eliminate joints, reduce pressure loss, and still provide the same offset produced by the reducer. Of course, the reducer is also eliminated.

Special processes may warrant special strainer housings. Steel or stainless steel strainers may be fitted with a fabricated or cast outer jacket with connections for the introduction of steam or other heating or cooling medium (Fig. 20). These find their application mainly in process piping where the liquid handled must be maintained at other than ambient temperatures.

In addition to special process needs, there may be special maintenance needs. Simplifying the handling of strainers during cleanings or inspections reduces maintenance costs. Strainers are available with many types of quick-opening covers to reduce the length of time and labor involved in cleaning operations (Fig. 21). Among these are swing eye bolts, yoke covers, pinwheel covers and "C" washers. The variety of closures are too numerous to mention, but consideration should be given to them where reduction of down time is important. Additionally, many of these closures can be operated without the use of tools, which enables operators to service the strainer where Union contracts require only maintenance personnel to use tools.

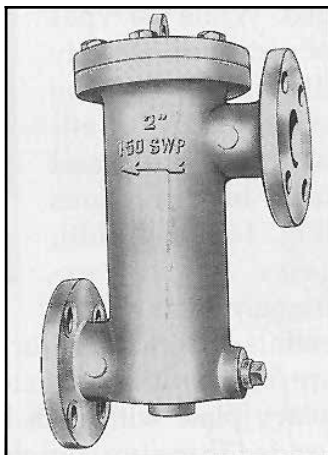


Fig. 18

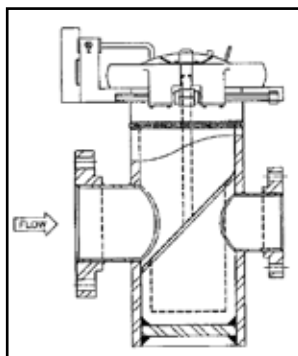


Fig. 19

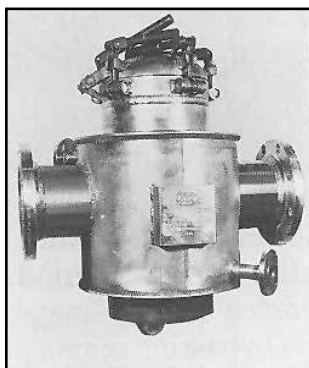


Fig. 20

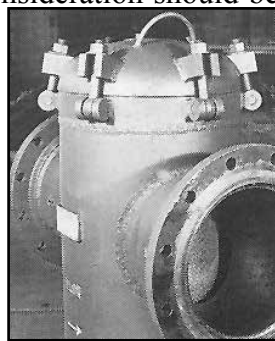


Fig. 21

## **CHAPTER 2**

### ***End Connections***

Strainers are available in a variety of end connections. Iron strainers are most commonly furnished in either threaded or flanged ends. Steel, stainless steel and bronze are supplied in any of the types discussed below. The four most common groups of end connections are listed and described below.

### ***Threaded***

Usually a tapered female pipe thread, although male connections are also available.

### ***Flanged***

ANSI (American National Standards Institute) and MSS (Manufacturer's Standardization Society) standard flange ratings 25, 125, 150, 250, 300, 400, 600, 900, 1500 and 2500 pounds can be supplied. Ring-type joints (male and female), and tongue and groove joints are also available. The U.S. Navy also has some flange standards which are quite different from the commercial standards. Among these are B-175, B-177, and MIL-F-20042C.

### ***Weld Ends***

Butt weld end strainers are generally available in all sizes, and although many forms of end preparation can be used, the standard 37-1/2° beveled end is most common. ANSI B16.25 illustrates the various types of weld joint preparations available.

It is very important that the purchaser specify the bore of pipe being used so that the manufacturer can provide a matching bore in the strainer.

Socket weld end strainers are usually available in sizes through 3", and again, it is important to specify the bore of the pipe used. In ordering weld end strainers of any type, consider whether you desire a welded blowdown connection.

### ***Special Ends***

Grooved ends are available on many strainers, and a detail of this end should be supplied to the manufacturer. Other special ends such as "O" ring and union ends are also available on special order, and complete details should be furnished.

Most "Y"-type and certain other types of small strainers are designed according to the fitting standards for full pressure ratings and therefore can be subjected to higher working pressures at lower temperatures. It should be clearly understood, however, that most of the larger types and many of the smaller strainers are designed for the working pressure requested and should not be operated above that pressure without consulting the manufacturer. It is important to note that the flange rating is not necessarily the same as the pressure rating of the vessel. A fabricated carbon steel strainer, for example, may be operated at 40 psig at 500°F, designed



for 100 psig at 650°F, and have 150-lb ANSE flanges. The maximum safe pressure at any temperature (650°F and below) for this vessel is 100 psig, even though the flange can be taken to 170 psig at 500°F.

It is important, at the time of initial design, to specify working pressure, working temperature, design pressure, design temperature, required flange rating and any operating conditions affecting vessel loading.

## **CHAPTER 3**

### ***Materials of Construction***

Strainer components can include a body, flanges, cover, perforated plate mesh, wedge wire, gasket and cover fasteners. Listed below are some materials of construction for these components.

#### ***A- Housing/Body***

<b>Description</b>	<b>ASTM Specification</b>
Iron Castings	A 126, A 278
Ductile Iron Castings	A 395, A 536
Iron-Austenitic Castings	A 436
Carbon Steel Castings	A 216
Carbon Steel Castings	A 27
Carbon Steel Pipe	A 53, A 106
Carbon Steel Plate	A 20, A 285, A 515, A 516
Carbon Steel Forgings	A 105
Carbon Moly Castings	A 217, A 352
Chrome Moly Forgings	A 182
Stainless Steel Castings	A 743, A 744, A 351
Chrome Moly Plate	A 387
Chrome Moly Pipe	A 335
Stainless Steel Pipe	A 312
Stainless Steel Plate	A 240
Stainless Steel Forgings	A 182
Aluminum Castings	B 26
Bronze Castings	B 61, B 62
Monel	B 164, B 127
Nickel 200 Plate	B 160, B 162
Hastelloy B Castings	A 494
Hastelloy B Plate	B 333
Hastelloy C Plate	B 575
Hastelloy C Pipe	B 619
Titanium Pipe	B 337
Titanium Castings	B 367

#### **B - Per. Plate/Mesh/Wedge Wire**

Carbon Steel	S.S. (Various Grades Available)
Monel	Hastelloy B
Hastelloy C	Alloy 20
Nickel	Brass
Copper	Galvanized Steel
Incoloy	Inconel
Titanium	Aluminum

#### **C - Gaskets**

Red Rubber	Compressed Nonasbestos
Teflon	Buna-N, O Ring
Neoprene	S.S. - Jacketed
Graphite	S.S. - Spiral Wound
D - Fasteners	
Carbon Steel	Alloy Steel
Silicon Bronze	304 S.S.
316 S.S.	Monel

## **CHAPTER 4**

### **Corrosion Resistance - Selection of Materials**

Almost every strainer operating in a pipe line is subject to some degree of corrosion or erosion. It is therefore very important that corrosion/erosion resistance is considered when selecting materials and or coatings. The selection of the material or coating used is also usually based on economic considerations and should be made by the customer and/or consulting engineer after some discussion with the strainer manufacturer.

It is important that the type of fluid, the pressure and temperature conditions, type of adjacent piping, desired service life, and the customer's prior experience with similar fluid conditions be known. Corrosion resistance charts offer some assistance in the selection of materials or coating. (See Corrosion Data Survey -Metals Solution, 6th Edition, NACE).

Electrolytic corrosion is also a consideration in some services and the manufacturer should be advised. Sometimes the inclusion of magnesium or zinc-consumable bars in the body will retard this action.

Most types of strainers can be lined with various coatings to retard corrosion, and some of these are listed below:

Epoxy	Asphalt
Teflon	Vinyl
Kel-F	Rubber
Neoprene	Baked Phenolic
Penton (Plating: Zinc, Cadmium, Nickel, Galvanizing, etc.)	

## **CHAPTER 5**

### ***Perforations and Mesh Sizing***

An extremely important consideration in the selection of a strainer is the size of the perforations, mesh or wedge wire opening used in the making of the straining element. A tendency exists to select smaller holes than those actually needed, leading to too-frequent cleaning, excessive pressure drops, and screens constructed of thinner metal which will withstand less pressure

differential.

Generally, stainless steel perforated metal can only be obtained in a thickness which is one gage thickness less than the diameter of the punched holes. Carbon steel and brass can be obtained in approximately the same thickness as the hole diameter. These limitations are important considerations. For example, a strainer made with stainless steel plate perforated with 1/64" diameter holes in a 16" line would be impractical, as the plate would be about 17" in diameter and only .014" thick, and would have a very low maximum allowable differential pressure.

The most common way to accomplish fine straining in large strainers is by mesh lining a larger hole, heavier gage perforated plate.

The following table illustrates available perforations, mesh and wedge wire and their respective straining capability. The main criteria for choosing hole and mesh size is the size and quantity of particles which can pass through downstream equipment without causing damage.

#### PERFORATED METAL\*\*

Hole Diameter x Hole Spacing	Percent Open Area
.020" x .043	20
.027 x .066	17
*.033 x .077	20
*.045 x .086	28
*.057 x .121	25
*.062 x .3/32	41
*.094 x 5/32	33
.100 x 5/32	37
1/8 x 3/16	40
*5/32 x 3/16	63
3/16 x 1/4	51
*1/4 x 3/8	40
5/16 x 7/16	47
3/8 x 1/2	51
7/16 x 19/32	49
1/2 x 11/16	48
5/8 x 13/16	54
3/4 x 1	51
1 x 1 x 3/8	48

#### MESH

Mesh (Openings/In.)	Wire Diameter In.	Opening Inches	Micron	Percent Open Area
2	.063	.437	11100	76.4
2	.092	.407	10360	66.6
3	.063	.270	6860	65.6
4	.047	.208	5160	65.9
4	.063	.187	4750	56.0
5	.041	.159	4040	63.2
6	.035	.132	3350	62.7
7	.035	.108	2740	57.2
8	.028	.097	2460	60.2

10	.025	.075	2460	56.3
11	.018	.073	1850	64.5
12	.023	.060	1520	51.8
14	.020	.051	1300	51.0
16	.018	.044	1130	50.7
18	.017	.038	980	48.3
20	.016	.034	872	46.2
30	.013	.020	513	37.1
40	.010	.015	384	36.0
50	.009	.011	282	30.3
60	.007	.009	231	33.9
80	.005	.0075	180	36.0
24x115		.0056		
100	.0045	.0055	141	30.03
120	.0037	.0046	118	30.1
30x160		.0046	118	
150	.0026	.0041	105	37.4
40x200		.0033	85	
170	.0024	.0035	79	35.1
30x260		.0029	75	
200	.0021	.0029	74	33.6
250	.0016	.0024	62	36.0
50x250		.0024	62	
28x480		.0023	59	
300	.0015	.0018	46	29.7
325	.0014	.0017	44	30.0
400	.0010	.0015	39	36.0
80x700		.0012	40	
125x600			30	
165x800			28	
165x1400			17	
200x1400			10	
250x1400			83	
25x2300			53	
75x2400			4	
400x2800			3	

#### WEDGE WIRE

Opening	Micron	% Open
.003"	75	7.7
.005"	127	14.3
.010"	254	25
.015"	381	25
.020"	500	25
.031"	775	34
.034"	864	20
.062"	1550	51
.063"	1600	50
.094"	2350	44
.125"	3175	66
.156	3962	71



## **CHAPTER 6**

### ***Capacity***

The capacity ratio, or open area ratio (OAR) of a strainer influences such operating characteristics as the length of time it can operate without cleaning and the created pressure loss. The ratio/OAR is the relationship between internal cross sectional area (flow area) of the pipe and the open flow area of the material which makes up the straining element.

A 100% OAR, or 1-to-1 ratio would give an unrestricted flow area equal to that of the pipe while the element was clean. As clogging occurs, however, flow would provide full flow, after the element became 50% clogged. A 250% OAR is a good standard for general heating and air conditioning service. However, larger OAR's or ratios would be appropriate for flow in which much debris is expected to be strained or where very viscous fluids are being handled.

When considering the OAR of a straining element, there are two accepted methods of analysis used by various specifying agencies and manufacturers. One method maintains a 'line of sight' reasoning and uses the multiple of the open areas for elements in series. In this method, a 60% open area material in series with a 40% open area material has a resultant combined open area of 24% (i.e. as in accordance with military standards). An alternative method allows the open area of the more restrictive element in series to be used. This would be 40% for the example above (i.e. as in accordance with Underwriter Laboratory Standards). The method used influences the estimated operating pressure drop, as well as design decisions such as sizing.

As an example, fuel oils are generally strained to a fine degree to protect small orifices in burner nozzles. This requires a fine woven mesh be used in series with a reinforcing perforated plate. Due to the fact that the perforated plate may have a 50% open area and the mesh 30%, the resultant combine open area may be considered to be only 15% if there is no flow path other than line of sight through the two element in series. This, of course, would mean that to have a OAR of 250%, a high capacity, large bodied strainer is required.

This same strainer using only the perforated plate would have a OAR more than three times as great. So, it may be seen that in any given strainer, the OAR may be varied by using various perforations or meshes having different open areas. Thus, it is essential to specify not only the OAR desired, but the straining element opening size and the method for calculating OAR.

## **CHAPTER 7**

### ***Pressure Loss***

Because strainers are made with various dimensions

and configurations, most reputable manufacturers have tested and published pressure drop results.

Most pump installations designed for reasonable velocities will permit approximately a 2-psi drop across the strainer. When a screen becomes clogged, the pressure drop varies with the clogging pattern experienced and the type of strainer being used. While some manufacturers speculate as to the change in head loss at different percentages of clogging, it should be recognized that this type of testing is very difficult to relate to actual line performance. This is because of differences in strainer clogging characteristics - a 1/4" perforated basket two-thirds full of 1/2" stones will be less affected than a small amount of fine leaves on large 100-mesh basket. If large amounts of solids are expected, use a strainer with a high net open area as discussed in Chapter 6.

As a strainer becomes clogged to the point where the OAR of the strainer approaches the pipe area, the pressure drop across the strainer increases very rapidly and unpredictably. It is at this point, therefore, that it is recommended the strainer be cleaned. Otherwise, a large differential pressure will develop. The maximum differential pressure a strainer can withstand varies widely with strainer type, line size and material used. Always consult the manufacturer for maximum differential pressure a straining element can withstand.

From the foregoing discussion, it is obvious that periodic cleaning is essential in any strainer installation. Once the rate of clogging is established, a cleaning schedule can be set up. Pressure gauges on each side of the strainer can be valuable to determine when the strainer requires cleaning. Differential pressure switches can be set up to operate warning lights or alarms if so desired.

Some manufacturers have related their strainers' pressure drop to equivalent feet of pipe at various turbulent flow rates, and this can simplify the computation of head loss for an entire system. However, varying field conditions and fluid properties can affect the accuracy of general type pressure drop estimations. Further, operating viscous fluids under laminar flow conditions requires analysis different from that for fluids under turbulent conditions. Accordingly, the manufacturer should always be consulted for the most specific and accurate estimated pressure loss.

## **CHAPTER 8**

### ***Specifications and Manufacturer Testing***

Needless to say, the more information provided to the manufacturer when ordering strainers, the better the chance of obtaining a strainer which is appropriately

suited for a particular job. It is for this reason that considerable space is devoted to the preparation of specifications.

### ***Specification***

To allow the manufacturer to make selections or recommendations for a particular strainer, as much as possible of the following information should be provided:

#### **A- Physical Characteristics**

- 1- Pipe size and schedule.
- 2- Strainer type required.
- 3- End connections.
- 4- Material (body, screen, studs, gaskets).
- 5- Pressure rating (design/operating-including shock)
- 6- Temperature rating ( design, operating, minimum)
- 7- Straining element opening size.
- 8- Capacity:
  - (a) Net effective open area required.
  - (b) Method of net open area calculation.
- 9- Special requirements (hinged cover, vent tapping, jacketed, etc.)
- 10- Applicable specifications (military specifications, special nondestructive tests or other QC Requirements).
- 11- For automatic self-cleaning strainers, specify the following:
  - a) Voltage and frequency of power supply;
  - b) Air supply pressure if available;
  - c) Type of controls desired;
  - d) Type of motor, switch and control panel enclosure required.

#### **B - Flow data.**

##### **1 - Liquid**

- (a) Description of fluid
- (b) Rate of flow - gallons per minute (g.p.m.) or pounds per hour (lbs/hr).
- (c) Viscosity - SSU.
- (d) Specific gravity/density.
- (e) Temperature.
- (f) Concentration (if acid or other corrosive).

##### **2 - Gas**

- (a) Description of Gas
- (b) Rate of flow - standard cubic feet per minute (scfm).  
-actual cubic feet per minute (cfm).
- (c) Specific gravity.
- (d) Temperature and pressure.

- (e) Molecular weight.

#### **3 -Steam**

- (1) Flow-pounds per hour.
- (2) Temperatures.
- (3) Pressure
- (4) Density.
- (5) State of flow.

#### **C - Solids to be removed:**

Specify the nature and relative size of the sediment. Parts per million (ppm) or percent by volume or cubic inches per hour or percent by weight can also be specified.

NOTE: If strainer is to be steam jacketed, the following information for the heat transfer fluid or steam must be given:

- (a) Type of fluid.
- (b) Rate of flow.
- (c) Temperature
- (d) Pressure
- (e) Type and size connections desired.
- (f) Material for jacket construction
- (g) Whether strainer end flanges are oversized to match jacketed pipe.

#### **D- Allowable pressure drop (psi)**

- 1 - Clean.
- 2 - 50% clogged

NOTE: Operating pressure drop is a function of operating conditions, fluid characteristics and strainer geometry. Consequently, if specifying a strainer type and geometry, a desired pressure drop may not be obtainable if fluid parameters are fixed. The "trade-off" relationship between fluid conditions, strainer geometry and operating pressure drop establishes what compromises must be made.

#### ***Available Types of Manufacturer Testing***

##### ***A- Hydrostatic:***

Most common test - usually 1-1/2 times working pressure to determine that strainer body, cover gaskets etc., are sound.

##### ***B- Radiographic examination:***

To determine if the casting or welded joint has any slag or sand inclusions, gas pockets or subsurface defects. This type of test is quite expensive and usually specified only for high pressure strainers.

### ***C- Magnetic Particle:***

A reasonably low cost examination to reveal relatively shallow subsurface cracks, gas pockets, etc. Iron dust is sprinkled on the surface of the casting/weld and a magnetic force is induced electrically, causing the dust to align over defects and cracks showing their location and size. Can be used only on iron and steel.

### ***D- Dye penetrant:***

Equivalent to magnetic particle testing, except used mainly with nonmagnetic casting/welds to reveal surface defects, cracks, depressions, etc.

### ***E- Air test:***

Either under water or with part covered with soap solution. This is a more stringent test for porosity and gasket leakage than hydrostatic, and leaks often are more obvious. Sometimes not done, due to relative danger involved.

### ***F- Hydrostatic burst test:***

Sometimes done to establish manufacturer's maximum working pressure rating, or at the request of purchaser.

### ***G- Shock:***

Usually a government requirement where strainers will remain operative or intact in the event of a near proximity explosion. Test normally conducted on a machine where weighted hammer strikes plate on which strainer is mounted.

### ***H- Vibration:***

Normally a government requirement where strainers must withstand a vibration test which involves a number of frequencies. This usually simulates shipboard vibrations, earthquake, etc..

### ***I- Surge test:***

A strainer is pressurized with water and a quick opening valve on the outlet flange is rapidly opened to determine that no damage is sustained by the basket. Normally, a military requirement.

### ***J- Helium leak test:***

A very stringent test where the strainer is pressurized with helium and leaks are checked with sensitive instruments. A maximum leak rate is usually specified. Used mostly for nuclear plants for radioactive water piping .

### ***K- Ferroxy:***

A test to detect free iron in stainless steel strainers where the iron would contaminate the product .

NOTE: Many tests by their very nature can more or less stringent. Acceptance standards should be included in any inquiry calling for such tests. Naturally, the more

stringent the test requirements, the more costly the ultimate strainer becomes.

## **CHAPTER 9**

### ***Shock-hydraulic and Thermal***

Any liquid being transmitted in a pipe line possesses a certain amount of energy (weight times velocity). A rapid change in velocity results in a momentary shock wave. In the case of a quick-closing valve, the energy of the flowing fluid must be used up in some way, and the resulting shock, or "water hammer", is clearly audible. A pressure wave, in some cases, travels at over 3,000 feet per second and traverses the pipeline in one direction, then the other, until it dissipates. A theoretical figure of 54 psi for each foot per second that is stopped by the valve may be used. A 12 foot per second velocity could produce a shock wave having a peak of 648 psi; therefore, consideration should be given to the shock and non-shock rating of the strainer.

No attempt will be made here to go into the highly technical field of hydraulic shock, and it is covered briefly to point out that even if your system can produce only a specific head, if the possibility of shock is present, tremendous overpressures may result.

Commonly known is the phenomenon of pouring hot tea into a glass and watching the glass crack. This is an example of thermal shock. Rapid changes of temperature in piping systems can have the same effect, and in selecting strainers consideration must be given to this possibility.

In improperly trapped steam lines, condensate can collect in low points and subsequently become a slug of water traveling at high velocity down the line. Almost all strainers cause a change in direction of flow due to their configuration, and the result can be obvious if the strainer cannot absorb this type of shock. In considering this situation, it is important to remember that steam velocities of 4,000 to 20,000 feet per minute are quite common.

## **CHAPTER 10**

### ***Conclusion***

Strainers are no longer confined to a simple cast body with a wire mesh screen, but are a technical, highly refined, carefully designed piece of equipment.

Sometimes they operate at 1,500 degrees F and 10,000 psig or at cryogenic temperatures. They are modified with steam jackets, cover lifting davits, magnets, motorized cleaning devices and automatic vent valves. They are supplied with screwed, flanged, socket weld, butt weld, ring joint and silver brazing end connections.

Accordingly, the implementation of a strainer needs to be well thought out and engineered. While it is good practice to use a strainer to protect down-stream equipment, it is very important to carefully consider the options available. Choosing the correct strainer can save money not only by protecting equipment, but also by keeping operations and maintenance costs at a minimum.

This guide for the selection, installation and maintenance of pipeline strainers has been created within the cooperation of the Fluid Controls Institute, Inc., Pipeline Strainer Section, and represents the collective knowledge and experience of its members.

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The logo for Metraflex, featuring the word "Metraflex" in a stylized, red, sans-serif font. The letter "M" is large and bold, with the "e" and "t" connected. The "r" is also connected to the "a", and the "f" is connected to the "l". The "e" and "x" are separate. A registered trademark symbol (®) is located to the upper right of the "x".

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