Pressure Drop Chart

System fluid passing through a Spirovent or Spirotrap will create a certain pressure drop, depending on the size of the nozzles, diameter of the shell, and the volume (flow) and speed (velocity) of the fluid. Figures D-1 and D-2 (pages 3 and 4) show the pressure drops and water velocities for all product sizes up to and including 36” units. To determine pressure drop of a given unit, you must first determine the water velocity at the inlet nozzle (the flow of water in feet per second entering the unit). For example, with an entering water velocity of 4 feet per second, the pressure drop of a 2-1/2“ standard unit in a system designed for 45 GPM would be less than one foot of pump head.

Even after years of operation, the initial pressure drop remains constant with a Spirovent or Spirotrap. Other products with strainers or screens have to be inspected and cleaned regularly to prevent the strainer mesh from getting clogged with dirt and debris.

Pressure drop is an important factor when considering the energy loss and investment costs involved. To establish and maintain water circulation in closed loop systems, mechanical energy is usually supplied by a circulator’s electric motor to overcome the pressure losses of all of the system components and piping. Boilers, chillers, valves, controls, air eliminators and dirt separators all contribute to the overall pressure loss to operate at their listed efficiencies.

The amount of energy required to pump 1 GPM to a one (1) foot higher level is easily calculated with the help of basic energy laws. Theoretically speaking, the required energy per second is as follows:

$$0.1884 \times 1 \text{ GPM} \times 1 \text{ ft.} = 0.1884 \text{ Watt}$$

Practically, we need to adjust for circulator and electrical motor deficiencies. The efficiencies of circulators varies between 0.3 and 0.8; electrical motors between 0.7 and 0.95. For commercial installations, efficiencies of 0.7 to 0.9 are realistic. After taking these variations into account, the energy required to pump 1 GPM to a one-foot higher level would be:

$$0.1884 / 0.7 / 0.9 = 0.2990 \text{ Watt}$$

(0.000299 kWatt per GPM of foot loss)

For example, in a chilled water installation that circulates 2500 GPM, an installed centrifugal air separator selected incorrectly at line size causes approximately ten (10) feet of pump head loss. The annual electricity demand would be:

$$0.000299 \text{ kWatt} \times 2500 \text{ GPM} \times 10 \text{ ft} \times 365 \text{ days} \times 24 \text{ hrs} = 65481 \text{ kWh}$$

The cost for the year could then be calculated by multiplying the total kWh by the local costs per kWh.

An 18” Spirovent in the same installation would cause a loss of only 2.2 feet of pump head, with an accompanying electrical demand of 14406 kWh – 4-1/2 times lower than the centrifugal separator, as shown below:

0.000299 kWatt x 2500 GPM x 2.2ft x 365 x 24 hrs = 14405.82 kWh

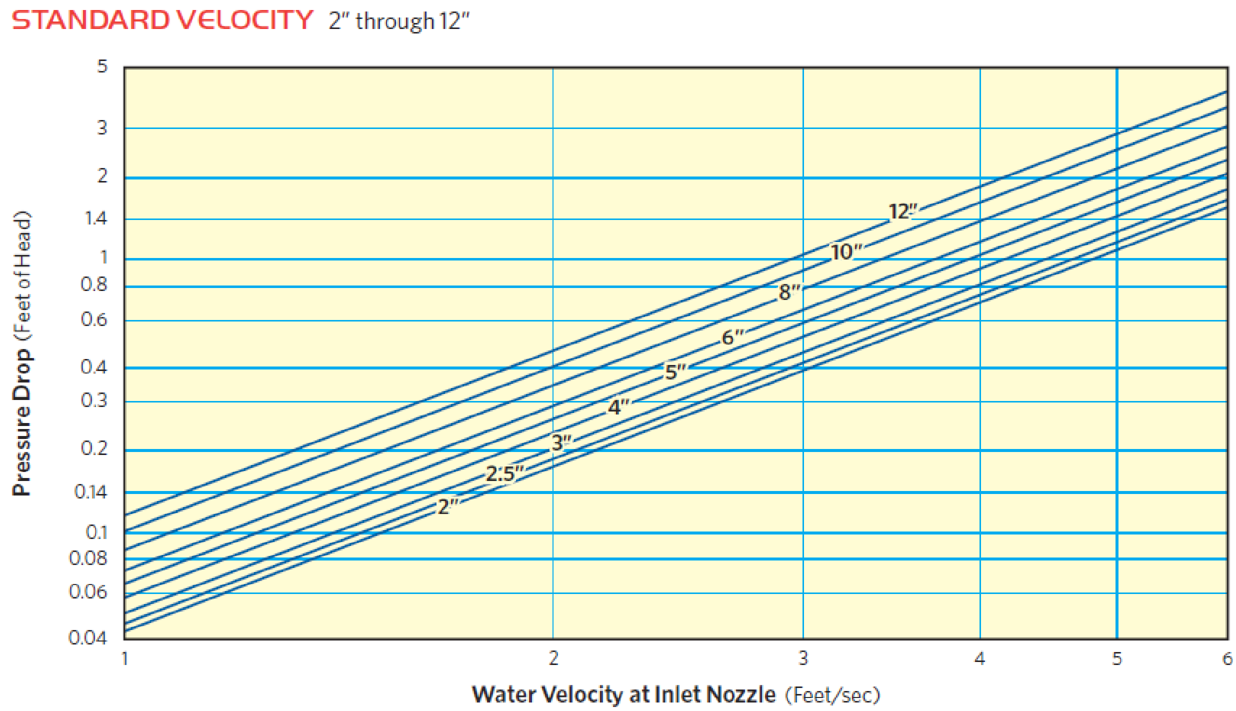
A good industry practice is to allow for a maximum entering water velocity of up to six (6) feet per second to the standard velocity model separator.

Without significant pressure loss, the Spirovent air eliminator eliminates all forms of air, including microbubbles and stationary air pockets. The Spirovent Dirt and Drain models will eliminate air and separate dirt simultaneously with the same low pressure drop.

Using the HV Series with an entering velocity of up to ten (10) feet per second, Spirovent and Spirotrap efficiencies are maintained while providing a smaller connection. In the above example, a 12” HV could be used for an annual kWh usage of 39,289 based upon 6 feet of pump head. This is still 40% less than the incorrect line-size centrifugal.

The following pages list the Pressure Drop charts and the Recommended Selection Data for both the standard Spirovent and Spirotrap series and the HV series.

Figure D-1


STANDARD VELOCITY 2″ through 12″
Pressure Drop (Feet of Head)
5
3
2
1.4
1
0.8
0.6
0.4
0.3
0.2
0.14
0.1
0.08
0.06
0.04
12″
10″
8″
6″
5″
4″
3″
2.5″
2″
1
2
3
4
5
6
Water Velocity at Inlet Nozzle (Feet/sec)

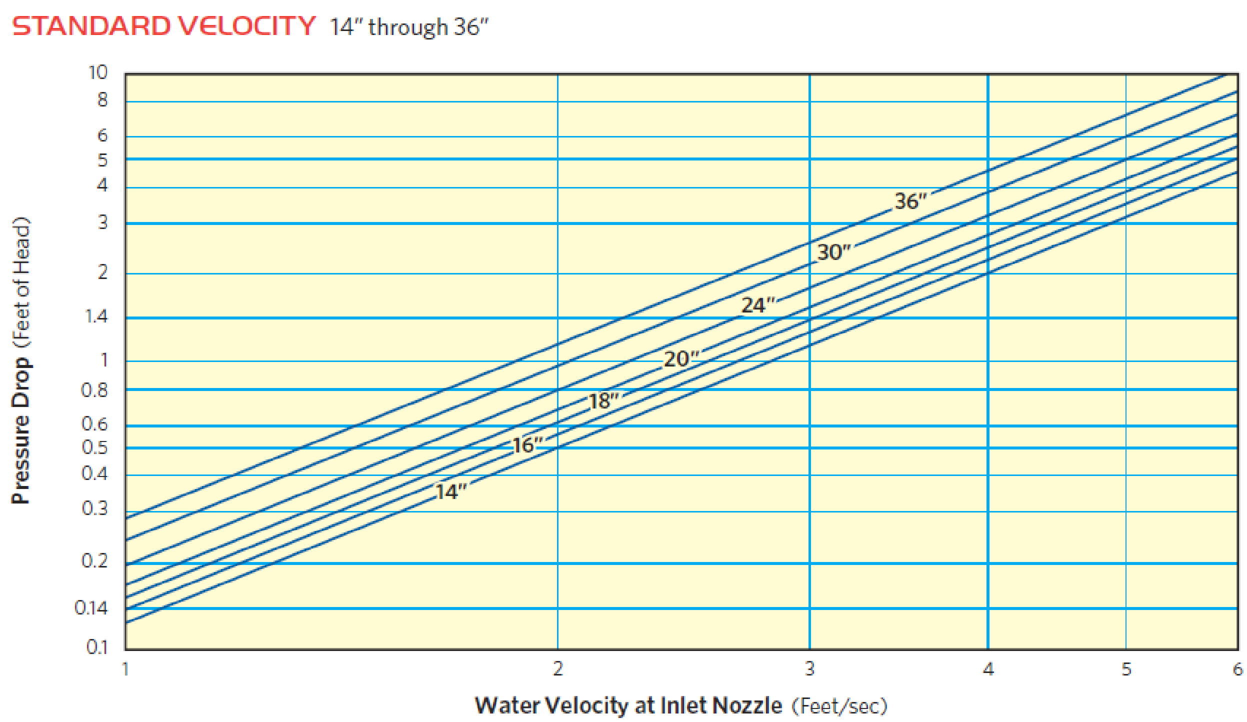
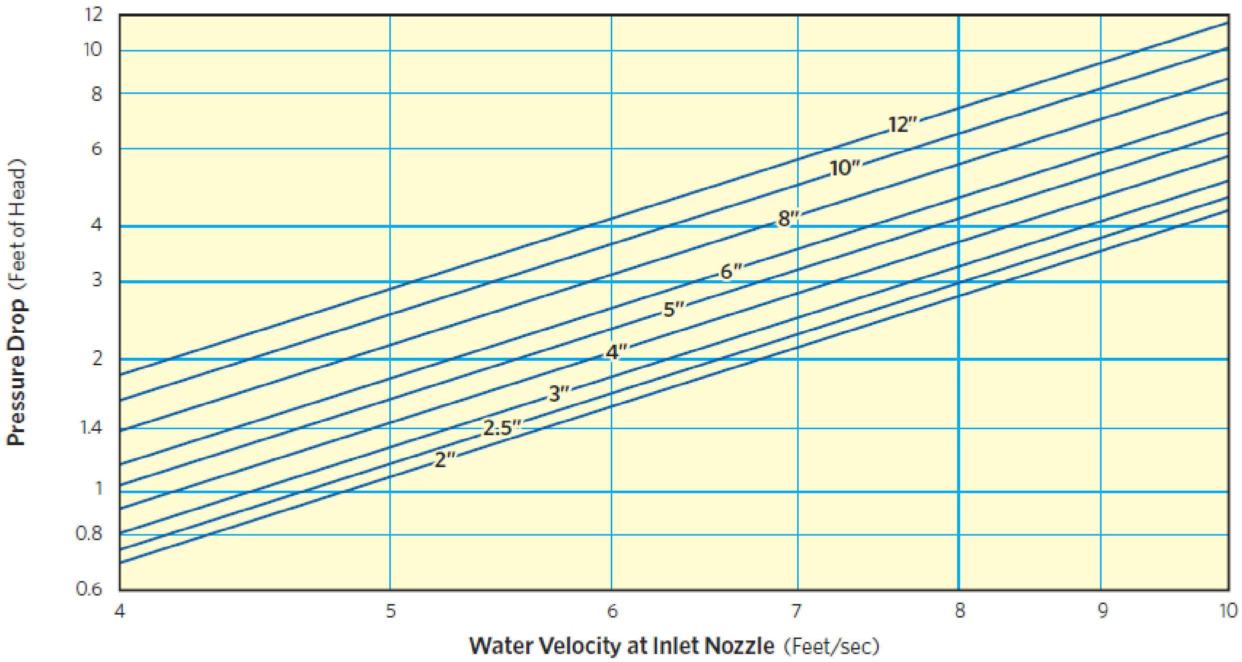
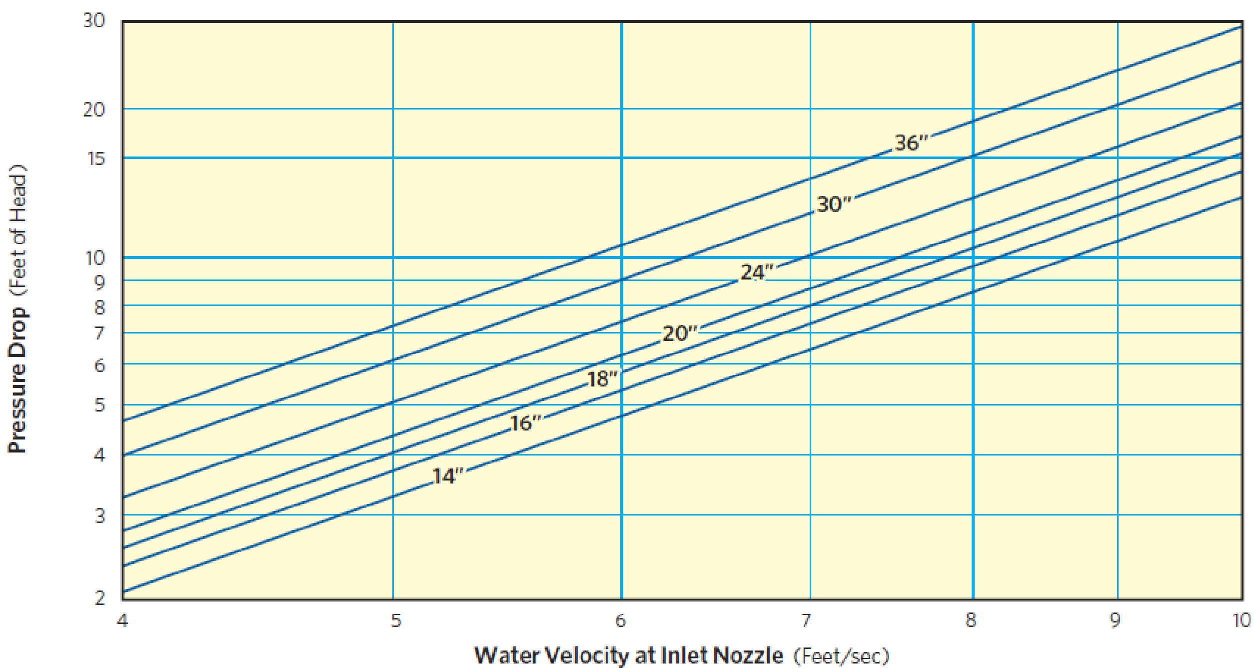

STANDARD VELOCITY 14″ through 36″
Pressure Drop (Feet of Head)
10
8
6
5
4
3
2
1.4
1
0.8
0.6
0.5
0.4
0.3
0.2
0.14
0.1
36″
30″
24″
20″
18″
16″
14″
1
2
3
4
5
6
Water Velocity at Inlet Nozzle (Feet/sec)

Figure D-2

HIGH VELOCITY 2″ through 12″



HIGH VELOCITY 14″ through 36″



Recommended Selection Data

Spirovent/Spirotrap Series (VJR, VSR, VDT, VDN, TDT, TDN)

- Pipe size is not a factor in the proper selection of an air eliminator or dirt separator.
- Units are selected based on system flow.
- Actual pipe size used remains at the designer's discretion.
  - No change to piping design selection required.
  - Reducers may be needed to connect units to piping.
    - Common practice with many system components.
- Flows shown below represent the following:
  - Water velocity at inlet nozzle at 6 feet per second for 2" and larger.
- This criteria represents the most economical selection to achieve the following performance:
  - 100% free air eliminated.
  - 100% entrained air eliminated.
  - Up to 99.6% dissolved air eliminated.
  - Dirt particles 30 microns and larger will be removed within 100 passes (dirt and air / dirt separators only).
- Lower flows through larger units will result in lower velocity further improving unit's performance.

System Flow (GPM)*	Unit Selection
6	¾"
10	1"
15	1-1/4"
30	1-1/2"
60	2"
90	2-1/2"
140	3"
240	4"
370	5"
540	6"
940	8"
1470	10"
2090	12"
2530	14"
3300	16"
4180	18"
5200	20"
7500	24"
12,100	30"
17,400	36"

* These are recommended flows through each unit.

Recommended Selection Data

Spirovent/Spirotrap High Velocity Series (VHR, VHT, VHN, THT, THN)

- Pipe size is not a factor in the proper selection of an air eliminator or dirt separator.
- Units are selected based on system flow.
- Actual pipe size used remains at the designer's discretion.
  - No change to piping design selection required.
  - "HV" units often match pipe size.
    - Never install an HV unit smaller than pipe size.
- Flows shown below represent the following:
  - Water velocity at inlet nozzle up to 10 feet per second.
  - Maximum recommended flows.
- This criteria represents the most economical selection to achieve the following performance:
  - 100% free air eliminated.
  - 100% entrained air eliminated.
  - Up to 99.6% dissolved air eliminated.
  - Dirt particles 30 microns and larger will be removed within 100 passes (dirt and air / dirt separators only).
- Lower flows through larger units will result in lower velocity further improving unit's performance.

System Flow (GPM)*	Unit Selection
100	2"
150	2-1/2"
230	3"
400	4"
620	5"
900	6"
1550	8"
2450	10"
3500	12"
4300	14"
5500	16"
6950	18"
8650	20"
12,500	24"
20,200	30"
29,600	36"

* These are maximum flows through each unit size.

Air Removal Rates

To claim an exact percentage of per-pass air removal by an air separator is not only unrealistic, but often deceptive as well. That's because the per-pass efficiency is dependent on several factors: the type of air separator used, the size of the gas bubbles, the velocity, the temperature and pressure, and the fluid viscosity.

Entrained air bubbles come in many sizes. It is important to make a distinction in the size of air bubbles to be separated when comparing the air removal efficiency of air separators, just as it is common practice when comparing separation efficiencies regarding dirt particles. For example, it wouldn't make sense to install an ordinary strainer to separate sand from the flow when only a fine mesh filter will do.

Similarly, why employ a standard centrifugal or "scoop"-type air separator to separate **some** air from a system, when the Spirovent air eliminator is capable of removing **all** types of air, including entrained air, dissolved air, and stationary pockets of air? The Spirotube coalescing medium in the Spirovent, combined with the engineered height of the vessel and proper selection criteria (noted on the preceding pages) allows for maximum efficiency. At these conditions, the fluid is scrubbed to a level at which it returns to the system in an oxygen-starved state. This unsaturated fluid is then capable of absorbing the stationary air pockets that are normally trapped throughout the system and carrying them back to the Spirovent for release.

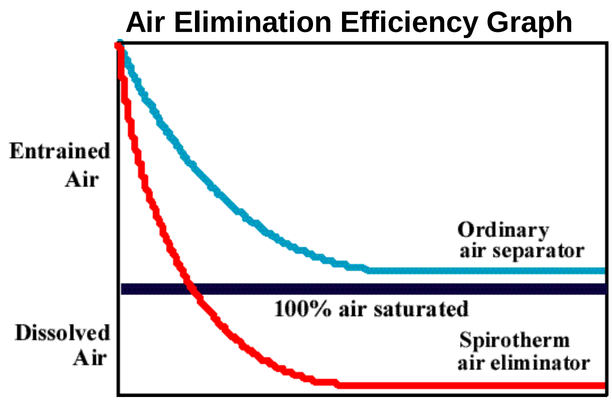
The tiny microbubbles, or entrained air, travel at the same speed as the water and are transported by the flow of the liquid. Entrained air can be difficult to eliminate because it must be separated from the flow before it can be accumulated and vented. Microbubbles will only migrate if the water velocity is greatly reduced, the turbulence suppressed, and a high rate of collision and adhesion is reached. The Spirovent air eliminator with its enlarged straight in-line flow passage and patented coalescing medium is the only air eliminator that provides these optimum conditions without substantial pressure loss. Entrained air is the type of air that most manufacturers claim is separated by their own brands of air separator, yet they do not define it. Using the incorrect line-size selection of a centrifugal separator with an entering velocity of approximately eight (8) feet per second, the efficiency is published at forty percent (40%) entrained air, which is undefined. Sixty percent (60%) of the entrained air remains in the system.

These poor air removal rates are due, in part, to the high speed at which the centrifugal separators normally operate. Furthermore, increased speed means additional pressure loss, which in turn, means higher operating costs. The

scoop-type separator allows for a decrease in water velocity, but is not capable of suppressing the flow turbulence.
The viscosity of the fluid also determines how easily air bubbles can be separated from fluid. More viscous fluids are resistant to removing air and do not easily allow it to break free of the flow path.

When choosing an air eliminator, one must be certain that the air removal rates promised by the manufacturer are true and accurate. One form of air might be separated to a certain degree depending on the fluid velocity, while others are conveniently left unmentioned.

Figure D-3



The Air Elimination Efficiency Graph (Figure D-3 above) illustrates the amount of dissolved and entrained air that a Spirovent is capable of eliminating in comparison to that of a centrifugal air separator in a closed loop system. As indicated, the Spirovent is capable of eliminating all but 0.4 % of the air. The centrifugal air separator cannot eliminate all sizes of entrained air, and as a result, cannot remove any of the dissolved air because the water never reaches the saturation point at which the stationary air pockets begin to dissolve.

Figure D-4 is a quick reference chart evaluating the capabilities of the four different types of air eliminators for hydronic systems. It is plain to see that the others are not as efficient as the Spirovent air eliminator in removing all types of air.

Figure D-4

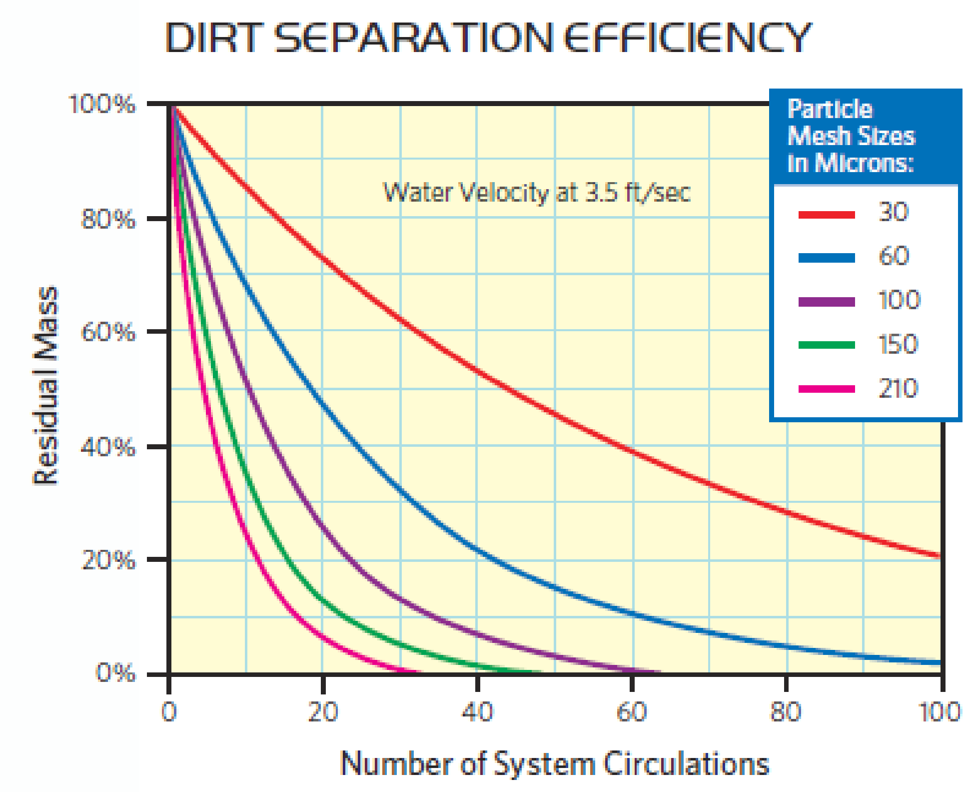
	Air Purging	Entrained Air Separation	Remote and Trapped Air Elimination*
Spirovent Air Eliminator	Yes	Yes	Yes
Centrifugal/Tangential Separator	Yes	Yes**	No
Air Scoop	Yes	No	No
Autovent/Highvent	Yes	No	No

* via an absorption process ** If selected properly to achieve peak efficiency

Dirt Separation Efficiency Graph

The TNO Laboratories researched the dirt separation efficiencies of the Spirovent and Spirotrap Dirt and Drain products. The results of these independent tests are shown below.

Figure D-5



At a water velocity of 3.5 feet per second, the units removed all dirt particles of 210 microns and larger within 35 passes. After 100 passes through the units, almost 80% of the particles down to 30 microns (0.0012” or #400 mesh) were separated and collected. In time, the units are capable of separating debris as small as 5 microns with continuous circulation.

Installation Instructions

Spirovent

For optimum performance, the Spirovent should be installed at the point of lowest solubility, or the place in the system where the temperature is the highest and the pressure is the lowest. This is the general rule for all installations.

Heating installation

In a heating installation, the Spirovent should be installed after the boiler, heat exchanger, or any heat source in the main supply line. In an installation with mixing or distribution valves, a Spirovent may be installed either in the supply line or in the line(s) after the valve(s) depending on the location of the circulator, the loop temperatures, the flow rates, and the duty cycle of the boiler.

For radiant floor loops with lower temperatures than the boiler circuit, the best location to install the Spirovent is in the boiler supply line. The Spirovent may also be installed after the mixing valve to minimize the re-absorption of boiler-generated microbubbles in the colder water.

Larger heating installations usually have more boilers connected to headers governing a number of circuits with separate controls of their own. A number of locations are appropriate in this situation:

- In every individual boiler supply line, or
- In the main supply, or
- In each individual zone.

Chilled water installation

In a chilled water system, the circulator can usually be found in the return line to the chiller between the air handlers/fan coils and the chiller. The optimum place for a Spirovent in this type of installation is in the line before the suction of the circulator at the point of highest temperature and the lowest system pressure.

In high-rise buildings with a high static pressure, the Spirovent should be installed on the highest floor of the building as explained earlier.

Spirotrap

The Spirotrap may be installed at any convenient location in the system. More detailed installation and operating instructions for the Spirotrap can be found on the following pages.

Spirotop

The Spirotop is suitable for risers, tanks, terminal units or any location where trapped air is a problem.

Notes: