

## Gas Scrubbers

### INTRODUCTION

The use of wet scrubbers for control of air pollution has gained wide acceptance throughout the industry. The ejector-venturi wet scrubber provides a number of advantages over many of the conventional single-purpose devices available. Particulate collectors such as cyclones and electrostatic precipitators cannot efficiently absorb gases or remove odors. Fabric filters, by design, cannot cope with gas streams having a high moisture content and are often affected by highly corrosive gases. Catalytic incinerators can be quickly poisoned by certain organic wastes.

On the other hand, ejector-venturi gas scrubbers are very effective at removing noxious gases, particulates, odors, fumes and dusts from gas streams. Particulate contaminants are removed through impaction by the high velocity spray of scrubbing liquid. Gases and odors are eliminated through absorption and/or chemical reaction between the gases and scrubbing liquid. When properly matched to the application, these scrubbers, by their nature, are better able to cope with the high temperatures and corrosive conditions often encountered.

Schutte & Koerting has over sixty years of experience in the control of commercial and industrial air pollution using wet scrubber technology. The ejector-venturi gas scrubbers described on the following pages have been engineered to operate effectively in a variety of applications. Using the same basic design, these standard scrubbers can be sized to meet volume requirements from a few CFM to thousands of CFM. This broad applicability permits Schutte & Koerting to stock these scrubbers in a wide range of sizes and materials. A stock ejector-venturi scrubber can often be the most economical and efficient solution to a pollution control problem.

### VERSATILE STOCK UNITS

To answer the need for an economical versatile and efficient pollution control device, Schutte & Koerting offers standard Fig. 7010 scrubbers in a variety of sizes and materials. Stock 7010 scrubbers are available for immediate shipment in sizes from 3" to 12" in materials which include carbon steel, stainless steel, polyvinyl chloride (PVC), Phenolic FRP (replaces previously supplied HAVEG), fiberglass-reinforced plastic (FRP) and cast iron. (A complete list of stock scrubbers is shown in the dimensions tables.) A minimum of three spray nozzle sizes are available with the stock scrubbers and can be selected to properly match the motive liquid used and capacity required.



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**FIG. 7010 EJECTOR-VENTURI SCRUBBER**

The Fig. 7010 scrubber is the key component in the Schutte & Koerting ejector-venturi system. These highly engineered scrubbers operate on the ejector-venturi principle illustrated. The Fig. 7010 is used in many applications to provide efficiencies as high as 99% or more in a single stage system (higher efficiencies can be obtained through use of multi-stage configurations). Gas handling capacities of over 90,000 CFM are possible with the larger size scrubbers (refer to Technical Supplement 7S for capacity data).

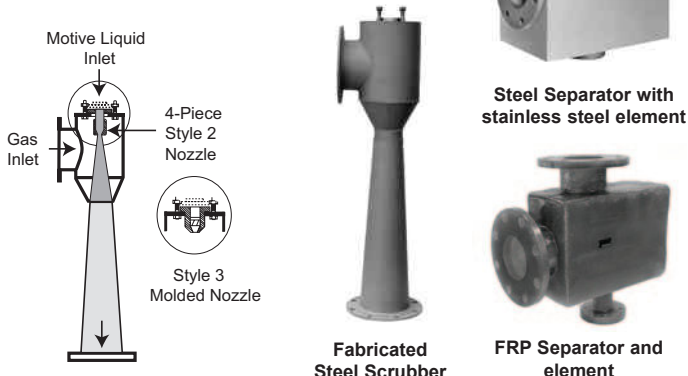
Installation, operation and maintenance are greatly simplified with these scrubbers. They can be mounted on an existing discharge or storage tank or provided with a Schutte & Koerting gas/liquid separator as shown.

To answer the need for an economical versatile and efficient pollution control device, S&K offers standard Fig. 7010 scrubbers in a variety of sizes and materials. Stock 7010 scrubbers are available for immediate shipment in sizes from 3" to 12" in materials which include carbon steel, stainless steel, polyvinyl chloride (PVC), Phenolic FRP (replaces previously supplied HAVEG), fiberglass-reinforced (FRP) and cast iron. (A complete list of stock scrubbers is shown in the dimension tables beginning on page 5.) A minimum of three spray nozzle sizes are available with the stock scrubbers and can be selected to properly match the motive liquid used and capacity required.

**FIG. 7040 SEPARATORS**

The Fig. 7040 separator is designed for use with the 7010 scrubber to maximize gas/liquid separation after the mixture is discharged from the scrubber. The Fig. 7040 reduces moisture carryover from the scrubber to as low as 0.0002 gallons per 100 cubic foot which, in turn, contributes to overall scrubber efficiency. The separator consists of an inlet at the top, a drain at the bottom and a clean gas outlet at the side of the separator. A separating element, which incorporates a unique baffling arrangement, is located just below the inlet. Scrubbing liquid from the separator can be drained to a storage tank or recirculated through the system.

Stock Fig. 7040 separators are available in sizes from 3" to 12" in fabricated steel, stainless steel, and FRP for use with stock Fig. 7010 scrubbers of the same size.

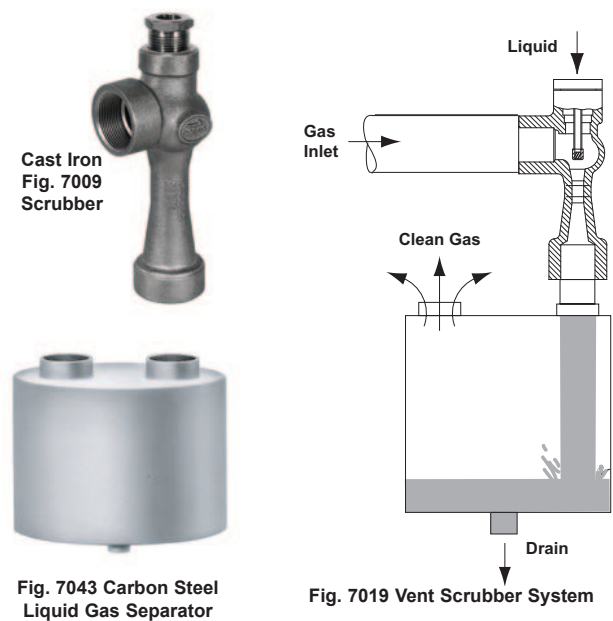

**FIG. 7019 VENT GAS SCRUBBER SYSTEM**

The Fig. 7019 vent scrubber system is a compact, light-weight and easy-to-install unit designed for economical and effective control of pollution from low volume sources. Typical applications include pollution from laboratory fume hoods, schools and industrial shops, pilot or bench scale plant equipment and smaller commercial and industrial uses.

These low-cost systems operate on the same ejector-venturi principle as the larger scrubbers, creating their own draft via a high velocity liquid spray, scrubbing fumes, gases, vapor or dusts with efficiencies as high as 99% or more. Low water consumption - a 3" unit will handle 30 CFM of air at 1" WC draft using only 2.6 gpm of water - makes the scrubber economical to operate, comparing favorably with a conventional laboratory aspirator.

**STOCK SYSTEMS**

The Fig. 7019 vent scrubber system is comprised of a Fig. 7009 scrubber combined with a Fig. 7043 liquid-gas separator. Both are available from stock. The Fig. 7009 scrubber is stocked in cast iron, stainless steel and PVC in a variety of sizes. Fig. 7043 separators are available from stock in carbon steel, stainless steel and polypropylene. The variety of sizes and materials of construction enable you to specify a stock system to meet your requirements and fit the corrosive properties of your application.



**FIG. 7014 SCRUBBER-SEPARATOR SYSTEM**

The Fig. 7014 scrubber-separator is a complete, single stage scrubbing system combining a Fig. 7010 ejector-venturi scrubber and a Fig. 7040 separator. This system utilizes the ejector-venturi principle to entrain and scrub large volumes of gas containing fumes, vapors, noxious gases, dusts, odors or particulates, and vent clean, dry gas to the atmosphere. The Fig. 7014 system is capable of providing efficiencies as high as 99% or more in a single stage system and higher in a multi-stage configuration. Gas handling capacities range from 25 CFM for a 3" scrubber to over 2000 CFM for a 12" scrubber (refer to Supplement 7S for detailed capacity data).

The compactness and design simplicity of the Fig. 7014 scrubber system permits installation in difficult to reach areas.



**ECONOMICAL STOCK SYSTEMS**

Schutte & Koerting has made both economy and efficiency possible in a pollution control system by offering stock Fig. 7014 systems in a variety of materials and sizes. Scrubbers from 3" to 12" are available in carbon steel, stainless steel, and FRP. A complete list of stock systems can be found in the dimensions tables beginning on page 5.

Virtually every type of contaminant including particulates, fumes, noxious gases, odors and vapors are encountered in the chemical plant. Here is where the Schutte & Koerting ejector-venturi scrubber finds its broadest use due to its removal efficiencies over the entire range of pollutants. Acid mists, amine fogs, furfural dusts and odors from organic wastes have all been removed from gas streams with 98% plus efficiencies using ejector-venturi scrubbers.

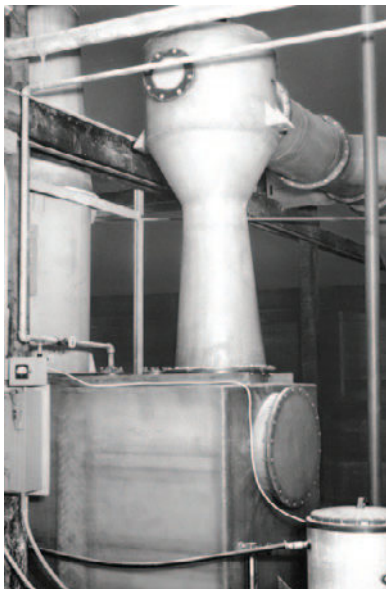


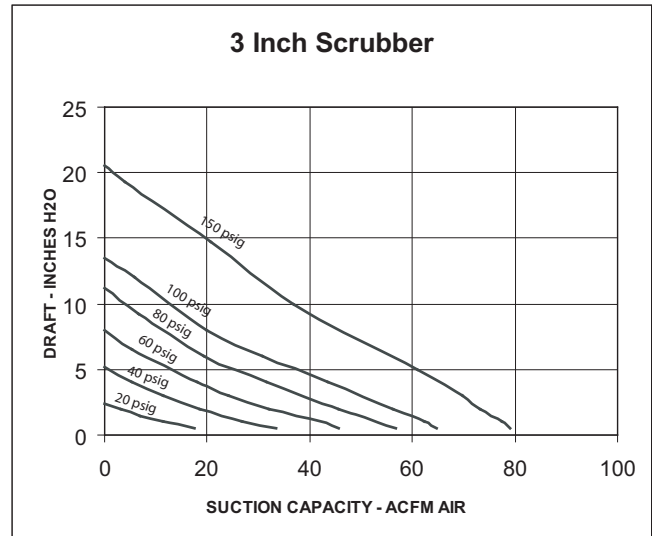
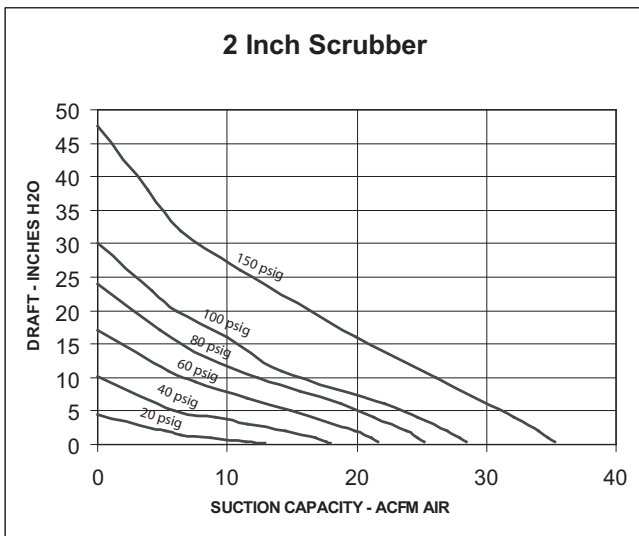
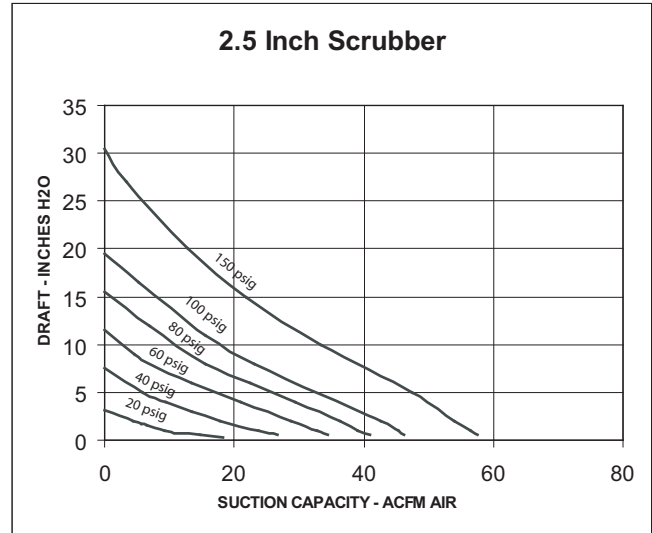
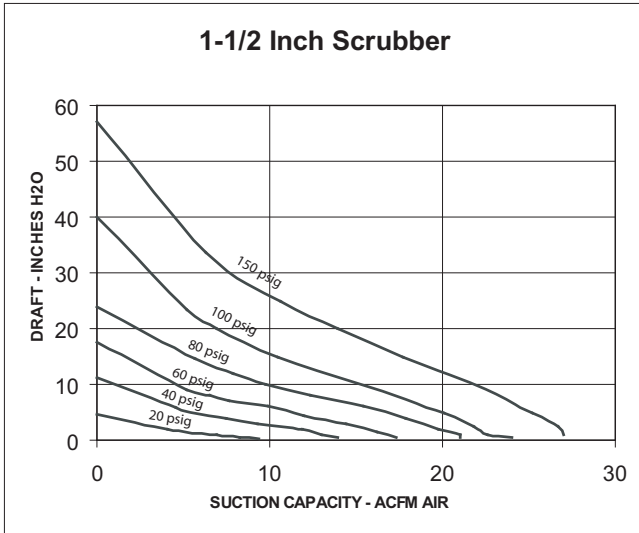
Fig. 7014 scrubber-separator system removes sulphur monochloride. It is part of a multi-unit system using a mild caustic as the scrubbing liquid.



Stock Fig. 7014 scrubber system, used to remove HCL fumes during tank venting, illustrates the benefits of a compact lightweight system.

**Performance**

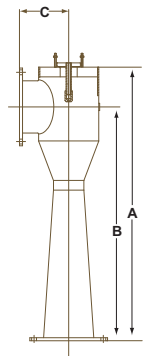
The charts below illustrate suction capacities-vs-drafts for the various Fig. 7009 scrubber sizes.


**WATER CONSUMPTION (FIG. 7009 - ALL SIZES)**

|      | Water Flow |     |     |     |     |     |
|------|------------|-----|-----|-----|-----|-----|
| psig | 20         | 40  | 60  | 80  | 100 | 150 |
| gpm  | 1.8        | 2.6 | 3.2 | 3.7 | 4.1 | 5.0 |

**FIG. 7010 CARBON STEEL AND STAINLESS STEEL SCRUBBERS**

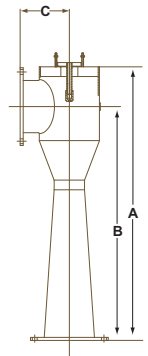
| Connections, Inches   |                                | Dimensions, Inches |        |       | Approx. Weight Lbs. |
|-----------------------|--------------------------------|--------------------|--------|-------|---------------------|
| Suction and Discharge | Motive Liquid Inlet            | A                  | B      | C     |                     |
| 3•                    | Four 1/2" studs on 3 1/8" B.C. | 18 5/8             | 14 1/2 | 4 1/4 | 16                  |
| 4•                    | Four 1/2" studs on 3 7/8" B.C. | 26 1/8             | 21     | 6     | 25                  |
| 6•                    | Four 5/8" studs on 5 1/2" B.C. | 39                 | 31 5/8 | 7     | 45                  |
| 8•                    | Four 5/8" studs on 5 1/2" B.C. | 52 1/8             | 43 7/8 | 8 1/2 | 75                  |
| 10•                   | Four 5/8" studs on 5 1/2" B.C. | 57 11/16           | 48 5/8 | 10    | 95                  |
| 12•                   | Four 5/8" studs on 5 1/2" B.C. | 61 1/4             | 49 1/4 | 12    | 140                 |



1. Stainless Steel units have Van Stone flanges.
- These sizes are normally carried in stock. For capacities and performance data refer to Supplement 7S.

**FIG. 7010 FIBERGLASS REINFORCED PLASTIC (FRP) AND POLYVINYL CHLORIDE (PVC) SCRUBBERS**

| Connections, Inches <sup>2</sup> |                                | Dimensions, Inches |        |       | Approx. Weight Lbs. |     |
|----------------------------------|--------------------------------|--------------------|--------|-------|---------------------|-----|
| Suction and Discharge            | Motive Liquid Inlet            | A                  | B      | C     | FRP                 | PVC |
| 4•                               | Four 1/2" studs on 3 7/8" B.C. | 26 1/8             | 21     | 6     | 10                  | 7   |
| 6•                               | Four 5/8" studs on 5 1/2" B.C. | 39                 | 31 5/8 | 7     | 20                  | 15  |
| 8•                               | Four 5/8" studs on 5 1/2" B.C. | 52 1/8             | 43 7/8 | 8 1/4 | 32                  | 23  |
| 10• <sup>3</sup>                 | Four 5/8" studs on 5 1/2" B.C. | 57 11/16           | 48 5/8 | 10    | 41                  | 30  |
| 12• <sup>3</sup>                 | Four 5/8" studs on 5 1/2" B.C. | 61 1/4             | 49 1/4 | 12    | 58                  | 40  |

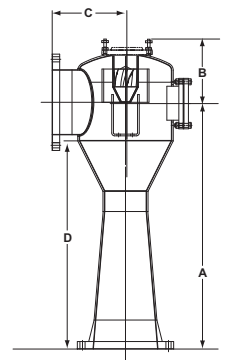


2. Flange O.D. & bolting conforms to 125 lb ASA B16.1
3. Stocked in FRP only
- These sizes are normally carried in stock. For capacities and performance data refer to Supplement 7S.

**FIG. 7010 LARGER SIZE METAL & FIBERGLASS REINFORCED PLASTIC (FRP) SCRUBBERS**

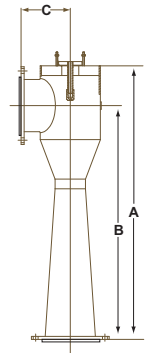
| Connections, Inches <sup>4</sup> |                                  | Dimensions, Inches |         |          |       |         |         | Approx. Wt. Lbs. |     |
|----------------------------------|----------------------------------|--------------------|---------|----------|-------|---------|---------|------------------|-----|
| Suction and Discharge            | Motive Liquid Inlet <sup>5</sup> | A                  | B       |          | C     |         | D       | Metal            | FRP |
|                                  |                                  |                    | Metal   | FRP      | Metal | FRP     |         |                  |     |
| 14                               | 2                                | 53 13/16           | 15 7/16 | 15 7/16  | 14    | 14 3/16 | 46 1/2  | 165              | 75  |
| 16                               | 2                                | 62                 | 16 5/8  | 16 5/8   | 15    | 15 3/16 | 54      | 210              | 100 |
| 18                               | 3                                | 66 13/16           | 19 3/8  | 19 3/8   | 16    | 16 1/4  | 56 5/8  | 250              | 120 |
| 20                               | 3                                | 71 1/16            | 21 1/8  | 21 1/8   | 19    | 19 1/4  | 60      | 375              | 150 |
| 24                               | 4                                | 83 13/16           | 24 1/2  | 24 1/2   | 22    | 22 1/4  | 70 1/2  | 900              | 185 |
| 30                               | 5                                | 102 3/4            | 30 3/16 | 30 3/16  | 25    | 25 1/4  | 84 7/8  | 1090             | 385 |
| 36                               | 6                                | 119 1/4            | 37      | 37       | 28    | 28 3/8  | 96      | *                | *   |
| 42                               | 6                                | 134 13/16          | 43 1/2  | 43 3/4   | 31    | 31 3/8  | 105 1/2 | *                | *   |
| 48                               | 8                                | 150 1/2            | 50 9/16 | 50 13/16 | 34    | 34 3/8  | 115     | *                | *   |
| 54                               | 8                                | 163 7/8            | 57 1/8  | 57 3/8   | 42    | 40 3/8  | 124     | *                | *   |
| 60                               | 12                               | 177 5/16           | 63 5/8  | 63 7/8   | 48    | 46 3/8  | 133     | *                | *   |
| 72                               | 12                               | 213 1/16           | 76      | 76 1/4   | 54    | 52 3/8  | 158 1/2 | *                | *   |
| 84                               | 14                               | 270                | 89 3/4  | 90       | 60    | 60      | 206     | *                | *   |
| 96                               | 18                               | 324                | 107 3/4 | 90       | 69    | 69      | 242     | *                | *   |

4. Flanges for FRP units agree with NBS Voluntary Product Standard PS15-69, Table 2; Flanges for steel units, check factory
5. Nominal size only - check factory for specific size
- \* Weight depends on material thickness - check factory.



**FIG. 7010 PHENOLIC FIBERGLASS REINFORCED PLASTIC (FRP) SCRUBBERS**  
(Replaces previously supplied HAVEG)

| Connections, Inches   |                                | Dimensions, Inches |        |       | Approx. Weight Lbs. |
|-----------------------|--------------------------------|--------------------|--------|-------|---------------------|
| Suction and Discharge | Motive Liquid Inlet            | A                  | B      | C     |                     |
| 3                     | Four 1/2" studs on 3 7/8" B.C. | 17 1/8             | 12 7/8 | 4 7/8 | 22                  |
| 4*                    | Four 1/2" studs on 3 7/8" B.C. | 26 1/8             | 21     | 6     | 37                  |
| 6*                    | Four 5/8" studs on 5 1/2" B.C. | 39                 | 31 5/8 | 7     | 70                  |
| 8*                    | Four 5/8" studs on 5 1/2" B.C. | 52 1/8             | 43 7/8 | 8 1/2 | 117                 |
| 10                    | Four 5/8" studs on 5 1/2" B.C. | 57 11/16           | 48 5/8 | 10    | 225                 |
| 12                    | Four 5/8" studs on 5 1/2" B.C. | 67 5/8             | 57     | 12    | 282                 |



\* These sizes are normally carried in stock. For capacities and performance data refer to Supplement 7S.

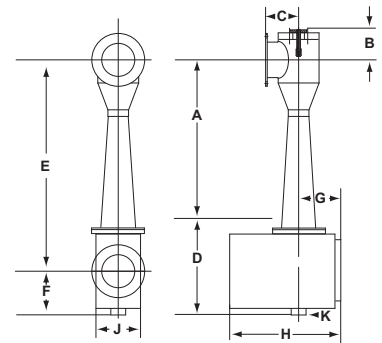
**FIG. 7014 CARBON STEEL SCRUBBER SYSTEMS**

| Conn. (IN.)† | Dimensions, Inches |        |       |          |          |        |        |        |        |       | Appr. Wt Lbs. |
|--------------|--------------------|--------|-------|----------|----------|--------|--------|--------|--------|-------|---------------|
|              | A                  | B      | C     | D        | E        | F      | G      | H      | J      | K*    |               |
| 3*           | 14 1/2             | 4 1/8  | 4 1/4 | 10 15/16 | 19 15/16 | 5 5/8  | 4 7/8  | 13     | 5 3/8  | 1 1/4 | 55            |
| 4*           | 21                 | 5 1/8  | 6     | 12 9/16  | 27 1/8   | 6 9/16 | 5 5/8  | 15 1/4 | 6 1/4  | 1 1/2 | 65            |
| 6*           | 31 5/8             | 7 3/8  | 7     | 17 1/8   | 40 1/16  | 8 3/4  | 8 1/16 | 21 1/2 | 8 7/8  | 2 1/2 | 198           |
| 8*           | 43 7/8             | 8 1/4  | 8 1/2 | 20 7/16  | 53 1/8   | 10 1/2 | 10     | 26 1/2 | 10 3/4 | 3     | 360           |
| 10*          | 48 5/8             | 9 1/16 | 10    | 25 5/8   | 61 1/4   | 13 1/8 | 12 1/4 | 33 1/8 | 13 1/2 | 4     | 520           |
| 12*          | 49 1/4             | 12     | 12    | 37 5/8   | 67 7/8   | 19 1/8 | 20 1/4 | 49 1/2 | 20 3/4 | 4     | 720           |

† Suction and Discharge Connection

\* NPT

• Systems available from stock: carbon steel; 3" through 12"; Cast iron scrubbers; check factory for availability



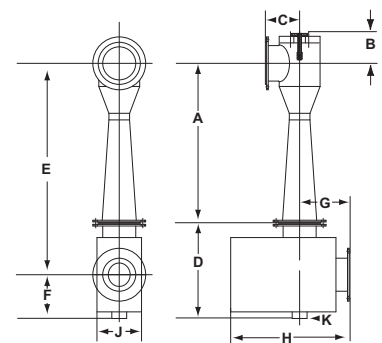
**FIG. 7014 STAINLESS STEEL AND ALLOYS SCRUBBER SYSTEMS**

| Conn. (IN.)† | Dimensions, Inches |        |       |         |          |          |         |        |        |       | Appr. Wt Lbs. |
|--------------|--------------------|--------|-------|---------|----------|----------|---------|--------|--------|-------|---------------|
|              | A                  | B      | C     | D       | E        | F        | G       | H      | J      | K*    |               |
| 3*           | 14 1/2             | 4      | 4 1/4 | 10 1/16 | 23 1/16  | 5 5/8    | 8       | 16 1/8 | 5 3/8  | 1 1/4 | 55            |
| 4*           | 21                 | 5 1/8  | 6     | 15 5/16 | 29 3/4   | 6 11/16  | 8 1/4   | 17 7/8 | 6 1/4  | 1 1/2 | 65            |
| 6*           | 31 5/8             | 7 3/8  | 7     | 20 1/8  | 43 1/4   | 8 5/8    | 11 1/16 | 24 1/2 | 8 7/8  | 2 1/2 | 198           |
| 8*           | 43 7/8             | 8 1/4  | 8 1/2 | 23 7/8  | 56 15/16 | 10 15/16 | 13      | 29 1/2 | 10 3/4 | 3     | 360           |
| 10           | 48 5/8             | 9 1/16 | 10    | 28 1/2  | 64       | 13 1/4   | 15      | 35 7/8 | 13 1/2 | 4     | 520           |
| 12           | 49 1/4             | 12     | 12    | 40 1/2  | 70 5/8   | 19 1/4   | 23      | 52 1/4 | 20 3/4 | 4     | 720           |

† Suction and Discharge Connection

\* NPT

• Systems available from stock: Stainless steel; 3" through 8"; Alloys; check factory for availability

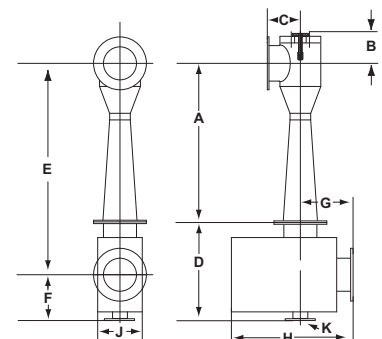


**FIG. 7014 FIBERGLASS REINFORCED PLASTIC (FRP) SCRUBBER SYSTEMS**

| Conn. (IN.)† | Dimensions, Inches |        |       |        |          |          |         |        |        |       | Appr. Wt Lbs. |
|--------------|--------------------|--------|-------|--------|----------|----------|---------|--------|--------|-------|---------------|
|              | A                  | B      | C     | D      | E        | F        | G       | H      | J      | K     |               |
| 4*           | 21                 | 5 1/8  | 6     | 17 1/4 | 29 3/4   | 8 5/8    | 8 1/4   | 17 7/8 | 6 1/4  | 1 1/2 | 30            |
| 6*           | 31 5/8             | 7 3/8  | 7     | 21 5/8 | 42 9/16  | 10 13/16 | 10 9/16 | 24     | 8 7/8  | 2 1/2 | 60            |
| 8*           | 43 7/8             | 8 1/4  | 8 1/2 | 25 7/8 | 56 15/16 | 12 15/16 | 13      | 29 1/2 | 10 3/4 | 3     | 90            |
| 10*          | 48 5/8             | 9 1/16 | 10    | 30 1/2 | 64       | 15 1/4   | 15      | 35 7/8 | 13 1/2 | 4     | 140           |
| 12*          | 49 1/4             | 12     | 12    | 42 1/2 | 70 5/8   | 21 1/4   | 23      | 52 1/4 | 20 3/4 | 4     | 200           |

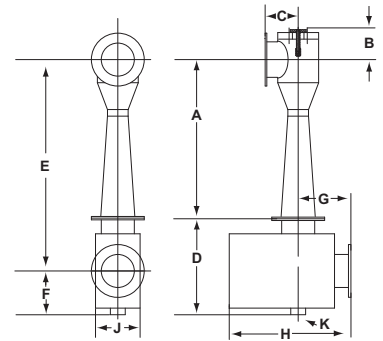
† Suction and Discharge Connection

• Systems available from stock: FRP; 4" through 12".



**FIG. 7014 POLYVINYL CHLORIDE (PVC) SCRUBBER SYSTEMS**

| Conn. (IN.)† | Dimensions, Inches |        |       |         |          |         |        |          |        |       | Appr. Wt Lbs. |
|--------------|--------------------|--------|-------|---------|----------|---------|--------|----------|--------|-------|---------------|
|              | A                  | B      | C     | D       | E        | F       | G      | H        | J      | K*    |               |
| 4•           | 21                 | 5 1/8  | 6     | 15 1/8  | 29 3/4   | 6 1/2   | 8 1/4  | 17 11/16 | 6 1/4  | 1 1/2 | 18            |
| 6•           | 31 5/8             | 7 3/8  | 7     | 19 5/8  | 42 9/16  | 8 13/16 | 10 1/4 | 23 13/16 | 8 7/8  | 2 1/2 | 48            |
| 8•           | 43 7/8             | 8 1/4  | 8 1/2 | 23 1/16 | 56 15/16 | 10 1/8  | 13     | 29 1/8   | 10 3/4 | 3     | 70            |
| 10           | 48 5/8             | 9 1/16 | 10    | 28 1/4  | 64       | 13      | 15     | 35 1/2   | 13 1/2 | 4     | 100           |
| 12           | 49 1/4             | 12     | 12    | 40 1/4  | 70 5/8   | 19      | 23     | 51 7/8   | 20 3/4 | 4     | 155           |



† Suction and Discharge Connection

\* NPT

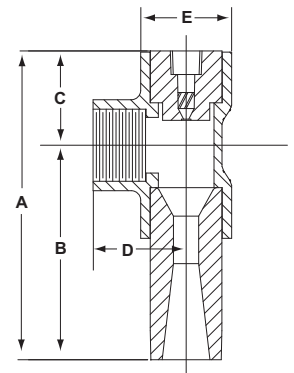
• Systems available from stock:

For all PVC construction, check factory for availability.

PVC Scrubbers only in 4", 6" & 8" sizes are available from stock and can be used with stock FRP separators if desired.

**FIG. 7009 POLYVINYL CHLORIDE VENT SCRUBBERS**

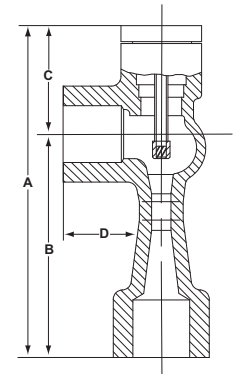
| Connections, Inches   |                     | Dimensions, Inches |        |         |         |         | Approx. Weight Lbs. |
|-----------------------|---------------------|--------------------|--------|---------|---------|---------|---------------------|
| Suction And Discharge | Motive Liquid Inlet | A                  | B      | C       | D       | E       |                     |
| 1 1/2•                | 1/2                 | 9 13/16            | 6 7/32 | 2 31/32 | 2 11/32 | 2 11/32 | 1 1/2               |
| 2•                    | 1/2                 | 10 15/32           | 7 9/32 | 3 3/16  | 2 5/8   | 2 27/32 | 2 1/2               |
| 3•                    | 1/2                 | 14 1/16            | 10 5/8 | 3 7/16  | 3 3/4   | 4 1/4   | 7                   |



• These sizes normally carried in stock.

**FIG. 7009 CAST IRON AND STAINLESS STEEL VENT SCRUBBERS**

| Connections, Inches   |                     | Dimensions, Inches |        |       |       | Approx. Weight Lbs. |
|-----------------------|---------------------|--------------------|--------|-------|-------|---------------------|
| Suction And Discharge | Motive Liquid Inlet | A                  | B      | C     | D     |                     |
| 1 1/2•                | 1/2                 | 9 1/4              | 6 1/2  | 2 3/4 | 2     | 3 1/2               |
| 2•                    | 1/2                 | 10 3/4             | 7 5/8  | 3 1/8 | 2 1/4 | 6                   |
| 2 1/2•                | 1/2                 | 12 7/8             | 9 1/4  | 3 5/8 | 3 1/8 | 11                  |
| 3•                    | 1/2                 | 15 3/8             | 11 1/4 | 4 1/8 | 3 1/2 | 20                  |

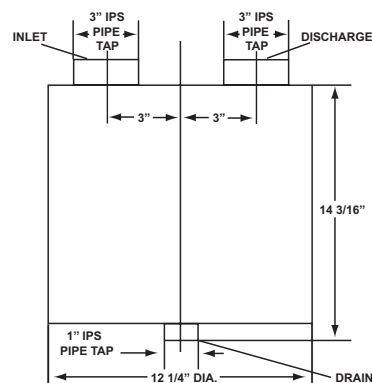


• These sizes normally carried in stock.

**FIG. 7043 LIQUID/GAS SEPARATOR**

Approx. Weight: Polypropylene - 6 lbs;  
Carbon Steel and Stainless Steel - 19 lbs.

• Stocked in polypropylene, carbon steel and stainless steel.



**FIG. 7185 HIGH ENERGY VENTURI SCRUBBER**
**Application**

Fig. 7185 Scrubbers are designed to remove fine micron and submicron particulate from industrial and commercial effluent gases. These scrubbers are effective in the removal of dusts, fumes, vapors, and mists; as well as a variety of other air pollutants (see Table 2 on page 9). Removal efficiency is related to the characteristics of the contaminant and the pressure drop induced across the throat section of the venturi. The relationship between pressure drop, removal efficiency and particle size is illustrated in Fig. 3 on page 9.

**Features**

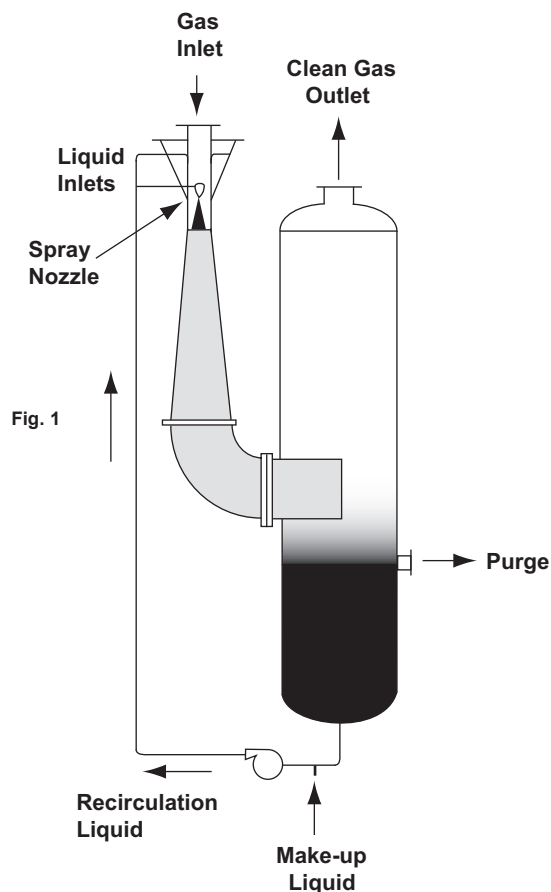
- High Efficiency: Efficiencies of up to 99% can be realized in many applications.
- Special Gas Inlet Design: Significantly reduces solids build up at inlet.

**Construction**

The Fig. 7185 is a wet scrubbing system which combines a Fig. 7070 High Energy Venturi with a Fig. 7063 Cyclonic Separator. These components are available in a choice of materials including stainless steel, fiberglass-reinforced plastic, and a variety of other corrosion-resistant plastics and alloys. A number of standard sizes are offered for capacities ranging from 1,600 to 37,000 cfm as shown in Table 1 on page 9. Larger units are available on a custom basis.

**Operation**

Contaminated gases enter the scrubber at the venturi inlet. Pressure differential is used to accelerate the gas to increasingly higher velocities until it enters the venturi throat. The scrubbing liquid is introduced at two points: (1) tangentially at the gas inlet to eliminate "wet-dry zone" solids build up, and (2) through a spray nozzle at the venturi throat - the point of maximum turbulence. This method of introducing the scrubbing liquid (usually water) maximizes the relative velocities between the gas and liquid streams and results in an energy transfer which atomizes the motive liquid droplets. As the gas gradually decelerates through the tapered venturi tail, further impaction and agglomeration of



the liquid droplets and contaminants occurs. This mixture enters the cyclonic separator through a tangential inlet which imparts a spinning motion upon it. The swirling motion forces the entrained liquid to the separator wall and the gas is drawn out the top of the separator. The liquid cascades down the walls and is drained at the bottom for discharge or recirculation. The Fig. 7185 scrubber is versatile enough to meet practically every submicron requirement. When conditions require it, additional equipment, such as a pre-cooler, can be installed.



FIG. 7185 HIGH ENERGY VENTURI SCRUBBER

Table 1. Dimensions and Capacities

| Size | Capacity (cfm)  | Dimensions (inches) |                |                  |           |     |     |     |
|------|-----------------|---------------------|----------------|------------------|-----------|-----|-----|-----|
|      |                 | A (Gas Inlet)       | B (Gas Outlet) | C (Liquid Inlet) | D (Drain) | E   | F   | G   |
| 12   | 1,600 - 2,200   | 12                  | 12             | 1                | 2         | 30  | 113 | 141 |
| 14   | 2,200 - 2,700   | 14                  | 14             | 1 1/2            | 2         | 30  | 122 | 166 |
| 16   | 2,700 - 3,600   | 16                  | 16             | 1 1/2            | 3         | 36  | 136 | 179 |
| 18   | 3,600 - 5,000   | 18                  | 18             | 1 1/2            | 3         | 42  | 150 | 199 |
| 20   | 5,000 - 7,200   | 20                  | 20             | 1 1/2            | 4         | 48  | 164 | 213 |
| 24   | 7,200 - 10,300  | 24                  | 24             | 2                | 4         | 60  | 192 | 252 |
| 30   | 10,300 - 15,000 | 30                  | 30             | 3                | 6         | 72  | 225 | 304 |
| 36   | 15,000 - 22,000 | 36                  | 36             | 3                | 6         | 84  | 258 | 356 |
| 42   | 22,000 - 28,000 | 42                  | 42             | 4                | 8         | 96  | 292 | 405 |
| 48   | 28,000 - 37,000 | 48                  | 48             | 4                | 8         | 108 | 325 | 457 |

NOTE: Cyclone length includes storage capacity for recirculation.

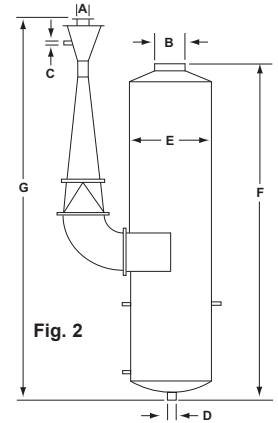


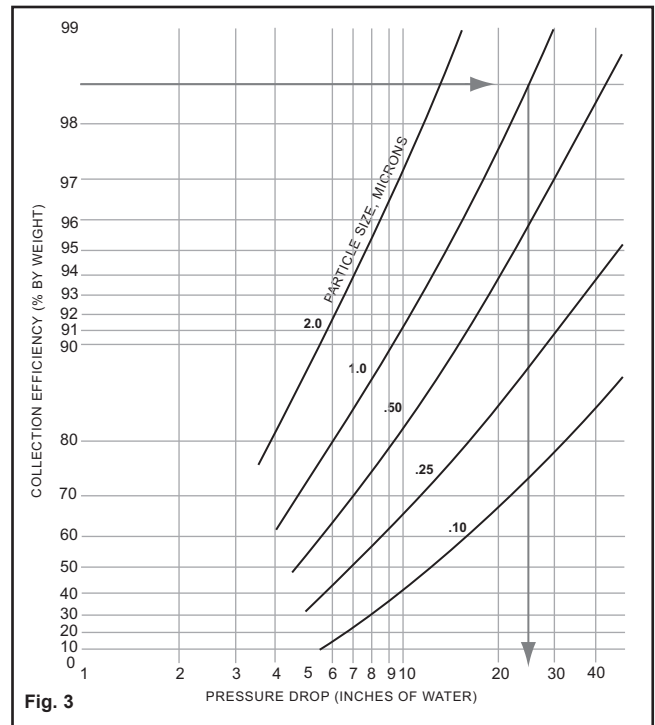
Table 2. Typical Applications and Efficiencies

This table gives a few applications for High Energy Venturi Scrubbers. These approximate collection efficiencies are based on an average inlet grain loading. Values fluctuate for specific applications.

| Source of Gas                                   | Contaminants                        | Average Removal Eff. (%) |
|---|-------------------------------------|--------------------------|
| <b>CHEMICAL INDUSTRY</b>                        |                                     |                          |
| Acid - Humidity SO <sub>3</sub>                 | H <sub>2</sub> SO <sub>4</sub> Mist | 99.4                     |
| (a) Scrub with Water                            |                                     | 99.3                     |
| (b) Scrub with 40% Acid                         |                                     | 97.5                     |
| Acid Concentrator                               | H <sub>2</sub> SO <sub>4</sub> Mist | 99                       |
| Copperas Roasting Kiln                          | H <sub>2</sub> SO <sub>4</sub> Mist | 98.9                     |
| Chlorosulfonic Acid Plant                       | Amine Fog                           | 90+                      |
| Dry Ice Plant                                   | Tar & Acetic Acid                   | 95                       |
| Wood Distillation Plant                         | TiO <sub>2</sub> -HCl Fumes         | 95                       |
| TiCl <sub>4</sub> Plant, TiO <sub>2</sub> Dryer | Detergents, Fume & Odor             | 95                       |
| Spray Dryers                                    | Furfural Dust                       | 95+                      |
| Flash Dryers                                    | H <sub>3</sub> PO <sub>4</sub> Mist | 98+                      |
| Phosphoric Acid Plant                           |                                     |                          |
| <b>FERTILIZER INDUSTRY</b>                      |                                     |                          |
| Fertilizer Dryer                                | Ammonium Chloride Fumes             | 85                       |
| Superphosphate Den & Mixer                      | Fluorine Compounds                  | 98                       |
| <b>METALS INDUSTRY</b>                          |                                     |                          |
| Gray Iron Cupola                                | Iron, Coke, Silica Dust             | 95                       |
| Oxygen Steel Converter                          | Iron Oxide                          | 98.5                     |
| Steel Open Hearth Furnace (Scrap)               | Iron & Zinc Oxide                   | 95                       |
| Steel Open Hearth Furnace (Oxygen Lanced)       | Iron Oxide                          | 99                       |
| Blast Furnace (Iron)                            | Iron Ore & Coke Dust                | 99                       |
| Electric Furnace                                | Ferro-Manganese Fume                | 99                       |
| Electric Furnace                                | Ferro-Silicon Dust                  | 95                       |
| Rotary Kiln - Iron Reduction                    | Iron, Carbon                        | 99                       |
| Crushing & Screening                            | Taconite Iron Ore Dust              | 99.9                     |
| Blast Furnace (Sec. Lead)                       | Lead Compounds                      | 99                       |
| Reverberatory Lead Furnace                      | Lead & Tin Compounds                | 92                       |
| Ajax-Furnace-Aluminum Alloy                     | Aluminum Chloride                   | 95                       |
| Zinc Sintering                                  | Zinc & Lead Oxide Dusts             | 98                       |
| Reverberatory Brass Furnace                     | Zinc Oxide Fume                     | 95                       |
| <b>MINERAL PRODUCTS INDUSTRY</b>                |                                     |                          |
| Lime Kiln                                       | Lime Dust                           | 99                       |
| Lime Kiln                                       | Soda Fume                           | 99                       |
| Asphalt Stone Dryer                             | Limestone & Rock Dust               | 98+                      |
| Cement Kiln                                     | Cement Dust                         | 97                       |
| <b>PETROLEUM INDUSTRY</b>                       |                                     |                          |
| Catalytic Reformer                              | Catalyst Dust                       | 95                       |
| Acid Concentrator                               | H <sub>2</sub> SO <sub>4</sub> Mist | 97.5                     |
| TCC Catalytic Regenerator                       | Oil Fumes                           | 98                       |
| <b>PULP &amp; PAPER INDUSTRY</b>                |                                     |                          |
| Lime Kiln                                       | Soda Fume                           | 99                       |
| Lime Kiln                                       | Lime Dust                           | 99                       |
| Black Liquor Oxidation                          | Black Liquor Oxidation              | 99                       |
| Black Liquor Recovery Boiler                    | Salt Cake                           | 90                       |
| <b>MISCELLANEOUS</b>                            |                                     |                          |
| Pickling Tanks                                  | HCl Fumes                           | 92                       |
| Boiler Flue Gas                                 | Fly Ash                             | 98                       |
| Sodium Disposal Incinerator                     | Sodium Oxide Fumes                  | 98                       |

Collection Efficiency

Fig. 3. This chart shows theoretical collection efficiency as a function of pressure drop for several particle sizes. For example, to obtain 98.5% efficiency for particulates measuring one micron in size, a pressure drop of approximately 25 inches of water would be required.



Performance of the systems described in this literature is typical of the results which can be achieved. Results of a specific system application will be made part of the quotation and subsequent purchase order after all facts have been supplied to Process Systems.

**FIG. 7055 PACKED-TOWER GAS SCRUBBER**
**Application**

S&K Fig. 7055 Packed Towers are low-energy gas scrubbers. They are used for gas absorption, cooling, and recovery. Because of their high scrubbing efficiency and low power consumption, they are used in many industries for a broad range of applications including those noted in Table 1 on page 11.

Scrubbers of this type perform best when gases to be handled are free of particles, since these tend to clog the packing. Other types of S&K Scrubbers (Fig. 7185 Sub-Micron, Fig. 7014 Ejector-Venturi, and Fig. 7032 Chamber Scrubbers) are more commonly used for gases containing particulates.

**Construction**

S&K Packed Towers are available in standard sizes, but can also be specially designed or modified to fit unusual service conditions. When desired, S&K can supply a complete, packaged system including fan, recycling pump, and liquid storage for recycling. Standard construction is as indicated in Fig. 1.

Towers are available in steel, stainless steel, polyester fiberglass, Phenolic FRP (replaces previously supplied HAVEG), and numerous other corrosion-resistant materials as required. Packing material is selected to provide best possible performance and corrosion resistance.

Noteworthy construction features include:

...**liquid distributors** are spray-nozzle types engineered for even liquid distribution, minimum channeling, easy maintenance, and flexibility under operating conditions.

...**gas distribution** is accomplished by gas-injection type support plates which provide uniform gas flow even at high liquid rates.

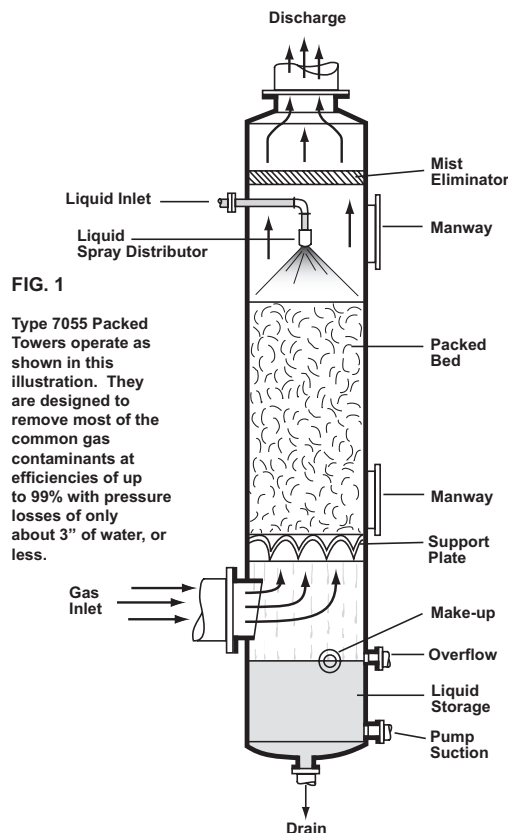
...**packed bed material** is sized for maximum efficiency at a low pressure drop, and the S&K standard tower is designed to facilitate increased packing height if customer's conditions change.

...**a mist eliminator** is provided in each tower to minimize liquid loss through carryover.

...**inspection openings or manways** are provided for easy access to internal components.

**Operation**

As indicated by the illustration, scrubbing liquid enters the tower through a nozzle and is sprayed uniformly across the top of a packed bed so that it trickles evenly through the packing material from top to bottom without channeling. Gas enters the tower through the inlet near the bottom and passes through the



**FIG. 1**  
Type 7055 Packed Towers operate as shown in this illustration. They are designed to remove most of the common gas contaminants at efficiencies of up to 99% with pressure losses of only about 3" of water, or less.

support plate into the packed bed, counter current to the flow of the scrubbing liquid, contaminants are removed.

The packed bed is designed to provide maximum gas to liquid contact at low pressure drop. The packing is carefully selected to provide continuous regeneration of the liquid surface as liquid flows over it while, at the same time, dispersing the upward gas flow evenly throughout the bed.

After passing through the packed bed, the cleaned gas passes through a mist eliminator section near the top of the tower. Here, any entrained liquid is removed before the clean air is discharged through the outlet.

**Performance**

S&K Packed Towers are designed to remove most of the common gas contaminants at very high efficiencies (up to 99%) with low pressure losses (3" of water or less). Table 1 on page 11 illustrates typical efficiencies obtainable in a packed tower using water or mild caustic as the scrubbing medium.

As noted previously, packed towers are used most effectively in applications where the gases to be cleaned do not contain particulates.

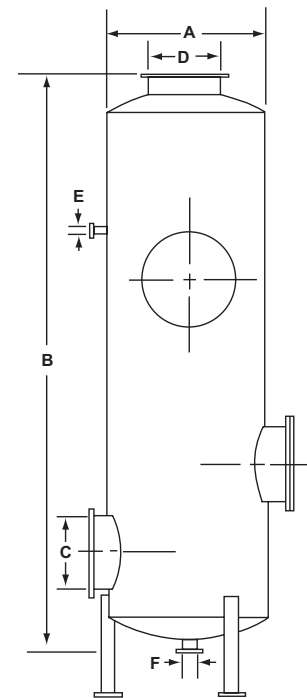
**FIG. 7055 PACKED-TOWER GAS SCRUBBER**
**Table 1. Typical Cleaning Efficiencies For Various Common Contaminants**

| Contaminant       | Scrubbing Fluid | Efficiency | Contaminant       | Scrubbing Fluid | Efficiency |
|-------------------|-----------------|------------|-------------------|-----------------|------------|
| Acetic Acid       | Water           | 95-99%     | Hydrogen Sulfide  | Caustic         | 93-99%     |
| Alcohol           | Water           | 99%        | Mercaptans        | Caustic         | 98%        |
| Ammonia           | Acid            | 99%        | Nitric Acid       | Caustic         | 96-99%     |
| Bromine           | Water           | 90-99%     | Phosphoric Acid   | Water           | 99%        |
| Chlorine          | Caustic         | 90-99%     | Pickling Solution | Water           | 99%        |
| Chromic Acid      | Water           | 99%        | Sodium Hydroxide* | Water           | 99%        |
| Hydrobromic Acid  | Water           | 98%        | Sulfur Dioxide    | Caustic         | 99%        |
| Hydrochloric Acid | Water           | 99%        | Sulfuric Acid*    | Water           | 99%        |
| Hydrofluoric Acid | Water           | 99%        |                   |                 |            |

\*Entrainment from Solutions

**Table 2. Capacities, Dimensions, and Approximate Weights**

| Maximum Rated Capacity (In scfm) | Total Pressure Drop (In in. H <sub>2</sub> O) | Nominal Size A | Dimensions (in inches) |       |       |       | Approx. Weight (In Lbs.) PEEG |
|----------------------------------|---|----------------|------------------------|-------|-------|-------|-------------------------------|
|                                  |   |                | B                      | C & D | E     | F     |                               |
| 400                              | 3   | 12             | 130                    | 6     | 3/4   | 1     | 100                           |
| 1,000                            | 3   | 18             | 137                    | 8     | 1     | 1 1/2 | 170                           |
| 1,900                            | 3   | 24             | 147                    | 10    | 1     | 2     | 250                           |
| 3,000                            | 3   | 30             | 155                    | 12    | 1 1/2 | 2     | 350                           |
| 4,300                            | 3   | 36             | 165                    | 16    | 2     | 3     | 475                           |
| 5,800                            | 3   | 42             | 173                    | 18    | 2     | 3     | 600                           |
| 7,600                            | 3   | 48             | 181                    | 20    | 2     | 3     | 750                           |
| 9,600                            | 3   | 54             | 191                    | 24    | 3     | 4     | 1,100                         |
| 12,000                           | 3   | 60             | 203                    | 30    | 3     | 4     | 1,300                         |
| 17,000                           | 2.5   | 72             | 210                    | 36    | 3     | 4     | 2,000                         |
| 23,000                           | 2.5   | 84             | 225                    | 42    | 4     | 6     | 2,500                         |
| 30,000                           | 2.5   | 96             | 235                    | 42    | 4     | 6     | 3,100                         |
| 38,000                           | 2.5   | 108            | 251                    | 48    | 4     | 6     | 4,400                         |
| 47,000                           | 2.5   | 120            | 261                    | 48    | 6     | 8     | 5,200                         |
| 56,000                           | 2.5   | 132            | 279                    | 54    | 6     | 10    | 6,200                         |
| 67,000                           | 2.5   | 144            | 289                    | 54    | 6     | 10    | 7,200                         |



**FIG. 7030 VENTURI CHAMBER SCRUBBER SYSTEM**
**Application**

The S&K Fig. 7030 Venturi Chamber Scrubber will handle condensable or absorbable gases and gases with solids which can be cleaned by the Fig. 7010 Scrubber. This unit, however, is particularly suitable for large total capacities and horizontal installation. Over-all draft is approximately zero.

**Construction**

The S&K Fig. 7030 Venturi Chamber Scrubber consists of S&K Fig. 622 Spray Nozzles (described on page 13), throat pieces, piping, and a scrubber box.

S&K Throat Pieces are made in two sizes: the No. 1 for handling up to 1500 cfm of gas; and the No. 2 for handling up to 3000 cfm. Both sizes are normally made in cast iron, but can be furnished in other materials.

Scrubber boxes are usually made by the customer to fit the location and requirements and can be constructed of steel plate, wood, concrete or other materials as desired. S&K will provide scrubber box dimensions to meet requirements if requested. The system is flexible - can be arranged in two, three, or four banks depending upon the characteristics of the gas and the scrubbing efficiency required. The number of nozzles and throat pieces in any

given bank is determined by the volume of gas to be handled.

**Operation**

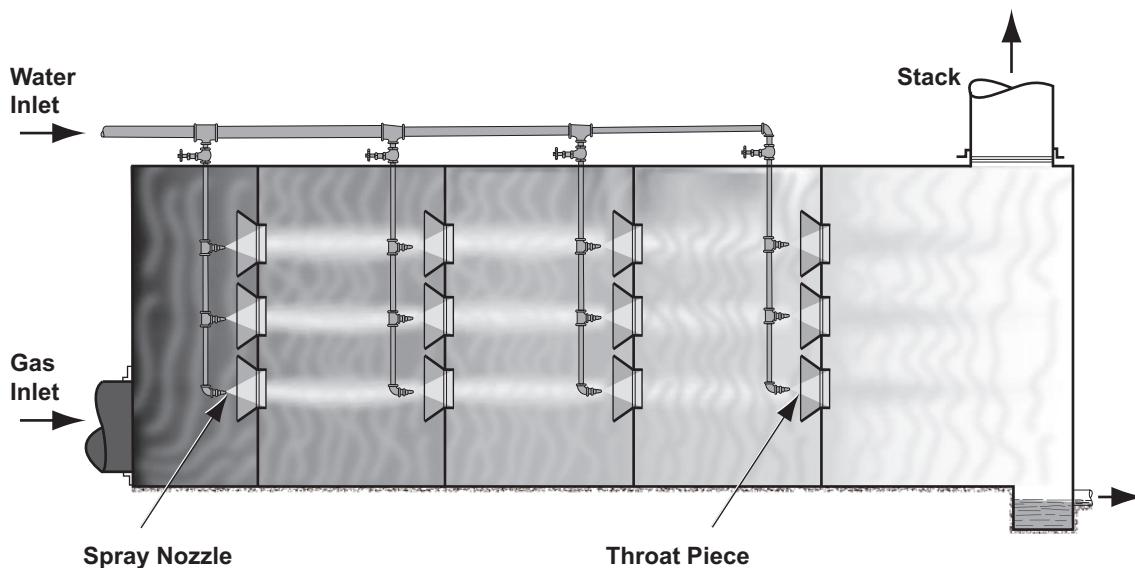
Gases are scrubbed by the action of the liquid spray which creates sufficient suction to entrain the gas and enter the throat piece where the gas and spray are mixed and the gas thoroughly scrubbed. With this system, gases cannot bypass the spray. Instead, due to the suction created by the spray, the passage of gas through the scrubbers is accelerated. High efficiency is obtained by using this type of unit due to the high impact of the spray particles, the large surface area of spray and the fact that all of the gas must pass uniformly through the spray.

**Dimensions**

Scrubber boxes are made by the customer to meet requirements. If required, S&K will provide dimensions to fit the application.

**Capacities**

Normal water consumption is 4.5 gpm at 40 psig for each No. 1 Throat Piece using the 3/8" Fig. 622H Nozzle. With the No. 2 Throat Piece, normal water consumption is 8.5 gpm at 40 psig using the 1/2" Fig. 622H.



Typical Fig. 7030 Venturi Chamber Scrubber

**FIG. 7030 VENTURI CHAMBER SCRUBBER SYSTEM**

The gas handling capacity of a No. 1 Throat Piece is 1500 cfm, and the gas handling capacity of a No. 2 Throat Piece is 3,000 cfm of gas. Using more than one No. 1 Throat Piece, capacities would be about as follows:

|              |   |                   |
|--------------|---|-------------------|
| <i>two</i>   | - | <i>3,000 cfm</i>  |
| <i>three</i> | - | <i>4,500 cfm</i>  |
| <i>four</i>  | - | <i>6,000 cfm</i>  |
| <i>five</i>  | - | <i>7,500 cfm</i>  |
| <i>six</i>   | - | <i>9,000 cfm</i>  |
| <i>seven</i> | - | <i>10,500 cfm</i> |

Using more than one No. 2 Throat Piece, capacities would be about as follows:

|              |   |                   |
|--------------|---|-------------------|
| <i>two</i>   | - | <i>6,000 cfm</i>  |
| <i>three</i> | - | <i>9,000 cfm</i>  |
| <i>four</i>  | - | <i>12,000 cfm</i> |
| <i>five</i>  | - | <i>15,000 cfm</i> |
| <i>six</i>   | - | <i>18,000 cfm</i> |
| <i>seven</i> | - | <i>21,000 cfm</i> |

Upon receipt of specific information, S&K will make recommendations regarding the scrubber design requirements.

**FIG. 622 SPRAY NOZZLE**

The S&K Fig. 622 Spray Nozzle used is considered standard for this equipment. This type is employed because it provides a medium coarse spray which is fine enough for efficient scrubbing yet not so fine as to make difficult the separation of water from air after scrubbing.

The nozzle consists of a body with tip, and a spiral. It is so designed that the angle and type of spray are correct for the size and the scrubber and the air handling and scrubbing contact requirements.

Although usually furnished in stainless steel, brass or PVC for the small sizes, these nozzles can also be furnished in cast iron, Monel, Teflon, hard rubber, molded neoprene, and in virtually any material.



Fig. 622. Photo and sectional view of S&K Spray Nozzle used as standard equipment on S&K Venturi Throat Scrubbers.

**FIG. 7025 PACKAGED SCRUBBER SYSTEM**

**Application**

The S&K Fig. 7025 Packaged Scrubber System is a completely “packaged”, movable gas scrubber separator system that is designed for use in pilot plants, laboratories, or temporary locations in full size processing plants. The Fig. 7025 Packaged Scrubber System uses water or other liquid to clean large quantities of objectionable gases that are inherent in most laboratories or processing applications.

**Construction**

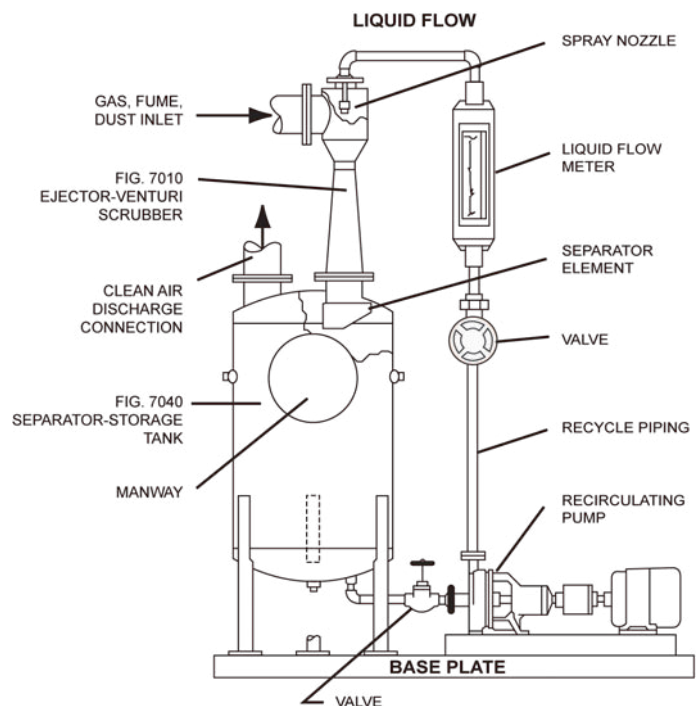
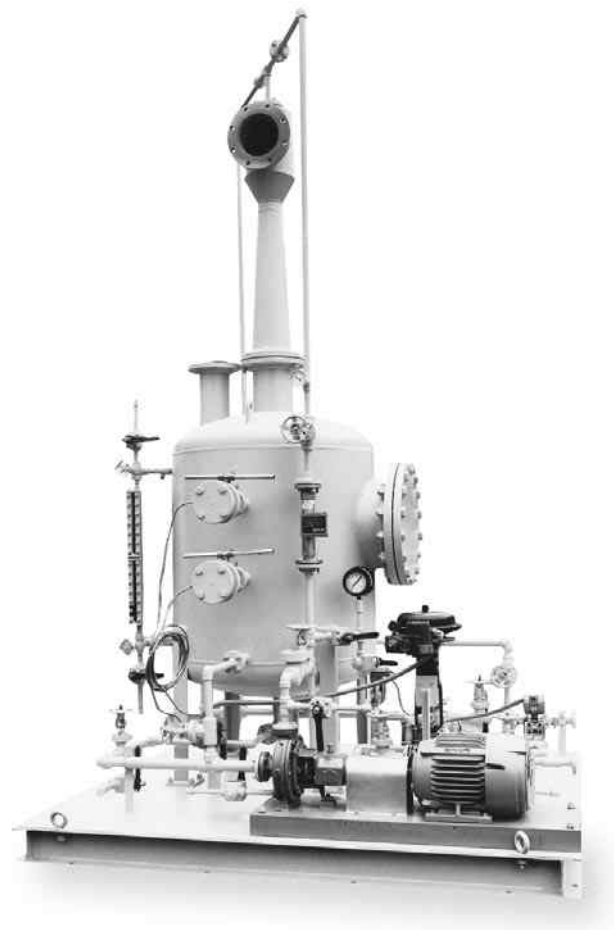
The Fig. 7025 Packaged Scrubber System can achieve contaminant removal efficiencies as high as 99.99% in many applications. This package typically consists of a Fig. 7010 Ejector Venturi Gas Scrubber and Fig. 7040 Separator with storage mounted on a steel baseplate. Depending on the customer’s requirements, pump and recirculating piping may be supplied. Optional accessories may include a heat exchanger, a level gauge or alarm or an additional liquid storage tank. Since all Fig. 7025 Packaged Scrubber Systems are custom sized and designed, design temperature and pressure will be accounted for on an individual basis.

The Fig. 7040 Separator uses a special S&K designed impact baffle separator element to direct the downward discharge of a Fig. 7010 Ejector Venturi Gas Scrubber through a turbulent 90 degree bend of direction into a sidewall. There, an inertial separation occurs as the impacted liquid drains downward and the gas stream, free of liquid, reverses its direction and heads out of the separator through a nozzle located opposite to the region of liquid-air impact.

**Advantages**

Fully customized, complete engineered solution. Versatile, flexible, and expandable. Tolerates system upsets.

The Fig. 7040 Separator is recommended whenever space for gravity separation is not possible, desirable, or combined discharge of the liquid gas streams is undesirable. The continued contact through the impact baffle aids scrubbing efficiency. The unit is more compact than a gravity or cyclonic separator. Units can be designed with or without liquid storage capacity.



## HOW THE EJECTOR-VENTURI SCRUBBERS WORKS

