Tri-Mer® Crossflow Scrubbers

High Efficiency Wet Scrubbers for Semiconductor Manufacturing, Metal Finishing, Chemical Processing

Design Criteria

Tri-Mer Crossflow Scrubbers operate at velocities between 150 and 500 ft./min. The exact velocity depends on these variables:

1. inlet load
2. outlet requirement (removal efficiency, generally expressed as a mass emissions number, such as lbs./hr.)
3. volumetric flow (CFM)
4. inlet gas temperature
5. total gas stream profile (residuals in gas stream in addition to the primary contaminant)
6. site constraints, such as height restrictions and other architectural/plant limitations.

Detailed Design Discussion

Velocity

The velocity through the scrubber is a key design element. Velocity translates into residence time. Residence time requirements in the system can vary from 1/2 second to several seconds. This time variable is specified by Tri-Mer engineering on an individual system basis.

Inlet/outlet load factors

For a specific system design guarantee, regarding removal efficiency, it is necessary to have a definition regarding input vs. output. This number is usually expressed as mass emission per hour in vs. out. Volumetric expressions, including ppmv, are also appropriate. With this information, as either a measured or calculated number, it is possible to provide a specific efficiency guarantee.

Volumetric flow

The gas flow through the scrubber system, expressed in cu. ft/min., is an important factor in the design of the scrubber vessel. Since residence time in the scrubber is a critical design consideration, the volume of air passing through the scrubber directly affects the cross sectional area.

Inlet gas temperature

Tri-Mer Crossflow Systems are engineered to accommodate inlet temperatures from ambient to over 2000°F. High temperature systems require a gas quench unit, integral to the system. In systems where elevated temperatures are, or could be present, it is important to know the temperature variables.

Gas stream profile

Understanding the gas stream variables, which include residuals riding in the gas stream in addition to the primary contaminant to be removed, is crucial. These residuals may not be of primary interest from the standpoint of removal efficiency, but could affect system chemistry, or, if particulates are involved, may restrict flow if not accommodated.

System blow-down rates

Each system's blow-down rate is determined by the specific chemistry involved within that scrubber. As an example, systems requiring low ppb outputs would require higher water blow-down capacities than systems operating with higher output dynamics. Specific multi-stage systems may require multiple blow-down points to a final treatment tank.

Liquid-to-gas ratio

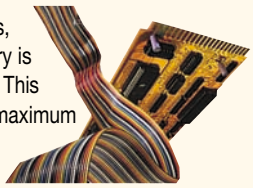
This ratio is determined by the items discussed earlier. System removal requirements (efficiency) will play an important role in determining this ratio. Tri-Mer engineering will be responsible for specific calculations.

System Mechanics

Control panels

All Tri-Mer scrubber packages are available with electrical control panels, which can incorporate the following features:

- Panel-mounted flowmeters, pH controls, flow indicators, ORP controls, alarms and auxiliaries.
- **PLC options.** Most customers specify a dedicated PLC control interface for scrubber operation. Auxiliary loop tie-ins can be made to specific plant processes, so that system chemistry is activated automatically. This provides the user with maximum control and flexibility.



Control screens

Tri-Mer CRT operator screens depict system status in full detail, in color, and in a form most useful to plant personnel. Valve positions, liquid and air flow conditions, pH, reduction or oxidation potential and other required parameters are available at-a-glance. System alarms and other process interrupt functions are detailed through the CRT.

Pre-wiring

Skid-mounted: Tri-Mer systems under 40,000 cfm are available completely skid-wired prior to shipment.

Larger systems: available pre-wired to terminal boxes specific to each piece of equipment. This greatly simplifies field wiring.

Piping

All piping modules depicted in this brochure are pre-assembled and pre-tested at Tri-Mer. Each piping module is carefully assembled, mated to the appropriate pump and coupled to the scrubber.

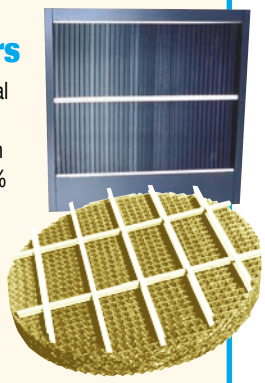
Piping materials typically supplied are PVC and FRP. Double-containment piping is available where codes require.

Packing

The standard random dump section of the wet scrubber system incorporates ultra high efficiency TRI-PACKS® tower packing, originally engineered for use with Tri-Mer's TRI-NOX® MULTI-CHEM™ system.

In the UltraScrub version, secondary stages incorporate a rigid packing section called RP1, developed by Tri-Mer for use in the staged interface design. RP1 insures molecular contact between the gas or fume being scrubbed and the ionized salts in a way that insures reliable low limit performance.

Mist eliminators



Mist elimination is a critical part of wet scrubber design. Tri-Mer's minimum design requirement is 95% on 10 micron droplets.

Higher efficiency mist eliminators are available for 99% at 2 microns for applications requiring extremely low output numbers and the highest degree of mist elimination. High efficiency mist eliminators are widely specified within the semiconductor industry.

Pumps

Pumps for the Crossflow scrubber systems are offered in two categories:

1. ANSI horizontal units
2. Vertical submerged head units

Exhaust blowers

In the Tri-Mer standard design, materials of construction include polypropylene, PVC or FRP. The inlet cone is laminar flow-molded; its bell-shaped design insures smooth air entry, with minimal system effect loss.

The impeller design is backwardly inclined, flat blade (or air foil wheel). Wheels are available in Class 2, 3 or 4 categories, depending on pressure requirements. Materials of construction for fan impellers are mild steel with FRP coating, stainless steel, and special alloys such as Hastelloy.

Standard arrangements include one and nine. Vibration isolation is available for the inlet and outlet duct; spring isolation is available for the fan base. The fan discharge depends on stack requirements and fan position. The fan package is then metered to the appropriate scrubber and tested.

Fabrication

The standard material of construction for Tri-Mer's crossflow system is UV-stabilized polypropylene. Optional materials include UV-stabilized PVC and alloys such as 316 stainless steel.

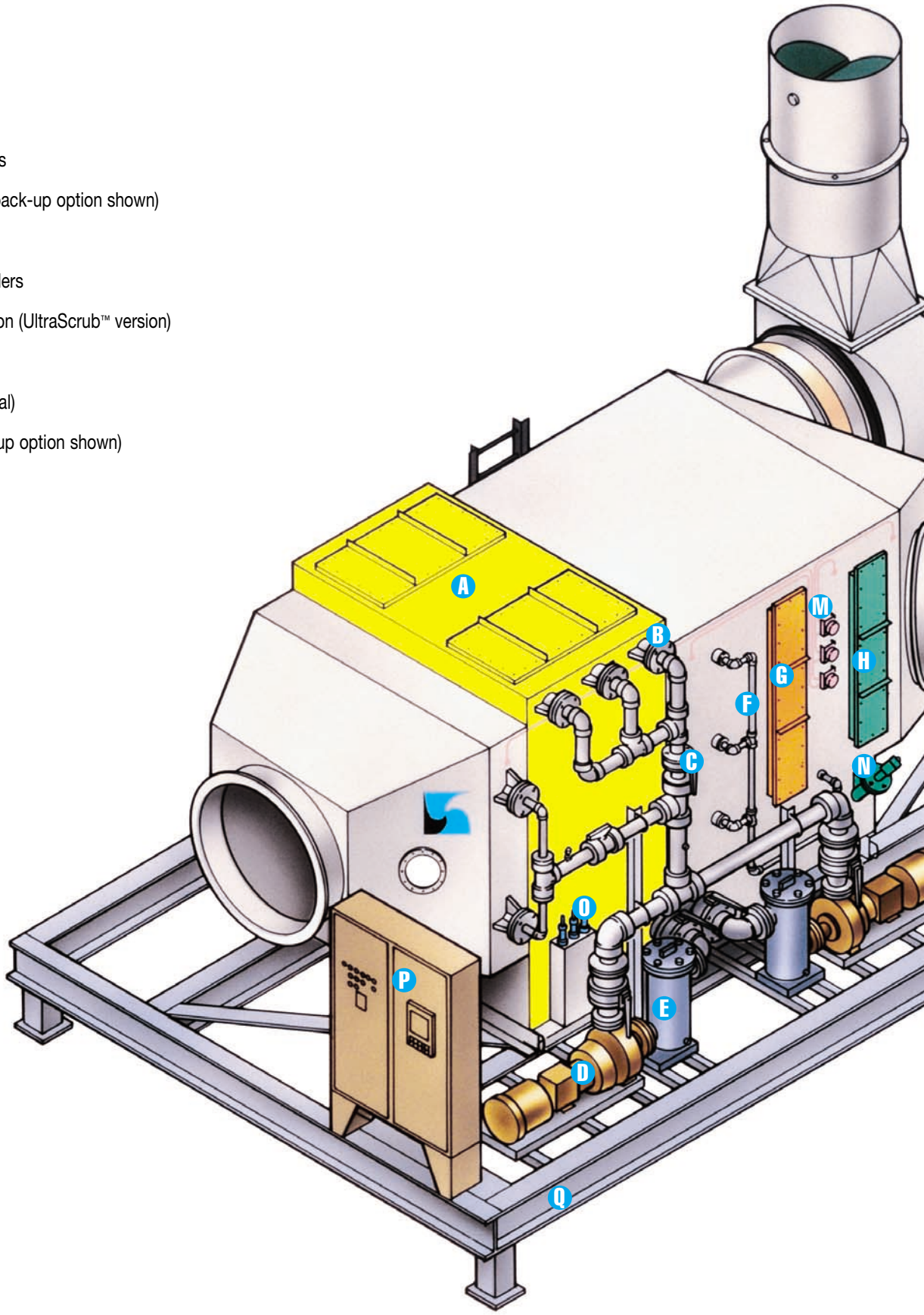
To assure highest strength at corners and seams, Tri-Mer technicians use programmable extrusion welding systems. The extrusion welder operates under high temperature and pressure, grinding and melting virgin polypropylene and extruding it through a die. The molten material is mated to virgin sheet stock to form a molecular bond equal in strength to solid sheet.

To insure seamless structural integrity, Tri-Mer technicians use specially engineered, programmable welders. A hot blade heats the material; when the blade is lowered, the system fuses the sheet ends, creating a bond equal in strength to seamless virgin grade material.

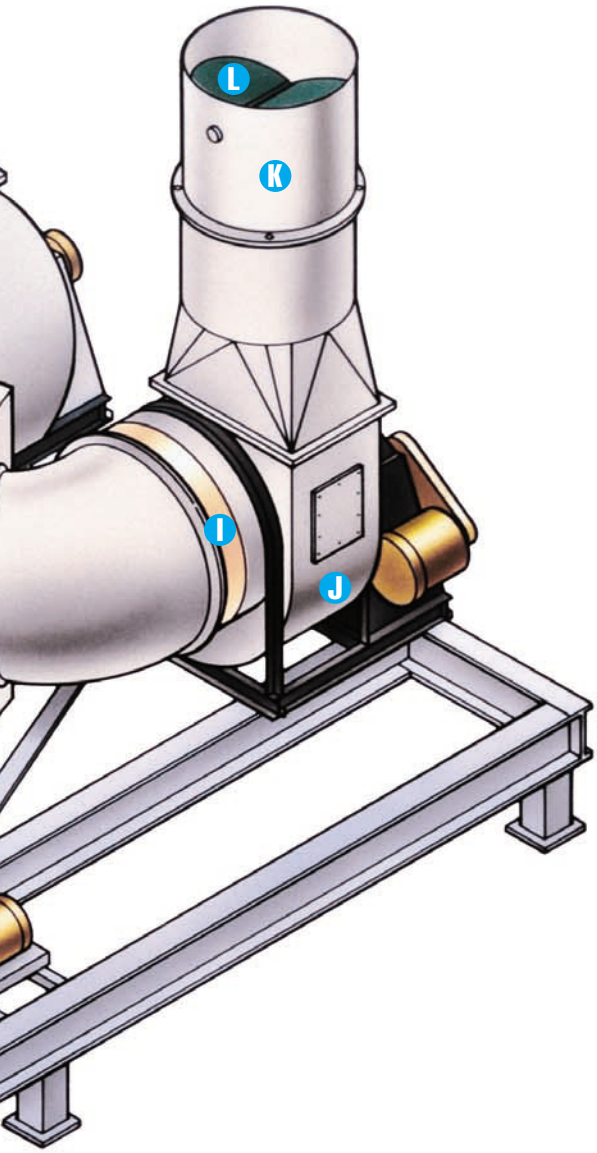
To insure full strength at all bend sites, Tri-Mer uses an automatic bend system. A heated knife serrates sheet stock at the bend site. When ejected, the machine creates a corner equal in strength to unfabricated virgin grade material. Corners formed in this manner eliminate corner welds, which inevitably cause structural weaknesses.

UltraScrub™ Model of Tri-Mer's Horizontal

- A Packed bed
- B Distribution headers
- C Recirculation piping & valves
- D Recirculation pumps (dual back-up option shown)
- E Basket strainers (optional)
- F Secondary pack spray headers
- G Second stage packed section (UltraScrub™ version)
- H Mist eliminator
- I Inlet control damper (optional)
- J Exhaust blower (dual back-up option shown)
- K Exhaust stack
- L Butterfly dampers (optional)
- M Pressure drop indicators
- N pH probe
- O Level switches
- P Control panel
- Q Support frame (optional)

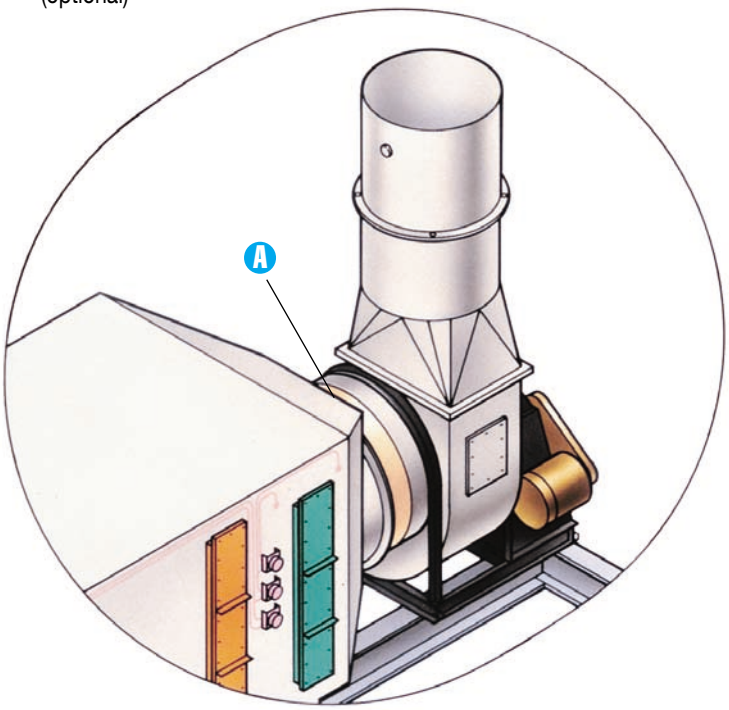


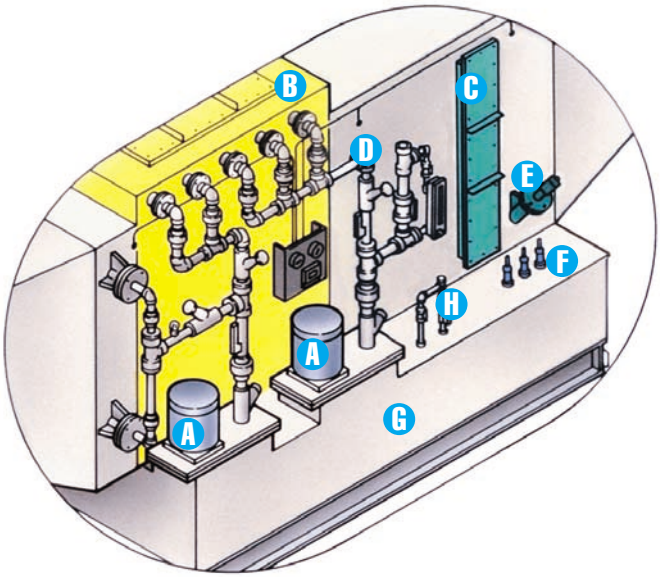
Crossflow



UltraScrub™ Showing Single Fan Installation

Ⓐ Manual or automatic damper (optional)





Horizontal Crossflow Scrubber – Vertical Pump Option

Ⓐ Vertical pumps
Ⓑ Packed bed
Ⓒ Mist eliminator
Ⓓ Piping package
Ⓔ pH probe
Ⓕ Level controls
Ⓖ Internal recirculation tank
Ⓗ Fresh water make-up

Internal Tank/ANSI Pumps

This version of the horizontal packed scrubber system incorporates standard ANSI pumps, which recirculate the scrubbing liquor. Pump construction is based on specific chemistry; standard pump heads are available in FRP, polypropylene and stainless steel. Other materials are available for unique applications.

Recirculation tank

The recirculation tank in this model is designed internal to the system. Tank dimensions are determined by the scrubber model and will vary in capacity.

Piping

Recirculation piping, valves and auxiliaries are constructed of materials compatible with the application. ANSI pump versions can incorporate basket strainers or Y strainers, flow sensor fittings, pressure gages and other options.

Scrubber internals

The standard scrubber uses ultra high efficiency TRI-PACKS® random dump packing in depths from 2' to 15' or more, depending on the application.

Internal Tank/Vertical Pumps

This option uses various lines of standard, corrosion-resistant vertical recirculation pumps. These pumps are incorporated into the design of the scrubber and are rigidly mounted as a unit on the scrubber body. This precludes the need for suction piping, because the pump head is submerged in the recirculation liquor. Alternatives for construction of the pump head generally include polypropylene, PVC and CPVC.

Vertical pumps can be installed in a series, with two or more pumps mounted on larger systems, in order to increase recirculation flow rates to meet high demand, or provide pump redundancy.

Recirculation tank

In this version, as in the ANSI version discussed above, the recirculation tank is internal to the scrubber. Pumps and residual hardware are mounted to the recirculation tank, which allows the smaller systems to be skid-mounted and pre-piped.

Piping

Piping modules are mounted to each vertical pump, supplying recirculation liquor to the scrubber. In versions where multiple pumps are installed, each has a dedicated supply piping system. Auxiliaries such as flow sensors, control valves and pressure gages are available.

External Recirculation System – Dry Sump

This version of the horizontal system is available with ANSI or vertical pump systems. The system is not limited in size by the type of pump available. Both large capacity ANSI and vertical pumps are available in this version. Standard pump materials of construction for both versions include FRP, polypropylene and stainless steel.

Recirculation tank

The recirculation tank in this version is located remotely from the scrubber. As an example, the scrubber can be located on the roof, with the recirculation system on the factory floor. This allows easiest access for maintaining pH controls, chemical feed systems, valves, pumps and associated peripherals. This system is widely specified by users in cold climates and wherever freeze conditions exist.

Piping

Piping packages for the remote tank versions connect the scrubber feed and drain piping, unifying the system into a single operating package. Materials of construction vary with the application and typically include PVC and FRP. Standard peripherals are available as described in the above two sections.

UltraScrub™

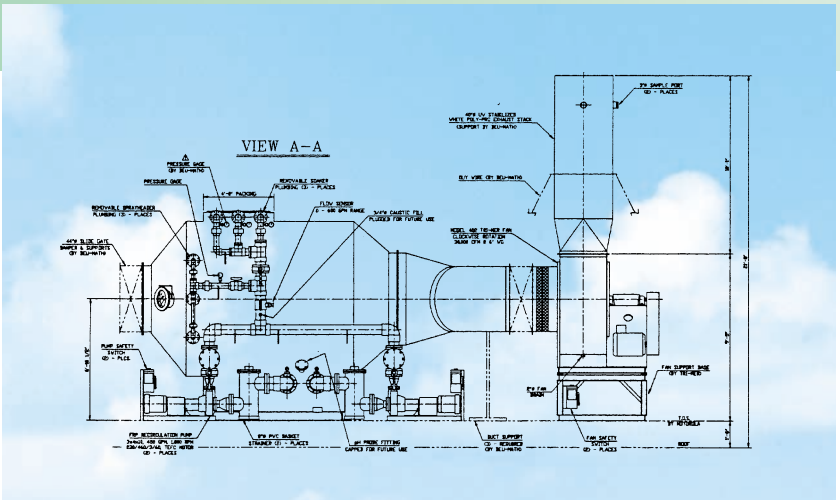
This option incorporates rigid packed staged gas flow compression.

Mist eliminators

Rigid frame mist eliminators are featured in the system's design, insuring zero droplet carry-through.

System capacities

250 cfm through 100,000 cfm for all systems.



Scrubber internals/ mist eliminators

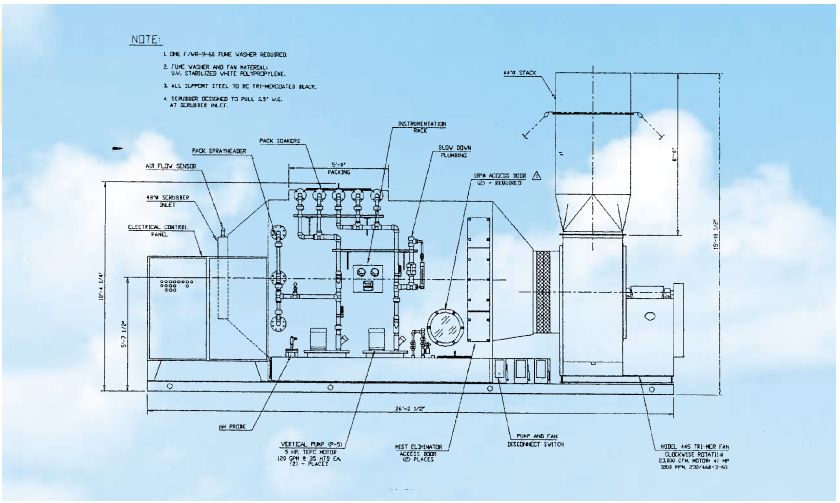
This version features the same options as the ANSI version.

UltraScrub™

This option incorporates staged gas flow compression.

Capacities

The vertical pump version is generally available from 50 cfm through 40,000 cfm. Larger capacity systems usually require ANSI pumps for most efficient operation.

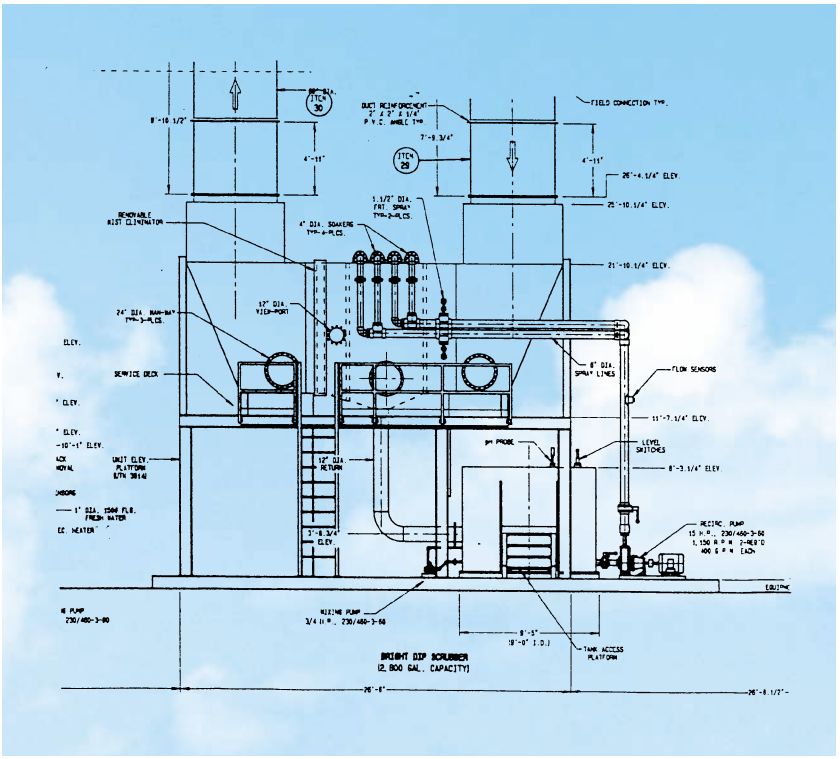


Scrubber internals/mist eliminators

This Tri-Mer model is also available in three versions including single stage units, multi-stage wet sections, and the UltraScrub™ option. This version has a long, successful track record with multi-stage wet scrubbing processes, which incorporate technologies developed by Tri-Mer for industrial odor control. It is also a model capable of incorporating TRI-NOX® MULTI-CHEM™ technology, which requires two or three stages.

Capacities

System capacities are theoretically unlimited; however, due to shipping restrictions, 120,000 cfm is a recommended limit for standard fabrication of individual units.



Technical Data

Model #	Typical Air Flow Through Scrubber *1*	Internal Recirculation Tank With Ansi Pumps	Internal Recirculation Tank With Vertical Pumps	External Recirculation Tank – Dry Sump Scrubber	Typical Recirculation Tank Size *3*
C/F *8*	CFM	L x W x H *2,5,6*	L x W x H *2,5,6*	L x W x H *2,5,6,7*	Diameter x H
1	50 - 100	7'-10" x 3'-2" x 2'-6"	7'-10" x 3'-0" x 2'-6"	6'-6" x 1'-0" x 2'-0"	1'-6" x 2'-0"
2	100 - 300	7'-10" x 3'-6" x 2'-6"	6'-6" x 4'-0" x 3'-0"	6'-6" x 1'-6" x 2'-0"	1'-6" x 2'-0"
3	300 - 500	7'-10" x 3'-6" x 2'-10"	6'-6" x 4'-0" x 3'-4"	6'-6" x 1'-8" x 2'-0"	1'-6" x 2'-6"
4	500 - 1000	7'-10" x 3'-6" x 3'-4"	6'-6" x 4'-0" x 3'-10"	6'-6" x 2'-0" x 2'-4"	1'-6" x 2'-6"
5	1000 - 2000	7'-10" x 4'-4" x 4'-0"	7'-0" x 4'-10" x 4'-6"	7'-0" x 3'-0" x 2'-8"	1'-6" x 2'-6"
6	2000 - 3000	7'-10" x 5'-0" x 4'-8"	7'-0" x 5'-6" x 5'-2"	7'-0" x 3'-2" x 2'-8"	2'-0" x 2'-6"
7	3000 - 5000	9'-10" x 6'-6" x 5'-2"	7'-6" x 7'-6" x 6'-0"	7'-6" x 4'-2" x 3'-2"	2'-0" x 2'-6"
8	5000 - 7000	10'-10" x 6'-10" x 5'-11"	7'-6" x 7'-10" x 6'-9"	7'-6" x 4'-6" x 4'-0"	2'-6" x 2'-6"
9	7000 - 9000	10'-10" x 7'-6" x 6'-4"	8'-0" x 8'-6" x 7'-2"	8'-0" x 5'-6" x 5'-4"	3'-0" x 2'-6"
10	9000 - 11,000	10'-10" x 7'-8" x 6'-10"	8'-0" x 8'-8" x 7'-8"	8'-0" x 6'-0" x 5'-8"	3'-0" x 3'-0"
11	11,000 - 14,000	11'-10" x 8'-6" x 7'-6"	8'-6" x 9'-6" x 8'-4"	8'-0" x 6'-6" x 6'-2"	3'-0" x 3'-6"
12	14,000 - 17,000	13'-0" x 11'-0" x 9'-0"	9'-0" x 11'-6" x 9'-10"	9'-0" x 9'-0" x 7'-6"	3'-6" x 3'-6"
14	17,000 - 20,000	13'-0" x 11'-6" x 9'-6"	9'-6" x 12'-0" x 10'-4"	9'-6" x 9'-0" x 7'-8"	3'-6" x 4'-0"
15	20,000 - 24,000	13'-0" x 11'-6" x 9'-6"	10'-0" x 12'-0" x 10'-4"	10'-0" x 9'-0" x 8'-0"	3'-6" x 4'-0"
16	24,000 - 28,000	14'-4" x 11'-7" x 10'-6"	10'-0" x 12'-1" x 11'-4"	10'-0" x 9'-6" x 8'-2"	3'-6" x 4'-6"
17	28,000 - 32,000	14'-4" x 11'-8" x 10'-6"	10'-0" x 12'-2" x 11'-4"	10'-0" x 9'-8" x 8'-6"	3'-6" x 4'-6"
18	32,000 - 40,000	14'-4" x 13'-11" x 10'-8"	11'-6" x 14'-5" x 11'-6"	11'-6" x 10'-0" x 9'-0"	4'-0" x 4'-6"
19	40,000 - 50,000	15'-4" x 16'-0" x 11'-0"	11'-6" x 16'-6" x 12'-0"	11'-6" x 11'-6" x 10'-6"	4'-6" x 5'-0"
20	50,000 - 60,000	16'-4" x 19'-0" x 11'-6"	N/A	12'-6" x 14'-0" x 11'-0"	5'-0" x 5'-0"
21	60,000 - 70,000	16'-4" x 22'-6" x 11'-6"	N/A	14'-0" x 17'-0" x 11'-0"	6'-0" x 5'-6"
22	70,000 - 80,000	19'-0" x 24'-0" x 12'-0"	N/A	15'-6" x 19'-6" x 11'-0"	6'-0" x 6'-0"
23	80,000 - 90,000	19'-0" x 27'-0" x 12'-0"	N/A	16'-0" x 20'-0" x 11'-0"	6'-0" x 6'-6"
24	90,000 - 100,000	19'-8" x 29'-0" x 12'-0"	N/A	18'-0" x 28'-0" x 11'-0"	6'-6" x 6'-6"
25	100,000 - *4*	*4*	N/A	*4*	*4*

NOTES:

1. Chart based on approximately 300-450 fpm velocity.
2. Chart dimensions are approximate. Consult Tri-Mer sales engineering for exact size based on performance requirements. Chart dimensions based on 5'-0" packing depth.
3. Recirculation tank size will depend on application, use chart for typical requirements.
4. For applications over 100,000 cfm consult Tri-Mer sales engineering for best options.
5. In all cases UltraScrub® will add 3'-6" to overall length.
6. Dimensions do not include fan. Consult Tri-Mer sales engineering for single and dual fan dimension data.
7. Height dimension does not include external recirculation tank.
8. Consult Tri-Mer sales engineering for recirculation rates, pump and fan h.p.

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