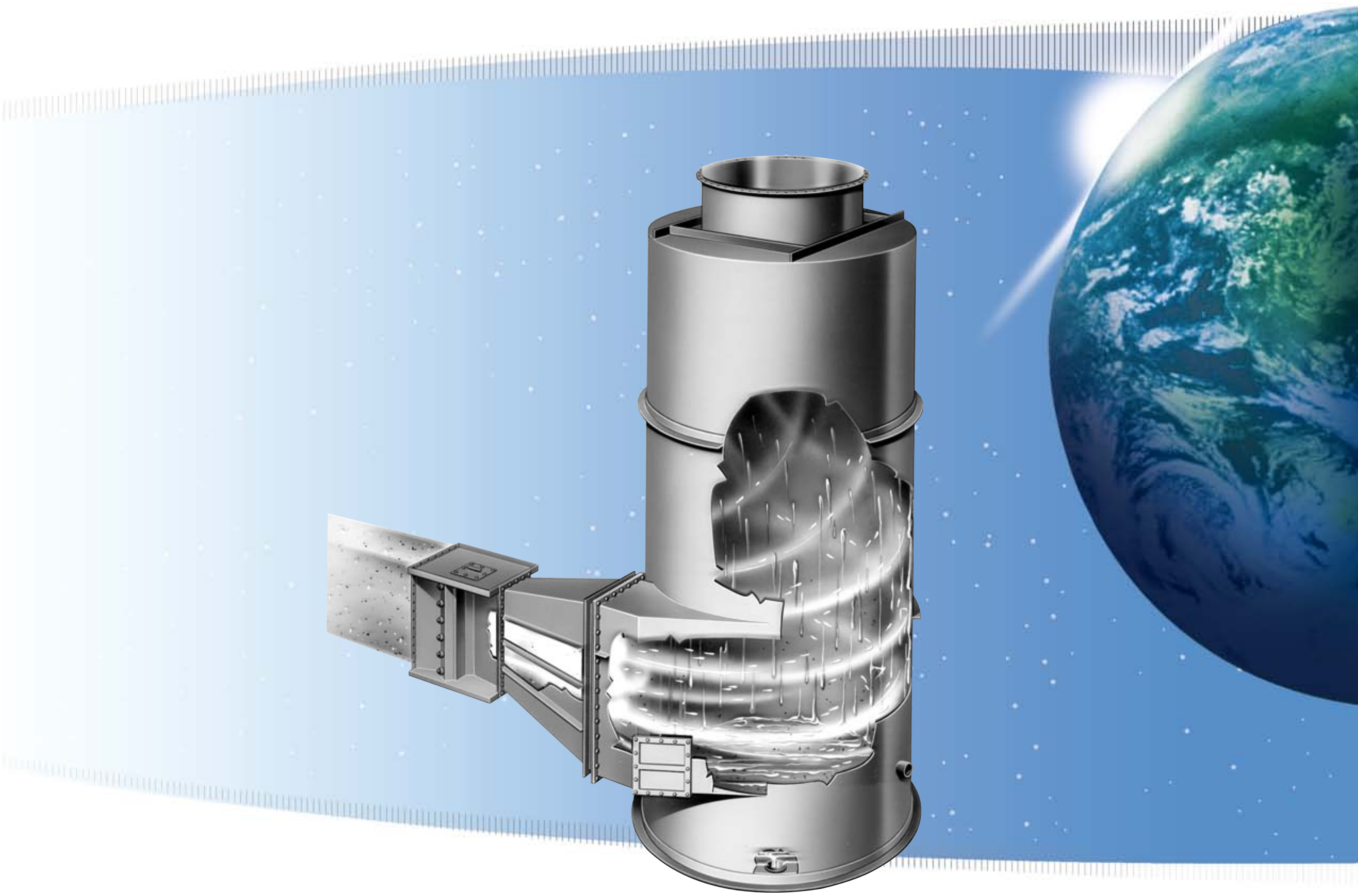


AmericanAirFilter®

KinPactor®

Venturi-Type Wet Dust Collector

Better Air is Our Business®

AAF® INTERNATIONAL

AmericanAirFilter®

KinPactor®

Venturi-Type Wet Dust Collector

Operating Principle

The KinPactor® utilizes kinetic energy to accomplish dust collection through the principle of impaction. The contaminated gas stream is accelerated through a venturi shaped throat section reaching velocities between 9,000 and 24,000 feet per minute (100 to 280 miles per hour). Water introduced ahead of the throat is atomized by the high velocity gas stream, and dust particles collide with and are captured in the millions of small droplets.

In the long diverging section behind the KinPactor throat, static pressure is regained as the velocity of the gas stream is reduced. Sub-micron size particulate and water droplets coalesce during this interval providing additional collection.

The water laden gas stream enters the separator tangentially where droplets are removed by centrifugal force and impingement. Clean, droplet-free air passes through the separator outlet and slurry is continuously drained from the water eliminator section.

Why the Venturi Shape?

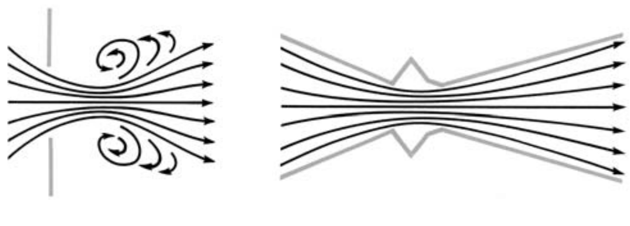
Orifice-type wet collectors have been widely used for many years and depend on the mechanisms of inertial impaction, direct interception, and coalescence to collect dust or fume. The AAF KinPactor and the orifice type employ kinetic energy of the gas stream to create the conditions required for gas cleaning as follows:

1. Pressure, potential energy, is produced in the gas stream by an air mover such as a centrifugal exhauster.
2. The potential energy is used to force the gas stream through a constriction or orifice. This is the conversion of potential energy (static pressure) into kinetic energy (velocity).
3. Water is introduced at or ahead of the orifice by various methods and the high gas velocity fragments or atomizes the water into millions of tiny droplets.
4. Since the water droplets have a low velocity relative to dust or fume particulate which has the same high velocity as the gas stream, these particles collide with and are captured in the water droplets.

The venturi shape of the KinPactor provides the most efficient conversion of potential energy (static pressure) into kinetic energy (velocity), and then allows maximum regain or reconversion of this high velocity back to static pressure as velocity diminishes in the diverging section.

Many orifice-type collectors utilize a construction shape somewhere between that of the sharp edged orifice and the venturi, and demonstrate a more efficient energy conversion than the sharp edged orifice but less efficient conversion than the KinPactor. Due to its higher performance capabilities, the venturi-type collector has been categorized in its own classification rather than grouped with the orifice type. The KinPactor, with its venturi shape, provides the highest possible collection efficiency for a given power consumption, since the power expended is most effectively utilized.

Sharp Edge Orifice vs. KinPactor



A. Sharp edged orifice shown in cross section with air passing through it. The air stream obtains a cross section which is smaller than the orifice and is referred to as the "Vena Contracta." Here, maximum velocity occurs. High shock losses are encountered as the gas converges abruptly to enter the orifice.

B. KinPactor cross section (using venturi shape) shown with air passing through it. The venturi cross section follows the contour of the stream lines and the "Vena Contracta" occurs in throat area of KinPactor. Angle of KinPactor diverging section allows maximum reconversion of velocity pressure to static pressure. Shock losses are minimized with shaped inlet.

Horsepower vs. Collection Efficiency

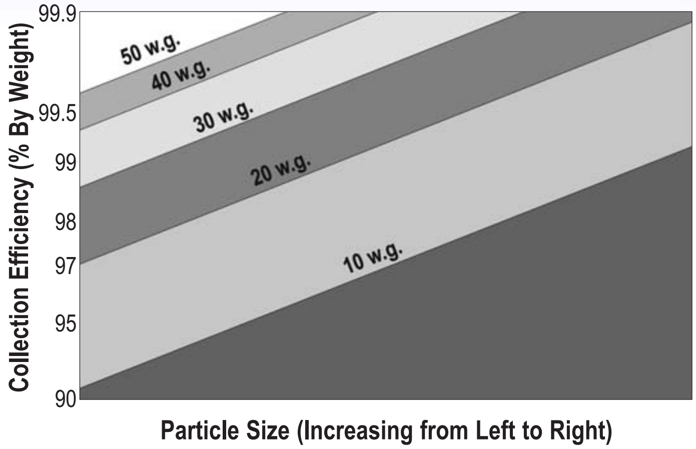
Collection efficiency is a function of the energy expended in the air to water contact process. Higher energy consumption provides more violent interaction and greater collection efficiency for a given particle size. Pressure drop is a measure of the energy used and is directly proportional to the power required. Since this power must be supplied at the air mover (fan or compressor), higher collection efficiencies are obtained at the expense of higher power costs. Using the minimum pressure drop which provides required efficiency - for the particle size distribution which exists - ensures most economical equipment and operating cost.

Pressure Drop

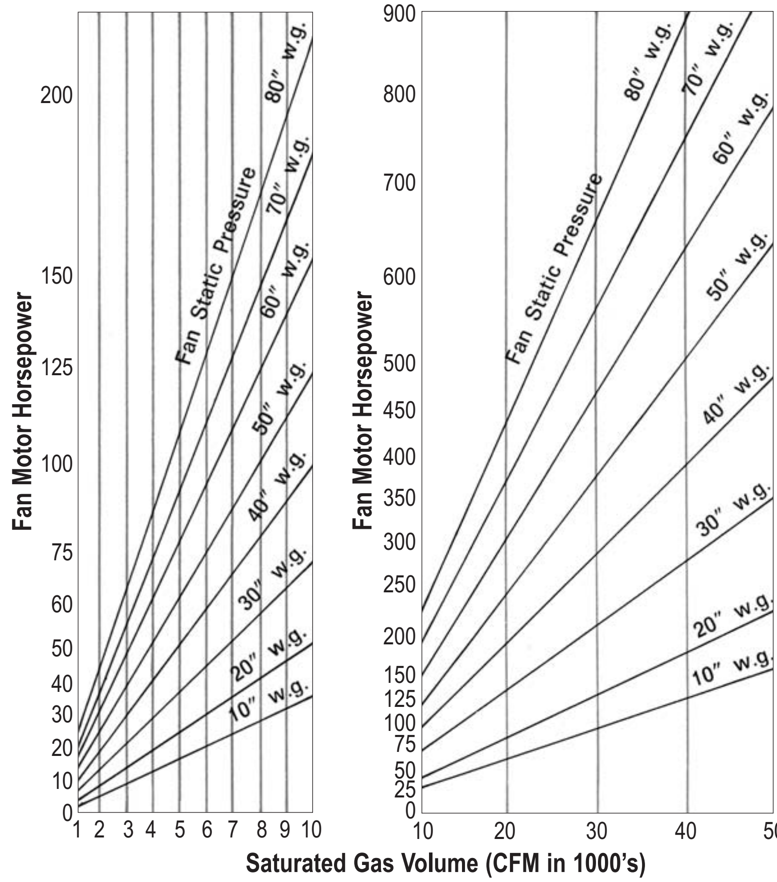
Pressure drop is the difference between inlet and outlet static pressures as measured across the KinPactor throat. The required pressure drop varies from application to application and is selected on the basis of desired efficiency and particle size distribution.

The KinPactor will cool incoming gas, by evaporation, to saturation and the saturated gas volume must be used to determine actual flow. When air entering the KinPactor is at an elevated temperature, horsepower read from this chart is the operating requirement and does not allow for higher requirement when cool air is handled at startup. Chart is only an approximation since a fan efficiency is assumed.

Collection Efficiency and KinPactor Pressure Drop



Typical Horsepower Requirements



Typical horsepower requirements versus volume and static pressure. Fan static pressure is KinPactor pressure drop plus external resistance of hood, ductwork, and water eliminator.

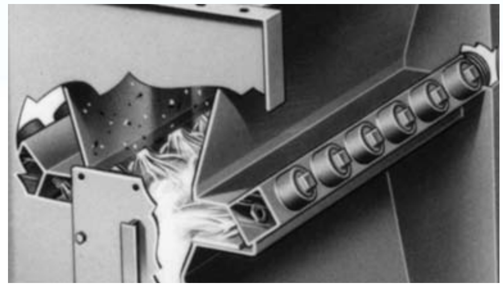
Unique Water Injection System and Water Requirements

A new concept for injection of water is used. The water is injected in the form of sheets rather than solid jets or sprays. This sheet is introduced forcefully, under pressure, to achieve optimum trajectory and complete throat coverage. There are no void areas through which the contaminated gas can bypass.

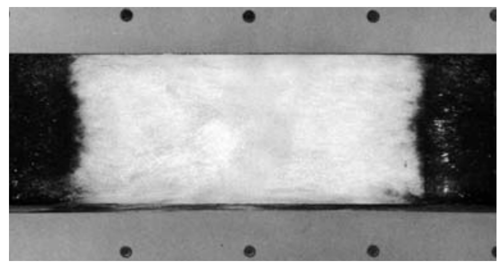
Water requirements for the KinPactor range from 6 to 12 gal/1000 cu. ft. of gas. Water can be recirculated if sufficient make-up to replace evaporation losses is added. The recirculating system must contain some means of clarification or at least be designed to limit the concentration of suspended solids.

Normal pressure requirement is 40 psig at the KinPactor supply manifold. Where recirculated water is anticipated to be quite dirty, larger jets with lower pressure requirements may be provided.

AAF, with more than 70 years experience in the application of wet collectors, can provide engineering know-how in the design of water recirculation systems.

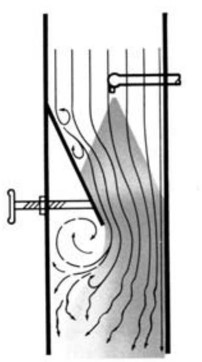


Injection system for the KinPactor. Manual reamers are an optional accessory. The relatively large diameter of the jets and the use of reamers allow recirculation of water without concern for pluggage.

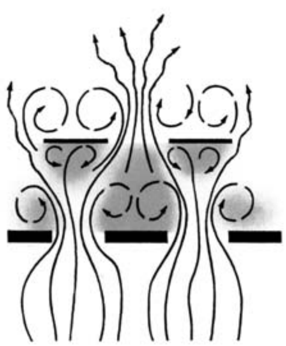


View into the KinPactor inlet, as the dirty incoming air would see it. This picture of a full-scale KinPactor shows clearly the complete water coverage of the throat area.

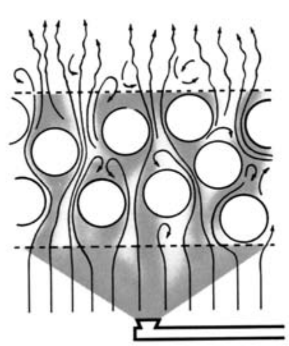
Typical "High Energy" Wet Collectors



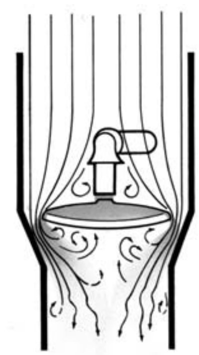
Damper Type



Orifice/Baffle Type



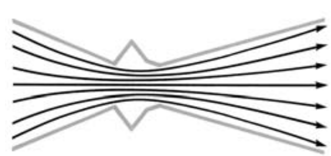
Sphere Type



Annular Slot

All of the above demonstrate high shock loss at the inlet as air converges without the benefit of a shaped entrance. Eddy currents exist within the air to water contact zone presenting voids and increased pressure loss. As a result of the abrupt enlargement of the air stream, extreme turbulence occurs behind the water contact region, thus eliminating the possibility of regain.

The venturi shape of AAF's KinPactor combines efficient conversion of pressure into velocity with maximum regain and complete coverage of the collection zone with low velocity water droplets.

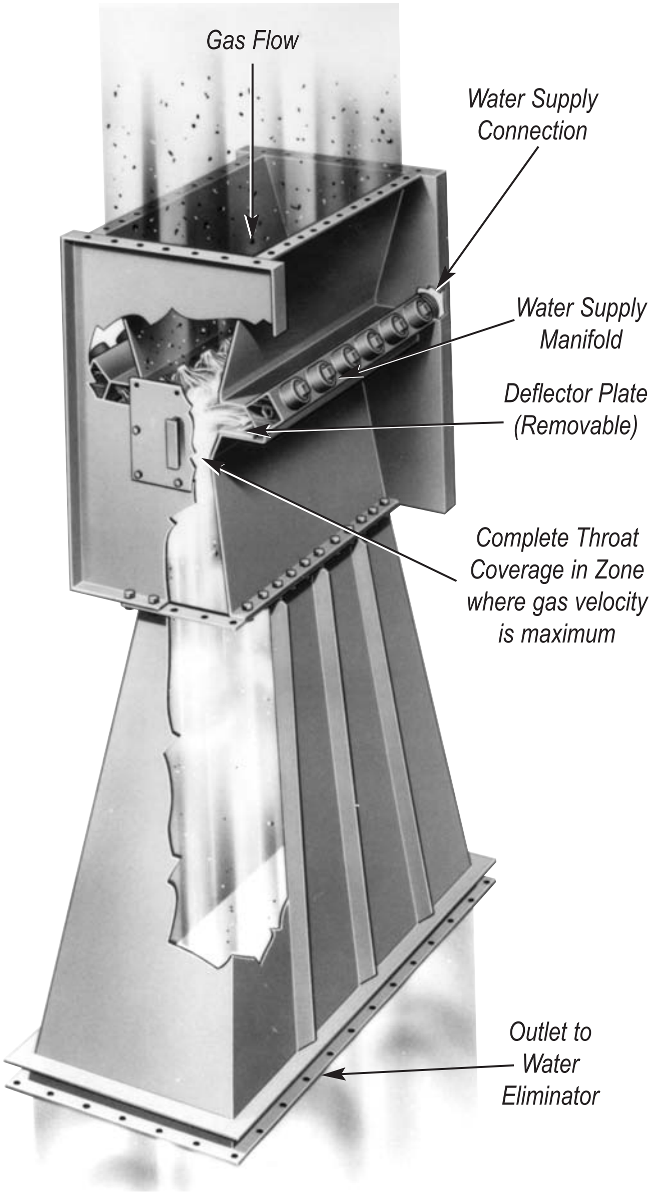


High energy consumption does not necessarily mean effective utilization and a comparable collection efficiency.

The KinPactor has been designed to provide the high degree of collection efficiency required for difficult air pollution problems. Considered to be one of the most sophisticated of wet collectors from a performance standpoint, it is still operationally simple, rugged, and dependable.

- Deflector plates are provided ahead of the throat section which are easily replaceable.
- Manual reamers can be provided for insurance against jet pluggage due to solids in recirculated water.
- Other than the reamers there are no moving parts in the standard KinPactor. A variable throat design is available if operating conditions should indicate the need for such an arrangement.
- The KinPactor has been fabricated of mild steel, stainless steel, and fiberglass reinforced polyester. This choice allows economical selection of the proper materials if corrosive agents are present.

The KinPactor is the heart of the collection system; but since its purpose is only to collect dust within the water droplets, it must be followed by an entrainment eliminator or separator.



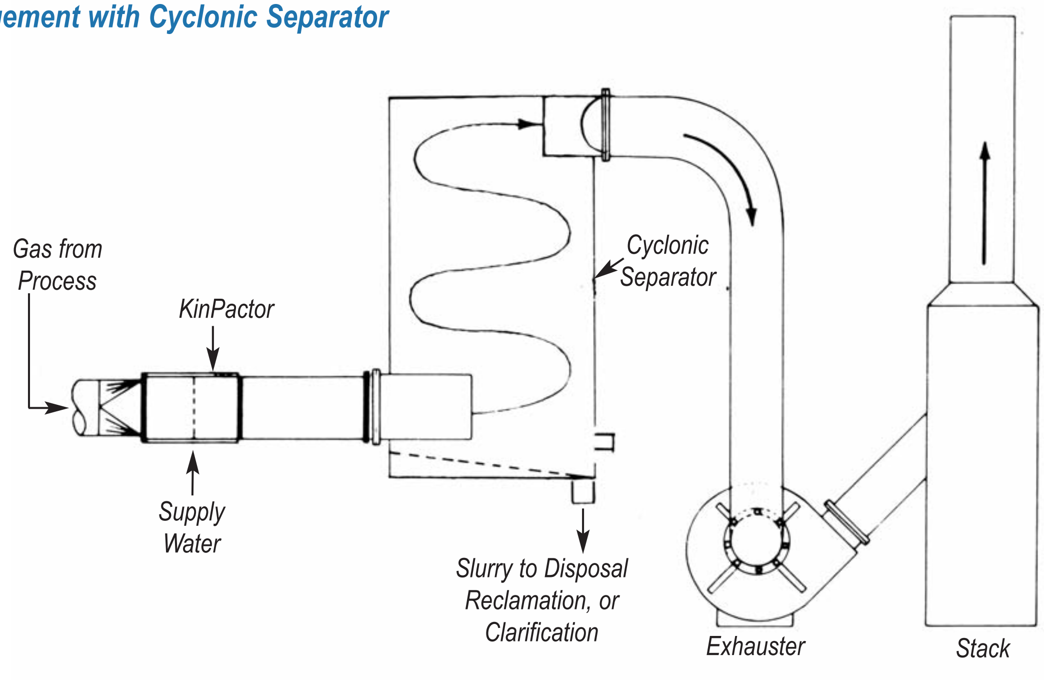
Cyclonic Separator

The Separator uses the principle of cyclonic action to separate the dust laden water droplets from the gas stream. The air enters the lower portion of the separator tangentially. Centrifugal force is employed to capture the water droplets on the sides of the separator's cylindrical housing and the captured water droplets are eliminated through a drain in the bottom of the separator. The clean dry gas stream is discharged out of the top portion of the Cyclonic Separator by either a side or a top outlet.

The Cyclonic Separator offers maintenance free operation because of its simplicity of operation. There are no moving parts or small air passages to plug. An access door is provided on the air inlet for easy entry into the separator's interior. The cost is up to 50% less than conventional water eliminators.

The choice of materials of construction includes mild steel, 304 or 316 stainless steel, and fiberglass reinforced polyester.

Typical Arrangement with Cyclonic Separator



KinPactor Size Selection

Size is selected on the basis of exhaust volume and the operating pressure drop required to achieve a desired degree of collection efficiency. With other types of equipment, designed to operate at one pressure drop with fixed performance, it is simply a matter of selecting required size for a given exhaust volume. While KinPactor sizing may seem complicated, it offers the advantage of ensuring adequate collection efficiency and minimum power consumption.

The sizing procedure which follows is considered an approximation. AAF engineers will make the necessary detailed calculations to determine actual size.

The following data must be determined to select the correct KinPactor size:

1. KinPactor pressure drop
2. Saturated gas volume
3. Saturated gas density factor

From experience in many applications fields, AAF can usually provide data on required pressure drop.

Items 2 and 3 are most easily determined from a Psychrometric Chart, if the actual gas volume and its condition of temperature and humidity are known. Any **two** of the following variables will establish the quality of an air stream and allow location on the psychrometric chart:

- Dry bulb temperature
- Wet bulb temperature
- Pounds of water per pound of dry air
- Dew point temperature
- Density of mixture
- Humid volume - cubic feet per pound dry air

With the above data the inlet condition can be plotted on a psychrometric chart, as for example, Point #1 in the chart below. The evaporation process through KinPactor is, for all practical purposes, adiabatic, and humidification is complete to saturation. Therefore, inlet gas is cooled along a constant wet bulb line to saturation or Point "S."

The saturated gas volume, Qs, is equal to the inlet volume multiplied by the ratio of humid volumes,

$$\frac{\text{Humid Volume "S"}}{\text{Humid Volume \#1}}$$

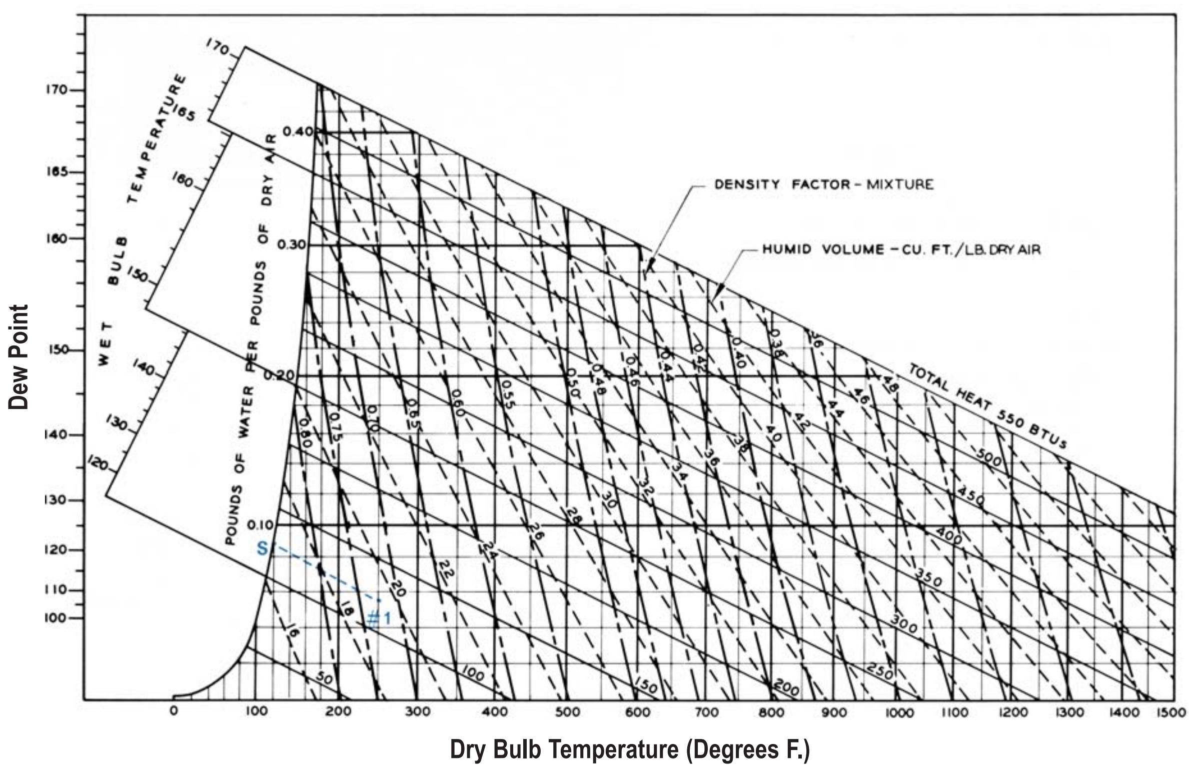
Humid volumes are read from the chart.

$$Qs = \frac{hv_s}{hv_1} \text{ x inlet volume} \qquad \text{Eq. 1}$$

Saturated gas density factor can be read directly from the chart at Point "S". Knowing KinPactor pressure drop - △ P, saturated gas volume - Qs, and saturated gas density factor - dfs, the KinPactor size can be approximated from the KinPactor Sizing Chart on the next page.

Psychrometric Chart for Humid Air

Based on One Pound Dry Weight



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Cyclonic Separator Size Selection

The cyclonic separator size required is determined by dividing the actual gas volume passing through the separator by 100. When the size selected falls between two standard sizes, the larger size must be used. Cyclonic separator pressure drop is 2.5" w.g.

CAUTION: The procedures shown in the example problem below are an approximation, good enough to allow preliminary discussion, but inadequate for design work.

Example Problem

Given: 21,100 ACFM air at 250°F dry bulb and 120°F wet bulb. The application calls for KinPactor pressure drop of 25" w.g.

Solution: From the Psychrometric Chart, Point #1 (250°F db and 120°F wb), read inlet humid volume, hv_1 = 19.4 ft^3/lb. dry air. Move along constant wet bulb temperature line to saturation, Point "S", and read saturated humid volume, hv_s = 16.6 ft^3/lb. dry air.

From Eq. #1 Saturated volume,

$$Qs = \frac{16.6\ ft^3/lb.\ dry\ air}{19.4\ ft^3/lb.\ dry\ air} \times 21{,}100\ ACFM = 18000\ CFM$$

From the Psychrometric Chart, Point "S," read saturated density factor, dfs = 0.87

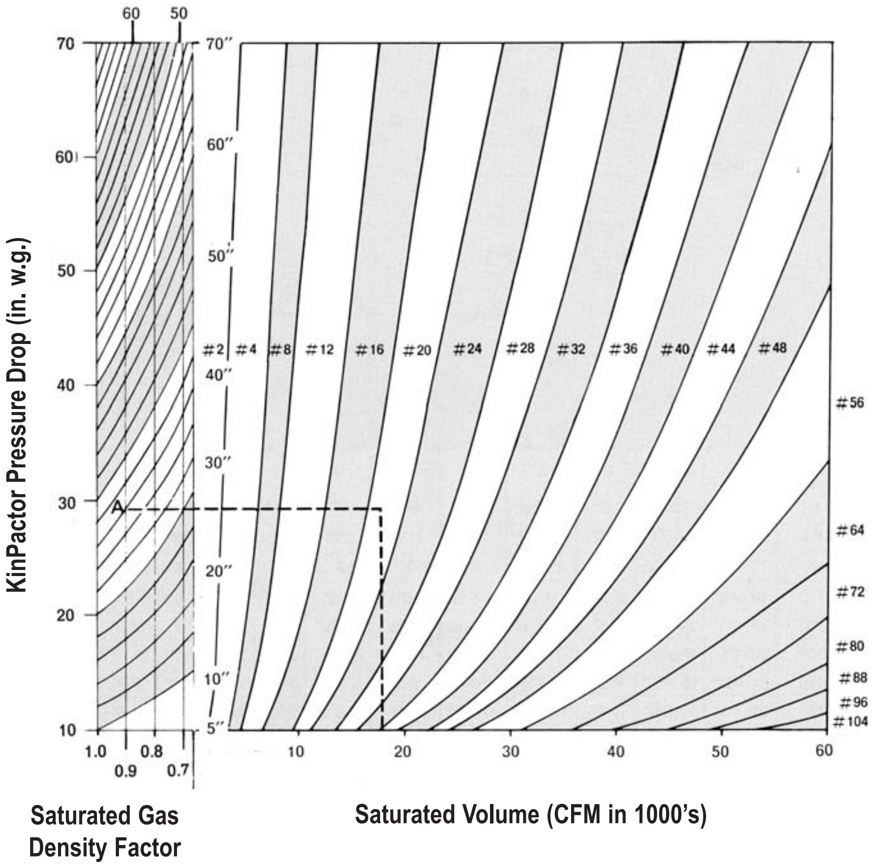
Enter KinPactor sizing chart below, with dfs = 0.87 and KinPactor pressure drop = 25" w.g. to locate Point "A". KinPactor size is found at intersection of horizontal line through Point "A" and vertical line through saturated volume of 18000 CFM. A Size #20 KinPactor is required.

Cyclonic Separator

$$\text{Cyclonic separator for size \#} = \frac{18{,}000}{100} = 180$$

A size #230 cyclonic separator is required. Separator pressure drop = 2.5" w.g.

KinPactor Sizing Chart



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