TM-1. TECHNICAL INTRODUCTION.

The Aerosizer particle measuring system is capable of measuring individually the size of particles in the range of less than 0.2 to 700 micrometers. The particles may be in the form of a dry powder, may be suspended in a gas, or may be sprayed from a liquid suspension. When the particles enter the sensor region, they are in the form of an air suspension.

The Aerosizer's Aerodynamic Time of Flight measurement technique was developed by Dr. Barton E. Dahneke. The Aerosizer measures particle size by expanding the air - particle suspension through a nozzle into a partial vacuum (see Figure 1). The air leaves the nozzle at a near sonic velocity and

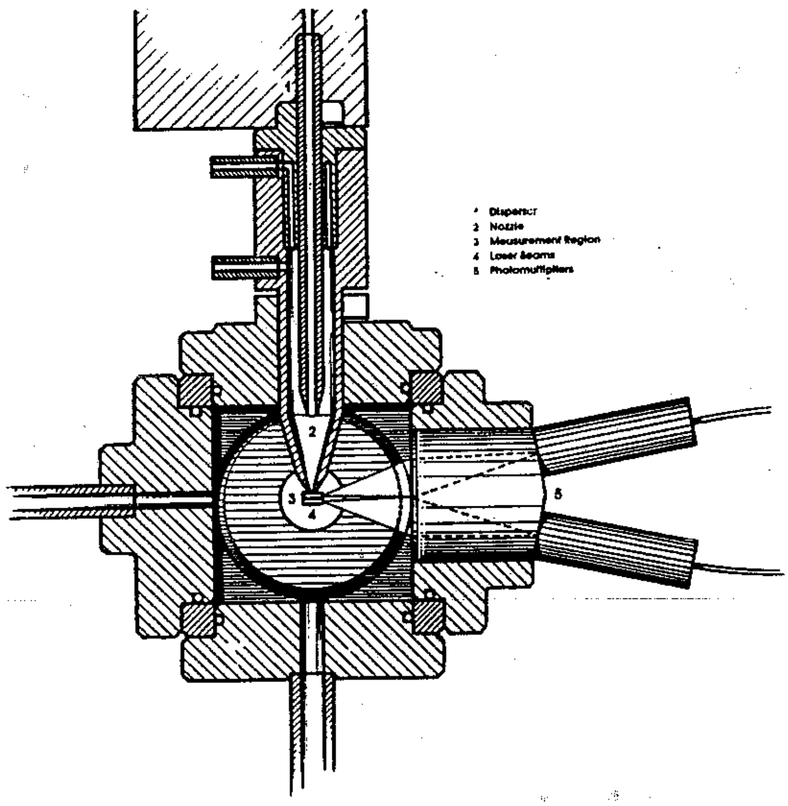


Figure TM-1.

continues to accelerate through the measurement region. Particles are accelerated by the drag forces generated by the accelerating air stream. Very small particles are accelerated to nearly the air velocity by the drag force between the air and the particles. Large particles experience lower acceleration because of their greater mass.

Force Equation

The General Form of the Force Equation is given by:

$$\underbrace{C_d \frac{\pi d^2}{4} \rho_a \frac{(v_a - v_p)^2}{2}}_{f} = \underbrace{\frac{1}{6}\pi d^3 \rho_p}_{m} \underbrace{\frac{dv}{dt}}_{a}$$

where:

C_d = Drag Coefficient

r_a = density of air

v_a = velocity of air

d = particle diameter

r_p = density of particle

v_p = velocity of particle

The $C_d \frac{\pi d^2}{4}$ term relates the drag coefficient and projected area of the particle to the force while the $\rho_a \frac{(v_a - v_p)^2}{2}$ relates the air density and differential velocity of the air and particle to the force applied on the particle.

The other side of the equation is simply the particle volume multiplied by the density $\frac{1}{6}\pi d^3 \rho_p$ to get the particle mass and the particle acceleration $\frac{dv}{dt}$.

Particle Velocity and Size

A comparison of the velocity of 1 and 5 micrometer diameter particles as they are accelerated through the nozzle is given in Figure 2. The end of the nozzle is at 0 mm. Positive positions are in the vacuum chamber while negative positions are before the nozzle exit.

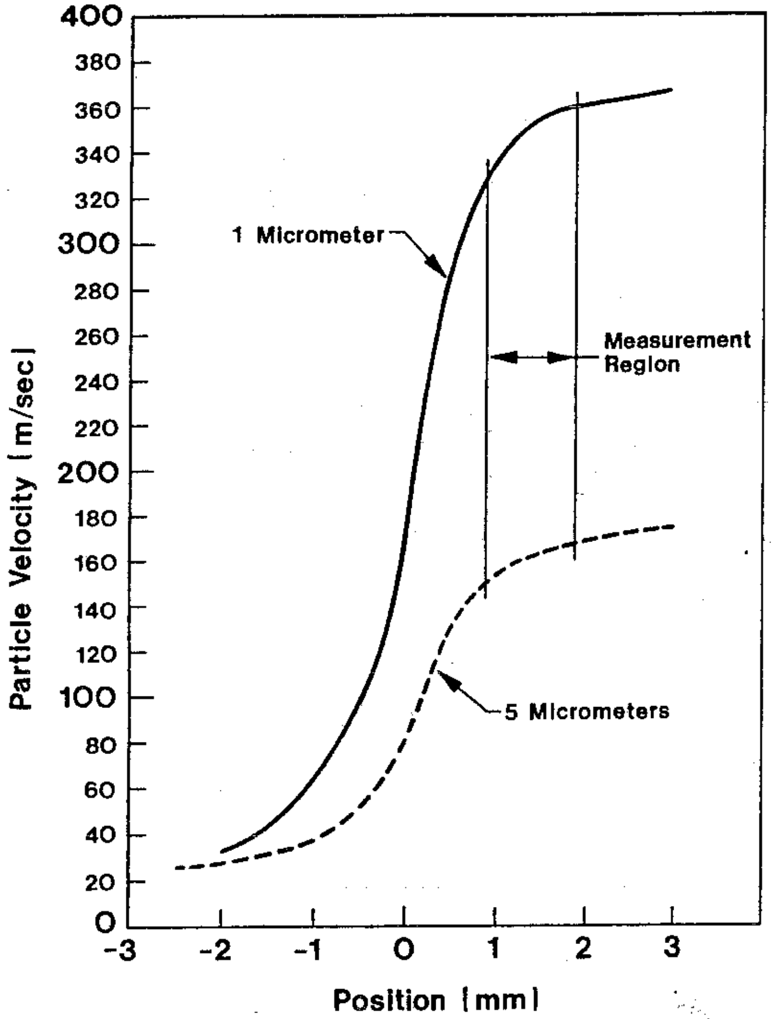


Figure TM-2.

Particle Size and Time of Flight

The Time-Of-Flight of a single particle is measured by generating two beams of laser light through the instrument's measurement region. As particles pass through the laser beams, they scatter light which is detected and converted into electronic signals by two photomultiplier tubes. One photomultiplier detects light scattered as the particles pass through the first beam. The other photomultiplier detects light scattered as the particles pass through the second beam. The time between these two events (the time of flight) is measured with a precision of 25 nanoseconds.

The relationship between the particle size and time of flight depends on the density of the particle. The relationship has been carefully determined using a combination of theoretical concepts and experimental measurements of particles with accurately known diameters and densities. Figure 3 shows the results of this determination. These results are entered into the computer program and are used to change measurements of the time of flight into particle size. Only the density of the particles must be known to permit this conversion.

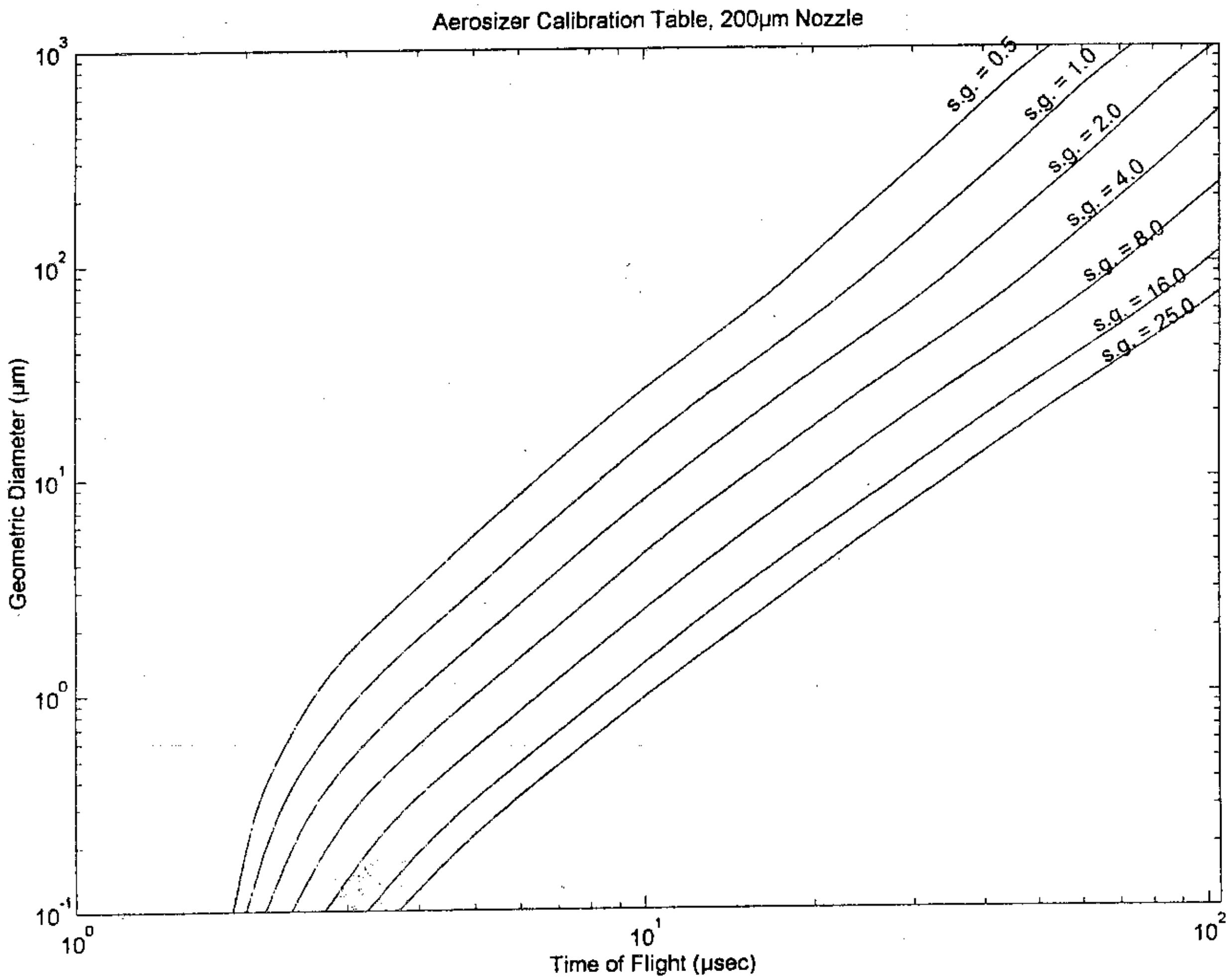


Figure TM-3

A detailed explanation of converting from Time of Flight to Particle Size is provided in Section TM-4

TM-2. Overview of the Aerosizer.

The Aerosizer system consists of four major components as shown in Figure 4. They are the Sample Presentation Device, Aerosizer Sensor Unit, Vacuum Pump, and the Aerosizer Controller. The Sample Presentation Device is used to introduce the sample in Aerosol form to the Aerosizer. The Aerosizer Sensor Unit contains the Hardware and Optics necessary to perform the Time of Flight measurement. The Vacuum System generates the necessary air flows and pressures required by the Sensor Unit as well as collecting the Analyzed Sample to reduce operator exposure. The Aerosizer Controller contains the API Data Acquisition hardware and software that communicates with the Sensor Unit and Sample Presentation Devices as well as collecting and analyzing the Time of Flight signals from the Sensor Unit.

SYSTEM COMPONENTS

AEROSIZER HARDWARE

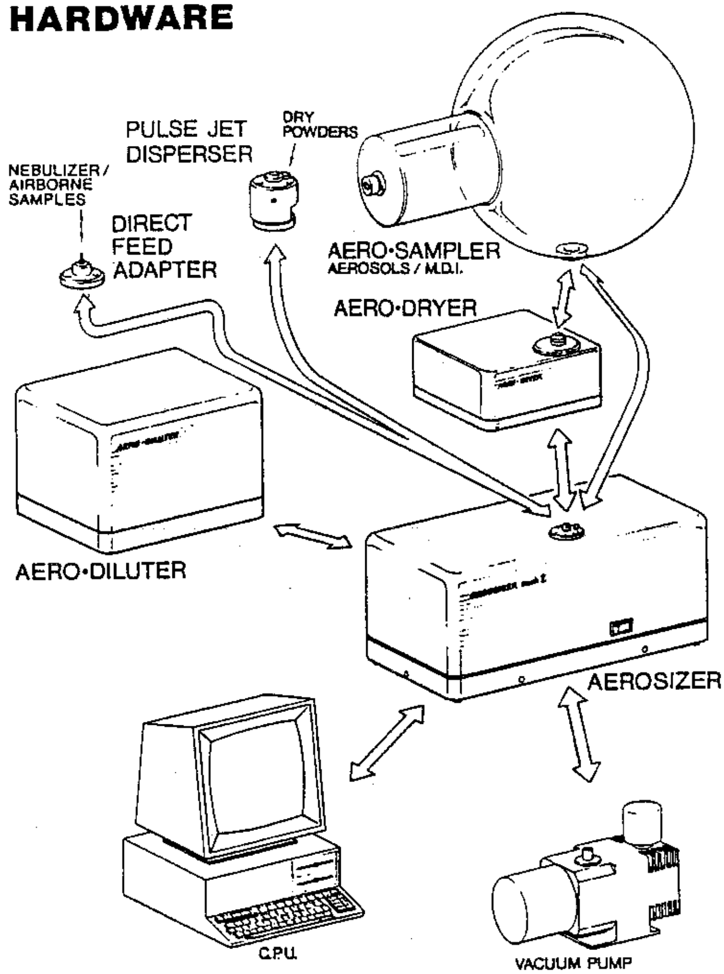


Figure TM-4.

TM-2.1. Sample Presentation Devices

Pulse Jet Disperser (for Dry Powders) API Part # 0-8005

The Pulse Jet Disperser is used to make measurements of particles in the form of a dry powder by making an airborne suspension of the powder. This is done by using a fine jet of compressed air to lift particles from the sample cup into a Sheath Toroidal Swirl air flow which carries the particles across to an Annular region at the disperser pin. The Particles pass through a high speed/high shear air flow region to break up remaining agglomerates and then into the sensor for measurement. The compressed air originates from an internal compressor within the Aerosizer Sensor Unit. The strength of both air streams is controlled by the Data Acquisition/Analysis Computer and is user set for either manual or automatic control. This allows for manual control over the dispersing characteristics of the Pulse Jet Disperser when desired or automatic control based on the number of particles entering the sensor. The type of control selected depends on the nature of the sample to be measured and the type of experiment being conducted.

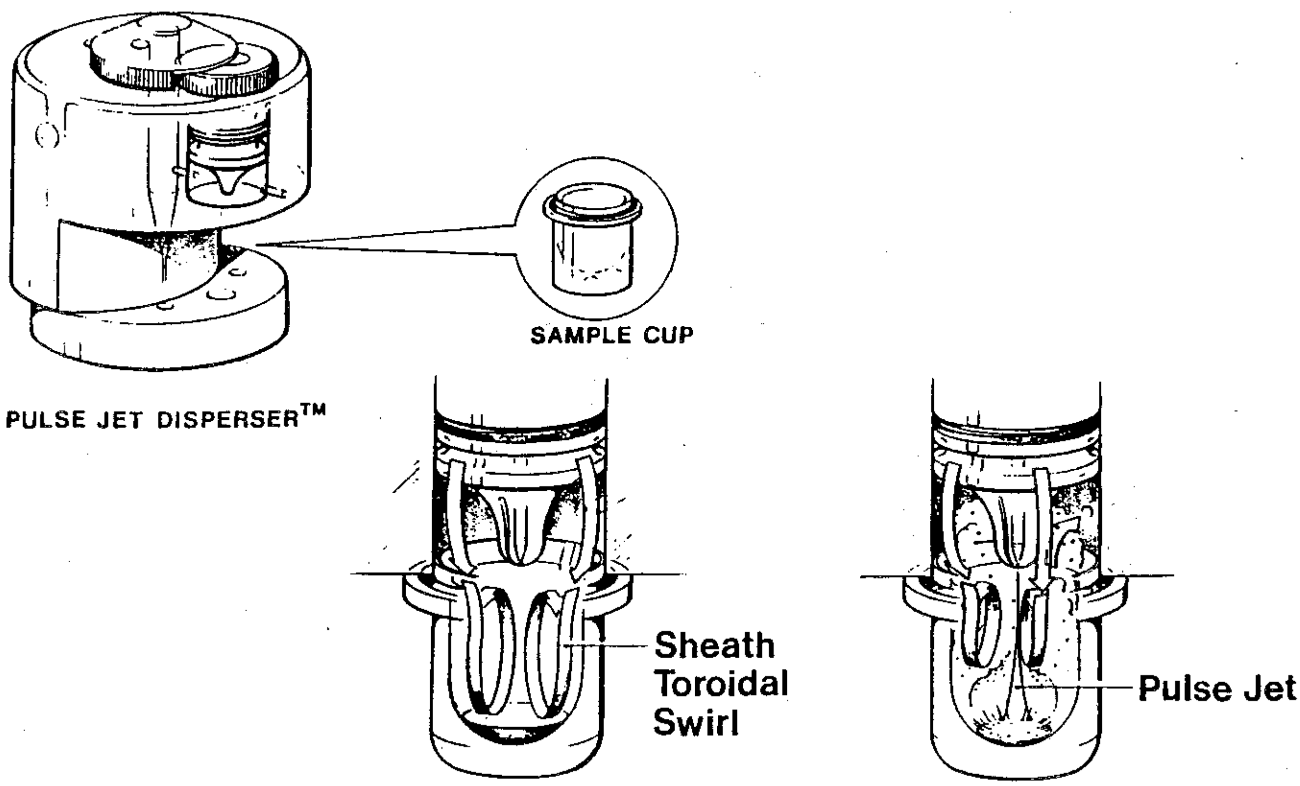


Figure TM-5

Aero-Sampler (for Metered Dose Inhalers and Aerosols) API part # 0-8015

The Aero-Sampler is a specially designed Aerosol collection chamber used for convenient sampling of Metered Dose Inhalers and pulsed aerosols. The dimensions of the Aero-Sampler are carefully designed to accept standard MDI discharge plumes while minimizing deposition inside the chamber. The Aero-Sampler contains the Aerosol Gas Cloud in a closed system reducing operator exposure. The Aero-Dryer is normally used in conjunction with the Aero-Sampler.

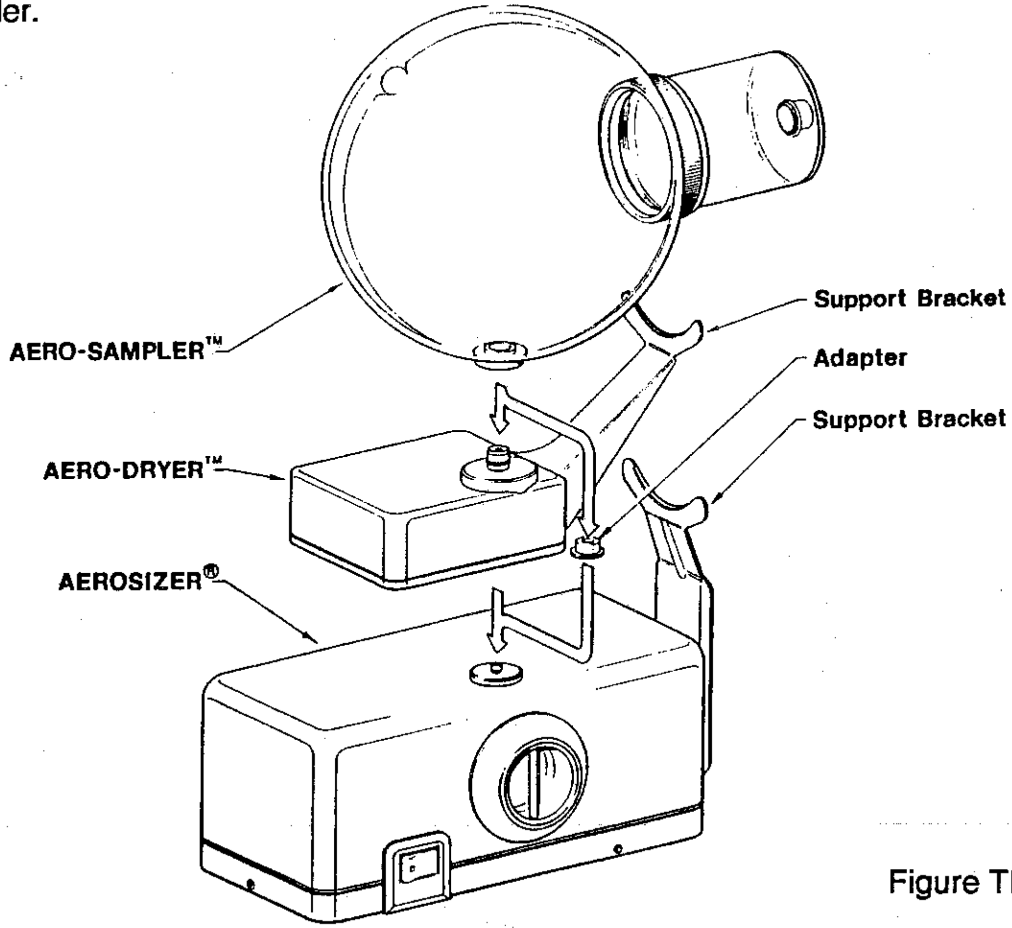


Figure TM-6

Aero-Dryer (Heater\Purge for use with Aero-Sampler) API Part # 0-8020

The Aero-Dryer provides both heating and purge capabilities to the Aero-Sampler system. The Aero-Dryer contains a core that is heated to 100^{o} C to flash off the propellants normally used in MDI's. The time to reach temperature is approximately five minutes. The time to cool down is approximately one hour. The Aero-Dryer also allows for a purge cycle to be performed at the conclusion of the measurement. The purge is done through the vacuum system where the remaining material is collected in the HEPA filter. Both the Heater and Purge are user selectable within the Aerosizer program and are controlled by the Data Acquisition/Analyzer Computer.

Calibration Nebulizer API Part # 0-8035

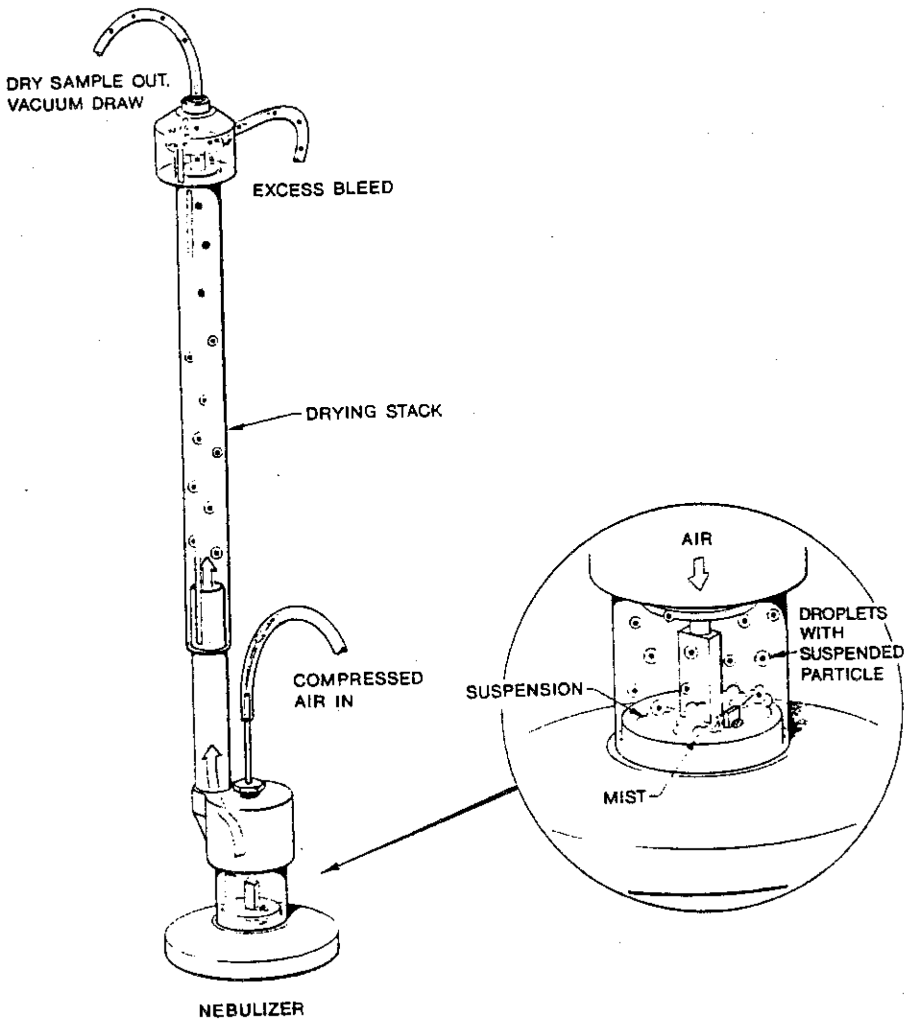
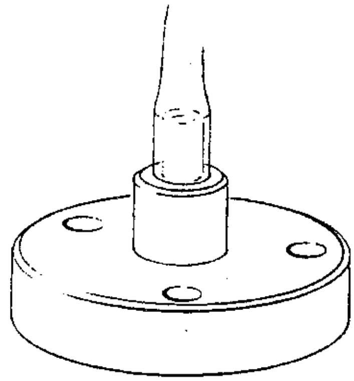


Figure TM-7

The Calibration Nebulizer aerosolizes particles suspended in a liquid allowing them to be measured by the Aerosizer. It is used to aerosolize narrow distribution standards for verifying the optical alignment of the Aerosizer. A fine mist of the liquid is generated and the suspending liquid is evaporated off in the drying stack leaving the dry particles suspended in air. This particle laden air stream is then fed to the Aerosizer through the Direct Feed Adapter. The Calibration Nebulizer is suitable for aerosolizing particles from 0.2 to 4 microns.

Direct Feed Adapter



If you are measuring particles that are already airborne (natural aerosols, engine fumes, and smoke are examples) you may not require a disperser or nebulizer. The sample can be taken directly from the atmosphere or through a 1/8" ID tube using the direct feed adapter.

AeroBreather

API Part # 0-8025

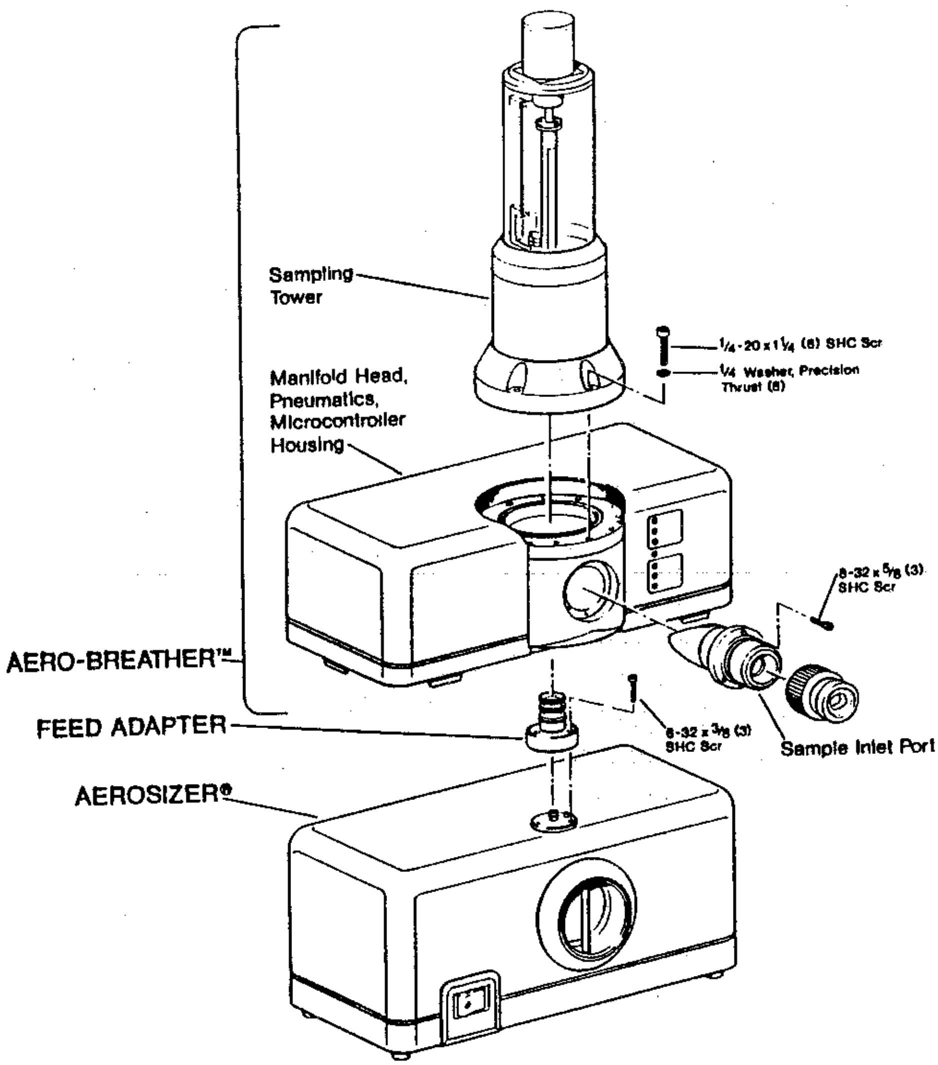


Figure TM-8

The AeroBreather is a microprocessor controlled variable volume, variable rate aerosol sampling system designed to simulate the action of taking a breath. The AeroBreather will trigger inhalation devices designed for actuation by air flow. The resulting aerosol is contained within the AeroBreather sampling chamber and is sampled through the Aerosizer. It can also be used to take a volumetric sample from an aerosol cloud or process line. The AeroBreather utilizes a stepper motor drive to provide control over the rate and displacement of a piston in the sample chamber. This ability for control allows the user to select volumetric sampling parameters (displacement, acceleration and final velocity) which will define the inspiration profile. The AeroBreather is capable of a peak displacement rate of 120 Liters/minute and an acceleration of 19 liters/sec^2 at 10 inches of water resistance. The maximum displacement volume is 1 liter. Once the sample is collected, it is analyzed by the Aerosizer.

Aero-Diluter (for controlled sample flow rates) API Part # 0-8010

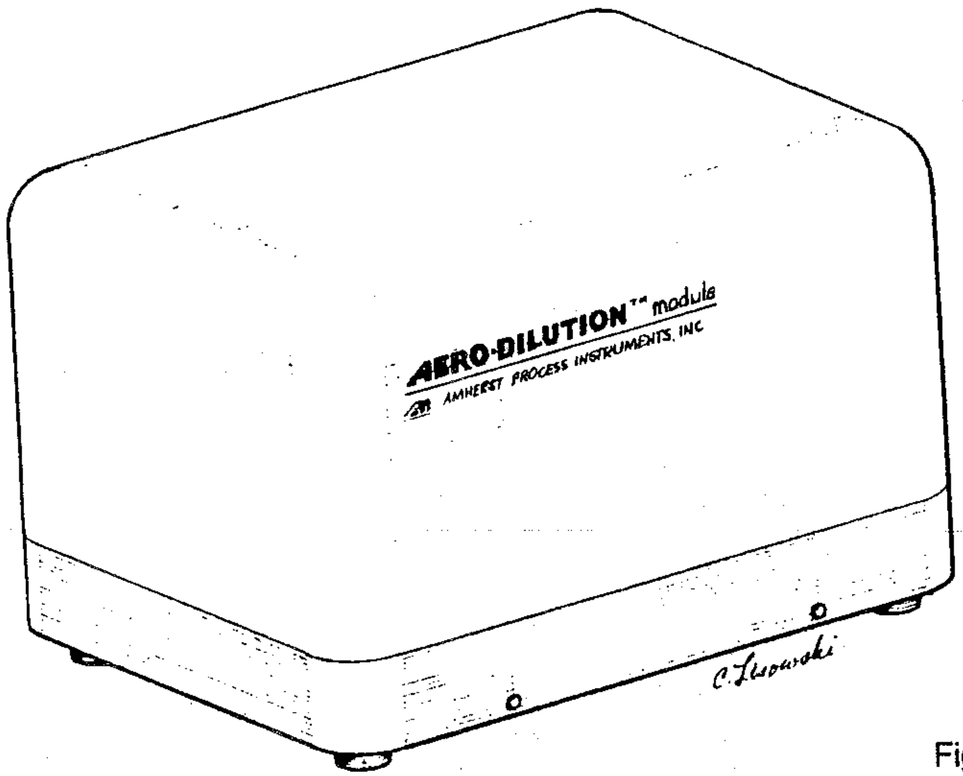


Figure TM-9

The Aero-Diluter is used to control the mass flow of sample air through the Aerosizer. It is useful for reducing the particle loading to the Aerosizer when measuring high concentration Aerosols, as are frequently found with some MDI formulations, and for providing a known sampling rate when using isokinetic and other sampling probes. The AeroDiluter fixes the rate at which aerosol is accepted into the Aerosizer over the range 0.1 to 2.5 liters/min.

AeroDisperser API Part # 0-8040

(Advanced Dry Powder Disperser for Cohesive and Free Flowing Powders)

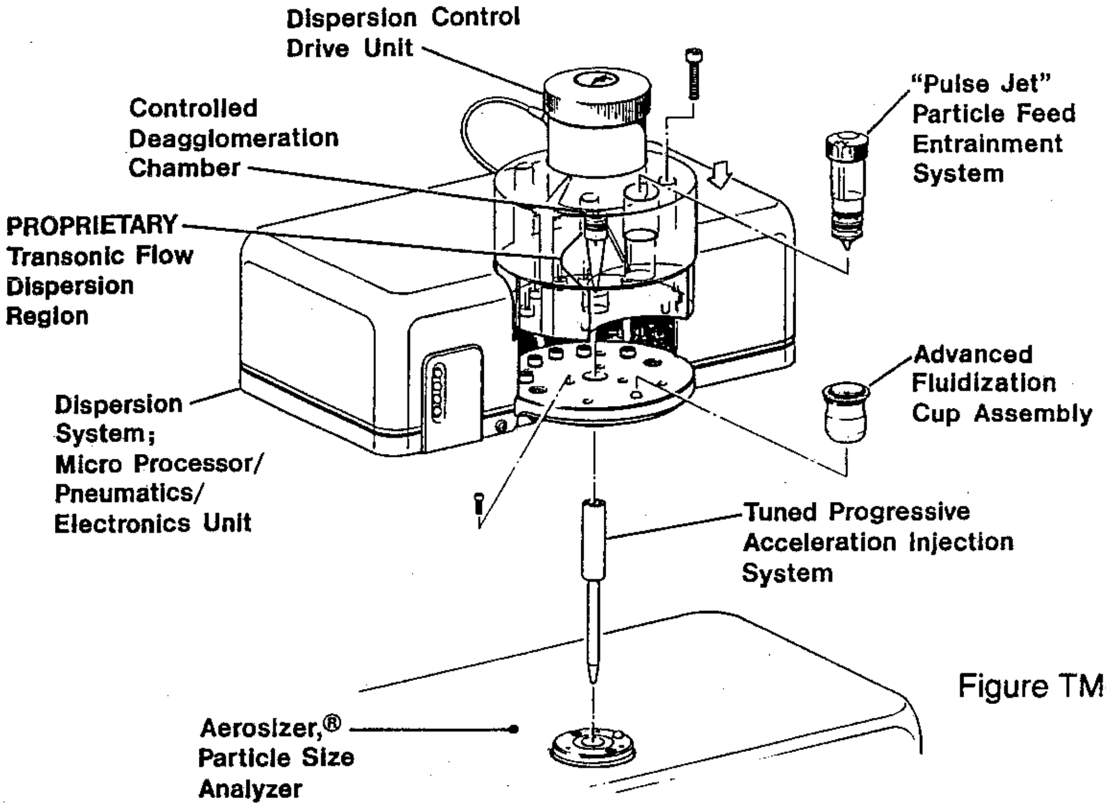


Figure TM-10

The AeroDisperser is a microprocessor controlled dry powder dispersing system that provides dispersion of highly cohesive as well as free flowing powders. The AeroDisperser allows the user to select the amount of shear force applied to the agglomerates in order to separate them down to their primary constituents. The sample is dispersed from a sample chamber within the sample cup by a pulsed jet of air. The pulsed jet fluidizes and reduces agglomerates within the sample cup. Some of this coarse aerosol will be released from the sample cup into the area above the sample cup where transport air is introduced. Material is entrained in the transport air and flows through an acceleration tube to the disperser pin where the agglomerates undergo further size reduction by impaction. Final de agglomeration is accomplished by passing the aerosol through a high shear flow field in the annular gap between the disperser pin and the profiled "pin-bowl" within the Disperser housing. The air velocities in the high shear flow field is a function of the position of the disperser pin in the "pin bowl" and the pressure drop across the annular gap between the disperser pin and "pin-bowl". The AeroDisperser monitors the pressure drop across the annular gap and adjusts the pin position to maintain the pressure drop specified by the operator. Varying the pressure drop will alter the air velocities and hence alter the amount of shear force applied to the particles. The AeroDisperser is constantly fed back the particle count rate from the Aerosizer and adjusts the strength and duration of the jet to provide the feed rate set by the operator.

TM-2.2. The Aerosizer Sensor Unit.

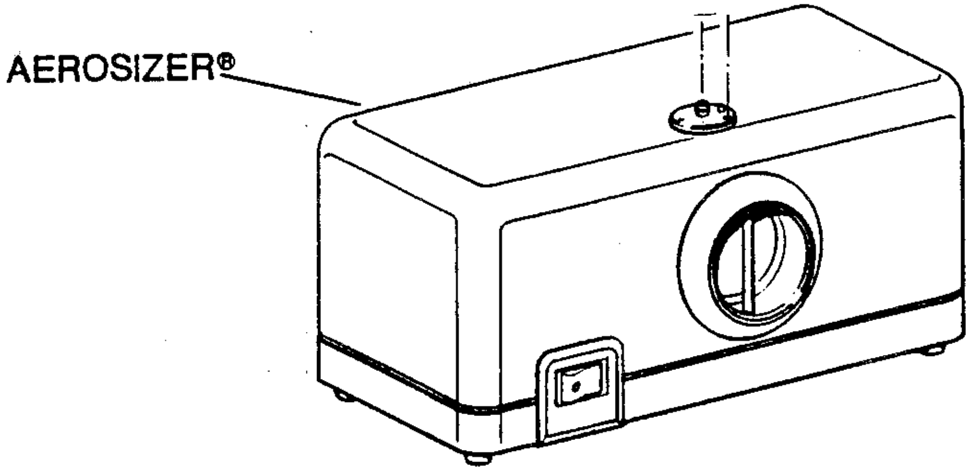


Figure TM-11

The Sensor Unit contains all the components necessary for making the time of flight measurement as well as a compressed air supply for running the accessories. The major subsystems of the Sensor Unit are the Particle Delivery system, the Source Optics, the Detection Optics and Electronics, and the Pneumatics Delivery and Control system.

Particle Delivery System

The sensor unit contains the Sonic Nozzle through which the air- particle suspension is accelerated. The Aerosizer uses a gas jet model in a choked flow condition to accelerate the particles through the measurement region.

A pressure differential is created across the nozzle by partially evacuating the sample chamber on the outlet side of the nozzle. When two regions at different pressures are connected by a nozzle, air will flow from the high pressure region to the low pressure region. When the pressure ratio increases, the air flow will increase until the air velocity at the nozzle exit is approximately the velocity of sound. This occurs when the higher pressure is greater than 2 times the lower pressure. For increased pressure ratios, the air flow will remain almost constant.

If the pressure differential across the nozzle is great enough a hypersonic air flow region will exist after the Sonic Nozzle. This region is contained by a shock wave known as the barrel shock. The size of this region is determined by the pressure ratio across the nozzle. A pressure ratio of 7 will produce a shorter barrel shock than will a ratio of 20. Inside the barrel shock region, the air stream velocity, density, and temperature do not depend upon the pressure ratio. The barrel shock is terminated by a flat shock wave known as a mach disk. The Aerosizer will function properly provided a minimum pressure ratio is maintained across the nozzle. The pressure differential across the nozzle is monitored within the Aerosizer and the program will not allow data acquisition to occur if the minimum ratio condition is not satisfied.

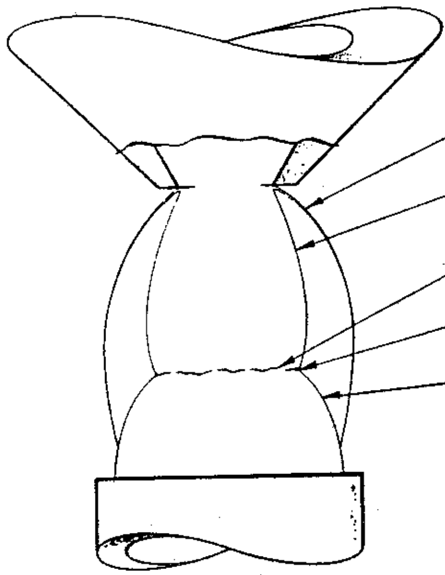


Figure TM-2

SOURCE OPTICS

The Aerosizer source optics create the two laser beams required to measure the particles time of flight. A 3 mW beam generated by a Laser Diode, 760 nm wavelength (or by a 5 mW HeNe laser in the Aerosizer Mach II) , is passed through a lens train that flattens out the beam as it passes through the measurement region. The beam is then reflected off a retro focusing mirror to generate the second flattened beam directly above the first. The reflected beam is then passed through to a beam dump. The laser drive current is monitored in the Aerosizer LD. The laser intensity is monitored in the Aerosizer MachII.

DETECTION OPTICS

The Detection Optics employs two photomultiplier tubes to monitor the two laser beams. As particles pass through the each laser beam they scatter light. This scattered light will cause a pulse to be emitted from the photomultiplier tube monitoring that laser beam. This arrangement removes any doubt as to whether a signal is a particle crossing the first beam or a particle crossing the second beam. The signal from the photomultiplier monitoring the first beam is used to start a timer and the signal from the photomultiplier monitoring the second beam is used to read the timer.

ELECTRONICS

The Aerosizer contains the electronics used to discriminate the photomultiplier signals, control the valves in the pneumatic system and generate the high voltage for the photomultipliers. The photomultiplier signals are discriminated at two levels. When the pulse from the photomultiplier crosses a set threshold a TTL signal is produced and sent to the data acquisition board in the computer. A low level threshold is set for high sensitivity so that it will pick up signals from small particles. When large particles are present their signals may cause more than one trigger of the high sensitivity due to afterpulsing and ringing in the photomultiplier signal. Therefore a second higher level threshold is set for low sensitivity which will only be triggered once by larger particles.

Signals are passed from the computer to the Electronics in the Aerosizer to control the valves for the pulse jet disperser and the compressed air out. A signal is also passed from the computer to the Aerosizer to set the photomultiplier voltage. This allows all control to be done via the Aerosizer program in the software.

PNEUMATICS

The Aerosizer contains a small compressor used to supply air to run various accessories for the Aerosizer. Air is used to disperse powder in the Pulse Jet Disperser and to create drops in the Calibration Nebulizer. The air is also used to trigger switches in the AeroDryer™ to control the heater and purge functions.

TM-2.3. The Vacuum Pump.

The vacuum pump is required to reduce the pressure in the sensor chamber. A pump capable of continuous operation at a pressure of 0.1 atmospheres with 22 liters per minute flow is sufficient. If you use a pump supplied with the Aerosizer, it will include a filter to remove all particles from the air stream before entering the vacuum pump and an oil demister to capture the oil mist at the pump exhaust. The sensor unit automatically measures the air pressure at several points in the sensor unit. If one or more of the air pressures fall outside the normal operating range, a warning message will be displayed on the computer screen together with suggestions as to the cause of the abnormal pressure readings. If the pressures are sufficiently out of range to affect operation the instrument will not allow data collection.

TM-2.4. The Data Acquisition/Analysis Computer.

The Data Acquisition/Analysis computer is used to provide all the control and analysis necessary to operate the Aerosizer. Inside the computer are two API Data Acquisition boards which control the sensor unit and receive the discriminated PMT signals to generate the time of flight data. The API proprietary software calculates the particle size distribution from the measured time-of-flight data. Output is provided as a graphical display of the particle size distribution as well as in tabular format. The Output is available both on screen and from a printer. The computer may also be used for other computing jobs when the Aerosizer™ is not in use but caution should be exercised if other plug in boards are used as conflicts may occur.

The Aerosizer Data Acquisition Boards use:

I/O Locations:

300 - 311

340 - 34E

Memory Locations

D0000 - D07FF

D4000 - D47FF

Interrupt IRQ 5

The following line should appear in the config.sys file

device=ansi.sys

and the file ansi.sys should be present in the root directory (C:\).

The Aerosizer program uses a "DOS Extender" that can have conflicts with the EMM386 memory manager supplied with DOS. API recommends that EMM386 not be used with the Aerosizer software.

TM-3: Combining High and Low Sensitivity

Overview

The Aerosizer collects time of flight data simultaneously in two data acquisition sections. The high sensitivity section is optimized to detect small particles, and the low sensitivity section is optimized to detect larger particles. In order to get an overall size distribution, it is necessary to combine the data sets from these two sections into a single distribution. The size range where the two sensitivities overlap is affected by several factors, so the region in which the combine is done must be adjusted to match the associated data sets This can be done either manually or through the software's Auto-Combine feature.

Factors Affecting Combine Size Range

The appropriate size region for combine is determined by the low sensitivity detection threshold size. This size is affected by the following factors:

PMT Voltage

The voltage applied to the photo-multiplier tubes affects the gain of the device. If the device gain is decreased by reducing the voltage from 1100V to 850V, the smallest size detected by the low sensitivity decreases accordingly.

Detection Thresholds

The detection threshold voltages are set using the trimpots on the back of the instruments. These are set during instrument calibration and not normally adjusted by the end user.

Scattering Efficiency

Different materials scatter light with varying efficiency depending on both the particle size and the refractive index of the material. This affects the smallest size detectable by the low sensitivity channel for a given material.

Sample Deposition on Detection Optics

When the detection optics become coated with a thin film of sample material, the amount of scattered light that arrives at the PMTs is reduced. If the optics are only slightly coated, the sensitivity of the instrument may be reduced without rendering it unusable. In this case, the minimum size detectable by low sensitivity will decrease.

Combine Algorithm

The software combines the two data sets by scaling the low sensitivity to match the high sensitivity in the overlap region. For sizes smaller than the lower end of the combined region, the high sensitivity data is used. For sizes larger than the upper end of the combined region, the low sensitivity data is used. In the combined region, the data is the sum of fractions of each channel.

Compute Low Sensitivity Data Scale Factor

The low sensitivity data is scaled by the ratio of the high to low sensitivity maxima in the combined region.

$$S_L = M_H/M_L$$

Where

M_L = Max bin count of low sensitivity in combined region

M_H = Max bin count of high sensitivity in combined region

S_L = Low Sensitivity Scale Factor

Use High Sensitivity Channel Below Combine Region

For sizes below the lower combine size limit, the combined data set is equal to the high sensitivity data.

Compute Combined Channel Values Between Lower And Upper Combine Limits

The data in the combined region consists of a sum of a fraction of the high sensitivity data and a fraction of the scaled low sensitivity data. The portion of each data set used varies across the combine size range. Data at the beginning of the range is all high sensitivity and data at the end is all low sensitivity. This portion of each data set is described by:

$$F_{Li} = (D_i - D_S) / (D_L - D_S)$$

$$F_{Hi} = 1 - F_{Li}$$

Where

F_{Hi} = Fraction of high sensitivity data used in channel i

F_{Li} = Fraction of low sensitivity data used in channel i

D_i = Diameter at center of channel i

D_S = Diameter at smallest size of combine region

D_L = Diameter at largest size of combine region

The number of particles in the size bins within the combine region is described by:

$$n_i = F_{hi} * n_{Hi} + F_{li} * S_L * n_{Li}$$

Where

n_i = Channel count for combined channel i

n_{Hi} = Channel count for high sensitivity channel i

n_{Li} = Channel count for low sensitivity channel i

Use Low Sensitivity Data Above Combine Region

The data in the combined data set for sizes above the upper combine size consists of the low sensitivity data times the scale factor.

Determining the Combine Region

Auto-Combine Region Determination Algorithm

The auto-combine algorithm selects a region to combine the data from the low and high sensitivity channels based on how well the slopes and areas of the two curves match.

Set Allowable Combine Region

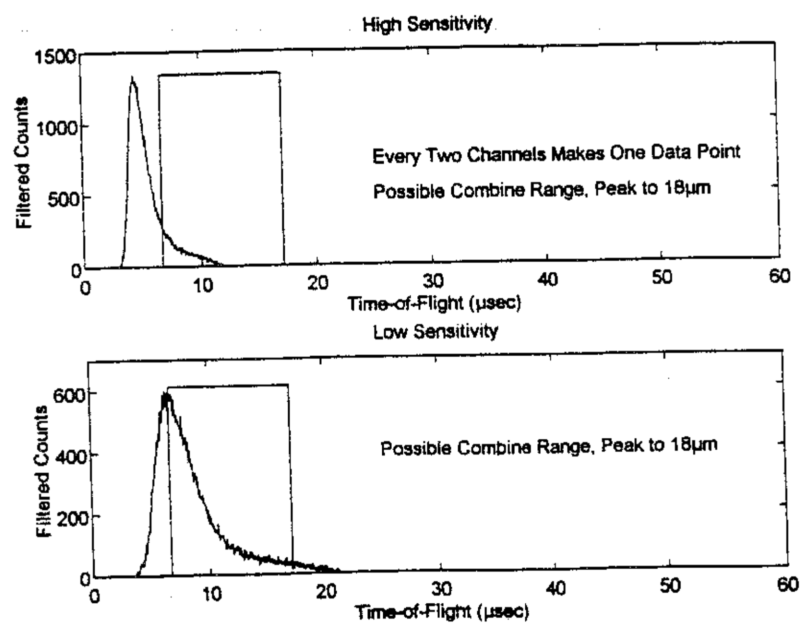
The first step of the auto-combine process is to place a lower and upper boundary on the search for overlap between the two channels. This region is determined by the instrument settings and a preliminary examination of the low sensitivity channel data.

Set Upper Limit Based on PMT Voltage

As the PMT voltage is decreased, the low sensitivity lower detection limit increases in size. The upper allowable combine size limit must be correspondingly adjusted. At 1100V, the upper allowable combine size is 15mm. At 800V, the upper combine size is allowed to go as high as 50mm. The maximum upper combine size varies as a linear function of PMT voltage between those two points.

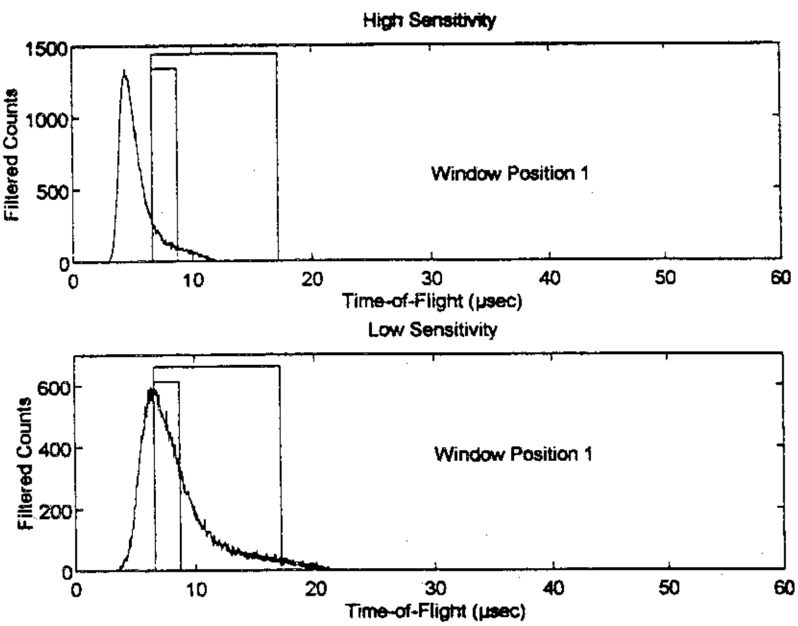
Adjust Lower Limit Based on Low Sensitivity Lower Detection Limit

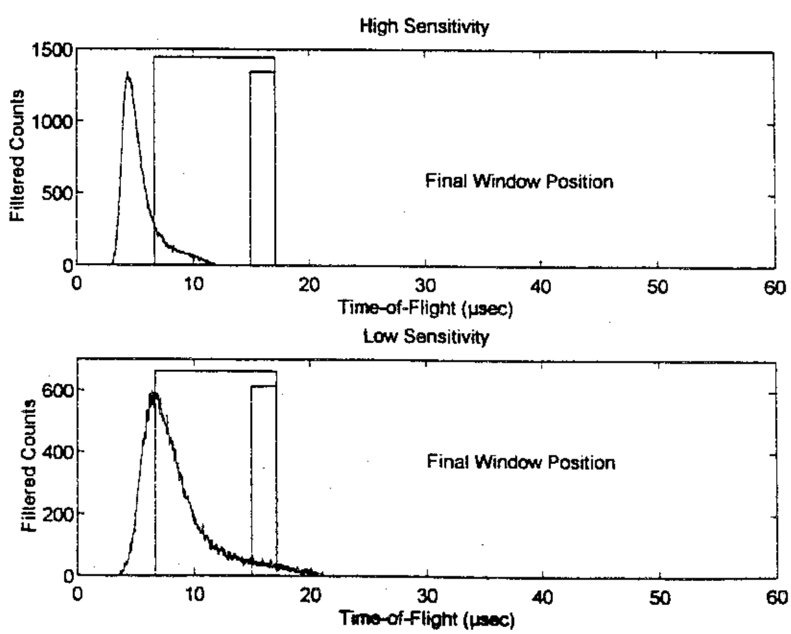
The program scans the low sensitivity data in the initial allowable combine region looking for the first peak. If a peak is found, the lower limit of the combine region is moved up to that first peak.



Slide Window Across Allowable Combine Region

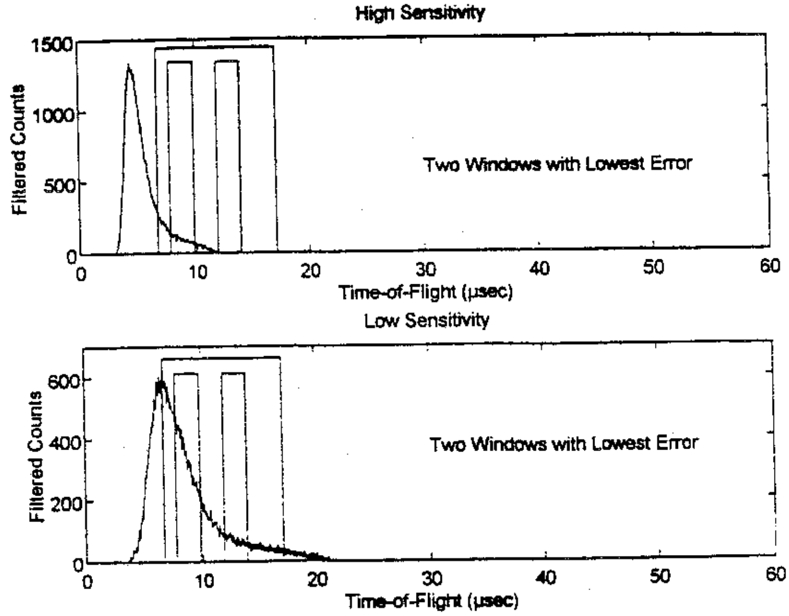
The program scans a window of one fifth the width of the allowable combine region across the region, looking for the best match between the two sensitivity channels.





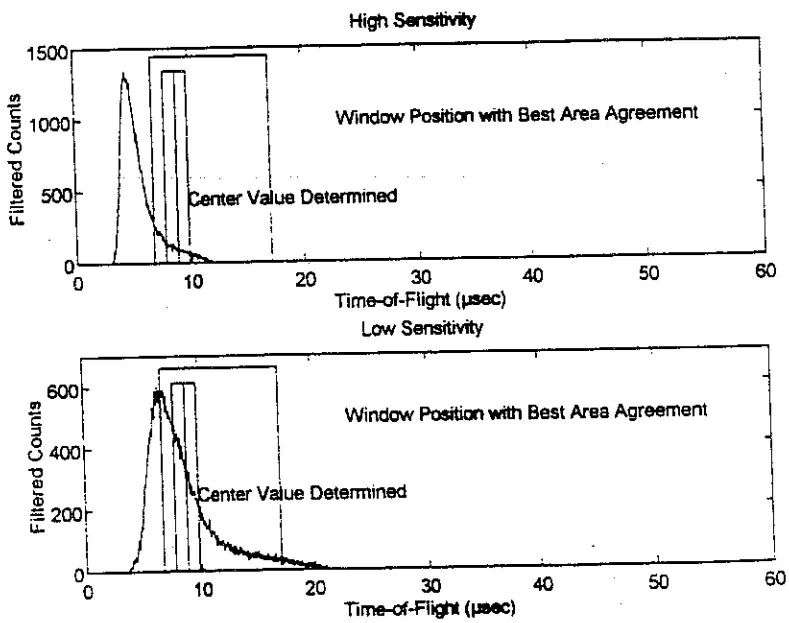
Matching Slopes

In the initial pass , the program finds the two non-overlapping windows with the smallest difference in slope for the two sensitivities.



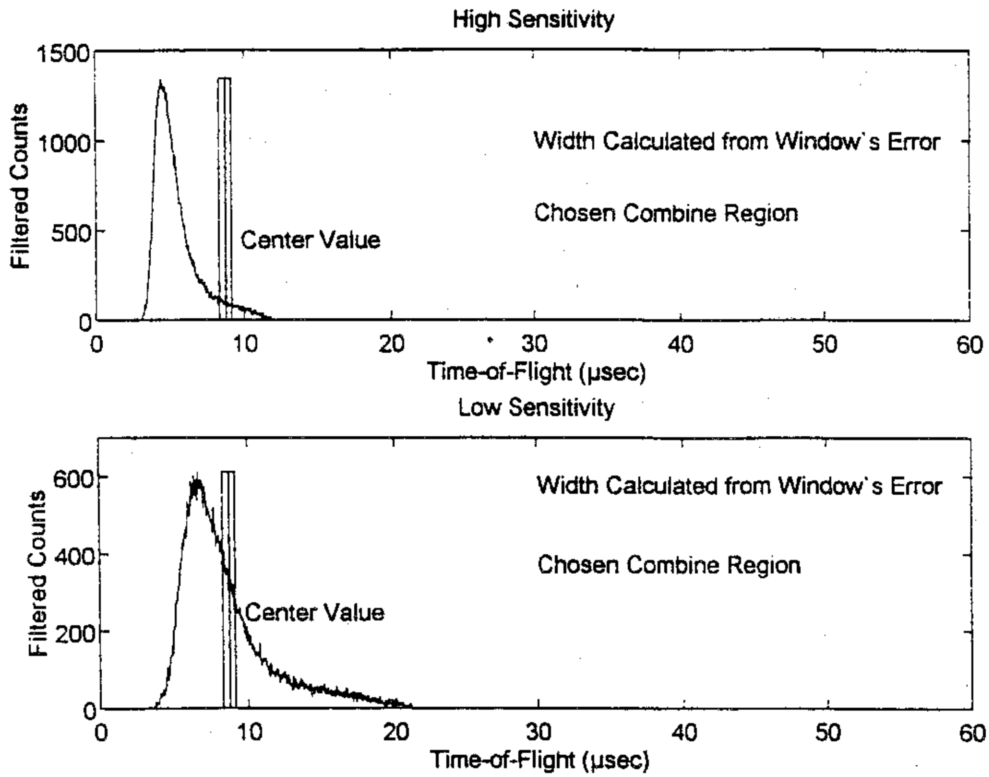
Matching Area

Once the two best windows by slope match are determined, the program compares how well the areas under the curves match. The window with the better area match is chosen as the region for combine.



Determine Width Of Combine Region

The center of the combine range is taken as the center of the selected window. The width of the combine window varies as a function of how well the slopes of the two curves matched over the window. The better the slope match, the narrower the combine region.



Manually Selecting the Combine Region

1 Turn Combine Off in F5 Options Box

2 Display the Overlay of High and Low Sensitivity Data

3 From F6 Display Type menu select:
Linear Scale
Number Distribution
Group Normalization

4 From F11 Display Runs enter the run numbers for the low and high sensitivity runs to be combined. The run numbers should be entered with a space between them. The low sensitivity data set associated with the high sensitivity data set will have a run number one higher than the run number for the high sensitivity data set. Example: to view the high and low sensitivity data for run 1 enter : 1 2.

5 Zoom in both X and Y axes in expected combine region.

6 Look for region on both curves with:
Matching slopes
Matching height

7 Note lower and upper sizes

8 Return to main menu

9 Set Combine to Manual in F5 Options Box

10 Display run info for first run in F11 Box. Press F3 to Edit the scan

11 Enter the new combine sizes
Press F1 to return to the main menu.

12 Return to F11 Box and display the combined run by entering the run number for the high sensitivity run only. With combine turned on entering 1 will display the combined run of 1&2.

TM-4 Baseline Subtract

Converting From Time Of Flight To Size Distribution

Remove Baseline And Noise From Raw TOF Data

Overview

Baseline subtraction is performed by sliding a window across the data to find a baseline region. Once a baseline is determined it is subtracted from the raw data to produce a distribution of 'single particle events'. The next step is to apply a peak filter to remove small peaks caused by statistical fluctuations in the baseline level. The result of this step is a particle number versus time of flight distribution.

Subtracting Baseline

In order to allow operation at high sample count rates, the Aerosizer uses a cross-correlation technique to measure times of flight. The Data Acquisition system actually measures and records the time between each start beam crossing and every following stop beam crossing for 100 usec. One of these times will be the correct time of flight for the particle, and the others will be randomly distributed based on the frequency of particles passing through the system. If the system is run at a very low count rate, no other particles will cross the beam in the 100 usec window, and there will be no random counts added to the time of flight data. If the particles come through the system more frequently, the true time of flight data will have randomly distributed counts added to it. These counts must be removed to create a particle number distribution. Since the noise is randomly distributed, it appears as a constant number added to each time channel, with some statistical fluctuations.

Finding Baseline Region

Set Window Size

The number of channels in the window used to determine the baseline region is set by the user in the system setup screen.
Slide Window To Find Baseline Region
The software begins scanning for the baseline after the first peak in the time of flight data. The total number of counts in each possible window of the selected baseline region width is computed as the window is scanned across the raw TOF data. The window with the lowest total count is selected as the baseline region.

Determining Baseline To Be Subtracted

Compute Mean Of Channel Counts In Baseline Region

The initial value of the baseline is set as the average channel count in the baseline region. This mean and it's standard deviation are used in the noise filter process.

Offset Baseline

If the Baseline Offset parameter in the system setup screen is zero, the mean value in the baseline region is used as the baseline.

If the Baseline Offset setting is greater than zero, then the baseline is set to:

Baseline = M + Offset * Sqrt(M)

Where M=Maximum Channel Count In Baseline Region

Baseline Subtraction

Once the baseline value has been determined, the program subtracts the baseline value from each channel in the time of flight distribution. If the result of that subtraction is negative, the channel is set to zero, otherwise it is set to the result.

Noise Peak Filtering

The next step is to remove statistically insignificant fluctuations from the data. This is done by setting a threshold that a peak must exceed to be considered valid. If any value in the peak exceeds the threshold, the entire peak is kept, otherwise the entire peak is rejected.

Compute Noise Threshold Value

The noise threshold is computed by taking the standard deviation of the channel counts in the baseline region around the mean channel count. This value is multiplied by the noise threshold setting from the system setup screen to form the noise threshold value.

Tn= Noise Threshold * SD

Where:

SD= Standard Deviation of Baseline region around mean

Tn= Threshold value for signal peaks

Isolate Peaks

The program scans across the data to isolate peaks for individual evaluation. A peak is defined as a region containing one or more non-zero channels bounded by two channels with zero counts.

Reject Peaks Below Threshold.

Once a peak has been found, the maximum channel in the peak is compared to the threshold value. If the maximum value in the peak is below the threshold, all the channels in the peak are set to zero. If the maximum value in the peak exceeds the threshold, all channels in the peak are unaffected.

The data has now been reduced to a particle number Vs, time of flight distribution. This data set may now be converted to a particle size distribution.

Converting TOF Distribution to Particle Size Distribution

Once a number Vs time-of-flight distribution has been created, it must be converted into a particle size distribution. The program maps the 2048 time-of-flight channels to 500 log spaced diameter channels based on the user entered density stored with the data set.

Map TOF Channels To Size Channels

The program creates 500 log spaced diameter bins based on the currently selected display range. The ranges are .1-200um and .5-1000um.

Based on the user entered density and the calibration curves for the instrument, the program computes a list of 501 TOFs that correspond to the 501 size bin edges.

Reduce Data from 2048 TOF Channels to 500 Size Channels

For each size bin, the program sums all the TOF bins that fall between it's lower and upper TOFs to create it's channel count.

Convert Number To Volume or Surface Area

If the currently selected distribution type is surface area or volume, the program converts the channels as:

Volume

$V_i = n_i * D_i^3$

Surface Area

$S_i = n_i * D_i^2$

Where:
n_i = channel count for channel i
D_i = diameter at geometric center of channel i

TM-5 Spreadsheet export

The Aerosizer program can export data for spreadsheet analysis. All of the information contained in the tables on the printout will be exported. The file format used is CSV, comma separated values. A partial listing of the file format appears below:

```
"","Run 99","% Under","Run 99","Lower","Upper","Run 99","",<CR>
"","","","","SIZE","SIZE","% In","% Under",<CR>
" ","lactose                    "," 5%",17.42,0.1,0.1,   0.0,   0.0,<CR>
"Taken on:"," 5:47 27 Jan 94","10%",22.10,0.1,0.1,   0.0,   0.0,<CR>
"GEOMETRIC VOLUME DISTRIBUTION"," ","15%",25.53,0.1,0.2,   0.0,
0.0,<CR>
"Material:","lactose              ","20%",28.38,0.2,0.2,   0.0,   0.0,<CR>
"Density (g/cc):",1.50,"25%",30.91,0.2,0.2,   0.0,   0.0,<CR>
"Run Length (sec):",656.99,"30%",33.23,0.2,0.2,   0.0,   0.0,<CR>
```

<CR> denotes an imbedded carriage return in the file

This format can be easily imported into all major spreadsheet programs.

Below is the same partial example imported into Microsoft Excel with the file opened as a text file with comma separated columns:

	Run 99	% Under	Run 99	Lower	Upper	Run 99	
				SIZE	SIZE	% In	% Under
	lactose	5%	17.42	0.1	0.1	0	0
Taken on:	5:47 27 JA	10%	22.1	0.1	0.1	0	0
GEOMETRIC VOLUME DI		15%	25.53	0.1	0.2	0	0
Material:	lactose	20%	28.38	0.2	0.2	0	0
Density (g/cc):	1.5	25%	30.91	0.2	0.2	0	0
Run Length (sec):	656.99	30%	33.23	0.2	0.2	0	0