# Laser-based Instrument
## Measures Mist Eliminator Carryover

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## Abstract

The Phase Doppler Particle Analyzer (PDPA) is a sophisticated laser-based instrument capable of accurately measuring droplet size and velocity. This device has been routinely used in the pilot plant to characterize mist eliminator removal efficiency. It has also been used in a number of field tests to characterize the carryover from mist eliminators operating in FGD scrubbers. This paper describes the PDPA and how it works, provides data to indicate its accuracy, and presents representative pilot plant and field test data obtained with the PDPA. It is concluded that this instrument is accurate in its measurements and is useful for determining if commercial FGD mist eliminators meet carryover performance guarantees.

## Introduction

Flue gas generated from non-compliance fossil fuels must be treated to remove sulfur oxides before it is discharged to the atmosphere. This process of flue gas desulfurization (FGD) is most frequently carried out in a wet scrubber. While many types of wet scrubbers exist, the most common in the power industry is a vertical tower in which the flue gas and scrubbing liquid are contacted countercurrently. The flue gas flows vertically upward in the tower and banks of spray nozzles at various elevations are used to introduce a slurry of limestone which flows vertically downward in the tower. High circulation rates of the limestone slurry produce a large interfacial area across which mass transfer of SO2 occurs. The SO2 reacts with the limestone slurry to form calcium sulfite which is then oxidized to calcium sulfate (gypsum) as the final product for most FGD systems.

The breakup of slurry into droplets through the slurry spray nozzles produces a wide range of droplet sizes. The vast majority of the volume of the spray is contained in large droplets which fall downward in the tower. However, the turbulent action in the contacting zone causes high local velocities, and the drag forces of the gas on the smaller droplets causes them to be carried up toward the gas outlet.

Carryover of slurry mist with the flue gas causes deposition of slurry in the exhaust ducts, heat exchangers (for reheat), induced draft fans, and stack. Entrained slurry can also be carried up through the stack and drop out of the plume causing environmental and aesthetic concerns. This carryover is prevented by the use of chevron type mist eliminators at the top of the scrubber.

Chevron mist eliminators are preferred for FGD applications since they are more resistant to plugging and have lower pressure drop than other types. A wide variety of chevron shapes is available[1]. These generally consist of parallel blades or baffles in a zig-zag arrangement. As the gas flow zigs and zags through the chevron, the droplets, because of their much higher inertia, hit the blades and are collected. The collected liquid forms large drops or streams at the bottom of the chevron and falls back down into the slurry spray zone of the tower. Water sprays are used to periodically wash the chevrons in order to prevent the buildup of solids on the blades.

The performance of chevron mist eliminators are characterized by several parameters: pressure drop, capacity, efficiency, and plugging resistance. These parameters are all of importance to commercial scrubber operation. The first three of these can effectively be measured on a pilot scale using an air-water simulator. Test methods and typical results have been reported previously[2].

The most difficult performance parameter to measure for mist eliminators is the removal efficiency or the carryover. The removal efficiency requires the measurement of the droplet concentration as a function of size at both the outlet and inlet. By measuring the droplet distributions at both the outlet and inlet, a curve can be generated for removal efficiency as a function of droplet size.

For evaluation of commercial chevrons in operation, it is usually impossible to measure the inlet conditions for the chevron. However, the important parameter for commercial operation is carryover rather than removal efficiency. Carryover gives the concentration or flux of liquid being carried over from the mist eliminator for a particular operating condition.

This value can be compared to supplier guarantees on carryover to see if the chevron is meeting expectations and can be used to estimate the buildup of solids downstream of the mist eliminator.

The Phase Doppler Particle Analyzer (PDPA) is an instrument that has been used successfully in both the pilot plant and commercial scrubbers to evaluate the efficiency and carryover of mist eliminators. This is a largely non-intrusive, laser-based instrument that is transportable for field measurements on commercial scrubbers. This instrument supersedes the droplet sizing interferometer(2) which had been used previously but was neither transportable nor suitable for field use.

## PDPA Measurement Technique

The Phase Doppler Particle Analyzer (PDPA) used in this study was manufactured by Aerometrics, Inc. of Sunnyvale, CA (now TSI, Inc. of Minneapolis, MN). This instrument uses a fiber optic probe assembly which can be inserted into a tower while the electronics remain outside the tower. This particular probe assembly was custom designed and built to rigorous specifications for use in harsh and corrosive environments.

The essence of the operation of the PDPA is shown in Figure 1. As shown in Figure 1a, a laser beam is produced and split by a beam splitter to form two identical polarized laser beams. These beams are conveyed to the transmitter by two fiber optic conductors in a shielded cable. The transmitter has an optional 0.25X beam expander. When in place, this optical device reduces the beam diameter and beam spacing by a factor of 4 for measuring large drops. The transmitter lens takes the two parallel laser beams and crosses them at the focal length of the lens. The volume in which the laser beams cross is called the "probe volume."

The crossing of the laser beams creates an interference fringe pattern in the probe volume. The electromagnetic waves of the two beams interfere constructively and destructively to form bright and dark fringes in the probe volume. The probe volume is ellipsoidal in shape and, if the two intersecting beams are in the vertical plane, the interference fringe pattern appears as alternate bright and dark elliptical planes of light oriented horizontally in the probe volume. A droplet passing through the probe volume acts as a spherical lens and scatters light both by refraction and reflection. The receiver is placed at 30° off axis to maximize the collection of refracted light.

The receiver intercepts a portion of the refracted light scattered by the droplet, and the receiver lens focuses it on a slit as shown in Figure 1b.

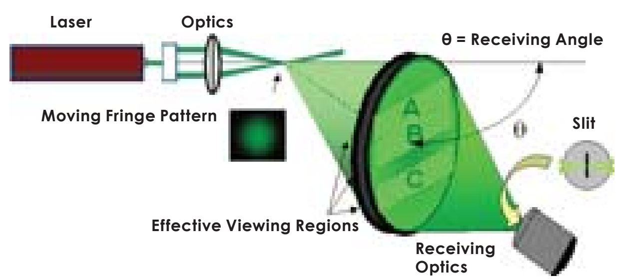


**Figure 1b. Transmitter and Receiver**

The detectors, which sit behind the slit, therefore see only a slice of the probe volume from top to bottom through the center of the ellipsoid. The three detectors are lined up parallel to the axis of the slit and are maintained at a fixed separation from each other. These detectors are connected to fiber optic conductors that pass through a shielded cable to the photodetector unit. This unit has three photomultiplier tubes that convert the three light signals from the three detectors into three electronic signals that are processed to extract velocity and size information.

**Figure 1. PDPA Operation**

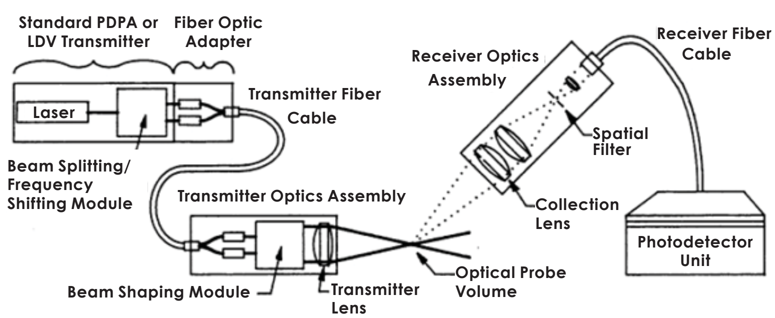


**Figure 1a. Probe Schematic**

Figure 1c shows a typical signal from one of the detectors as it might appear on an oscilloscope.

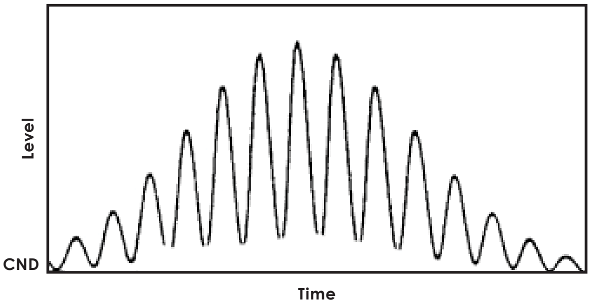


**Figure 1c. Signal**

The ordinate is signal intensity and the abscissa is time. The overall shape of the signal is Gaussian (bell shaped) because the intensity of the beams is Gaussian over the beam diameter. Superimposed on the Gaussian shape is a fine "Doppler" component. This component arises as the droplet centers over bright fringes (high intensity) or dark fringes (low intensity) in the probe volume. The signal processor measures the time between successive peaks or valleys in the Doppler signal.

From the optical set-up (wavelength of the laser light, focal length of the transmitter lens, and the distance between the two beams before the transmitter lens, all of which are known) the fringe spacing can be calculated. This fringe spacing divided by the time to transit one fringe gives the velocity of the droplet passing through the probe volume.

The droplet diameter is determined from the phase shift between the signals seen by the three detectors.

Figure 1d shows the signals after they have been filtered to remove the Gaussian component.

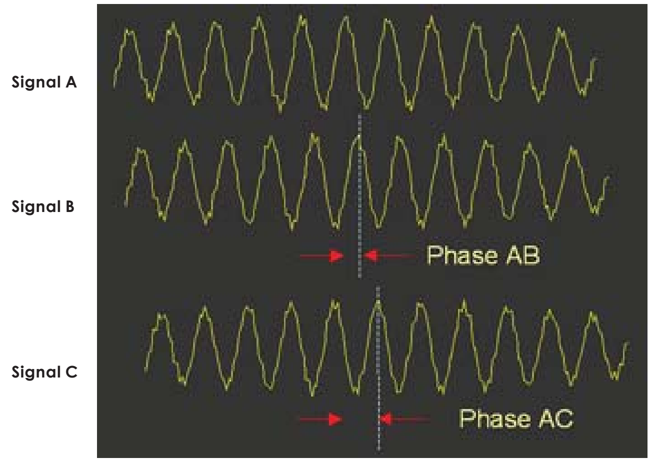


**Figure 1d. Filtered Signals from the Three Channels**

A particular fringe is detected first by Detector #1, then by Detector #2, and finally by Detector #3. The signal processor determines the phase shift between Detectors #1 and #2 and between Detectors #1 and #3. The phase shift is related to the reduced diameter of the droplet as shown in Figure 1e (where delta is the fringe spacing in microns).

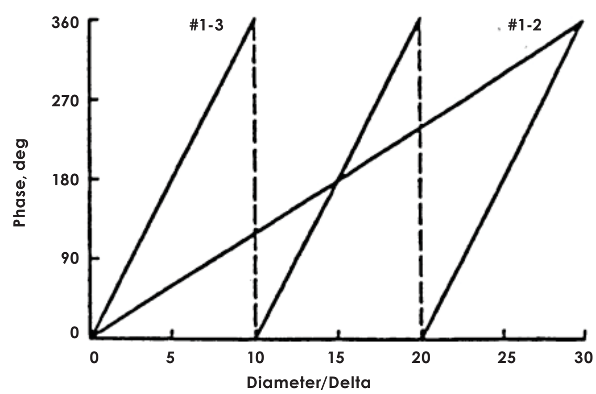


**Figure 1e. Instrument Response Curve**

This relationship arises because a small droplet acts as a more powerful lens than a large droplet. The projected fringes of a small droplet are therefore farther apart giving a smaller phase shift between the pair of detectors. Detectors #1 and #3 are separated by three times the distance of Detectors #1 and #2; therefore, as shown in Figure 1e, the phase shift is three times as great for Detectors #1 and #3 as for Detectors #1 and #2. The correct phase shift for both pairs of detectors is required before the signal can be accepted as valid.

The instrument software provides a variety of ways in which the data may be viewed. A typical graphical output of the instrument is shown in Figure 2.

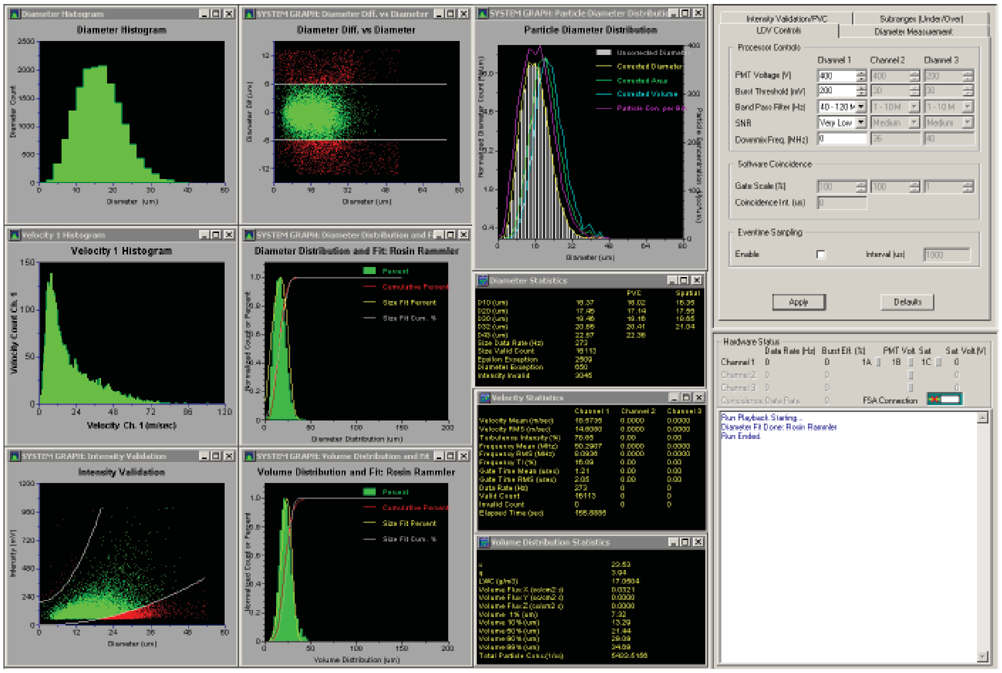


**Figure 2. Typical PDPA Results for Field Tests**

The raw data are collected in the form of number histograms. The droplet size range is divided up into 50 bins of equal width. When a valid droplet is detected, its diameter is determined and it is assigned to the bin whose range includes the determined diameter. The histogram is a bar graph of the number of counts in a bin vs. the diameter range. A velocity histogram is generated in the same way.

For the diameter histogram, a probe volume correction is applied to get a corrected histogram. This probe volume correction arises because of the Gaussian intensity distribution of the laser beams. The intensity of light scattered by a droplet is proportional to the square of its diameter. Small droplets passing through the edges of the probe volume where the laser beam intensity is low will not scatter sufficient light to exceed the threshold intensity and will be considered as noise. Because of this, the probe cross-sectional area decreases with droplet size, and the counts for the smaller bins must be multiplied by a number greater than one to correct them to the same probe area as the largest droplet in the distribution. The software also saves the velocity for each droplet so a correlation can be made between droplet size and velocity.

Once the number histogram is obtained, the instrument software can analyze and present the data in a variety of ways. Various mean diameters, such as the linear mean, surface mean, volume mean and Sauter mean, can be calculated. The volume frequency distribution can be calculated as well as the cumulative number and volume distributions. The cumulative number distribution can be fit to a Rosin Ramler distribution, which is a two-parameter equation that describes the distribution.
A size-velocity correlation can also be viewed to see if larger droplets are moving at a different velocity than the smaller droplets.

Significant advances have been made to the PDPA in recent years particularly in the area of signal processing and data management. The instrument used in this study was purchased in 1991.

## Laboratory Tests

Before an instrument can be used with confidence to measure spray distributions in a pilot plant or commercial environment, there are some simple validation checks that the instrument should pass in the laboratory. First, the instrument should be able to accurately measure the size and flux of a monodisperse droplet stream, and, second, it should be able to accurately measure the flux of a polydisperse spray. It should be noted that there is no calibration adjustment for the PDPA. Once the optical parameters are properly entered into the software, the instrument should indicate the correct droplet diameter and velocity.

A detailed description of the laboratory tests is beyond the scope of this paper. Briefly, the PDPA was, on several occasions, checked against a monodisperse droplet generator(3,4) (Model 3050 Berglund-Lui (BL) generator from TSI, Inc.). The difference between the diameter calculated from the droplet generator parameters and that measured by the PDPA was typically less than +/- 2-3%. In addition, the flux from an ultrasonic humidifier was measured by the PDPA and compared to that measured volumetrically. The agreement was reasonable, with the corrected flux measured by the PDPA about 10% lower than the volumetric flux.

## Pilot Tests

The PDPA has been routinely used in our pilot plant to measure the removal efficiency as a function of droplet size for a wide variety of chevron and mesh pad mist eliminators. This pilot plant has been described previously(2). The PDPA is also routinely used in the pilot plant to measure carryover. In many commercial situations, it is impossible to measure at the inlet of the chevron. In these cases, only the outlet is measured and used to calculate a carryover rather than a removal efficiency. Carryovers measured in the pilot plant are meaningful in predicting commercial performance only to the extent that the mist size, concentration, and hydrodynamics in the pilot plant properly simulate those of the commercial system.

The ability of the PDPA to measure mist carryover has been evaluated at an independent testing laboratory using a 3-ft x 6-ft rectangular vertical-flow tower. The description of the test system and the results of comparing various droplet measurement methods have been presented elsewhere[5,6]. The true carryover was measured volumetrically by expanding the carryover mist into a large horizontal duct and collecting the liquid that dropped out of the gas. At steady state, the carryover rate was measured by a bucket-and-stopwatch technique. This volumetric technique for measuring carryover is valid only above the reentrainment point of the chevron. Below the critical velocity for reentrainment, the carryover is too small to be accurately measured by this technique.

During these tests, the personnel of the independent testing laboratory operated the system and measured the volumetric carryover flux. The PDPA was operated by Koch-Glitsch, Inc. personnel to obtain the PDPA carryover flux. Neither team of operators knew the results obtained by the other. A third independent contractor took the data from both teams and compared the results. This eliminated any possibility of collusion in the tests. Measurements were made with the PDPA in the outlet duct above the chevron in a region where the duct narrowed to 15 in. by 6 ft. At this elevation (about 30 in. above the outlet of the chevron), essentially all of the droplets entering the narrowed duct were carried over and collected downstream. This afforded the best opportunity for agreement between the PDPA and the volumetric measurements. At lower elevations just above the chevron, a portion of the large drops settled out by gravity and were not collected in the expanded duct downstream.

Table 1 shows the carryover as a function of velocity for both the volumetric and PDPA measurements.

**Table 1. Comparison of Mist Eliminator Carryover as Measured by the PDPA and by Collection and Volumetric Measurement**

| Test | Mist Loading gpm/ft² | Gas Velocity ft/sec | Volumetric Carryover gpm/ft² | PDPA Carryover gpm/ft² |
|---|---|---|---|---|
| 1 | 1.5 | 12.07 | 0.0004 | 0.00046 |
| 2 | 1.5 | 15.26 | 0.0022 | 0.0018 |
| 3 | 1.5 | 17.07 | 0.038 | 0.052 (0.043) |
| 4 | 1.5 | 12.06 | 0.0005 | 0.00049 |

sectional area where the PDPA measurements were made (7.50 ft2). The volumetric carryovers are identical to those reported previously[(6)] for this work. The PDPA carryovers are slightly different from those reported previously and are the result of a more careful analysis of the data. At the velocity of 12 ft/sec, two different optical setups were used. The first measured droplets in the diameter range of 3 to 90 microns; the second measured droplets in the range of 90 to 3,000 microns. The smaller droplets result from penetration of droplets through the chevron while the large droplets result from reentrainment. At 12 ft/sec, the flux measured for the smaller droplet range was about one tenth of the flux measured for the larger droplet range. The fluxes for both optical setups were added together to give the total flux at this velocity as reported in Table 1. (Previously published numbers[(6)] for tests 1 and 4 were 0.0004 for both tests and were based only on the optical setup for the larger droplets.) For higher velocities, the flux of small droplets is negligible compared to the flux of large droplets, and no corrections were made to the flux determined by the large droplet optics.

Comparing Tests 1 and 4, which are for identical conditions, it would appear that the measurement error of the volumetric technique is about +/- 0.0001 gpm/ft$^2$. This is consistent with the stated detection limit of 0.0001 gpm/ft$^2$ for this system in vertical flow[(5)]. Thus, at 12 ft/sec, the PDPA gives measurements which are within the error bars on the volumetric data. At 15 ft/sec, the PDPA flux is 18% below the volumetric flux. At 17 ft/sec, the PDPA flux is 37% higher than the volumetric flux. However, at this velocity, two sequential traverses of the duct were carried out. The average flux for the second traverse (0.043 gpm/ft$^2$) is shown in parentheses and is only 13% higher than the volumetric flux. It is possible that the first traverse at this condition was made before the system fully reached steady state.

The accuracy demonstrated by the PDPA in this independently sponsored test program is quite acceptable for commercial applications where the carryover can vary over orders of magnitude with velocity. The PDPA was judged to be the most accurate of the droplet sizing techniques tested[(6)].

## Field Tests

While the PDPA is used routinely at our pilot facilities for mist eliminator characterization, there are times when field tests are required. In general, these field tests are conducted at operating power stations where the objective is to determine if the mist carryover from the mist eliminator complies with guaranteed performance.

Table 2 on page 8 lists the various field tests conducted to date. Of these 19 tests, 4 were at pilot facilities and 15 were at operating power stations.

## Site Preparation

Some significant site preparation may be required before the PDPA can be used to characterize a specific commercial chevron. First, a suitable access port above the chevron must be located or installed. Only the PDPA probe needs to be inserted into the tower. The current probe can be inserted through a 6-in. diameter hole in the tower wall or in a blank flange; however, it is recommend that an access port of 8 in. diameter be available for field tests since additional room is usually required to get the probe attached to the traversing mechanism.

The probe consists of the transmitter, receiver, and support bar upon which the transmitter and receiver are mounted and weighs about 15 pounds. The support bar is extended as the probe is inserted into the tower by attaching to it additional 3-ft long sections. For tower diameters of about 8 ft or less, the extended support bar is sufficient to support the probe in the tower. If opposing ports are available, the probe can be traversed 8 ft from each side to cover a 16-ft diameter without internal supports.

**Table 2. Sample of PDPA Field Tests Conducted by Koch-Glitsch since 1992**

| Number | Location | Tower Diameter, ft |
|---|---|---|
| 1 | Zimmer Power Station, Moscow, OH | 40.5 |
| 2 | Lawrence Power Station, Lawrence, KS | 20 x 20 |
| 3 | Ratcliffe Power Station, Nottingham, England | 53 |
| 4 | EPRI HSTC at Kintigh Power Stn, Barker, NY | 5 |
| 5 | NELS Consult. Serv, St. Catharines, Ont. Canada | 3 x 6 |
| 6 | Zimmer Power Station, Moscow, OH | 40.5 |
| 7 | B.L. England Power Station, Beesley Point, NJ | 33.6 |
| 8 | Petersburg Generating Station, Petersburg, IN | 21.5 & 29.5 |
| 9 | Petersburg Generating Station, Petersburg, IN | 21.5 & 29.5 |
| 10 | B&W Research Div., Alliance, OH | 5 |
| 11 | Big Bend Generating Station, Apollo Beach, FL | 36 |
| 12 | McDermott Technology, Inc., Alliance, OH | 5 |
| 13 | Dakota Gasification Co., Beulah, ND | 43.5 |
| 14 | Taiwan Power – Hsinta Station (Unit 1) | 45.3 x 30.0 |
| 15 | Taiwan Power – Hsinta Station (Unit 2) | 45.3 x 30.0 |
| 16 | Intermountain Power, Delta, UT | 35.5 x 37.0 |
| 17 | Taiwan Power – Hsinta Station (Unit 4, Coals 1&2) | 56.76 |
| 18 | Taiwan Power – Hsinta Station (Unit 3, Coals 1&2) | 56.76 |
| 19 | Kansas City Power & Light, LaCygne, KS | 20 x 32.5 |
| 20 | Danieli Corus / Alcoa | 51.5 |
| 21 | Taiwan Power – Taichung Power Station | 55.77 |

For tower diameters larger than about 8 ft, some internal means of support is required for traversing the probe across the tower. This has usually taken the form of a track and trolley arrangement. The track is simply a U-shaped channel installed horizontally in the tower. The trolley is a stainless steel block that extends through the open top of the channel and has four wheels that rides within the channel. The PDPA support bar is attached to two of these trolleys and is traversed across the tower above the track. The probe assembly is pushed or pulled along the track by threaded rod connected in 3-ft sections to the support bar. These tracks must be installed in the tower during a shut-down sometime prior to the field test. Care must be taken in installing the track that there are no internal obstructions (e.g., bolts or nuts) within the track where it is attached to supports or where two sections of channel meet.

A number of sites have installed three tracks that meet at the access port. The center track extends across the tower diameter and the others extend across a cord to the left and right of the diameter. This allows a larger portion of the cross-sectional area to be traversed. However, this arrangement still misses much of the flow. A preferable arrangement would be to have four access ports equidistant from each other at the elevation of the measurement. With this arrangement, internal tracks may not even be necessary. For example, in a 30-ft diameter tower, traversing 8 ft toward the centerline from each of four equally spaced ports would cover all but 22% of the cross-sectional area. However, the arrangement of the scrubber outlets is such that four equally spaced ports are seldom available.

More recently, stainless steel cables, typically 3/8" in diameter have been used rather than tracks to support the PDPA probe. The cable is stretched taut across the tower, and the probe is suspended below the cable. This arrangement is preferable to the track and trolley arrangement since it avoids the common problem of obstructions within the tracks and also avoids the obstruction to flow caused by the track near the probe volume.

A safe staging area is needed next to each access port. This area must be at least 4 ft x 4 ft where personnel can stand to insert and traverse the probe within the tower. A larger area (at least 4 ft x 8 ft) is needed nearby for the instrument electronics, computer, and auxiliary equipment. Lighting and rain protection in this area are helpful but not essential. The only essential utility is 110V/20amp electrical service.

## Logistics

The PDPA is more correctly referred to as a transportable instrument rather than a portable one. Prior to the tests, the instrument is shipped to the site by air freight. The shipment usually consists of 5 hard-body, foam-lined containers that protect the delicate optics and electronics.

The field tests generally require three to five days to execute. The first day is devoted to transporting the equipment to the staging area, setting up the instrument, aligning the optics, repairing any damage that has occurred in shipping, and making preliminary measurements. The last day is devoted to site restoration, breaking down the instrument, packing it for shipping, and transporting it to a local air freight station. Intervening days are used to collect data.

Based on the preliminary measurements, an assessment is made as to which optics to use. Usually, the mist eliminator is operating below the critical velocity at which reentrainment occurs. In this case, no droplets are observed above the 100 micron size, and the optical setup for small droplets (3 to 130 microns) is used. The measurement time at each position on the traverse ranges from 5 to 15 minutes depending on the number density of the mist encountered. For large diameter towers, traverse points are usually 3 ft apart. The test plan is adjusted to fit the needs, constraints, and objectives of each particular site.

It is helpful to have a line of communication with the FGD control room during the PDPA tests. Gas velocities measured with the PDPA, using the velocity of the small droplets as an indication of the gas velocity, should be consistent with the superficial velocities calculated from control room data. In addition, it is sometimes desired to assess the carryover both with and without the wash nozzles operating. In this case it is necessary to ask the control room to turn on or off the wash water in specific locations.

## Personnel

The PDPA is a sophisticated instrument that takes a high level of expertise and training to operate properly. Each field test requires two engineers trained in the use of this instrument.

## Typical Results

Figure 2 (page 5) shows a typical size histogram and a typical velocity histogram for one of the field tests of Table 2. For this field test, measurements were made in the stack downstream of the scrubber. At the elevation of the measurements, four equally spaced ports were available to traverse the stack in the north-south direction and in the east-west direction. Six points were measured along each traverse. The maximum droplet size detected is 46 microns. The Sauter mean diameter is 20 microns, and the volume mean diameter is 15 microns. The small droplet size indicated by the histogram indicates that these droplets result from penetration through the chevron rather than reentrainment.

The instrument data reduction shows the flux based on the raw counts (solid bars of the histogram) as 5.8 x 10-6 cc/s/cm2. Using the probe cross-sectional area indicated in Figure 2, the run time of Figure 2, and the text file for this run (which prints out the size and number of counts for each bin) the flux based on the corrected droplet count (open bars of the histogram) is 7.43 x 10-6 cc/s/cm2 or 0.000109 gpm/ft2. (The software has since been corrected to calculate flux from the corrected droplet count rather than from the raw count.) The velocity indicated by the PDPA is 11.0 m/s for this run or 36.4 ft/sec.

Figure 3 shows one of nine sets of velocity profiles across the stack.

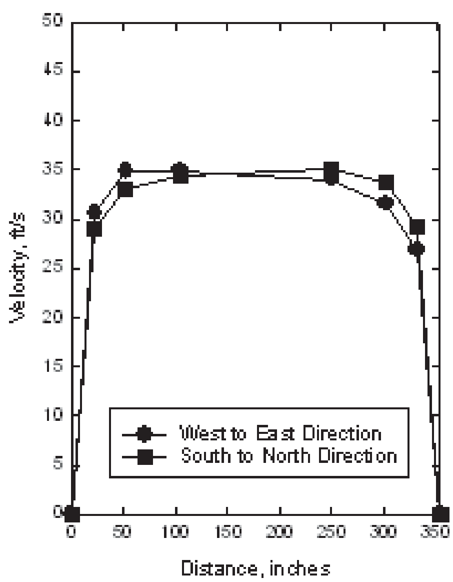


**Figure 3. Typical Velocity Profile across Stack as Determined with the PDPA**

These profiles are characteristic of well-developed turbulent flow. The traverse points were selected using the “tangential” method which, in this case, divides the cross-sectional area into three annular zones of equal area and assumes the average velocity for each zone is measured at a position which divides the zone into two equal annular areas. Then the average velocity for the stack is simply the mean of the 12 measured values. For Figure 3, the mean of the 12 raw PDPA measurements is 34.2 ft/sec. This may be compared to an average velocity of 38.7 ft/sec measured independently with a Pitot tube traverse.

The average PDPA velocity is about 12% below the average Pitot tube velocity. For all nine traverses, the average raw PDPA velocity was 34.22 ft/sec and the average Pitot tube velocity was 38.16 ft/sec. Based on these average numbers, the PDPA velocity is about 10% below the average Pitot tube velocity.

Figure 4 shows one of nine mist concentration profiles across the stack. As expected, the mist concentration is reasonably uniform from point to point. The average mist concentration for this test is 0.0032 gr/ACF. The overall average for all nine traverses is also 0.0032 gr/ACF. This may be compared to the mist eliminator guarantee of <0.01 gr/ACF for this installation.

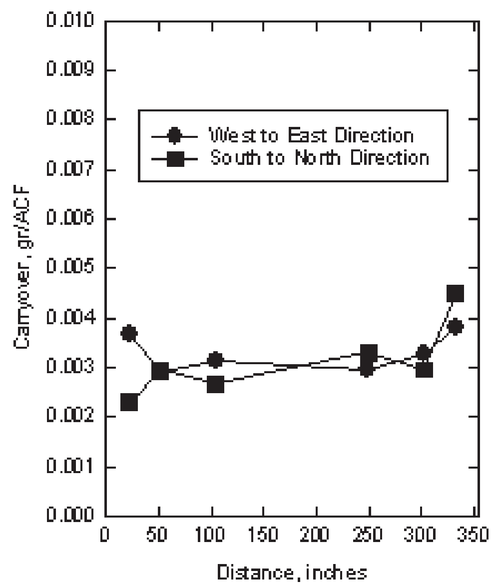


**Figure 4. Typical Carryover Profiles across Stack as Determined with the PDPA**

## Conclusions

The PDPA is a sophisticated laser-based instrument that is capable of accurately measuring the size and velocity of droplets which pass through a probe volume defined by the intersection of two laser beams. This enables mist flows to be characterized in situ with a device that is basically non-intrusive. In addition to laboratory calibrations, this device has been routinely used in the pilot plant to characterize the removal efficiency of mist eliminators and in commercial FGD scrubbers and stacks to characterize the carryover of mist from mist eliminators. Where the PDPA can be checked against other measurement and calibration devices, good agreement has been observed. For commercial applications, a specially designed fiber optic probe is used. This probe can be inserted into a tower and traversed from point to point to map out the velocity and mist concentration profiles downstream of a mist eliminator. The utility of this device in commercial environments has been demonstrated in a number of field tests where carryover measurements have been made to assess compliance of actual mist eliminator performance with vendor guarantees.

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