spray research, inc.

Full-Scale Mist Eliminator Carry-over Testing: Capabilities and Experience

Introduction

Since its founding in September, 1995, spray research, inc. has performed full-scale mist eliminator carry-over evaluations at three coal-fired powerplants. Two of these evaluations were performed with the lab's Dantec laser phase doppler particle analyzer (*pdpa*). The third was evaluated with both the pdpa and the lab's Greenfield Instruments video imaging particle analyzer (*vipa*).

The ability to perform cost-effective evaluations on full-scale systems is the result of spray research, inc.'s development of compact insertion probes for both the pdpa and vipa instruments. These probes can be used in either vertical or horizontal vessels and can measure carry-over to a depth of 3.0 meters [new proposed probe boom: 5.0 meters]. Unlike previous probe technology that requires the expensive and time-consuming installation of intrusive alloy guide rails, spray research, inc.'s new probe design can be easily inserted through existing inspection ports and manways. Since the probe does not rely on fixed tracks, sampling locations can be chosen with great flexibility. With the relatively simple installation of additional ports, carry-over measurements at multiple elevations downstream of the mist eliminator are easily performed.

Choosing between PDPA and VIPA

Advantages of the PDPA

While spray research, inc. has successfully used both the pdpa and vipa systems for these evaluations, the pdpa instrument is generally preferred because it is less intrusive, more reliable under severe operating conditions, simultaneously measures both particle diameter and velocity [and thus provides a direct measurement of the carryover rate], and acquires data at much higher rates:

1. Intrusiveness: both probes are intrusive assemblies that can disrupt the near-field gas flow. Of the two, the vipa is much the more intrusive. In the saturated and often condensing, conditions of the gas stream, light intensity attenuation and poor contrast requires the field-of-view of the vipa to be aggressively restricted. Our experience is that the field-of-view needs to be restricted, by adjustable fins, to between 10 and 15 mm. In addition to significantly perturbing the near-field gas flow (which will yield a bias against the small diameter particles), the tight fin spacing also biases against the larger droplets. Standards of practice dictate a minimum fin gap distance of four (4) times the diameter of the largest particle expected to be encountered. Using this criterion, particles up to approximately 2500 µm could be satisfactorily sampled with a 10 mm gap.

   The pdpa probe uses 400 mm F.L. optics, allowing a clear width of about 70 mm normal to the flow direction, and a clear aperture height of approximately 650 mm A low-pressure air purge and desiccant system is incorporated into the probe to reduce fogging and wetting of the optical components.

atomizer testing
spray characterization
sprays research
product development
process development
inspection services
consulting

16 Depot Street, Monroe Bridge, MA 01350
PH: 413-424-8229 FX: 413-424-8240 Toll Free: 888-85-SPRAY
EMAIL lab@sprayresearch.com

2. Reliability: The pdpa probe is composed of optical components connected to the remote processor and laser head by fiber-optic cables. Absent physical crushing damage to the sheathed fibers, the probe is insensitive to the temperature and humidity levels found in the flue gas. We have not experienced any problems associated with the pdpa probe (other than temperature-induced alignment drift) during the three evaluations performed to date.

   In contrast, the vipa probe contains temperature- and humidty-sensitive electronic components (CCD sensor, xenon flash tube, condenser) connected to the remote processor by a large number of signal cables. Even with the probe fitted with a vigorous desiccant and cooling air purge, the probe electronics failed four times during the single test series in which it was employed. The most significant was total failure of the CCD sensor, requiring a two days' delay in testing while a new unit was shipped to the site.

3. Velocity Measurement: The pdpa yields simultaneous measurements of the particle's diameter, velocity and direction of travel. The pdpa thus provides a direct measurement of the carryover rate. The data file contains (among other values) the diameter, velocity components and time-of-arrival of all validated particles. This allows a variety of time-series analyses to be performed on the collected data. Such analyses on some of the field measurements have indicated a periodicity in the carryover loading and particle size spectrum related to the operation of ME and BES wash systems.

   The vipa probe relies on a separate dual-RTD velocity transducer located downstream of, and centered on, the fin gap. The heated transducer is prone to rapid scaling. There is uncertain correlation between the velocity recorded by the transducer and that of the gas passing through the fin gap, the [undisturbed] free flow gas velocity, and the velocities of the individual particles [or class sizes]. These uncertainties confound the calculation of the carryover rate. The vipa system does not retain information on individual particles, relying instead on assigning each particle to a bin size class. Even crude time-series analyses are not possible without resorting to manual transcription throughout the test.

4. Data Rate: Our field experience suggests that the pdpa acquires validated data at between 4- and 10-times that of the vipa. The primary limitation on the vipa's data rate is that the system can process a maximum of approximately 10 frames containing under 25 particles per sec, compared to the 170 kHz of the pdpa. A further factor depressing the vipa data rate appears to be the poor contrast of the field-of-view which forces very stringent threshold criteria in order to minimize artifact data.

   The low data rate encountered with the vipa in field evaluations implies either that the duration of data acquisition be significantly increased or that the investigators accept relatively small data sets. The latter approach tends to produce data with large variances, confounding more highly resolved mapping of carryover characteristics across the duct section.

5. Acceptance: As part of EPRI's continued research in the mist eliminator area, two studies evaluating the performance of mist eliminator carryover measurement methods were initiated. The first study [1990] evaluated four methods, including a video droplet analyzer (*vda*). The study's conclusion was that while the vda was the most accurate of the four methods studied, none demonstrated accurate measurements over the range of carryover levels likely to be encountered in the field.
   The second study was conducted in 1994 to evaluate a new method [pdpa], an improved method [MgO/treated paper] and AIMS hot-wire anemometry. The study's conclusion was that the pdpa was the most accurate method. The next most accurate method was MgO/treated paper, followed by the AIMS. The study also concluded that a combination of MgO/treated paper and AIMS was better than either method individually.

16 Depot Street, Monroe Bridge, MA 01350
PH: 413-424-8229 FX: 413-424-8240 Toll Free: 888-85-SPRAY
EMAIL lab@sprayresearch.com