Such a mass flow system is similar to that embodying a magnetic flow meter, except it uses a vortex velocity domain sensing type of clamp-on sonar flow meter (Reference: www.cidra.com), shown in Figure 11.

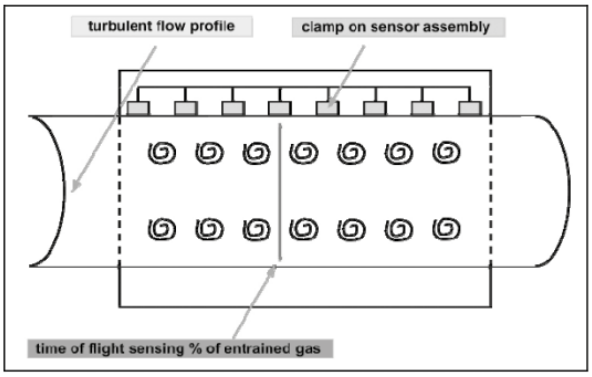

FIGURE 11. Vortex Velocity Domain Sonar Flow Meter.

Unlike a magnetic flow meter the vortex velocity domain sonar technique allows measurement of both electrically conductive and non-conductive media. Unlike Doppler shift or 'time of flight' ultrasonic techniques, vortex velocity sensing is independent of media density. Consequently, it is a volumetric flow device and ideal for mass flow measurement when processed with the noise free signal from the SCIAM Density Meter.

The vortex velocity domain sonar technique uses an array of sonar sensors and passive sonar algorithms to detect, track and measure the time taken by the following coherent disturbances to pass between set points within the axial direction of the flow meter:

a) Vortices caused by slurry flowing in the Reynold's Number turbulent regime, typically 0.6 – 12 m/s (2 – 40 fps)
b) Fluidic waves in the media, typically 80 – 1500 m/s (260 – 5000 fps)
c) Pipe wall vibrations, typically > 3000 m/s (> 10000 fps)

Each type of disturbance is identified by the sonar sensors, from which an accurate account of the slurry mean velocity is processed, and hence its volumetric flow is determined.

A significant advantage of this particular sonar flow meter is that it can also measure % entrained gas in the media using a separate 'time of flight' ultrasonic energy directed diametrically across the pipe. The time taken for the ultrasonic signal to traverse the pipe is proportional to the % of entrained gas. In this way the mass flow signal, computed by the product of noise free signal from the SCIAM Density Meter and the sonar volumetric flow meter, is accurately compensated by the measured % entrained gas:

density x volumetric flow x % entrained gas = compensated mass flow (8)

CONCLUSIONS

The SCIAM Density Meter is the first viable and 'green' alternative to nuclear density meters for measurement of mining slurry. Uniquely, it measures directly mass per unit volume, where the referenced volume not only accounts for variation in density across the complete pipe cross section, but where its length is also sufficient to be significantly representative of the media.

The hitherto major problems of direct and continuous weighing of the media have been overcome by the SCIAM Density Meter technology, which results in improved accuracy, resolution and reliability, with faster response time and significant reduction in maintenance and operational costs.

Used with a vortex velocity domain sonic flow meter, the SCIAM Density Meter measures for the first time wet or dry mass flow rate and totals, with wet density or % dry solids of mining slurry containing entrained gas, including slurries which may be non-conductive. Since direct mass is sensed, an extra benefit is that continuous density is now traceable to the USA National Institute of Standards and Technology (NIST) and other international standards.

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