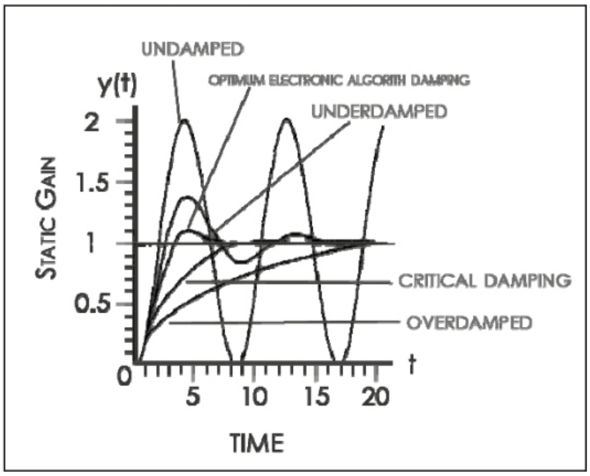

Figure 4. Response of a second order Sciam Density Meter to a step function.

The values of ρ are achieved in two basic ways: a) by the low natural frequency internal design of the Sciam Density Meter, including a virtual solid state mass transducer, and b) by the remote Sciam Density Meter electronics incorporating appropriate algorithm conditioning, which responds to and compensates for frequencies 0.25 – 110 Hz, programmable at the various ρ values.

The remote Sciam Density Meter electronics is programmable for optimum, critical and over-damping algorithms, to accommodate damping factor ρ values between 0.8 and 3, as shown in Figure 4. The response time is typically 5 to 15 seconds (time constant 1 – 3 seconds) and very acceptable to industrial users in the mining industry. However, should special applications requiring faster time constants occur, the Sciam Density Meter can have time constants down to 45 milliseconds. Such fast response capability ensures sudden changes in media density are measured.

CONSTRUCTION AND THEORY

The overall construction of the Sciam Density Meter is shown in Figure 5.

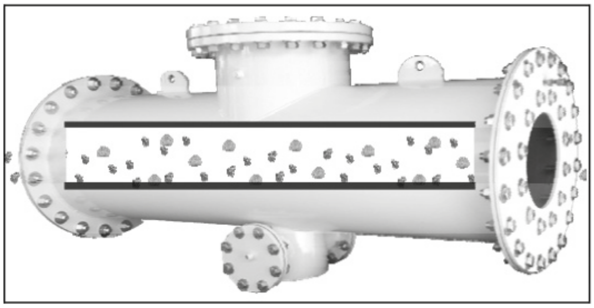

Figure 5. Construction of a SCIAM Density Meter.

Since the Sciam Density Meter is bi-directional, slurry may enter the Rubber Flow Tube at either end. The slurry runs continuously through the Flow Tube.

At the longitudinal center portion of the Flow Tube there is a 'C' Clamp arrangement. This is accessed through a flanged upper standpipe. The 'C' Clamp embraces virtually the complete Flow Tube circumference. This ensures the internal diameter of the Flow Tube remains the same at internal pressures typically to 10 bar g (150 psig) and results in a negligible pressure error coefficient. Higher pressures are available.

A peg on the underside of the bottom-most 'C' Clamp communicates with the 'solid state' Mass Transducer. The measurement of the mass of the Flow Tube and the slurry flowing within it is a measure of its density. The Flow Tube is designed as light as possible, without compromising mechanical stability and stiffness, and such that the measuring system has optimized accuracy and resolution. An electrical cable from the Mass Transducer passes through a pressure tight cable connector to the remote electronics transmitter. The transmitter both powers the Mass Transducer and accepts a signal from it, and converts the signal to a 4-20mA proportional output. It also provides a wide variety of communication networks.

The term 'mass' is used, rather than weight, since the Sciam Density Meter is so sensitive that the remote transmitter may be programmed to accommodate variation in earth's gravitational force, using factors related to major cities throughout the world.

The Rubber Flow Tube is of a special composite construction, with typical wall thickness of 25 - 40mm (1 – 1.5 inch). The outer half of the wall is a relatively hard rubber, reinforced with several layers of polyester ply. For vacuum conditions a metal spiral is molded into the outer wall. The inner half of the wall is normally a natural gum rubber. It is particularly soft with high resistance to erosion and suitable for the vast majority of dredging and similar slurries.

The Rubber Flow Tube is suspended on a stainless steel Suspension Rope. The Suspension Rope is in tension to provide the second order linear function of the Sciam Density Meter. Tensioning Bolts at each end of the density meter provides a force to oppose both media noise and externally induced vibration forces proportional to their rate of change. The Suspension Rope also embodies a method to temperature compensate for media and ambient temperatures, dependent on its length and angle to the horizontal axis. The tension in the stainless steel Suspension Rope is far greater than the Flow Tube and also provides a much more repeatable elasticity than would be obtained solely from the Rubber Flow Tube.

The deflection of the Flow Tube and Suspension rope may be described as virtually solid state, it being typically measured in hundredths of a millimeter (thousands of an inch) for full scale measurement. It is fundamentally important for relatively high tensional forces to be applied to the Suspension Ropes in order to achieve displacement repeatability of typically < ± 0.2% of reading. At the same time the Suspension Rope must suitably support the Flow Tube and allow optimum ease of deflection due to change of media density. However, the angle of suspension of the Suspension Rope to the longitudinal axis of the Flow Tube must be as small as practical. This is illustrated in the art of mechanical statics, whereby classical Lami's Theorem teaches that when 3 forces act on a point, the magnitude of each is proportional to the geometrical sine of the angle opposite each force. From this it can be shown with reference to Figure 6, that when an angle is relatively small, a force vector CD applied to Point C is correspondingly small compared to the tensional forces in Suspension Rope.

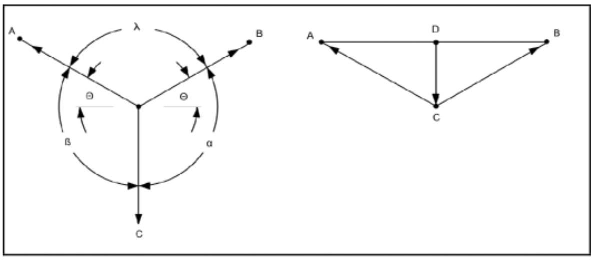

Figure 6. Magnitude of forces acting on the mass transducer.