Training materials

For the WorkSafeBC Blasting Examination

Shock Tube Systems

from the International Society of Explosives Engineers (ISEE)

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SHOCK TUBE SYSTEMS

Shock tube nonelectric systems have come to dominate the initiating system market in the past several decades. Their ease of use, durable construction, intuitive layout, and electrical insensitivity has made them one of the most widely used systems in the world.

This classification includes those activated by detonating cord, and shock tubing. In the past, a gas activated system was in wide use, but it is obsolete in North America, and its use is not presently known outside North America. It will not be discussed in this handbook.

The advantages of nonelectric versus electric initiation systems are perceived to principally be their lack of susceptibility to premature activation by extraneous electrical energy. Additional advantages are the ease of hookup and the relatively simple activation devices that most systems use. The principal shortcoming of most nonelectric systems is the lack of a circuit testing capability.

Shock tube initiations systems have proven their dependability and flexibility in most blasting applications. From small-scale quarry and construction blasts to very large and complicated surface and underground blasts.. Many configurations and applications have developed since their inception, and they have become very flexible.

Use Benefits

Electrical insensitivity is the main benefit of using shock tube systems. Their proven ability to be safely loaded and fired in high-static, high-stray current environments has been a great improvement in blasting safety for all users. The often simple and intuitive (logical) tie-in process has also made more effective blast timing and control available to blasting personnel worldwide. Nonelectric shock tube systems can replicate timing patterns once only possible by using electric detonators with sequential timers.

Use Limitations

The primary objection to nonelectric shock tube systems has been the inability to check the circuit for continuity and condition. The blaster is totally dependent on the manufacturers to have effective quality control processes in place to ensure proper and complete filling of the shock tube, and the error proof assembly of the shock tube to detonator connections. The use of double or redundant units in the borehole and on the surface greatly increases the reliability of shock tube systems. Redundancy also reduces the firing time scatter of the system.

Characteristics

Shock tube systems may be found with a great many varieties of fittings and configurations, depending on the application and the particular manufacturer's product in use. These systems are the most common initiation system used today and are continuing to replace both electric detonator and detonating cord downline systems. In general, the products discussed in this chapter are manufactured by most initiation system companies.

In normal practice the tubing remains intact after activation, and except for the disappearance or discoloration of the internal coating, appears as it did prior to activation. Under certain circumstances, however, tubing may rupture and vent hot gases through the opening. For this reason it is never advisable to hold the tubing in the hand during initiation. A variety of shock tube system configurations are available for specific applications. Millisecond trunkline delay assemblies are used for surface blasting. Also available under a variety of trade names are assemblies with a delay unit attached to one end of the shock tube and a conventional shock tube delay detonator to the other. These directional devices are used to generate individual borehole delays in a modified series hookup. These shock tube initiation systems are very application flexible with the hookups and timing configurations easy to design and execute. For specific information the various manufacturers should be consulted.

Construction

Nonelectric shock tube is a plastic tube coated with a thin layer of reactive material on the inside. The plastic shock tube is composed of one or more layers of plastic which are designed to enhance the physical properties (tensile strength, flexibility, and abrasion resistance). The thin interior coating of reactive dust (HMX and aluminum) is bound to the inner wall of the tube. The inner tube wall may be coated with other materials to provide additional water and abrasion resistance. Figure 13.6 is a cross section of the construction of standard shock tube and figure 13.7 illustrates the cross section of a shock tube detonator.

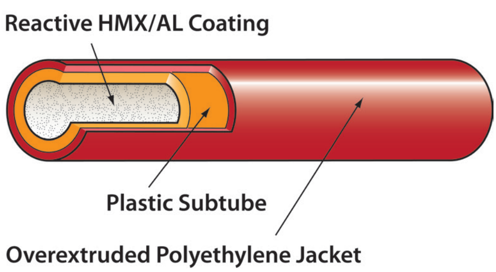

Figure 13.6 - Shock tube construction (Dyno Nobel).

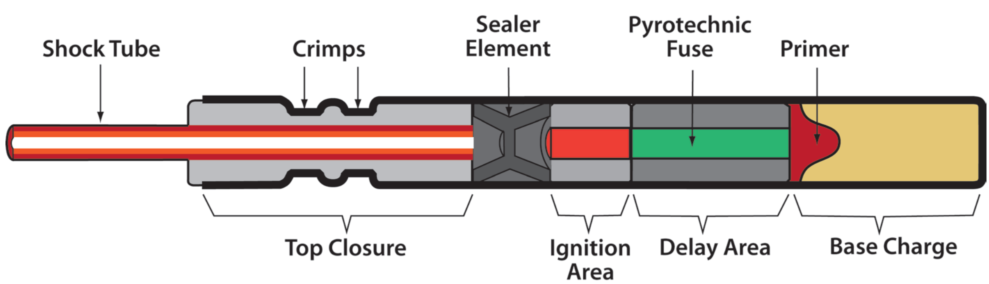

Figure 13.7 – Shock tube detonator construction (Source: ISEE Blasters Handbook™ 17th Edition, figure 12.3).

Performance Features

The shock tube is very insensitive to initiation by ordinary heat or impact and requires an intense high impulse shock to be energized. The most commonly used initiation sources are various forms of mechanical devices that utilize a shot shell primer activated by a firing pin. Also used is a handheld initiation device, which generates energy by using a piezoelectric crystal. Tight connections to appropriate strength detonating cords or initiators also serve as means of initiation.

The reactive material is comprised of the high explosive octogen (HMX) mixed with aluminum, and is held on the inside wall of the tubing by a static charge. When sufficient shock is delivered to the tubing the reactive components are shaken loose from the wall and the ignition propagates similar to that in a coal dust explosion in an underground mine. This reaction continues, generating a shock wave within the tube as shown in figure 13.8 that travels at a rate of approximately 6,500 feet/second (1,981 meters/second). Nonelectric shock tubing has no adverse effects on the explosive in the borehole.

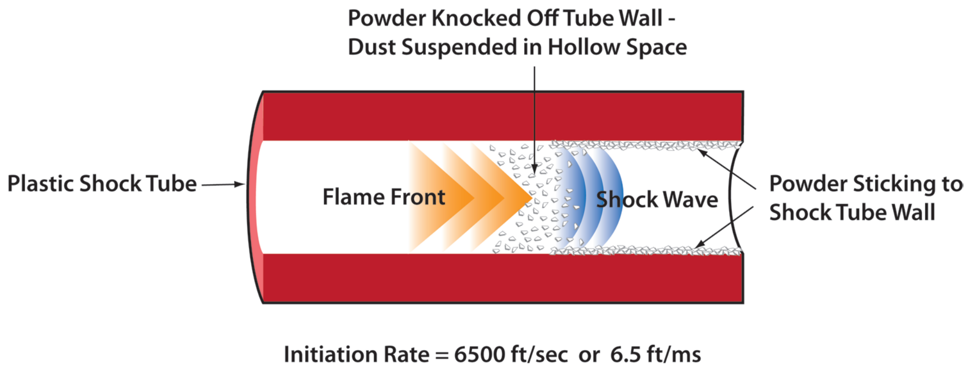

Figure 13.8 - Shock tube functioning mechanism (Source: ISEE Blasters' Handbook™, 17th Ed. figure 19.1).

Safety Features

Three important features create the electrical safety of the system. The high-resistivity of the plastic tube is the first feature, although the tube will conduct static, and stray or other electrical currents. This conductivity is much lower than electrical legwires. The second feature is an electrostatic bleeder feature incorporated into the sealer element to dissipate any static electricity or electrical current that has traveled down the tube.

The third and most important safety feature is the "Isolation Cup" shown in figure 13.7, this is a conductive plastic that provides a path for any electrical current coming down the tube to be dissipated to the detonator shell.

Caution

In the presence of lightning, operations involving the handling and loading of explosives should be immediately suspended and the areas secured until the threat is gone. In the United States federal regulatory authorities forbid the handling and loading of explosives upon the approach of a storm.

Accessories and Tools

Software is available to plan and report blast designs with shock tube blasts. These software products often calculate holes per delay period, direction of movement, ms per meter (foot) of burden, and quantities of product needed for specific designs. These are valuable tools in the design, layout, and tie-in of shock tube blasts. They also provide for the important documentation program of a good blasting operation.

General Use Techniques

Shock tube initiation systems are composed of various components and factory manufactured units. They allow much flexibility in delay pattern designs. The various products are discussed here.

> **Manufacturer's Recommendations**
>
> Shock tube initiation systems are available from a number of manufacturers. Many shock tube products made by different manufacturers look alike but should not be mixed within a blast. The manufacturer's recommendations must be followed and training by their representatives is important for proper and reliable operation of these systems.
>
> Each shock tube initiation system manufacturer has developed and tested component combinations to ensure the signal is transferred from component to component.

Shock Tube Lead-In Line Detonators

Shock tube lead-in detonators can be used when nonelectric blast patterns require nonelectric initiation at a safe distance from the blast site. These units are factory assembled precut in lengths from 25 meters to 300 meters (75 feet to 1000 feet) or longer. Figure 13.9 is an example of a lead-in line/detonator assembly. Shock tube lead-in-line is also available in very long length spools with no detonator attached. This shock tube can be spliced to other shock tube assemblies and then used to connect to a loaded blast pattern. This is often used when there is a need for a greater distance from the blast to the blaster. It must be emphasized that this is the only case where splicing shock tube is recommended. The manufacturer's accessories and techniques for splicing must be used.

Figure 13.9 - Shock tube lead-in-line with detonator. (Courtesy: Austin Powder Company)