Sonic horns: Sounding off against flow problems

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A sonic horn can get material flowing in your storage vessel or hopper truck or railcar by directing low-frequency sound vibrations into the vessel to fluidize stagnant material and buildup. This article gives a brief introduction to storage applications for sonic horns, explaining sonic horn benefits, how the horn operates, and how to select one.

A sonic horn (also called an acoustic horn or acoustic cleaner) is one of many types of flow aids you can use to get bulk solid materials flowing from vessels and ensure complete discharge to prevent batch-to-batch contamination. Such aids are commonly used to remove ratholes, bridging, and sidewall buildup caused by fine materials like kaolin clay, cement, carbon black, graphite, PVC compound, wheat flour, and food powders.

Unlike flow aids that depend on continuous mechanical vibration, air blasting, or manual air lancing, a sonic horn produces and amplifies low-frequency sound vibrations at high intensity to fluidize and remove material buildup. Because the sonic horn doesn’t apply mechanical vibration, it doesn’t compact material or segregate it by particle size and is less likely to cause vessel failure than a continuously operating mechanical vibrator. Unlike an air cannon, which directs a narrow localized air blast into one vessel area, the sonic horn provides fluidization throughout the vessel. The horn also uses less compressed air than an air cannon, eliminating a need for a large compressed-air reservoir that can be a source of potential moisture contamination. The sonic horn also eliminates the labor required for injecting fluidizing air into a vessel with a manual air lance.

How the sonic horn works

The sonic horn consists of three main sections, as shown in Figure 1: a driver, which includes a compressed-air inlet and a steel diaphragm; a cone-shaped chamber called a bell with a round or square cross section; and a larger-diameter horn outlet. The horn can be equipped with a mounting flange at any of various points along the horn depending on how it will be installed. The horn is available in carbon steel and other materials for special applications, including stainless steel for resistance to reactive chemicals, sanitary-finish stainless steel for food and dairy applications, and lightweight aluminum to make the horn easy to transfer from one truck or railcar to another.

The sonic horn can be used on silos, bins, and hoppers and on hopper trucks or railcars. On a storage vessel, as shown in Figure 2, the sonic horn is typically top-mounted — that is, mounted in the access hatch on the vessel’s roof — so that the horn can direct sound vibrations down into material in the vessel. (In some applications, chains are used to suspend the horn in the vessel.) A second sonic horn can be bottom-mounted — that is, installed on the vessel’s cone section, just above the discharge or at the cone-body transition point, with the horn outlet facing inward to break up material bridges above the discharge. In some cases, the bottom-mounted sonic horn is installed on a small fluidizing chamber mounted below the vessel discharge. On a hopper truck or railcar, the sonic horn can be top-mounted
in the roof’s loading hatch to fluidize compacted material and break up ratholes, and a second horn can be bottom-mounted at the truck or railcar’s discharge to fluidize compacted material and bridges above the discharge.

In operation, an automatic timer linked to the sonic horn driver’s compressed-air inlet releases a burst of 60- to 80-psig compressed air into the driver. Typically, each air burst lasts several seconds (up to about a 20-second maximum), with the intervals between bursts depending on the application. The air burst entering the driver causes the diaphragm to vibrate. This produces sound waves that are amplified as they move out through the bell, which functions much like a handheld megaphone. The sound waves move through the horn outlet into the vessel and displace the air, producing low-frequency sound vibrations at a high-pressure acoustic energy level. Because sound waves are pressure waves, they cause pressure fluctuations that break the bond structure in the material buildup. This fluidizes the material and facilitates its flow from the vessel. The vibrations’ acoustic energy level falls within a fixed frequency band determined by the bell’s shape and size.

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**Sound pressure level.** The sonic horn’s ability to remove material buildup depends on its sound vibration intensity, which is commonly called the *sound pressure level* and is measured in decibels. To fluidize material buildup, the
sound pressure level must be above 120 decibels. The greater the sound pressure level, the more effective the material removal.

**Low-frequency sound vibrations.** The sonic horn’s sound frequency is typically between 125 and 250 hertz (that is, cycles per second). Frequencies above 250 hertz are more audible and likely to annoy nearby plant workers. But this doesn’t mean that the lower the frequency, the better. In fact, sound vibrations at frequencies below 60 hertz not only lose their power to remove material buildup but can damage solid structures, such as silo walls and support legs, and mechanical connections, such as feeders and dischargers.

**How to select a sonic horn**

Work with a sonic horn supplier to determine which horn features are best for your application. Typically, the supplier will ask you to complete a technical data sheet describing your current flow problems; your material’s flow properties; your vessel type, size, and operating details; the maximum operating temperature; and other details about your application.

Based on this data, the supplier will recommend a sonic horn whose dimensions, sound pressure level (in decibels), and frequency level (in hertz) can get material flowing from your storage vessel, truck, or railcar. The supplier will also help you choose the horn’s construction materials. Once you’ve selected a sonic horn, the supplier can provide advice on where and how to install it and how often to actuate the horn to promote flow from your vessel.

**Other applications**

Sonic horns also have widespread application in dust collectors, where they can fluidize dust collected in hoppers to aid discharge and can be used in conjunction with the filter-cleaning system — even replacing a baghouse shaker system — to dislodge dust from filters. Among the major benefits are reducing pressure drop across the collector and extending filter life. Sonic horns can also be used in duct and pipe elbows to reduce dust accumulation in these areas, in fans to dislodge dust from the fan vanes and eliminate fan balance problems, and in spray dryers to dislodge buildup from the dryer walls.

**Editor’s note**

1. For sonic horns supplied by the author’s company, this decibel level is measured at 1 meter of free air from the horn outlet. Other suppliers may use other decibel-measurement methods.

**For further reading**

Find more information on solving flow problems in storage vessels in articles listed under “Solids flow” and “Storage” in Powder and Bulk Engineering’s comprehensive “Index to articles” (in the December 2001 issue and at www.powderbulk.com).

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