In Depth Look: Brake Noise

Mar 12, 2012 | Posted in All Articles, Technical Papers

Brake noise is a very elusive problem that has plagued the industry since asbestos materials were banned decades ago. Until that time, noise had not been a problem. A friction material specialist explained that asbestos is *hygroscopic*, meaning it has the affinity to attract water molecules. In braking applications, it is thought that the moisture in the asbestos keeps the surfaces cooler during the evaporation process and lubricates the mating surfaces. But, people working with brakes and friction materials need a safe environment separated from the dangerous affects of breathing asbestos particles.

Sound is created by vibration. With dry-friction applications, two components are rubbing against each other: the friction pad, and the cast-iron disc surface. The resulting vibration from these two bodies may result in frequencies above or below the audible human range. We run into trouble when it is within the audible human range. A professor at the University of Maine once compared a friction type brake pad and brake disc to a violin. As the players run the bow across the string, both vibrate and the string in engineered to resonate at a particular audible pitch. The design of the violin "box" amplifies the sound. With the brake system, contributing sources of vibration and the right environmental conditions lead to an audible "noise" and it is possible the disc amplifies these sound vibrations.

Montalvo has spent a great deal of time and money over the years discovering causes and finding solutions to brake noise. There are two approaches to solving this problem. (1) eliminate the vibrations causing the audible noise or (2) accept a certain degree of vibration in the system and attempt to dampen it to levels not audible by the human ear. Dampening features can be added to any component of the brake system and into the friction material itself. The dampening characteristics of the pad, however, are affected by operating conditions and the environment. The feasibility of such dampening methods must also be considered.

We've heard about customers claiming to have resolved brake noise problems with "WD-40" and "Coca-Cola", or a pile of shop rags stuffed between the discs. These are only temporary fixes and can be dangerous, especially where "WD-40" is flammable and the rags can get caught up in the brake. They also make it more difficult to diagnose since these "fixes" alter the system we are trying to troubleshoot.

Friction pads normally take the blame for brake noise. However, there are many other elements that can contribute to noise problems and therefore the brake system, environment, and nearby machine components must be examined. When brake noise occurs in the converting/paper/packaging industries, it is heightened by the fact that such brakes operate in a continuous slip manner (rather than a start-stop manner, such as with brakes on vehicles). These brakes are located inside a closed environment where people must be subjected to the noise. It becomes a very sensitive issue that we take very seriously and approach with caution.

Each and every application is unique and can only be handled through experimentation. Again, it is an elusive problem. An application can run great for years and then, all of a sudden, it generates noise. Some customer's only have squealing problems in the winter, some only during a particular process, and others

can't get rid of the noise no matter what the condition. To troubleshoot, we have to collect as much information as possible. In all but a few cases the problem can be solved, but it requires some patience.

Friction Pad Dust
It is inevitable that in any dry-friction application dust will form along the inside of the brake cover, around the friction pads, and on the brake modules. Excessive dust buildup increases the propensity for noise, especially around the working surface of the friction pads and discs. The dust no longer possesses the properties of the original friction material. This may introduce audible vibrations, similar to a pebble or sand getting caught in your vehicle's disc brakes. This material should be removed using a damp cloth or a vacuum cleaner.

Glazing
Glazing can be identified as a hard, glassy surface on the friction pad. There are two common types of glazing. The first is "mechanical" which occurs typically at low temperatures and operating pressures. The second is "thermal" which occurs due to excessive operating temperatures exceeding 350° F.

Thermal glazing is typically more severe and occurs when the excessive heat in the pad begins to draw the resins to the surface and literally "cooks" the pad. When the pad cools, its surface crystallizes, changing the pad's properties. Typically, the entire pad becomes very hard if subjected to disc temperatures about 400° F for extended periods of time. Brake disc temperature should never exceed 350° F when coupled with today's friction materials. If the pad has not been exposed to prolonged high temperatures, it is most likely that only its surface has been altered. Once the pad is cooled down, break the glaze on the pad's surface by rubbing it with a heavy grit sandpaper or emery cloth in a circular motion. If the application causes the brakes to overheat, a larger brake or fan cover may be required.

Mechanical glazing is essentially like polishing a surface with a mild abrasive cleaner. This normally occurs when the piston is at an air pressure below 20 psi and/or disc temperatures below 150° F. The friction material is basically not working hard enough. Try to reduce the number of actuated pistons and increase the air pressure to the remaining pistons (if using an open-loop system). Only reduce the number of actuated pistons that are necessary. Each remaining pad must do more work since this concentrates the load onto fewer pistons. Make appropriate control allowances if all of the pistons are needed for e-stops or for any other urgent reasons. Make certain the operators are aware they will need to turn some of these pistons back on if they run other applications that require more brake torque. If the noise has not gone away after a few runs, remove the pads after the brake has cooled and break the glaze on the pad's surface by rubbing it with heavy grit sandpaper or emery cloth in a circular motion. If running fewer pistons alleviates the problem, be sure to alternate pads at least once per week to attain even pad wear.

Disc Surface
Friction material not only glazes on the pad but will coat the surface of the brake disc. Also, foreign substances applied to the disc may worsen the problem. This is an important starting point after removing the friction pad. It ensures you are only dealing with the friction material and the disc, not other factors. It is also important to clean the disc surface when trying new pads. Each friction material is unique and materials left behind by the previous friction pads could alter the characteristics of the new pads. Sometimes cleaning the brake surface will eliminate or reduce squealing.

After the brake has cooled, use a light grit sandpaper or preferably an emery cloth and rub in a circular motion while slowly rotating the disc. After each rotation, wipe the surface down with a clean cloth. You will immediately notice the cloth is now soiled to some degree. If it all possible, repeat this using a clean section of the cloth until the cloth no longer picks up any visible particles.

Alignment and Mounting

Brake Disc run-out must be at a minimum. Please refer to Montalvo installation instructions for more detailed specific brake installation information. If the brake is not running true to the shaft, it creates vibration that could lead to noise. If the alignment is bad enough, one can actually see the friction pads and brake disc oscillate. This greatly increases the propensity for noise. Also make sure all brake components are tightly fastened and that the machine frame itself is rigid and true. Any sort of flexing or the presence of loose components can lead to misalignment during operation and can increase vibration and cause damage to the brake components.

Machine Components
There have been many instances where vibration traced back to other machine components translated into an audible noise at the brake. If this can be proven, the manufacturer of the machine should be contacted. Shaft misalignment, loose collars, loose or defective bearings, or other component run-out can cause these vibrations. Vibration can also be caused by misuse or damage.

Brake Sizing and Fan Covers
While multiple range brakes are each designed to handle a wide range of applications, if a brake is greatly oversize, it may be running so cool the friction materials never approach normal operating temperatures of at least 150°-200° F minimum. Historically, there is a high propensity for squealing at cold start-up temperatures. While it may not be practical to resize a brake, this at least may be a start in a diagnosis. However, if the brake has a fan, try shutting the fan off during a run. Sometimes the squealing will diminish or cease after disc temperature increases.

Friction Pad Selection
Friction pads are generally formulated for specific applications. It is not possible to formulate any friction lining to handle every application since it is required to accommodate a variety of coefficients, working temperatures, stresses, and wearability requirements. Due to the limits of the compounds used in manufacturing friction pads, there is often a tradeoff with these characteristics and not all can be satisfied. As stated earlier, a pad that runs much quieter in a particular application may also wear faster. Sometimes these limits have to be accepted. It also should be noted that pads with high coefficients and low wear rates tend to have the highest propensity for making audible noise as they do not possess the sound-dampening qualities of certain lower coefficient pads.

Past testing has concluded that in certain instances mixing different coefficients on the same brake can reduce propensity for noise.

Friction Pads and Other Brake Components
All components in the brake system should be “original equipment” parts. Since the friction material is a component that is matched to the other parts of the brake and is designed to work as part of the system, performance can only be guaranteed if original equipment is used. Use of original parts also makes it easiest to pinpoint problems and develop solutions.

Friction Pad Dampening
One method for dampening squeal is to apply a special hot, or cold bonded noise dampening insulator to the back of the friction material. Such materials are typically made up of multi-layered combinations of rubber, steel, fiberglass, and glues.

Anti-squeal composite materials, or shims, are excellent for brake applications demanding insulation for vibration and noise. Shims change the frequency of the noise being generated by the brake or connected mechanical components. They may solve the problem on their own or may be used in conjunction with other corrective actions to dampen squeal.

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