What to Know About Imbalance in Processing Plant Fans

Since imbalance can be a potentially dangerous and costly problem, it's critical to understand what it is, how to detect it, what causes it and how to address it

'The sooner a problem is detected, the lower the cost of repair or correction.' By Les Gutzwiller and Thomas J. Kuli Imbalance is a common problem with all industrial fans, including those in chemical processing applications. Since imbalance is a potentially dangerous condition and can result in breakdowns and costly operation shutdowns, it is imperative that plant managers and engineers understand what it is, how to detect it, what causes it and how it can be addressed. Detecting imbalance early can save large amounts of money. The less damage there is, the less the cost of repair. In some cases, imbalance results from an improper manufacturing process. However, this article will review a number of causes that may originate at the site of operation. First of all, it is important to clarify the difference between "imbalance" and "vibration." A fan rotor is generally comprised of a welded, riveted or cast fan impeller mounted on a shaft. Even if the manufacturer takes care in locating the blades and weighing the component parts, one can be sure that the weight center will be separated from the axis of rotation by a small amount at least. This differential between the weight center and the axis of rotation is referred to as imbalance. Imbalance is not a function of rotating speed and, therefore, can be assessed and measured when the fan is not in operation. Imbalance can be quantified by multiplying the weight of the fan rotor by the radial distance between the weight center and the axis of rotation. Vibration, which occurs during fan operation, can have many causes. One is imbalance. Other causes are mechanical looseness, coupling misalignment, defective bearings, insufficient flatness of bearing mounting surfaces, rotor cracks, driver vibration and V-belt slippage. The main causes of imbalance include buildup on blades, temperature differentials, dirt or fluid in hollow blades and loose hub-to-shaft fit. Let's review each of these below.

Buildup on Blades: In some applications, wet or sticky particulate matter can adhere to the surfaces of the fan impeller. Usually buildup of this sort is evenly distributed over all surfaces and the resulting imbalance is minimal. However, if a piece of the buildup material flies off due to centrifugal force, then significant imbalance will occur. In most cases, buildup can be prevented through innovative impeller designs. In some cases, backward-curved fan blades have proven effective in controlling buildup. However, their design must be carefully selected. If there is too much curvature of the blade, buildup can develop in the hollow pocket on the backside of the blade. Backward-curved fan designs are

available with steeply sloped blades so buildup of this sort can be prevented. **Temperature Differentials:** Another common cause of imbalance is non-uniform temperature. If a fan rotor is left at rest during an outage, a differential temperature can develop between the top and bottom of the fan housing. A similar though less pronounced temperature differential can develop in the shaft, resulting in differential thermal expansion. For typical steel shafting, the coefficient of thermal expansion is approximately 6.5E-6 in./in.-&#176F. A temperature difference of one degree between the bottom and top of the shaft will cause bowing in the shaft, which will cause vibration upon startup. The vibration will be quite high at first and then will decrease slowly as rotor temperature becomes uniform. If correction weights are applied during startup, then vibration will be minimal during startup but quite severe once the temperature differential is corrected. The solution is an auxiliary drive that rotates the fan rotor slowly during shutdown periods, ensuring uniform temperature.

Dirt or Fluid in Hollow Blades: Imbalance can also occur because of the accumulation of dirt or fluid inside hollow sections of rotor blades. Some centrifugal fans, for instance, have hollow airfoil blades, which offer maximum efficiency in clean operating conditions. However, during extended operation in wet or dirty environments, pin holes can develop in the blade skins, resulting in dirt or fluid buildup in one or more of the blades. **Loose Hub-to-Shaft Fit:** During initial startup, the fan hub will probably be held securely in place by set screws. After a period of time, however, the set screws can loosen, due to fretting or corrosion. This loosening of the set screws can allow the hub and entire fan impeller to become displaced relative to the axis of rotation. The result can be extreme imbalance. For this reason, hub-to-shaft connections with an interference fit or some type of tapered bushing are usually preferred.

In conclusion, those in charge of plant fans must be vigilant. Regular maintenance and inspection of fans can prevent costly shutdowns and catastrophic failures, which can result in injury or damage to other equipment. One means of monitoring the health of a fan is a proximity probe, which is applicable in sleeve-type bearing installations. Proximity probes are not practical, however, with roller bearings. When rolling element bearings are used, vibration can be measured effectively on the housing. In all cases, the best insurance is a close relationship with a fan service professional. Most balance and vibration problems can be corrected through adjustments or repairs. In general, repairing fans is much more economical and efficient than buying replacements. The sooner a problem is detected, the lower the cost of repair or correction. *Les Gutzwiller is vice president of technical services and Thomas J. Kuli is chief engineer at Robinson Industries Inc., Box 100, Zelienople, PA 16063, a leading manufacturer of custom-engineered and custom-built industrial fans. With four U.S. locations, Robinson Industries works in a variety of industries including mining, pulp and paper, cement, chemical process, steel, power and pollution control. Parts of this article come from AMCA Standard 204, "Balance Quality and Vibration Levels for Fans." A copy of the standard can be purchased by contacting Air Movement and Control Association International Inc., 30 W. University Dr., Arlington Heights, IL 60004 or calling 847-394-0150. Additional information is available by visiting* www.amca.org *[1] and*

www.robinsonfans.com *[2] or calling 724-452-6121.*We need to be looking at the possible ramifications at the same time the technology is being developed," he says. "There's certainly a lot of promise here but no one knows the potential downside or possible implications. The point being you don't want another situation like asbestos or PCBs, where the technology gets ahead of itself and doesn't take into consideration the potential human and environmental effects that could occur if the technology gets to the point where there's an application of the materials without any kind of study about how it might impact things."

Focus on Implications

For this reason, the EPA and other government agencies are beginning to commission studies related to the implications as well as the applications of nanotechnology. "EPA wants to see Americans benefit from this exciting new technology while ensuring that human health and the environment are protected," says Gray. "Therefore, EPA has awarded 14 grants totaling $5 million to universities to investigate potential health and environmental effects of manufactured nanomaterials. By performing research on potential adverse affects, EPA is doing what is right for both human and environmental health and technological processes." In addition to the grants, which were awarded through EPA's Science to Achieve Results (STAR) research grants program in partnership with the National Science Foundation and the National Institute for Occupational Safety and Health, the agency is calling its Toxic Substances Control Act into play. The program reviews and assesses new chemicals prior to their entry into commerce. And the EPA is working with a range of other agencies, stakeholders and businesses to develop a stewardship program that will allow the EPA to gain a better understanding of the benefits and risks associated with nanomaterials. While the voluntary program would ask participants to expose any ill effects they may find &#151 even if it means millions of research dollars have been spent to develop an application that ultimately can't be brought to fruition &#151 it is receiving chemical industry support. "We strongly support the EPA's stewardship program and we are trying to encourage EPA to get it into motion," says Bill Gulledge, managing director of the Nanotechnology Panel at the American Chemistry Council. "We believe eventually that the information that the EPA gathers from a stewardship program will help lay the groundwork for future applications."

Responsible Development

As Gulledge implies, there seems to be no stopping the development of nanotechnology. However, policy makers, the EPA and scientists are calling for responsible development. "The term 'responsible development' embodies what the EPA is trying to put together in its stewardship program," says Walker. "It is a dialogue between nanotechnology developers and the scientists and agencies that would deal with any problems that might be found. Such dialogue includes discussions about product safety, workplace safety and toxicology assessments of materials that are nearing commercialization." He adds: "Big companies that have invested a lot are well in tune with 'responsible development' and 'product

stewardship' because they realize that if they put out a product that turns out to be hazardous and they haven't evaluated it, their liability is huge." However, the trend toward open dialogue has not necessarily trickled down to smaller companies that are rushing to get product to the marketplace. Walker cautions against this. "Chemical engineers who are used to dealing with chemistry may not understand toxicology," he says. "It is in their best interest to be in touch with regulatory authorities in the early stages of development to determine if they are going down a road that is potentially hazardous and may have some problems. They don't want to produce anything that the EPA may eventually regulate or ban." For this reason, the steps the government takes toward guided development, which Walker says includes ethical, legal and environmental implications while nanoproducts are developed rather than after they are developed, is important. "It is much easier to guide the development than to clean something up after the fact," he says. For the time being, experts suggest that chemical engineers working with nanotechnology proceed with caution. "I don't see a day where we will be able to say that all nanomaterials are safe. It is too broad an area and development is moving too quickly," concludes Walker. "But on the flip side, we can't let the studies with detrimental results lead us to believe that nanotechnology and nanomaterials are bad because a small handful of studies don't reflect the full range of nanoscale materials out there. For this reason, it is important to follow the government's lead and adopt responsible development guidelines. It will allow us to find the promise and avoid the pitfalls of nanotechnology." *Joy LePree is a contributing writer for CHEM.INFO. She has worked as a journalist for 13 years, covering a variety of issues and trends involving chemicals, processing, engineering and maintenance. To share your comments about the content of this article, send an e-mail to Lisa Arrigo, editorial director, at* lisa.arrigo@advantagemedia.com *[3].*

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