Noise Pollution in the Laboratory

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Abstract

The overall level of noise in a laboratory depends on a number of factors including the location of the laboratory, the materials used in construction of the building as well as the instrumentation and equipment used to carry out the tasks of the facility. Since high noise levels can lead to a variety of medical issues for laboratory personnel and are regulated by government agencies, the laboratory manager must develop strategies to reduce the noise level to an acceptable level. In addition, excessive noise levels can lead to potential hazards due to misunderstood verbal instructions. An excellent way to reduce the noise levels in the lab is to select devices that are designed to generate less noise. An example is provided to demonstrate that selection of a device that is specifically designed for low noise output can significantly lower the noise level in the laboratory.

Introduction

Former U.S. Surgeon General William H. Stewart said in 1978, "Calling noise a nuisance is like calling smog an inconvenience. Noise must be considered a hazard to the health of people everywhere."

A number of studies have shown that high noise levels can contribute to significant cardiovascular effects and even exposure to moderately high noise levels during a single eight-hour period can a statistical rise in blood pressure of five to ten points and an increase in stress[1-4]; Vasoconstriction or narrowing of the arteries, and increased incidence of coronary artery disease. In addition, chronic exposure to noise may cause noise-induced hearing loss.

The degree of annoyance from noise produced by multiple sources is not fully understood but has been identified as a problem in environments operating equipment with varied noise levels and frequencies. There is evidence that combined sources of noise pollution lead to an increased level of stress and aggravation which can have a negative impact on efficiency, health and quality of work.

Noise levels are typically expressed in decibels (dBA), which is a logarithmic ratio of the observed level compared to a standard. Table 1 includes the decibel level of a few common activities to provide the reader with an understanding of the intensity of typical noise levels.

In the workplace, noise pollution is generally considered to be an issue once the noise level is greater than 55 dBA. Approximately 35 to 40% of workers in office settings find noise levels from 55 to 60 dB (A) to be irritating. To provide a healthy, safe and stress free environment, the laboratory manager should ensure that the noise level should be kept at a suitably low level. While the overall noise level in a laboratory comes from a variety of sources, an important approach for minimizing laboratory noise is the selection of instrumentation and ancillary equipment which are designed to minimize the noise generated and meet regulatory guidelines. Two instruments operating at 52 dB produces a noise level of 58 dB; adding a third instrument operating at 58 dB yields a noise level of 62.5 dB.

There is a large amount of practical information readily available to lab managers, engineers and architects related to this topic. Organizations like The Noise Pollution Clearinghouse, Noise Free America or the Occupational Safety and Health Organization offer links to articles and resources that may be useful to those interested in performing their own research.

Regulatory considerations for Noise Levels in the Workplace

The noise level in a workplace has been identified by the US Occupational Health and Safety Administration (OSHA) as a serious health concern and is covered by the Occupational Noise Exposure Standard (29 CFR 1910.5). This standard requires employers to have a hearing conservation program in place if workers are exposed to a time weighted average noise level of 85 decibels over an 8 hour work period. The permissible exposure limit (PEL) is 90 dBA; if the noise level is above the limit, the allowable exposure time is reduced. As an example, if the noise level is 95 dBA, a worker can be exposed to the noise for only four hours over a work shift. The National Institute for Safety and Health (NIOSH) has an 8-hour time weighted average recommended exposure limit of 85 dBA.

Similar standards have been established by the European Agency for Safety and Health at Work. In Germany, the noise standard for mentally stressful tasks is set at 55 dB(A)[5] however, if the noise source is continuous, the threshold level for tolerable noise levels for office workers becomes lower than 55 dB(A).

Sources of Laboratory Noise

To control the noise levels requirements and provide a safe laboratory workplace, it is critical to understand the various sources of noise in the laboratory. While it is obvious that each laboratory is unique and presents a different set of noise sources, a number of general sources contribute to the overall noise experienced by workers.

a) Equipment Noise - Almost all equipment that is employed for the direct performance of the function of the laboratory generates some noise. The nature of the equipment and the noise level depends on the type of laboratory; a chemical laboratory may include fume hoods, refrigerators, nitrogen gas generators, compressors and freezers. A biochemistry laboratory or a clinical laboratory might employ ultracentrifuges, large automated analyzers, tissue homogenizers, stirrer motors as well as the equipment in the chemistry lab. In addition, specialized laboratories include other types of noise generating equipment, as an example a geology laboratory might include a rock crusher while a quality assurance lab will likely have pneumatic sample injectors on the gas chromatography or liquid chromatography equipment.

The temporal noise level of the various noise generating systems should likewise be considered. Some systems will generate a steady noise (e.g. a fume hood), others are operating on a periodic basis (e.g. a refrigerator) and yet other operate on a shot basis (e.g. a pneumatic sample injector for

an LC or GC) and the overall instantaneous noise level is a sum of all of the devices in the facility.

b) Extraneous Noise – In addition to the noise generated by various devices in the laboratory, additional noise is generated by devices in the laboratory that are not directly related to the function of the lab. Noise from radios, piped in music and telephones is present in many laboratories.

c) Laboratory Design Considerations – The construction parameters of the laboratory may have a significant impact on the noise level. Since many laboratory facilities are constructed using reinforced concrete for the floors and walls, the walls and ceiling should be fitted with sound absorbing materials, if possible.

d) External Noise - The noise level in a laboratory can be significantly affected by noise from the overall environment. If, for example, the building housing the laboratory is in an industrial area, it is likely that there will be noise from vehicular traffic.
It should be noted that noise is additive, it is usually the case that there will are several sources of noise in a laboratory. While normal conversation is approximately 50 dB, if there are noisy systems in the laboratory, the overall noise level will be excessive and it will be difficult for people to be heard. This may create dangerous situations and/or leading to misunderstood information.

Controlling Laboratory Noise

When a laboratory is being designed, the manager should work with the architects to ensure that the facility is designed to meet OSHA standards and provides a safe workplace. If a new building is being constructed, all of the above sources of noise should be considered. The design and location of the building should be such that the external noise is minimized and sound deadening materials are used in the construction.

In many cases, however, the laboratory is located in an existing building and the external location and general construction materials are essentially fixed. When this situation arises, the laboratory manager must ensure that objects that create a high noise level are shielded whenever possible. For a laboratory in an existing facility, the most effective approach to minimizing the noise and ensuring that health and safety of the occupants are optimized may be to ensure that the instrumentation and ancillary equipment are selected to minimize the noise that they generate create..

Reducing Noise by Selecting Low Noise Generating Equipment - A Typical Scenario

Liquid Chromatography/Mass Spectroscopy (LC/MS) instrumentation requires a stream of high purity nitrogen to displace all of the oxygen in the mass spectroscopy chamber. The gas must contain an extremely low level of organic material; as such compounds will provide a signal in the MS and thereby make interpretation of the observed data more difficult. In addition, the level of water vapor and oxygen should be kept to a minimum as these may lead to reactions in the MS chamber and make interpretation of the data more difficult. While nitrogen gas can be provided in a number of ways (e.g. tank gas or liquid nitrogen) many laboratories provide the necessary gas using an in-house generator which provides the gas by extracting it from laboratory air as it is a safer, more convenient and less costly approach. When an in-house generator is used, intake ambient air is first filtered to remove airborne organic and particulate materials and then compressed (the maximum pressure is typically around 100 psig). The compressed gas is then delivered to a membrane that is capable of separating the nitrogen from the oxygen and water vapor in the air. Most nitrogen generators with internal compressors are quite noisy (55-60 dBA typical).

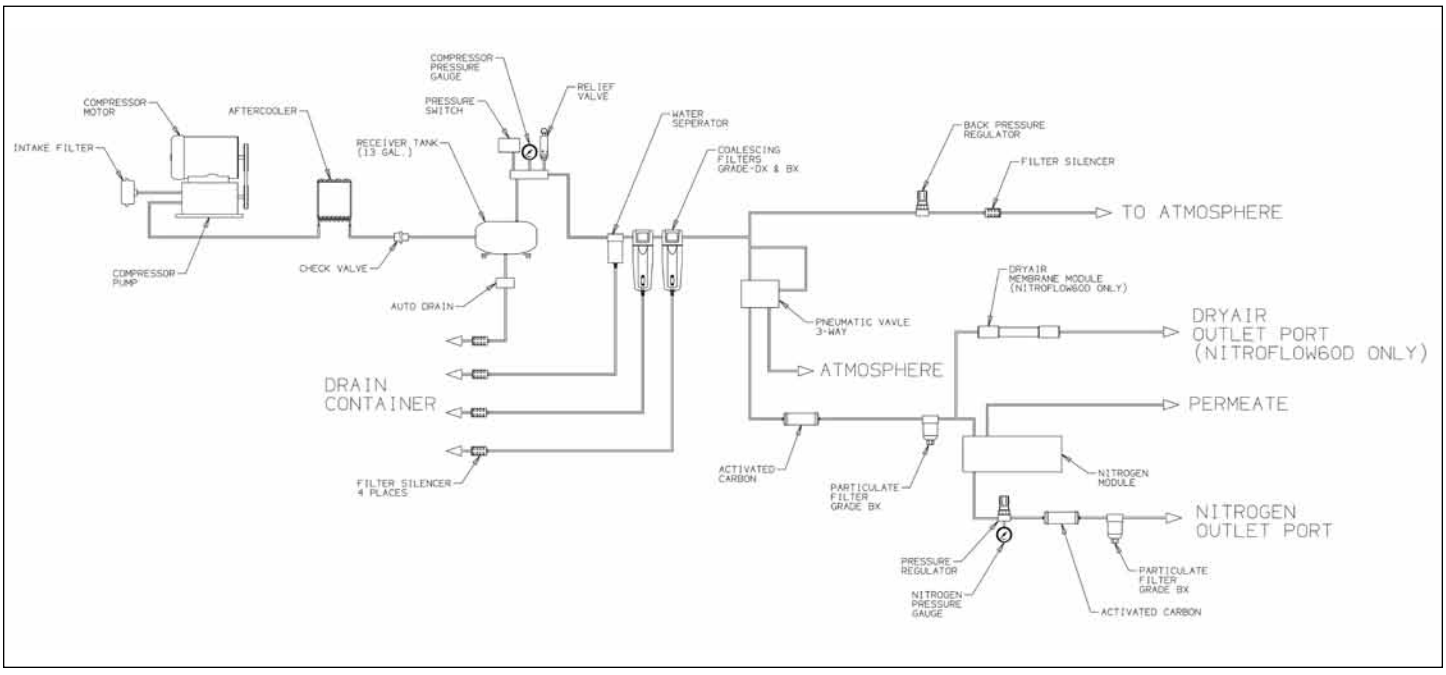

Figure 1: Schematic Diagram of Nitroflow60 Nitrogen Generator

Alternatively, Nitrogen generators that employ an oil-less rotary scroll system (e.g. the Nitroflow60 Parker Balston, Haverhill MA) can significantly reduce the noise compared to other compressor designs. The oil-less rotary scroll system consists of two identical spirals; that are offset 180° with respect to the other so the scrolls mesh. One scroll is orbited around the fixed scroll, trapping and compressing gas pockets as the pockets move to the center of the fixed scroll. The compressed gas is discharged from the pump through the center outlet to an air-cooled after cooler on the scroll compressor which includes a series of cooling fins and a high output fan. The cooling features allow the scroll compressor to operate at lower temperatures and extend bearing, tip seal and grease life. An additional benefit of the scroll generator is that no oil will be introduced into the LC/MS system.

The only moving part on the NitroFlow60 generator is the compressor which creates minimal noise during operation. Periodically there is an air discharge noise from the drain port eliminating accumulated fluids in the pre-filters and receiver tank and a silencer kit is included to minimize the drain discharge noise. There is also a pump "burp" noise lasting a few seconds each time the generator is shut down; this is due to the compressor depressurizing the pump during shutdown. The noise level for the system is 49 dBA which is considerably lower than nitrogen generators that employ other methods of compressing the air.

Conclusion

Excessive noise levels in a laboratory can create significant health hazards. Acceptable levels are provided by the Occupational Health and Safety Administration. The observed noise is a combination of external factors, which cannot be easily reduced and internal factors. Internal sources of noise are due to instrumentation and ancillary equipment in the laboratory. Noise from such devices can be reduced by selecting systems that are specifically designed with noise reducing components.

Table 1 Typical Noise Levels

Telephone dial tone	80dB
City Traffic (inside car)	85dB
Train whistle at 500', Truck Traffic	90dB
Jackhammer at 50'	95dB
Subway train at 200'	95dB
Level at which sustained exposure may result in hearing loss	***90 - 95dB***
Hand Drill	98dB
Power mower at 3'	107dB
Snowmobile, Motorcycle	100dB
Power saw at 3'	110dB
Sandblasting, Loud Rock Concert	115dB

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