Controlling noise from compressed air systems

It's been almost a decade since the 'Control of Noise at Work Act 2005'[1] was passed, becoming law in April 2006. With the aim of safeguarding workers' hearing from excessive noise, this put in place more stringent controls on exposure limits.

Figures from the HSE that were released not long after the act was passed, estimated that there were around 17,000 people in the UK on record as suffering from deafness, ringing in the ears or some other related hearing loss issue caused by excessive noise at work[2].

In a factory or process environment noise can be generated from many different sources. Although by no means the worst contributor, compressed air systems can contribute to overall noise levels. For example, mechanical noise can emanate from components such as the air compressor, dryer, filters, cylinders and valves, and from ductwork and pipes that resonate or transmit vibrations.

The nature of noise

Sound is a wave form of energy that is transmitted from a source, causing pressure variations in the air that are detected by the human ear. Noise is essentially unwanted sound. Noise perception is subjective and factors such as the magnitude, characteristics, duration and time of occurrence can all affect the impression of the noise.

The important characteristics of sound are frequency and amplitude. Frequency is the number of pressure fluctuations in a given unit of time, or the tone of the sound, while amplitude corresponds to the impression of loudness. In simple terms, a whistle has a high frequency with the amplitude or loudness depending on how hard the whistle is blown, given an unchanged distance from the source.

Sound is normally measured in Decibels (dB). There are internationally recognised methods of measuring sound, using one of a number of evaluation curves – listed as A, B, C or D - to adjust measurements so that they correspond to the sensitivities of the human ear. The evaluation curve used for measuring sound from industrial machinery is the A curve, so that results are shown as dBA. This is standardised in DIN 45635.

Excessive noise, especially over a prolonged period, can have a variety of effects.

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Although these effects may vary from person to person, depending on the sensitivity of their hearing and the nature of the sound being generated, the effects typically include:

- Psychic reactions such as irritation or anger – these can arise from sustained sound levels as low as 35dBA
- Vegetative reactions such as nervous effects, stress and reduced productivity and concentration – these can arise from sound levels from around 65dBA
- Hearing impairment including incurable damage to the inner ear – this can occur from sound levels from 80dBA upwards
- Mechanical damage and complete deafness – this can occur from sound levels from 120dBA upwards.

To put these figures into context, normal conversations are conducted at around 60dbA. Bear in mind, however, that levels of sound vary considerably with distance from the source and that the method

of measuring increasing levels of sound is based on a logarithmic scale; so a small increase in the decibel level can represent a significant increase in the volume of noise perceived by the human ear. For example, continuous sound at 85dBA may take as long at eight hours to cause permanent damage, while persistent sound just 15dBA higher, at 100 dBA, can start damaging the inner ear after only thirty minutes of exposure.

The effect of distance

The sound generated from a source always diminishes with increasing distance, as the energy dissipates.

Distance from source (m)	1	2	5	10	25	50	100
Reduction in sound (dbA)	0	5	12	16	23	28	32

Compressors in a large or open space and mounted on a solid base generally radiate sound energy in the form of a hemisphere. For example, a silenced BOGE screw compressor installed in a large hall generates according to DIN 45635 a sound level of 69dBA. At a distance of 10m the sound generated by the compressor is only around 53dBA.

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It is important to recognise that sound will be reflected by surfaces close to the source, causing a diffused field of reflected waves that will contribute to the overall perceived level of noise.

For example, solid and smooth surfaces, such as brickwork and concrete floors, will reflect a large amount of sound, while softer and generally more absorbent materials will have the affect of dampening noise. Surfaces that are capable of vibrating, such as thin metal ducts, can also absorb and transmit sound over considerable distances.

Measuring and controlling noise

The main method for measuring noise on air compressors is the enveloping surface method of DIN 45635 or other norms such as Cagi-Pneurop and PN 8 NTC 2.3. These standards define the conditions for measuring the noise that air compressors emit to the outside air (noise output) according to standard methods. This means that the results are comparable.

Providing solutions to this specific noise issue is based on understanding the source of noise on a compressed air system and how this can impact on workers. Some of the key culprits for creating high levels of noise are the motor, air end, after-cooler, and in the case of an oil-injected compressed air system, the air/oil separator. Additional sound sources include air escaping from leaking pipes and fittings and mechanical noise from moving pneumatic equipment, such as cylinders and actuators. The more frequently the compressed air system runs, the more intense and constant the noise level will be.

There are a number of methods to control the impact that noise from compressed air systems can have on shopfloor workers.

The BOGE High Speed Turbo 220 compressor

Best practice always dictates the use of appropriate ear plugs or defenders. Beyond these items of PPE then perhaps the simplest solution is to move compressors to an area or room away from workers. Although this is a common practice, with many factories having dedicated compressor rooms or enclosures, often located in a separate building, it can be an expensive option.

This is especially true if space is already limited, or the only location is some distance from the point of use and therefore demands considerable extra pipework, electrics and, if pipes have to be routed outside, protection from the elements. Remote locations, with extended runs of pipework, may also result in greater energy consumption and increased maintenance costs.

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An alternative to this is some form of engineering control, such as noise abatement, where acoustic enclosures or sound barriers are used as a solution for reducing compressed air system noise. Although these can be fitted around compressors a more cost effective approach is to have sound absorbent materials built into the compressor enclosure itself.

These silencing materials should be non-combustible and insensitive to both dust and oil and typically take the form of mineral cotton or foam panels that are installed within the steel sheet case of the compressor.

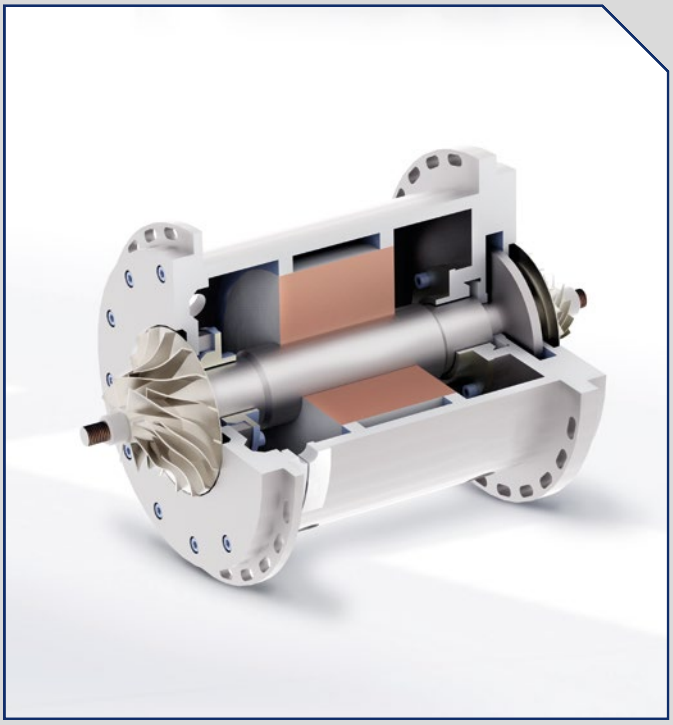
A further option is to fit specially designed silencers on air intakes and exhaust systems. These need to be matched to the frequency characteristics of the compressor or noise source, as frequency can vary considerably; for example, large reciprocating compressors may generate high noise levels at low frequencies from air intakes and require low frequency attenuation silences that do not restrict the air flow. These silencers or mufflers either contain sound absorbing materials or use a design of tuned reactive chambers and perforated tubes to dissipate the sound energy or reflect it back to the source.

The design of the compressor itself can also play an important role in minimising levels of sound. The latest machines use advanced technology to reduce the noise from moving parts, most notably recent developments to the size, speed and mechanical characteristics of the air-end, combined with the flexibility and power of variable speed controls can all play a crucial in both operating efficiency and noise reduction.

The new BOGE High Speed Turbo for example, is a completely oil and lubricant-free compressor system that emits substantially lower levels of noise than traditional oil-free machines. This no more than 63–69dBA, compared with many other oil-free screw compressors where the standard decibel level is 80dBA.

This is possible because the compact BOGE High Speed Turbo has very few central components and a much smaller motor. There are therefore fewer parts to generate mechanical and vibrating resonant noise.

Housed in a protective enclosure, this compact and lightweight compressor produces a more tolerable background noise with none of the high-pitched tones typically associated with compressed air systems.



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The effect of multiple sound sources

If there are several sources of sound present then noise levels, and the perceived intensity of sound, will increase. The correlation between the number of sources and the perceived sound may not, however, be linear and will depend on the structure of the room, the sound levels of the individual sources and their frequencies.

The following table shows the increase of the overall sound level without taking reflection or transient noise into account:

Number of sources	1	2	3	4	5	6	7
Increase in sound (dbA)	3	5	6	7	10	12	13

As a simple example, if there are three silenced BOGE C30 screw compressors in a large hall, with each generating a noise level of 69 dBA, then the overall sound level will be 74 dBA; i.e. 69dbA plus 5.

With no obtrusive noise, there is no need for a plant operator to consider a separate compressor room or additional silencing materials, thus removing the associated costs and labour.

Although controlling noise level is just one consideration when working with a compressed air system, the High Speed Turbo exemplifies how the latest technology can be used both to improve operational efficiencies and minimise the level of noise generated in a busy production environment.

To find out more about BOGE Compressors and specialist gas generators, please contact us or visit our website:

www.boge.com/uk

References

[1] HSE Controlling Noise at Work Guidelines: http://www.legislation.gov.uk/uksi/2005/1643/contents/

[2] HSE most recent statistics regarding hearing loss in the workplace: http://www.hse.gov.uk/noise/about.htm

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