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Review Article

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION STANDARDS FOR AIR SYSTEMS

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ABSTRACT

Air system is a system of mechanical refrigeration, in which cold air is compressed, cooled, and permitted to expand and thus acts as the refrigerating agent. International standards bring technological, economic, and social benefits. This article provides an introduction to the International Organization for Standardization (ISO) 8573 and ISO 12500 series of international standards which cover compressed air purity and test methods, as well as the purification equipment essential to achieve the standards. The amount of water present in a compressed air system is staggering. Combination of a small 2.8 m^3/min (100 cfm) compressor and refrigeration dryer operating for 4000 h in typical Northern European climatic conditions can produce approximately 10,000 L or 2200 gallons of liquid condensate per year. If the compressor is oil lubricated with a typical 2 mg/m^3 (2 ppm) oil carryover, then though the resulting condensate would visually resemble oil, oil would, in fact, account for <0.1% of the overall volume and it is resemblance to oil to which a false association is made. Testing standards are being revised to give the users an unblemished picture of how components will perform. These standards are being written to help users manage their total energy consumption. To help users evaluate their compressed air systems, additional standards are about to release and these newer standards can have a significant impact on plant energy consumption if properly applied.

Keywords: Air system, International Organization for Standardization 8573, International Organization for Standardization 12500.

INTRODUCTION

International Organization for Standardization (ISO) is the world's largest developer of voluntary international standards. International standards give state of the art specifications for products, services, and good practice, helping to make industry more efficient and effective. Developed through global consensus, they help to break down barriers to international trade [1].

Air system is a system of mechanical refrigeration, in which cold air is compressed, cooled, and permitted to expand and thus acts as the refrigerating agent.

Compressors in today's market shall essential meet a variety of standards written by a wide range of organizations throughout the world. Until recently, most standards were written to deal with safety, mechanical, electrical, and performance of the individual components of a compressed air system. Recognition of the significant amount of power used by compressed air systems has led to a shift in standards writing over the past couple of decades. Testing standards are being revised to give the users an unblemished picture of how components will perform. These standards are being written to help users manage their total energy consumption. To help users evaluate their compressed air systems, additional standards are about to release. Among these new standards, the most significant is the American Society of Mechanical Engineers EA-4-2 008 and ISO 11011. EA-4-2 008 will be known an American National Standards Institute standard when its development is complete [2].

One of the key features of ISO 11011 is the establishment of facts such as the capacity of compressed air to be used, its generation cost by a process indicating "baseline" performance. The purpose of baselining is to establish the current performance levels and costs of a compressed air system and to correlate the results with the plant's current production levels. As improvements are made to the system, it will be possible to estimate the success by comparing the new measurements with the original baseline.

Both of the standards deal with requirements for air system. The American Society of Mechanical Engineers (ASME) standard, EA-4-2 008, is a part of a suite of assessment standards that include compressed air system pumping stems, steam, and process heat. ASME describes EA-4-2 008 as follows:

- To understand the international standards for compressed air quality, it is essential to understand the sources of contamination, the individual contaminants found within a compressed air system and the problems that contaminants can cause the following:

Sources of contamination in a compressed air system [3]

Contaminants in a compressed air system can generally be recognized to the following:

The quality of air being drawn into the compressor

Air compressors draw in large volumes of air from the surrounding atmosphere containing large numbers of airborne contaminants.

The type and operation of the air compressor

The air compressor itself can also add contamination, for example, particles in coolants and lubricants.

Compressed air storage devices and distribution systems

The air receiver system and channeling are designed to store and distribute the compressed air. As a consequence, they will also store large amounts of contamination drawn into the system. In addition, channeling and air receivers will also cool the moist compressed air forming condensate which causes damage and corrosion.

Types of contamination found in a compressed air system [4]

Atmospheric dirt

Atmospheric air in an industrial environment typically contains 140 million dirt particles for every cubic meter of air. About 80% of these particles are <2 microns in size and are too small to be captured by the compressor intake filter, therefore, passing directly into the compressed air system.

Water vapor, condensed water, and water aerosols

Atmospheric air contains water vapor (water in a gaseous form). The ability of compressed air to hold water vapor is dependent on its temperature. The higher the temperature, the more water vapor can be held by the air. During compression, the air temperature is increased significantly, which allows it to easily retain the incoming moisture.

After the compression stage, air is normally cooled to a usable temperature. This reduces the air's ability to retain water vapor, resulting in a proportion of the water vapor being condensed into liquid water which is removed by a condensate drain fitted to the compressor aftercooler. The air leaving the aftercooler is now 100% saturated with water vapor and any further cooling of the air will result in more water vapor condensing into liquid water. Condensation occurs at various stages throughout the system as the air is cooled further by the air receiver, piping, and the expansion of air in valves, cylinders, tools, and machinery. The condensed water and water aerosols cause corrosion to the storage and distribution system, damage production equipment, and the end product. It increases both production efficiency and maintenance costs. Water in any form must be removed to enable the system to run correctly and efficiently.

Rust and pipe scale

Rust and pipe scale can be found in air receivers and the piping of wet systems purification equipment being installed. Overtime, this contamination breaks away to cause damage or blockage in production equipment which can also contaminate final product and processes.

Microorganisms

Bacteria and viruses will also be drawn into the compressed air system through the compressor intake and warm, moist air provides an ideal environment for the growth of microorganisms. Ambient air can typically contain up to 3850 microorganisms per cubic meter. If only a few microorganisms were to enter a clean environment, a sterile process, or a production system, enormous damage could because that not only diminishes product quality but may also even render a product entirely unfit for use and subject to a serious recall.

Liquid oil and oil aerosols

Most air compressors use oil in the compression stage for sealing, lubrication, and cooling. During operation, lubricating oil is carried over into the compressed air system as liquid oil and aerosols. This oil mixes with water vapor in the air and is often very acidic, causing damage to the compressed air storage and distribution system, production equipment, and final product.

Oil vapor

In addition to dirt and water vapor, atmospheric air also contains oil in the form of unburned hydrocarbons. The unburned hydrocarbons drawn into the compressor intake as well as vaporized oil from the compression stage of a lubricated compressor will carry over into a compressed air system where it can cool and condense, causing the same contamination issues as liquid oil. Typical oil vapor concentrations can vary between 0.05 and 0.5 mg per cubic meter of ambient air [5].

DISCUSSION [6,7]

This standard covers compressed air systems which are defined as a group of subsystems comprised of integrated sets of components including air compressors, treatment equipment, controls, piping, pneumatic tools, pneumatically powered machinery, and process applications utilizing compressed air. The objective is consistent, reliable, and efficient delivery of energy to manufacturing equipment and processes. This standard sets the requirements for conducting and reporting the results of a compressed air system assessment that considers the entire system, from energy inputs to the work performed as the result of these inputs. An assessment complying with this standard needs not address each individual system component or subsystem within an industrial facility with equal weight. However, it must be sufficiently comprehensive to identify the major energy efficiency opportunities for improving the overall energy performance of the system. This standard is designed to be applied primarily at industrial facilities, but many of the concepts can be used in other facilities such as those in the institutional and commercial sectors.

Table 1: Operational qualification and PQ of air systems

Tests	Acceptance criteria
Operational qualification	
Identification test	Oil-free compressed air must show a chromatogram with no additional peaks other than those obtained with the air standard
System supply reliability test	The data generated should be compared with the specifications of the system
PQ	
Moisture content	The dew point of compressed air less than or equal to −10°C or less than the lowest temperature to which the system is exposed
Oil content	Oil content of oil-free compressed air should be NMT 0.01 ppm
Non-viable particle count	Non-viable particulate counts must be ≤100/ft^3 of 0.5 µ or larger at all critical use points
Viable monitoring	<0.03 CFU/ft^3 or <1 CFU/m^3
Hydrocarbon monitoring	Should show <0.2 mg/m^3 (25 mg/125 L) detected (the lower limit of a dragger tube)
Identity and purity (nitrogen)	Not <99.0% nitrogen by volume. Not more than 0.001% carbon monoxide. No appreciable odor
Identity purity (oxygen)	Not <99.0% oxygen by volume. No appreciable odor

PQ: Performance qualification

The standard sets requirements for:

- Organizing and conducting an assessment
- Analyzing the data from an assessment
- Assessment reporting and documentation.

Main intention of the standard is to provide industry with set of uniform requirements that must be met during the assessment of particular factory energy system. The U.S. Department of Energy is working with the superior energy performance partnership, the ASME and industry experts in the development of these standards as part of an initiative to improve overall energy efficiency of manufacturing plants in the United States companies, American National Standards Institute, U.S. Environmental Protection Agency, and the National Institute of Standards and Technology. The Systems Engineering Plan is developing a program to certify industrial facilities for energy efficiency.

Filtration is required to remove the large volume of water aerosols, particulate, rust, pipe scale, and microbiological contamination entering the system. Failure to remove this contamination from the compressed air system can cause numerous problems. Compressed air is a safe and reliable power source that is widely used throughout the industry. Approximately 90% of all companies use compressed air in some aspect of their operations. However, unlike gas, water, and electricity, compressed air is generated onsite, giving the user responsibility for air quality and operational costs. Compressed air is not without its problems, and most systems suffer from some performance and reliability issues. Almost all of these can be directly attributed to contamination. The main sources of contamination in a compressed air system are the ambient air being drawn into the compressor, the type of air compressor, the compressed air storage vessels, and the distribution pipework.

Meeting the newest challenge – ISO 12500 [8]

ISO 8573, air quality standard is serving the industry well by raising "end user" awareness of how to measure and define the quality of compressed air. Using this, the end user can make educated decision as to the filtration performance required to generate a certain quality level. However, this standard does not address how manufacturers are to test and rate the filters. The playing field is not level and consumers become confused.

ISO 12500 filter standard addresses this issue and establishes how manufacturers test and rate compressed air filters. The standard defines critical performance parameters (namely, inlet oil challenge, inlet compressed air temperature, and pressure measurement techniques) that will deliver certifiable filter performance information suitable for comparative purposes.

ISO 12500 is a multipart standard, with subparts ISO 12500-1, ISO 12500-2, and ISO 12500-3.

ISO 12500-1

It encompassing the testing of coalescing filters for oil aerosol removal performance.

ISO 12500-2

It quantifies vapor removal capacity of adsorption filters.

ISO 12500-3

It outlines requirement to test particulate 3000 cfm filters for solid contaminant removal. The Standard and Poor's 500 Index (SPX) dehydration and filtration research and development center, located in Canonsburg, Pennsylvania, maintain advanced testing resources to conduct ISO 12500-1, 2, and 3 filter testing. Three separate test laboratories were constructed, each equipped with stainless steel piping, state of the art instrumentation, and contaminant measurement equipment. SPX D & F maintains the capabilities to generate dehydrate and filter compressed pass through 3000 cfm.

CONCLUSION

ISO standards for air systems help to harmonize technical specifications of products and services making industry more efficient and breaking down barriers to international trade. Conformity to international standards helps reassure consumers that products are safe, efficient, and good for the environment. These newer standards can have a significant impact on plant energy consumption if properly applied [9].

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