An Understanding of ISO8573 – The Compressed Air Quality Standard

Compressed Air Contamination and its Sources

Contents

Foreword

This booklet is part of a series of best practice guides produced by The British Compressed Air Society Ltd.

Compressed air is an essential component in many aspects of manufacturing production and processing, with the ever-increasing demands for clean, dry air from all sectors of industry and commerce.

This guide has been produced to aid in the selection of equipment to meet those demands by providing detailed explanations of the various technologies currently available and their energy efficiencies.

It provides useful guidance to allow informed decisions to be made on which type of compressed air treatment equipment is required, how it should be installed and maintained and importantly, the various levels of air purity (quality) currently achievable.

Acknowledgements

We worked with leading engineers in the field of air treatment and purification to compile this comprehensive overview and our thanks are extended to these and the members of the British Compressed Air Society Ltd who contributed to its production.[1]

BCAS member contributors were:

- BEKO Technologies Ltd
- Donaldson Filtration (GB) Ltd
- Factair Ltd
- Gardner Denver Ltd
- Hi-line Industries Ltd
- Parker Hannifin Manufacturing Ltd

Additional contributions were submitted by the following BCAS members:

- Atlas Copco Compressors Ltd
- D&F Techniek B.V.
- Ingersoll Rand International Ltd
- Michell Instruments Ltd

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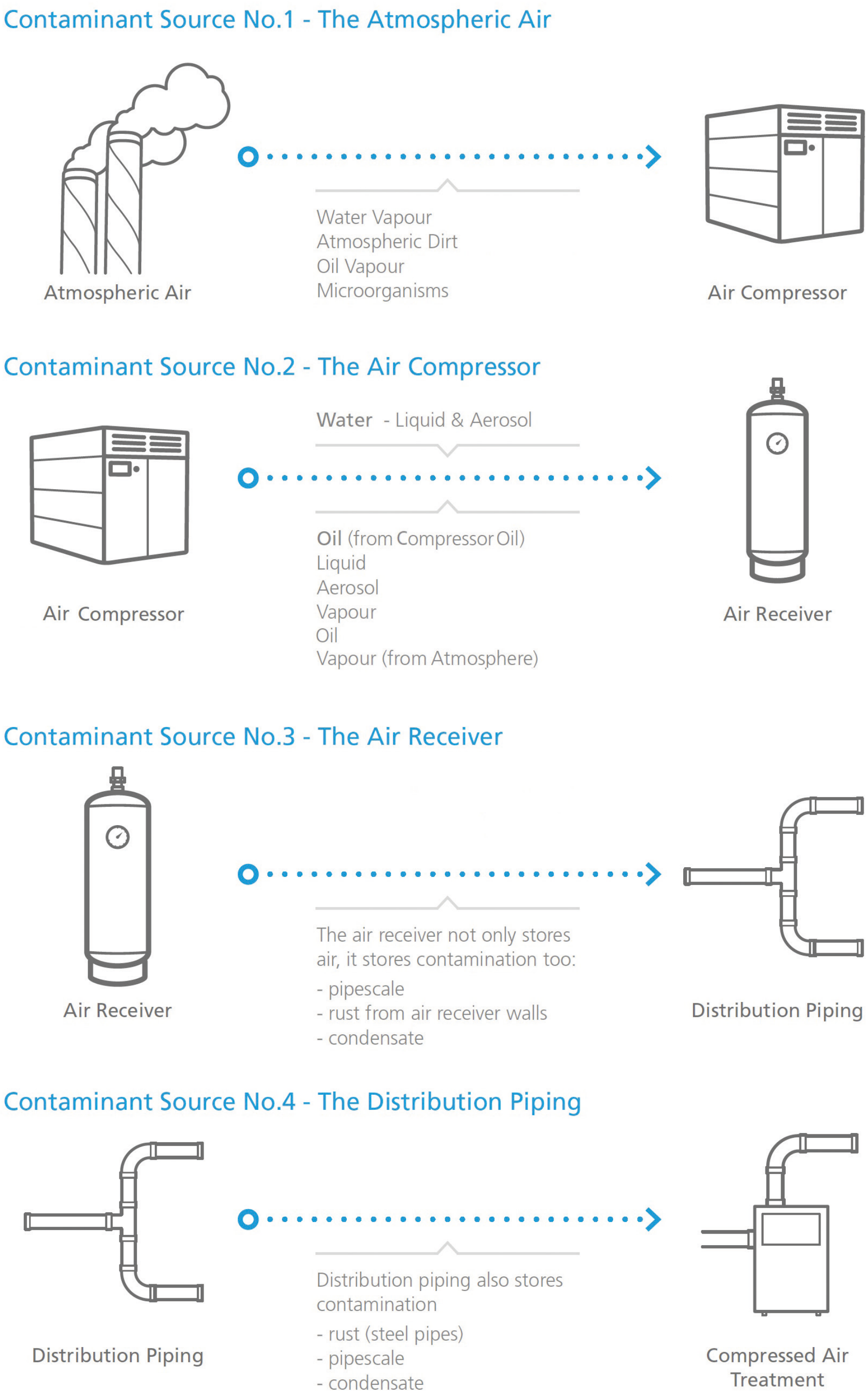
1. Compressed Air Contamination and its Sources

Compressed air is not clean. It contains many hazards in the form of contamination. In a typical compressed air system there are 10 main contaminants that require treatment if the system is to operate safely, efficiently and cost effectively. Contamination in a compressed air system comes from four different sources. Please note, the number of contaminants requiring treatment rises to 15 if the compressed air is used for breathing air or medical air applications.

Figure 1 shows the 4 sources of contamination and the 10 main contaminants of concern.

(Fig 1.)



1.1 Contaminants in Detail

Commonly, compressed air contaminants are combined into three distinct categories for simplicity, these are:

- Particles – (Including viable and non-viable microbiological organisms)
- Water
- Oil

ISO 8573-1, the international standard for compressed air purity (quality), refers to the main contaminants in this format.

Important Note:

When selecting purification equipment, it must be remembered that contaminants will be in one of three different phases (states of matter). For example, water and oil in a compressed air system will be found in liquid form, as an aerosol (fine mist) and in a vapour (gaseous) phase and a different purification technology will be required depending upon the phase of the contaminant (i.e. liquid, aerosol or vapour).

We will now look at the contaminants in further detail.

1.1.1 Solid Particles

Ambient air is subject to contamination which affects the quality of generated compressed air. This can include particulate matter containing viable and non-viable microbiological organisms. For example, in a typical industrial environment there can be more than 140 million dirt particles in every cubic metre of air.

Consider that, when this is then compressed on average to 7 bar g, the contamination is concentrated in line with the pressure increase.

While it is true that the compressor intake filter will remove some of this contamination, the fact remains that around 80 per cent of these particles are smaller than two microns in size and will pass directly into the compressed air system.

1.1.2 Water (Vapour, Liquid and Aerosols)

Water vapour enters the compressed air from the compressor intake. In total volume terms, condensed water vapour is the most prominent contaminant in the compressed air system and on investigation, will form much of the liquid contamination found in a compressed air system. See Table below.

75kW Compressor - 825 m³/hr - 7.5 bar g Discharge Pressure						
Ambient Temp	RH %	Discharge Temp	Water Vapour Entering Compressor (L/hr)	Liquid Water Removed at the Aftercooler (L/hr)	Remaining Water Vapour Entering the Compressed Air System (L/hr)	Total Water Vapour Entering the Compressed Air System Per Year (L)
10°C	65	20°C	4.88	1.67	3.21	28,043
15°C	65	25°C	6.82	2.26	4.56	39,836
20°C	65	30°C	9.41	3.03	6.38	55,736
25°C	65	35°C	12.85	4.03	8.82	77,052
30°C	65	40°C	17.42	5.29	12.13	105,968

If this moisture is not removed from the system, it can cause the pneumatic equipment to fail prematurely, resulting in contamination entering the compressed air stream and the potential for bacterial growth, and adversely affecting final product quality. The more critical the system is to the final production output; the more attention needs to be focused on removing this moisture from the compressed air.

In a compressed air system, water content is measured in terms of dewpoint, which is specified as a temperature. It is the point at which water vapour held in the compressed air is equal to the compressed air's capacity to hold water vapour and the temperature at which condensation will occur.

1.1.3 Oil (Vapour, Liquid and Aerosols)

Oil contamination in the compressed air system can enter from two separate routes.

The first of these is driven by the quality of the intake air. Even before compression begins, the air drawn in through the intake of a compressor contains hydrocarbons and VOC (volatile organic compounds) which when compressed, regardless of compressor type, will cause oil to be present in the compressed air system.

The term 'VOC' is used frequently in media articles in relation to ambient air quality.

Airborne hydrocarbons and VOC are common and are more prevalent in urban and industrial areas. One of the most common sources of hydrocarbons and VOC is fossil fuels, which when condensed and cooled will form a liquid contaminant in the system.

The other source of oil is from the compressor's own lubrication system. While there are several types of compressor available, this document will examine the two most common types; oil lubricated and oil-free.

Please note that this document does not intend to advise on compressor selection. It merely explains the main differences between the technologies and how oil is introduced to the system.

1.1.3.1 Oil Carryover from Lubricated Compressors

'Oil carryover' is the term used to describe the amount of lubricating oil that finds its way downstream of a compressor during its operation. For oil lubricated compressors, oil carryover is due to the efficiency of the air/oil separator in the compressor oil reclamation and recirculation system.

The figures in the table below illustrate typical oil carry over from different types of compressor.

Typical Oil Carryover from Lubricated Compressors	
Reciprocating (Piston)	New: 25 mg/m^3 - Old: 100-200 mg/m^3
Oil Flooded (Lubricated) Screw	New: <5 mg/m^3
Rotary Vane	New: <5 mg/m^3

For example, a 425 m^3/hr compressor, will add up to 18 litres of oil into an air system over an 8000-hour operation.

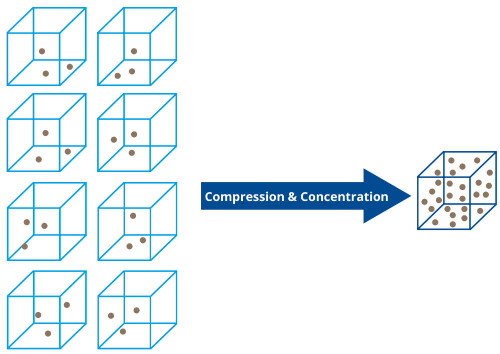
In any compressor, ambient hydrocarbons and VOC enter the intake from the external environment. With an oil-free compressor, the oil is reduced considerably but not removed, due to the presence of the ambient hydrocarbons and VOC (oil vapour).

1.1.3.2 Oil from Oil-Free Compressors

- Oil from an oil-free compressor is dependent upon ambient air quality
- Ambient air typically contains between 0.05 mg/m³ and 0.5 mg/m³ of oil vapour (this can be higher or lower and often varies)
- When ambient air is drawn into the compressor intake and compressed, the oil vapour it contains is concentrated.
    - Refer to the appendix in this document to reference DEFRA publications regarding hydrocarbons and VOC present in the ambient air
    - See below for an explanation and example of compression and concentration

In simple terms, to generate one cubic metre of compressed air, the compressor must draw in and compress multiple cubic metres of ambient air (the higher the pressure, the more cubic metres of ambient air are used).

Example: To generate 1m³ of air, at a pressure of 7 bar g (8 bar A), then 8m³ of ambient air will be required. And while the ambient air is squeezed into a smaller volume (compressed), any contaminants it contains will be concentrated. If that ambient air contains oil vapour, with levels between 0.05 mg/m³ and 0.5 mg/m³, once compressed to a pressure of 7 bar g (8 bar A) there will now be between 0.4 mg/m³ and 4 mg/m³ of oil vapour present after compression and concentration.



Concentration Examples

To highlight the effect of concentration, the table below contains the maximum hourly 'oil vapour concentration values' (averaged from the values recorded over four years).

Recorded Contamination Levels 1 Cubic Metre of Ambient Air Before Compression						
Pressure	Industry Values		Recorded Ambient Values (Average Over 4 Years)			
	Min	Max	Auchencorth Moss	Harwell	Eltham	Marylebone Road
0 bar g	0.05	0.5	0.29	0.14	0.48	0.67

The table below highlights the increased 'oil vapour' contamination levels that 1 cubic meter of compressed air would contain. (at industry typical operating pressures).

Oil Vapour Contamination Levels 1 Cubic Metre of Compressed Air						
Pressure	Industry Values		Effect of Compression on Recorded Ambient Values			
	Min	Max	Auchencorth Moss	Harwell	Eltham	Marylebone Road
7 bar g	0.40	4.00	2.32	1.12	3.84	5.36
10 bar g	0.55	5.50	3.19	1.54	5.28	7.37
13 bar g	0.70	7.00	4.06	1.96	6.72	9.38
40 bar g	2.00	20.00	11.6	5.60	19.2	26.8
All Concentration Values in mg/m³						

Negligible Values

So, what may appear as negligible values in the ambient air, are no longer negligible once the concentrating effects of compression is taken into consideration.