WHAT IS VACUUM?

1. Introduction

This factsheet is intended for end users, maintenance engineers, sales engineers and others seeking a basic understanding of industrial vacuum systems. Vacuum is widely used in industrial systems, but the basic concept is often misunderstood. This factsheet explains what vacuum is, how it works, and how to understand it correctly in practice.

2. What do we mean by "vacuum"?

Vacuum simply means a pressure that is lower than the air around us. The atmosphere is not empty — it has mass and exerts pressure on everything. At sea level, this is approximately 1 bar (absolute), or 1000 mbar. If some of that air is removed from a space, the pressure falls below atmospheric. That condition is referred to as vacuum.

> Vacuum is always a pressure below the surrounding atmospheric pressure.

3. Understanding how vacuum works

A common misconception is that vacuum 'sucks'. In reality, vacuum systems work by creating a pressure difference. Air is removed from a space, which lowers the pressure inside it. The surrounding air remains at a higher pressure and therefore pushes inwards.

A simple example is a suction cup. When it is pressed onto a surface, air is displaced from underneath it. The pressure inside becomes lower than the surrounding atmosphere, and the external air pressure pushes the cup firmly onto the surface.

It sticks because the outside air is pushing it on, not because anything is pulling it.

A useful other example is an aircraft cabin. If a window were to fail, the air inside the cabin is at a higher pressure than the outside at altitude. Air will rush outwards because of that pressure difference.

You are not being 'sucked out' — the higher pressure air inside is pushing towards the lower pressure outside. The same principle applies in vacuum lifting and packaging systems commonly found in industry. The same principle applies in vacuum systems. Movement is always from higher pressure to lower pressure.

4. How vacuum is created

Vacuum is created using a vacuum pump, which removes gas from a space. As gas is removed, the number of molecules decreases and the pressure falls. The achievable vacuum level depends on the pump type, the integrity of the system, and the presence of any leaks or outgassing.

5. Vacuum is a range

Vacuum is not a single condition but a range of pressures. For industrial applications, ISO 3529-1 defines low vacuum as pressures between atmospheric and approximately 1 mbar(a), and medium vacuum down to around 0.001 mbar(a). These classifications are descriptive ranges used to describe vacuum levels and should not be interpreted as performance targets.

Most industrial systems operate within the low vacuum range. Unlike vacuum, compressed air systems operate above atmospheric pressure, so the terminology is more straightforward and does not require the same formal classification.

6. Pressure measurement

Correctly understanding pressure measurement is essential in vacuum work. There are two fundamentally different ways of expressing pressure: absolute (a) and gauge (g).

Absolute pressure is measured from zero, which represents a perfect vacuum. It provides a true measure of how much gas is present and is always expressed as a positive value.

Gauge pressure is measured relative to atmospheric pressure. At normal atmospheric conditions it reads zero, and when pressure falls below atmospheric it becomes negative.

This means that the same physical condition can be expressed in two different ways.

For example:

Atmospheric pressure = 1 bar(a) = 0 bar(g)

200 mbar(a) = -0.8 bar(g)

The issue is that gauge pressure depends on its reference point – the surrounding atmosphere – which can lead to misunderstanding or incorrect interpretation. Confusion between gauge and absolute pressure is a common cause of specification errors, incorrect comparisons and misunderstanding of system performance.

Vacuum levels should be quoted using absolute pressure, expressed in bar(a) or mbar(a), to ensure consistency and avoid ambiguity.

A useful analogy is height. Absolute pressure is like measuring height from sea level – it is always consistent. Gauge pressure is like measuring height from your current position – it changes depending on where you start.

7. Where a vacuum is used

Vacuum is used in a wide range of industrial applications including, but not limited to, holding and lifting with vacuum cups, packaging processes, removal of moisture or gases, material handling and medical suction systems.

8. Common misunderstandings

Vacuum does not mean empty space – there is always some gas present. It does not 'pull' in the way it is often described; movement occurs due to pressure differences. Pressure readings can also be misleading if it is not clear whether they are absolute or gauge.

9. Why this matters

A correct understanding of vacuum allows systems to be interpreted properly, supports accurate measurement, and helps identify issues such as leaks or poor performance.

These misunderstandings can lead to incorrect equipment selection, unnecessary energy consumption and difficulties when diagnosing system performance issues.