# Autoclaves in industry: turning up the pressure

What do aircraft, racing cars, food and medical applications all have in common? The answer is the autoclave. These specialist devices play a major role in many different industry sectors and we explain how they work, why they are used, and what their name means.

**Industry Innovation**



Autoclaves are an essential tool for many different industrial sectors – without them, our everyday lives would look extremely different. They are used in the heat treating of composite materials that are used to build aircraft and vehicles, while in the medical field, they are used for sterilisation. Tyre manufacturers use autoclaves for vulcanisation. Some materials are even produced in autoclaves. Wood is impregnated in autoclaves, and laminated safety glass also originates in them. In medical and chemical laboratories, they are an everyday tool. In short: you can do a lot of different things with autoclaves.

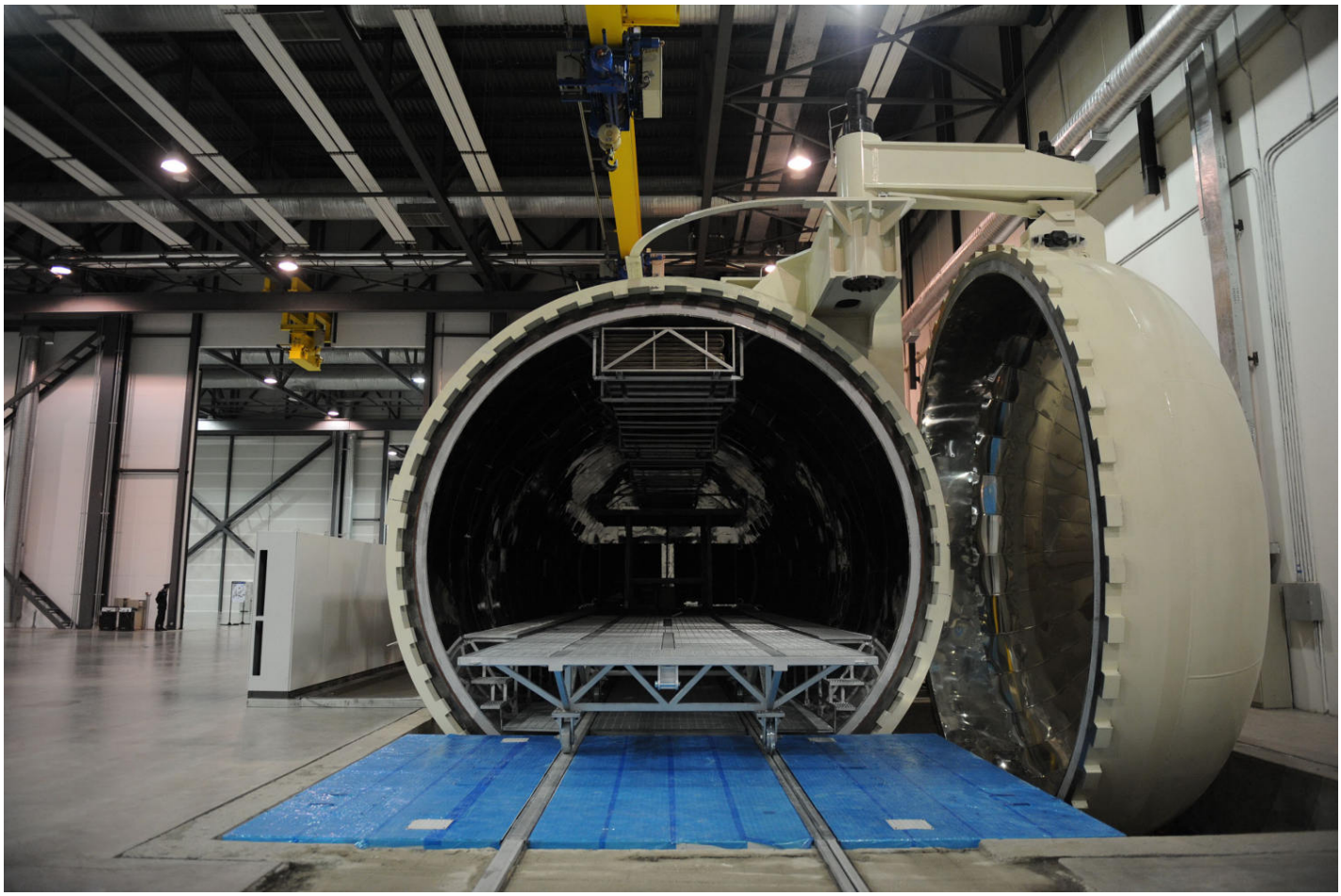
But what exactly are these machines that have such an influence on our way of life? The Oxford English Dictionary defines the word “autoclave” as follows: “A strong heated container used for chemical reactions and other processes using high pressures and temperatures, e.g. steam sterilization.” The word can also be used as a verb to describe the application of the process. The word has its origins in both the Greek and Latin languages. The Greek prefix “auto” means “self,” while the Latin root “clavis” means key. In other words, an autoclave is a device that locks itself. A simple autoclave can be found in almost any household: a pressure cooker. A simplified explanation is as follows: autoclaves are strong, metal containers that can be used to apply heat and pressure. They come in a number of different sizes and shapes, from tiny to enormous, always tailor made for their particular application.

Functional diagram of an autoclave

## Aircraft components are produced in an autoclave

None of this, however, describes how potentially versatile an autoclave can be, at least not in terms of the many potential applications. Our photographer, Wolfram Schroll, once again hit the road this month to photograph aspects of aircraft manufacture for our ARTS Calendar. At the Airbus factory in the Spanish capital, Madrid he photographed an autoclave in use, thereby creating the basis for this article.

As carbon fibre materials are increasingly commonly used in aircraft production, the importance of the autoclave grows. While airliners used to be made almost exclusively using metal construction techniques, more and more assemblies are made from carbon fibre. This material is valuable because of its combination of high strength and light weight. Greater payload, with lower fuel consumption and consequently lower emissions are the desired effects. In the double-decker Airbus A380, 20 per cent of the structure is made from carbon fibre, with over 50% of the A350 being made from the material. The American aircraft manufacturer, Boeing, adopts a similar approach in the construction of its 787 Dreamliner.



Airbus’s he enormous Harbin Hafei autoclave produces composite materials for the A350 XWB - © Airbus SAS 2017

The autoclave installed at Premium AEROTEC in Nordenham for the production of the A350 XWB measures 27 metres in length and eight metres in diameter, with a weight of 320 tonnes. Pre-impregnated carbon fibre sheets, known as prepregs, are first inserted into the moulds. A vacuum is generated underneath foil, while non-woven fabric absorbs the excess output of resins. The component is pressed and hardened at high temperatures and high pressure in the autoclave, resulting in very strong components with minimal weight.

Nevertheless, the resource requirements for producing composite airliner components of this kind are massive. For most manufacturers of two-to-four-seater aircraft, this technology is simply unaffordable: many still laminate their components by hand and work with traditional temperature chambers.

Motorsports is another area where the use of carbon fibre materials has become essential. From Formula 1 to MotoGP, every gram of weight saved counts for racers on two or four wheels. Composite components for use in motor racing are made to standards that are comparable to those that apply to the aviation world, with a Formula 1 consuming an average of 5.5 tonnes of this valuable material each year.


The electric BMW features a low weight thanks to the use of carbon fibrebodywork in the i3

## Autoclaves used as steam sterilisers: no room for germs

The fields of medicine and biology provide quite different applications for autoclaves, where they are used for sterilisation – for example to sterilise instruments, with the use of hot steam being the best way to kill germs. Depending on how the autoclave works the air is pumped out of the chamber multiple times to create a vacuum, then replaced by steam. As with a pressure cooker, the air is displaced in the so-called flow or gravity process. Steam may be generated inside the autoclave or generated externally. Temperatures during steam sterilisation are between 120 and 143 degrees Celsius, at pressure levels between one and three bar.

The food industry also uses autoclaves to kill unwanted micro-organisms, with the goal of making our food stay fresh for longer. In light of the 18 million tonnes of foodstuffs that are thrown away unused each year in Germany, this is an important concern for the sector. This effect is achieved partly through steam sterilisation, while food-borne germs are also killed by the application of pressure, with up to 7,000 bar being used to wipe them out. Food technologists attempt to retain

the products' natural flavour, while the packaging chain plays an important role in ensuring that food reaches consumers in an undamaged state, ready for use or storage.

## Chemicals, tyres, construction: autoclaves in widespread use

A further application for autoclaves is found in the chemical industry. For example, gases are made to react in autoclaves by the application of pressure. In this context, the manufacture of polymer plastics is also extremely important. The list of applications for autoclaves go on and on: tyre manufacturers use autoclaves to vulcanise raw rubber – a process that was discovered by Charles Goodyear in 1839, largely by chance. The process transforms raw natural or artificial rubber into a finished product by adding sulphur and other substances.

Rubber is vulcanised in an autoclave

The building industry also makes use of the characteristics of autoclaves. For example, wood may be imbued, steamed, or impregnated under pressure for use in buildings. Other building materials such as sand-lime bricks and porous concrete are produced using autoclaves, with the process affecting their strength and structure. Finally, laminated safety glass is another everyday product that is produced in autoclaves: a prefabricated foil and glass sandwich is permanently laminated inside the autoclave. Finally, even though the autoclave is used in many high-tech industry sectors, the invention itself is anything other than new: it was invented his "steam digester" which eventually evolved into the pressure cooker and became the godfather of the autoclave.

Sources: Airbus | Boeing | Chemnie.de | explainthatstuff.com | Glas Trösch | Oxford University Press | Pflanzenforschung.de | Praxisdienst | Premium Aerotec | Rubbermacnineryworld | Scholz-Autoclaves | Uniwb | WELT | Wikipedia



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