Julabo
THE TEMPERATURE CONTROL COMPANY

TECHNICAL REPORT

MATERIAL AND COMPONENT TESTS IN THE AUTOMOTIVE INDUSTRY

The automotive industry carries a great responsibility: Material, design, or manufacturing defects can affect not only the function of vehicles but also become a serious safety issue for road users. The requirements for quality assurance are correspondingly high. Test procedures used here must imperatively include the temperature fluctuations to which vehicles in real use are exposed. These are determined on the one hand by environmental conditions and on the other hand, by the operating temperature. Precise temperature management, therefore, plays a decisive role in test benches in the automotive and supplier industry.

Automotive

TEMPERATURE EFFECTS ON VEHICLES

In real use, vehicles are subject to high loads due to a variety of acting forces. These include, among other things, the pressure ratios and thrust forces built up in the engine as well as acceleration and shear forces due to contact with the road. The engine, transmission, and control electronics form a highly complex unit that must function reliably under all weather and temperature conditions. Whether the vehicle cools down heavily in winter and then reaches the operating temperature within a few minutes, or is stuck in traffic during midsummer, and the engine heat is difficult to dissipate due to high outside temperatures and the lack of wind - significant temperature differences within a short time place enormous requirements on the material, in particular, of load-bearing and pressure-bearing components. The conductivity within the electronics is also temperature-dependent. On tightly packed electronic components, temperature-related density changes and the associated expansion of circuit boards and conductors can also be a problem.
The automotive industry must ensure that its products operate in this wide temperature window and with rapid temperature changes without failures or material fatigue. Because a component failure is annoying in the best case, ends in the worst case deadly, and is in any case, expensive. Material and component tests that include a temperature simulation are, therefore, of immense importance and indispensable for the automotive industry, including all suppliers.

TEMPERATURE CONTROL SYSTEMS FOR TEST BENCHES IN THE AUTOMOTIVE SECTOR

Automotive test procedures are as diverse as the test specimens themselves. In addition to newly developed materials and individual components from gears to hydraulic gaskets, the test specimens also include complex systems that are tested in combination. Among others, temperature simulations ensure that materials remain (dimensionally) stable at extreme temperatures or rapid temperature changes and that gaskets remain leak-free over a wide dynamic range of pressure and temperature, and that pumping systems operate reliably regardless of the temperature and viscosity of the media. The increasing mechanization also requires a temperature-independent function of all electronic control components.
On test benches in the automotive sector, highly dynamic temperature control systems are used in material and component tests, which enable precise conditioning and rapid temperature changes. Only precise temperature management delivers reliable and reproducible results. The temperature control systems provide the test bench via liquid media directly or indirectly with constant temperatures or complex temperature profiles. In addition to the medium temperature, the temperature control systems also allow precise control of flow and operating pressure.
Temperature control systems are primarily used in two ways: They simulate external environmental conditions in a climate chamber or replace internal systems, such as the engine's cooling circuit. The latter allows realistic conditions to be created on the test bench in which the test specimens are supplied with cooling liquid per the operating requirements, such as in a vehicle. However, the test specimens may also be specifically tempered and so, e.g,. be brought to their load limits within the scope of safety tests.

TEMPERATURE SIMULATION IN E-MOBILITY

Even in electric vehicles, media-carrying components must withstand extreme pressure loads at variable temperatures. Pressure vessels, pumps, hose and pipe connections must pass dynamic and static pressure and temperature tests beforehand. In e-mobility, in particular, there is a growing demand to reduce the weight of the engines to a minimum. Therefore, more and more components are made of plastics. Adhesives are used where welding, brazing, or bolting used to be required. On the test bench, the plastics must withstand the mechanical load even under changing temperature conditions of -40° C to +100° C. Adhesives must maintain the required functional range between elasticity and strength throughout the entire temperature window.
In the context of mechanical stress tests, the test specimens are, therefore, additionally exposed to different temperatures or preheated in advance over a defined period of time.
Precise test procedures are of enormous importance in the development of electronic components and batteries as well. Due to the comprehensive interaction of the high-tech engines with sophisticated control electronics, even slight deviations of a single component from the target can paralyze the entire system or greatly reduce its performance. Due to the strong influence of temperature on conductivity, material properties and dimensions of boards and composite materials, as well as the performance of batteries, environmental simulations with temperature control systems within test benches are mandatory.

CONCLUSION

Quality and safety tests are a central element in the entire development and production process in the automotive industry. Due to the close interplay of mechanics and electronics, even the failure of a single circuit can be the end of the engine or transmission. Any failure of a component can also become a safety risk. Precise temperature simulation is essential on test benches in the automotive industry, as all vehicle components, from control electronics to gaskets and load-bearing elements, are subject to severe temperature fluctuations that stress material and circuits in addition to the mileage. This also applies in particular to new developments in the field of e-mobility. All electronic components must withstand a rigorous test under real conditions, which includes not only functional loads but also a simulation of environmental factors.
With the PRESTO series, we offer high-performance equipment to our customers in the automotive industry. They not only dynamically cover the entire temperature range from -40 °C to + 100 °C and rapid temperature changes required on the test benches, but are also extremely flexible and user-friendly thanks to extensive accessories and a sophisticated system design. A large number of automobile manufacturers and suppliers worldwide already rely on JULABO temperature control systems for their test benches. Thanks to our decades of experience and high quality standards, all devices are tailored to customer-specific requirements down to the last detail. Please contact us directly so that we can provide you with a suitable solution.