FLOW CONTROLLER VOOR PTB TESTINSTALLATIE A113

APPLICATION NOTE A113-GP03

Approval of car exhaust gas analysers

Gas analysers are used to measure the contents of car exhaust gases, for example during the periodic vehicle test of your car at the car workshop. To this end, a hose is connected to the car exhaust pipe, and via a bypass the exhaust gases enter the analyser. This is a self-sucking device with a fan inside which sucks-in the exhaust gases. Inside the analyser is a non-dispersive infrared (NDIR) sensor for quantitative gas detection.



Car exhaust gases typically consist of nitrogen, oxygen, carbon dioxide, water vapour, carbon monoxide and traces of hydrocarbons. Carbon monoxide (CO) is toxic for human beings, even in small concentrations, and plays a decisive role in the formation of ground-level ozone. A major source of CO pollution in the outdoor air is motor vehicle traffic - especially in the case of an incomplete reaction between the fuel and oxygen in the combustion engine.

PTB (short for Physikalisch-Technische Bundesanstalt), the national metrology institute of Germany, is quality testing exhaust gas analysers that are normally used at car engine manufacturers or in car workshops. All these gas analyser series have a type, which need to have a type approval prior to marketing the series, and in Germany this type approval is made at PTB. PTB turned to Bronkhorst Deutschland Nord because they needed an improved test facility to test these gas analysers.

Application requirements

The test facility needs to simulate the situation at the car workshop, which typically is at ambient pressure. To this end, combustion gases that leave the car exhaust pipe as well as in-leaking air during the measurement need to be measured. To be mobile, the test facility needs to be as compact as possible, with an easy connection to the gas analyser to-be-approved. Since it is a type approval, the analysers should be tested against the highest standards.

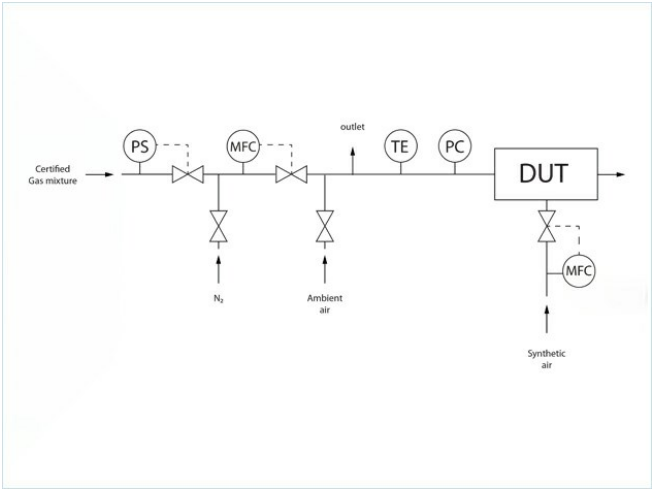
Important topics

- Accurate gas flow measurement
- Semi-automated: automation and flexibility
- Small flows for an effective use of expensive gases
- Flexibility to switch between Pressure control- and Flow Control Mode
- Optimized skid construction avoiding dead legs & allowing best accessibility for recalibration

Process solution

The test facility, which has been developed in a close cooperation between Bronkhorst and PTB, consists of a main skid and a leakage module. The test skid is OIML R99-1&2-compliant, and is used to implement defined test situations for the exhaust gas analysers. The main components inside the skid are a Bronkhorst Coriolis mass flow controller (series **mini CORI-FLOW**), two pressure meters (series **EL-PRESS**) and some shut-off valves, all integrated into a frame. In between the pressure meters the (portable) gas analyser with a typical size of half the volume of the skid is mounted. The fan of the gas analyser provides the driving force for gas flow. The Bronkhorst devices are for accurately measuring the gas flow, and to control the pressure which is around ambient. Typical gas flows are up to 12 normal liters per minute based on nitrogen.

In the client's laboratories, 24 premixed and calibrated test gas mixtures are supplied from gas cylinders to the skid. Near the entrance of the skid, the test facility is able to switch between different gas mixtures. The first pressure controller sets the pressure of the gas mixture to 0 bar gauge to simulate the situation at the exhaust pipe of the car in a controlled way. The normal gas test sequence is working in pressure control mode, where the Coriolis instrument measures the flow through the gas analyser.



Flow schema

In addition to this main (normal gas test) sequence, the gas analyser also has to meet the conditions of several other sequences in order to be approved. In a 'reaction test', it is measured how long it takes after opening the valve before the analyser measures the real flow, incorporating snapshots with a photo camera, also part of the testing protocol. In a 'low-flow test', in flow-control mode the flow is decreased in steps of 5%, where at a certain point the analyser must give an 'undersupply' alert that it detects not enough gas. In a 'tightness test' all valves are shut and on the analyser side a vacuum is created, and then the pressure evolution is measured. In between these sequences, or when switching to another gas mixture, the system is flushed with nitrogen.

The leakage module is a separate part of the test facility, with a thermal mass flow controller (**EL-FLOW Prestige**) and a piezo control valve as main components. Leakage in the system is simulated by supplying an exact ratio of synthetic air (nitrogen/oxygen) to the test gas mixture. The gas analyser has to detect this, which is another testing sequence for approval.

Control and programming of the sequences has been performed on a **LabVIEW** basis on two PC's of the client. The entire LabVIEW environment continuously communicates with the skid and the leakage module via Modbus. The various test sequences are selected and displayed on the program interface. Buttons allow for an ergonomic operation of the test facility. Target and actual values of the respective sequences are displayed in a flow diagram.

The monitoring of the test facility includes internal measurement variables such as input and output pressures from the gas analyser, process temperature via a PT100 temperature sensor, mass flows, as well as ambient data such as air pressure, temperature and relative humidity from a 'weather station', which are compared with the process data in the control system. Automatically generated logs completed with manual notes with time stamp are archived in test reports. These reports are stored at PTB, and will also be part of the legal protocol that is created for the type approval.

The entire measurement process is semi-automatic, to meet the client's requirement to have a high degree of automation on the one hand, for example by keeping the ratio between the test gas and the synthetic air stable during leakage testing. On the other hand, there is freedom to make interventions, for example by (also) manually opening of the piezo valve.

The process for conducting a type approval as described here meets the **ISO 17025** standard with general requirements for the competence of testing and calibration laboratories. The approval is needed for newly developed analysers, but also for modified and refurbished series.
Regarding these high requirements of accuracy and reliability, the Bronkhorst devices inside the test facility need to be easily dismountable, in order to be re-calibrated themselves. To this end, special VCR fittings inside are used allowing a tension-free (dis-) assembly of the measuring components.

The solution is such that on one hand the traditional bypass for the existing pressure control is no longer needed, on the other hand a special optimisation (e.g. no dead legs) could reduce the operational volume of the testing facility. Both meaning an efficient and sustainable use of expensive calibration gases and much less waste.

Due to the complexity of this solution, teams of Bronkhorst and PTB worked closely together. As a result, the factory acceptance test at Bronkhorst in Ruurlo, was not a 'discovery' but already 'recognition' of the already virtually known system. The client was practically immediately able to carry out the test runs on his own.

This solution is relevant for clients that have the same request of complexity, but not necessarily the means to do their own development projects, including programming and assembling. This specific solution is also interesting for state-driven national metrology institutes in other countries.

Recommended Products



MINI CORI-FLOW™ M12

Flowbereik 0…200 g/h

Drukklasse 200 bar

Onafhankelijk van vloeistofeigenschappen

Hoge nauwkeurigheid



EL-FLOW PRESTIGE FG-201CV

Min. flow 0,14...7 mln/min
Max. flow 0,4...20 ln/min

Drukklasse 64 bar

100 selecteerbare gassen

Aangepaste I/O-configuraties



EL-PRESS P-612CV (P2-CONTROL)

Min. druk 3,2...64 bar
Max. druk 5...100 bar

Absolute druk of overdruk

Hoge nauwkeurigheid

Would you like more information?

Would you like to receive the latest information about the trends in flow control? Sign up for our monthly newsletter.

BRONKHORST NEDERLAND

Lunet 10c

3905 NW Veenendaal

Tel. +31 (0)318 55 12 80

info@bronkhorst.nl