The GRIMM model 5.430 Condensation Particle Counter (CPC) was developed to measure Diesel emissions according to the EURO 5 Regulation 83.

In addition to the already well established condensate removal and anti-spill saturator design 1) this unit features a novel saturator shutter, which enables the transport of the CPC without the need for removing or drying the saturator.

This full flow CPC contains several design improvements for the automotive user, such as a fast response to concentration changes (T90), and easy maintenance.

Due to its rugged design the model 5.430 can be easily incorporated into test racks for Euro 5 compliance testing.

1) first introduced by GRIMM Aerosol Technik
**Measuring Principle**

The sample air is continuously drawn into the CPC and saturated with Butanol vapour in the heated saturator chamber. Then, aerosol particles and Butanol vapour pass through the cooled condenser unit, where the Butanol vapour condenses on the particles that act as condensation nuclei. This process increases the size of each individual nanoparticle to approximately 10 µm. Such large droplets can be conveniently detected by light scattering.

Unlike other models, CPCs for PMP measurements are operated with a reduced difference between saturator and condenser temperature. As result the minimum detectable particle size (D50) is increased to 23 nm, which means that such a CPC only counts carbonaceous particles with a solid core but not the undesired smaller volatile particles.

Within the self tests, the CPC also supervises the size of the Butanol droplets to ensure a proper condensation process.

Light scattering works in such a way that the droplet enters the laser illuminated optical volume. Each droplet passing the laser beam generates scattered light that is collected with a mirror onto a photodiode at 90° scattering angle. The signal is converted to an electrical pulse and counted.

Each particle is counted individually (single count mode) while the complete flow of the sample air (0.6 L/min) is used for the detection of particles (full flow sampling). The flow rate is controlled with differential pressure sensors across a temperature-controlled orifice.

The measured concentration is transmitted online to the computer via the USB interface.

**Calibration**

Every GRIMM model 5.430 is carefully tested to guarantee full compliance with PMP regulation. During calibration the candidate CPC is operated in parallel with a Faraday Cup Electrometer (FCE) that serves as a primary reference. Both counters - candidate CPC and reference FCE - are supplied with identical concentrations of monodisperse soot particles from a Combustion Aerosol Standard (CAST), classified with a DMA. Combustion soot particles are preferred for the calibration since they feature similar activation properties as Diesel particles.

Number size distribution of Diesel engine exhaust (reproduced from Kittelson 2004). A PMP-CPC must only count carbonaceous particles with solid core, i.e. particles larger than 23 nm.
Most often the GRIMM model 5.430 PM-P CPC is used as a detection system in combination with an engine exhaust dilution system. The typical setup consists of a CVS tunnel (measurements directly from the tail pipe are possible as well), a cyclone to remove the main fraction of coarse particles, and a two-stage dilution system with the removal of volatile compounds in a thermodenuder. The CPC in the complete setup for PM-P measurements.

If you are interested in a complete emission test system, please contact GRIMM as well.

Number concentrations measured by the CPC are then evaluated against the concentrations measured by the reference FCE. The graph above shows the excellent correlation between CPC (y-axis) and FCE (x-axis).

PMP Measurements

Setup and results for the calibration of the CPC model 5.430.

Number concentrations measured by the CPC are then evaluated against the concentrations measured by the reference FCE. The graph above shows the excellent correlation between CPC (y-axis) and FCE (x-axis).

Right: Data from the official test at UTAC (homologation laboratory of French Transport Ministry) in April 2008. Note: Ecomesure used the Grimm PM-P CPC, the other two participants used TSI.

The CPC in the complete setup for PM-P measurements.
Specifications

Model 5.430 Stationary Condensation Particle Counter for Automotive Applications

THE alternative to the TSI Model 3790 Engine Exhaust Condensation Particle Counter

<table>
<thead>
<tr>
<th>Particle Detection 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration Range</td>
</tr>
<tr>
<td>Concentration Accuracy</td>
</tr>
<tr>
<td>Concentration Linearity</td>
</tr>
<tr>
<td>Counting Efficiency at 23 nm</td>
</tr>
<tr>
<td>Counting Efficiency at 41 nm</td>
</tr>
<tr>
<td>Response Time</td>
</tr>
<tr>
<td>False Background Counts</td>
</tr>
<tr>
<td>Readability</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Liquid System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working Fluid</td>
</tr>
<tr>
<td>Condensate Removal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Air Flow System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Flow Rate</td>
</tr>
<tr>
<td>Pump</td>
</tr>
<tr>
<td>Flow Control</td>
</tr>
<tr>
<td>Suitied Aerosol Carrier Gas</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communications</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS-232</td>
</tr>
<tr>
<td>Data Output</td>
</tr>
<tr>
<td>Status Indication</td>
</tr>
<tr>
<td>Software</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operating Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Temperature</td>
</tr>
<tr>
<td>Ambient Humidity</td>
</tr>
<tr>
<td>Ambient Pressure</td>
</tr>
<tr>
<td>Power Requirements</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Dimensions (H x W x D)</td>
</tr>
<tr>
<td>Weight</td>
</tr>
</tbody>
</table>

1) Calibration is performed with soot particles from a Combustion Aerosol Standard (CAST) against a reference Faraday Cup Electrometer (FCE) with classified particles from a Differential Mobility Analyzer.

Further information is available upon request.

Publications

ECE / TRANS / WP. 29 / 2008 / 62, 10. April 2008
ED 4738 / 2004 / PNC - Issue 5 by AEA Energy & Environment
B. Giechaskiel et al. 2008. Calibration of PMP Condensation Particle Number Counters: Effect of material on linearity and counting efficiency, LB NA 23495 EN C

Just give us a call or visit our website.

The European Leader in Particle Measurement Technology

www.grimm-aerosol.com