AVL Fuel Consumption Measurement on Engine Testbeds and in the Vehicle

APPROACH

AVL has long understood the increasing importance of fuel consumption as a reference value for the development of state-of-the-art, low-consumption combustion engines, and this understanding is reflected in its in-house engine development department, as elsewhere. More than 45 years of concentrated know-how in the field of fuel consumption measurement technology, technological diversity and clever modular product concepts, in combination with a global presence and sophisticated service and system competence, make AVL the clear leader in the field of consumption measurement technology the world over.

BENEFITS AT A GLANCE

- Shorter time to achieve development objectives due to reliable AVL fuel consumption measurement systems, ensuring high levels of engine testbed availablity and significantly reduced test effort thanks to shorter measurement times and high levels of measurement accuracy, one example being the reduction of the measurement effort during automatic engine calibration
- Protection of investments through modular design, subsequent expandability and adaptation to new injection systems and applications
- Supporting bio fuel such as bio diesel and bio ethanol
- Increased productivity of the engine test facility due to lower product lifecycle costs: simple and projectable maintenance and service as well as quick availability of spare parts via AVL eSpares™

TASK

Stricter laws and regulations with regard to CO_2 and fuel consumption reductions increase the pressure to develop engines even faster, coupled with rapidly increasing measurement expenditures. Engineers developing diesel and gasoline engines are increasingly forced to implement measurements in automatic operation with ever shorter measurement times or in transient modes.

In addition to accelerated test procedures, new combustion and injection technologies require instrumentation devices delivering precise measurements even for efficient engines with low consumption levels during cyclic tests under partial load. And this is all the more true if fuel is a target variable in automated optimization and calibration procedures.

The call for higher testbed efficiency does not only mean an easy installation and quick commissioning procedure for the measurement system; it also means a reliable fuel supply for the engine with preselected parameters, such as fuel temperature and pressure. Precision fuel temperature control is required to achieve high- measurement accuracy in the overall system on the engine testbed, even in case of low fuel consumption values.

The layout of the fuel consumption measurement system, for example having fuel lines which adapt to different mixture preparation systems, has a decisive influence on the quality of the measurement results. Engines for alternative fuels also require the compatibility with bio diesel or alcohol admixtures of up to 100 %.

REFERENCES

Emissions Development in the Field of Commercial Vehicles

AVL has equipped engine test facilities of renowned manufacturers of commercial vehicles with the AVL Fuel Mass Flow Meter and Fuel Temperature Control. These fuel consumption measurement systems measure the transient fuel curve in a continuous, fast and precise manner.

AVL Fuel Exact™ PLU/ AVL Fuelexact Mass Flow

This covers a wide range of different engines and modern applications. Passenger car engine test facilities with up to 60 testbeds, from the single-cylinder, gear, climate and multi-cylinder engine testbed up to 500 kW, have been equipped with AVL Fuel Exact™.

Bio Fuels

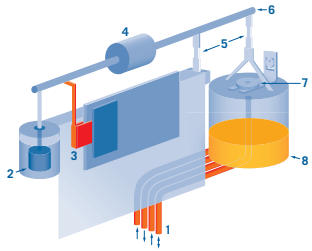
AVL has had many years of experience with the application of biofuels, such as methanol in racing and ethanol in Brazil. AVL fuel consumption measurement systems are suitable as FlexFuel designs for Otto cycles and diesel fuels, as well as for the admixtures of up to 100 % bio fuels.

Installed Base

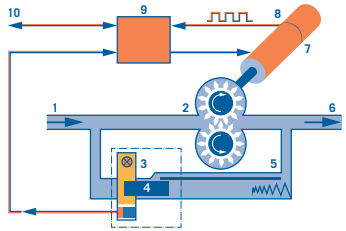
45 years of competence in the field of development and production of fuel consumption measurement systems. Already more than 15,000 systems have been delivered worldwide by AVL to be used in engine research, development, quality assurance and production as well as for road testing.

THE SUPPLY OF MORE THAN 15,000 FUEL CONSUMPTION MEASUREMENT SYSTEMS CONFIRMS OUR EXPERIENCE AND COMPETENCE IN THE FIELD OF FUEL CONSUMPTION MEASUREMENT.

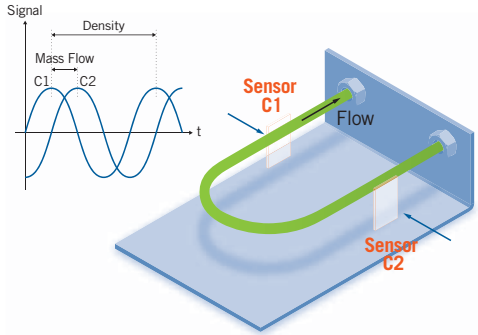
Unique Variety of Measurement Principles



1 Fuel supply connections (4)
2 Damping device
3 Capacitive sensor
4 Tara weight
5 Blade spring
6 Measurement beam
7 Calibrating weight
8 Measuring vessel



1 Inlet
2 Gear meter
3 Piston sensor
4 Piston
5 Bypass
6 Outlet
7 Servo motor
8 Encoder
9 Controller
10 Signal Output



Coriolis Force

GRAVIMETRIC (FUEL BALANCE)

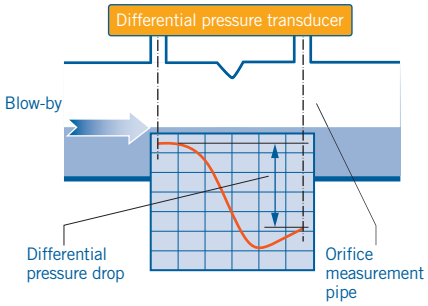
The fuel consumed by the engine is taken from a continuously weighted measurement vessel which has the same properties as the vehicle tank. The detection of the weight of the fuel is carried out with a capacitive displacement sensor connected to the measurement vessel by means of a beam. A calibration weight is used to perform the accuracy testing and calibration procedures in accordance with ISO 9001. Calibration takes place in a fully automatic manner within a few minutes and is integrated by default into the AVL Fuel Balance.

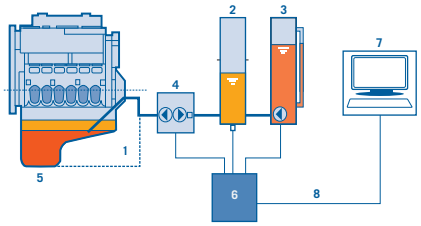
PLU MEASUREMENT PRINCIPLE

The PLU positive displacement meter combines a servo-controlled gear counter with a dynamic piston sensor. A gear meter (2) driven by a servo motor (7) with encoder (8) defines a geometric volume to pulse frequency ratio when gear rotation is adjusted to media flow. A bypass (5) ensures zero pressure difference ($\Delta p = 0$) between inlet and outlet, preventing leakage flow. Flow changes immediately displace a zero-friction piston (4) in either direction. A piston position sensor (3) and a servo controller (9) provide a fast gear speed control loop keeping the piston centered.

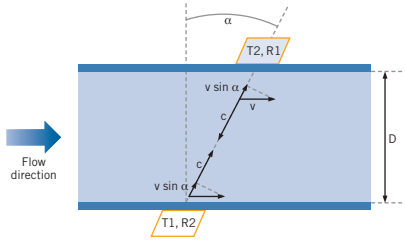
CORIOLIS

Fuel passes through a U-shaped tube which vibrates at its natural frequency. This frequency is proportional to the fuel density which, in addition to the mass flow, is a separate measurement variable and, thus, allows for the output of volumetric measurement values. The time lag of the vibration frequency C1 to C2 is proportional to the mass flow.





1 Oil dip stick
2 Measuring tank
3 Refilling tank
4 Pump
5 Drain plug
6 Electronics
7 PUMA CDH – Task
8 Hybrid interface or serial interface via RS232



T Transmitter
R Receiver
c speed of sound
v flow media velocity
α inclination angle

DIFFERENTIAL PRESSURE

For the determination of blow-by flow the orifice measurement principle (differential pressure measurement procedure) is used. A neck (orifice) in the tube cross-section provokes a pressure drop that is measured by means of a differential pressure sensor. The shape of the orifice of the AVL Blow By Meter means that it, on the one hand, ensures the accuracy in both flow directions and, on the other, prevents condensation at the orifice that might modify the cross-section. The selected shape of the orifice allows for a broad dynamic range of 1:50.

GRAVIMETRIC (OIL CONSUMPTION METER)

This measurement is based on the gravimetric principle. This means that oil is always sucked to a defined level or completely into a measurement tank with modified dip stick or an oil drain plug. Afterwards, the weight is determined with the help of a precision pressure sensor. After the weight has been determined, the oil is pumped back into the oil pan of the engine. This measurement cycle consists of three steps: pumping (out), weighing and pumping (back). The difference between two subsequent measurement cycles results in the oil consumption.

ULTRASONIC TRANSIT DIFFERENTIAL TIME

The measuring principle is based on the ultrasonic transit-time differential method. Two ultrasonic pulses are sent simultaneously through the flowing medium from Transmitter 1 (T1) and Transmitter 2 (T2). One pulse is propagating into the flow and the other one against it. The interaction between the speed of sound c and the velocity of flow v accelerates the pulse on one of the paths and decelerates the pulse on the other path. This effective propagation velocity results in different transit times through the medium: The signal at Receiver 1 (R1) arrives faster than the signal arriving at Receiver 2 (R2). The device measures the speed of sound traveling either way, corresponding to t1 and t2.

ACCREDITED ACCORDING TO ISO17025

AVL Calibration Laboratory

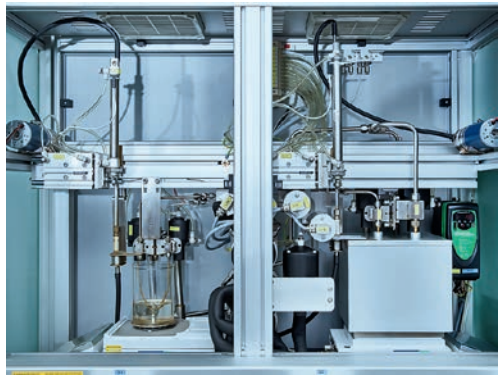
The globalization of the automotive industry requires measurement values which are comparable worldwide. Legislation covering CO_2 and fuel consumption reduction are imminent, with stricter requirements concerning the measurement uncertainty of fuel consumption.

QUALITY STANDARDS

The traceability required by the established quality assurance standards, such as ISO 9001 for measuring instruments in production and development requires measurement equipment to be calibrated on a regular basis.

ACCREDITATION

Measurement uncertainty and the evidence of traceability can now be established in the best way by the manufacturers of measurement equipment in the form of so-called factory calibrations, or in the context of tests, in accredited laboratories.



In this case state accreditation offices initially audit and accredit laboratories for their quality assurance processes and their actual measurement quality. Regular post audits, ensure that the measurement uncertainty stated by the laboratory is complied with. These audits are performed in accordance with ISO 17025. Besides such audits, the measurement quality is also checked in regular round-robin tests carried out among the laboratories.

AVL FUEL MEASUREMENT DEVICES

AVL has been accredited for the calibration of "liquid media". Standard calibrations for AVL Fuel Measurement Devices such as FuelExact or Fuel Reference are performed on an accredited AVL calibration bench, whereby the traceability to international measurement standards are assured and the specified measurement uncertainty is met.

DYNAMIC FUEL CONSUMPTION MEASUREMENT UP TO 2 MW ENGINES

AVL FuelExact™

The AVL FuelExact™ is a high-precision fuel consumption measurement system with harmonized fuel temperature control and fuel consumption measurement capable of detecting the volumetric and gravimetric fuel flow values in a highly precise manner and with shortest measurement times. The focus is on transient measurement and on the advanced field of application for measuring engines of up to 2,000 kW. The AVL PLUtron™ sensor with onboard intelligence provides unique robustness and Plug & Play usability.

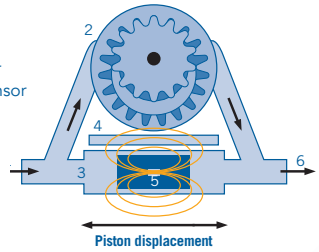
MEASUREMENT PRINCIPLE

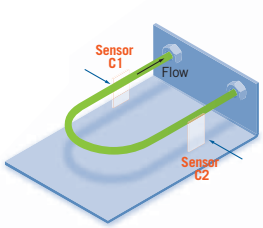
The FuelExact™ exists in two versions: one based on the PLUtron measuring principle and one based on the Coriolis measuring principle. For further information, please refer to page 130/131.

APPLICATION

AVL FuelExact™ covers applications from single-cylinder up to 2,000 kW engines in the field of engine research and development. Due to the high data rate of 100 Hz and the "Zero" step response (with AVL PLUtron™ sensor), the system is ideally suited for transient calibration methods that are increasingly being applied in the field of engine development. The AVL PLUtron™ sensor expands the application range towards development tasks with highest dynamic for close to engine measurements in returnless fuel injection systems. New and improved features consistently protect your investment.

1 Inlet
2 Gear meter
3 Piston sensor
4 Magnetic sensor array
5 High-power magnet
6 Outlet





Coriolis Force

BENEFITS AT A GLANCE

- Ideal for use in transient and dynamic fuel consumption optimization
- Unique data quality due to maximum temperature control accuracy and the application-oriented design of the measuring system
- Fast and easy setup on the testbed – AVL ActiveLink™
- AVL PLUtron™: self-diagnostic functions monitor operation conditions, optimize measurement analysis and protect the device
- Unmatched dynamics for close to engine measurement (with AVL PLUtron™ sensor)

HIGH PERFORMANCE IN FUEL CONSUMPTION MEASUREMENT

AVL Fuelsystem PLU

The AVL FuelSystem PLU is a high precision fuel consumption measurement system with integrated fuel conditioning and optional heating for continuous fuel consumption measurement in the range of 0.05 l/h to 300 l/h. The implementation of the newest AVL PLUtron sensor allows the fastest step response combined with a data-rate of 100 Hz.

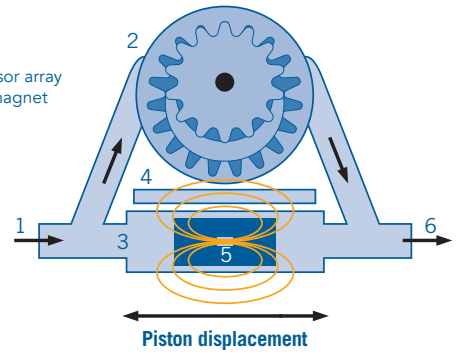
MEASUREMENT PRINCIPLE

The AVL FuelSystem PLU is based on the PLUtron principle. For further information, please refer to page 130/131.

APPLICATION

The FuelSystem PLU is used for fuel consumption measurements on engine testbeds in the development of passenger car engines. The integrated automatic venting and filling procedures make the highly scalable measurement device ideal for applications on testbeds where engines are changed frequently. The internal vacuum pressure regulator allows to generate negative relative pressure in the return fuel line. This measurement device is designed for Flex Fuel, covering all fuel types from gasoline (EN228) with up to 100 % alcohol (M100 or E100) and diesel (EN590) with up to 100 % biodiesel (EN14214).

1 Inlet
2 Gear meter
3 Piston sensor
4 Magnetic sensor array
5 High-power magnet
6 Outlet



BENEFITS AT A GLANCE

- Enhanced testbed efficiency through integrated functional check and online plausibility to prove the state of the hydraulic installation.
- High reliability and short installation and commissioning time enable long operational testbed availability.
- Low switching costs for the AVL KMA4000 installed base thanks to the 100 % backward compatibility (hydraulic and electrical).

FUEL CONSUMPTION MEASUREMENT

AVL Fuel Mass Flow Meter and Fuel Temperature Control

Regarding fuel consumption measurement, the mass flow measurement system AVL Fuel Mass Flow Meter and Fuel Temperature Control uses a Coriolis sensor optimized by AVL and supplies the engine testbed with fuel of the highest temperature stability. A pressure control system patented by AVL provides constant, adjustable fuel pressures and allows reliable and easy utilization with state-of-the-art mixture preparation systems. The FlexFuel version is applicable to bio fuels and, thus, provides investment safeguarding for future development tasks.

MEASUREMENT PRINCIPLE

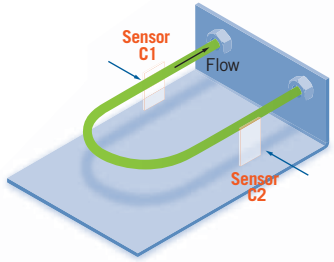
The fuel passes through a U-shaped tube which vibrates at its natural frequency. This frequency is proportional to the fuel density which, in addition to the mass flow, is a separate measurement variable and, thus, allows for the output of volumetric measurement values. The time lag of the vibration frequency C1 to C2 is proportional to the mass flow.

APPLICATION

Given its precision of 0.12 % and direct mass flow measurement capability, the AVL Fuel Mass Flow Meter with Fuel Temperature Control can be used on all engine and chassis dynamometer testbeds in the fields of research, development and production. The measurement system can be used universally for different engine sizes from single-cylinder engines up to 600 kW large-scale engines and for state-of-the-art mixture preparation systems and test cycles.

BENEFITS AT A GLANCE

- Shorter measurement and testing times due to precise fuel temperature control within +/– 0.02 °C
- The patented AVL pressure control allows for a universal application, in line with the requirements of state-of-the-art measurement methods and injection systems
- Increased testbed efficiency due to reliable measurement operation, integrated maintenance displays and detailed diagnosis functions
- With numerous options, a broad spectrum of applications is covered



Coriolis Force

BENEFITS AT A GLANCE

- Minimization of testbed times due to high levels of reliability and long maintenance intervals
- Time-saving ISO 9001 testing due to calibration within a few minutes
- Fast and low-cost integration in the engine testbed due to the presence of compatible interfaces
- Fast application with different injection systems

FUEL CONSUMPTION MEASUREMENT

AVL Fuel Balance and Fuel Temperature Control

The AVL Fuel Balance, based on the gravimetric measurement principle, is the fuel consumption meter used most commonly on engine testbeds. Providing advantages such as reliable operation, measurement accuracy of 0.12 % as well as very low maintenance expenses, it is the uncontested leader.

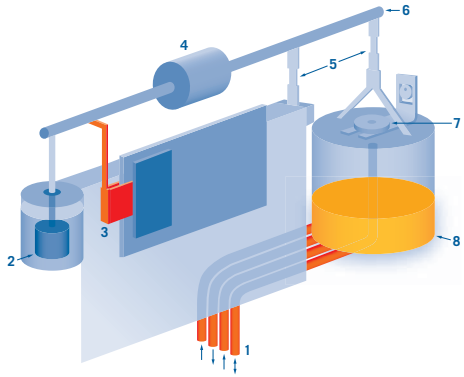
MEASUREMENT PRINCIPLE

The fuel consumed by the engine is taken from a continuously weighted measurement vessel with all the properties of the vehicle tank.

The detection of the weight of the fuel is implemented with a capacitive displacement sensor that is connected to the measurement vessel by means of a beam. A calibration weight is used to perform the accuracy testing and calibration procedures in accordance with ISO 9001. The calibration is implemented in a fully automatic manner within a few minutes and is integrated by default in the AVL Fuel Balance.

APPLICATION

In combination with the AVL Fuel Temperature Control or the AVL Cooling System, it is the ideal solution and industrial standard when equipping research, development, quality and endurance testbeds. It is used for single-cylinder and large diesel engines up to an output of 1,000 kW. The whole range of applications is covered by one AVL Fuel Balance using measurement range switching. Compatible interfaces, allow it to be easily be integrated into different testbed automation systems.



1 Fuel supply connections (4)
2 Damping device
3 Capacitive sensor
4 Tara weight
5 Blade spring
6 Measurement beam
7 Calibrating weight
8 Measuring vessel

FUEL MEASUREMENT SYSTEM CALIBRATION

AVL Fuel Reference

AVL Fuel Reference is an efficient calibration system that provides you with a simple way to check various types of fuel consumption measurement devices, including the way they are set up on the test-bed. Quality assurance, ISO calibration, periodic verification, and calibration according to UN ECE R49 and US EPA 40 C.F.R. part 1065. Depending on your requirements, it is capable of reducing time and effort for calibration (including testbed installation) to as little as 60 minutes. In order to increase the efficiency of the engine test field, it is also important that results from different testbeds are comparable.

MEASUREMENT PRINCIPLE

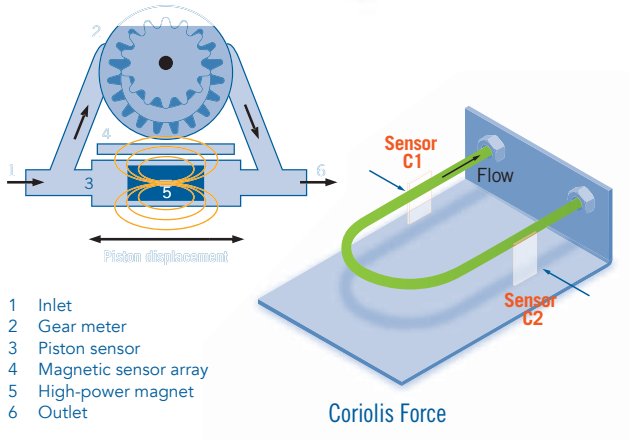
The Fuel Reference exists in two versions: one based on the PLUtron measuring principle and one based on the Coriolis measuring principle. For further information, please refer to page 130/131.

APPLICATION

An AVL Fuel Reference unit is typically connected to a fuel measurement system instead of an engine. It compares the fuel consumption value of the fuel measurement system with the sensor value of the AVL Fuel Reference. Within the software of the AVL Fuel Reference, various test runs with different flow rates and measurement times can be parameterized. For performing the test run, the operator is guided by the software to manually or automatically adjust different flow rates for the calibration points. The result: high accuracy down to low flow rates due to massively increased measurement resolution of the AVL PLUtron™ sensor.

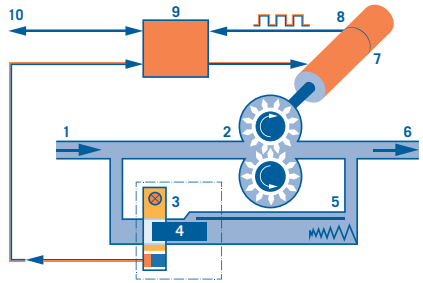
BENEFITS AT A GLANCE

- Applicable to the entire AVL fuel consumption portfolio
- High resolution at low flow rates with the AVL PLUtron™ sensor
- Calibration of the entire fuel consumption measurement chain (measurement device and testbed installation)
- Compliance with all statutory guidelines and standards (ISO, US EPA 40 C.F.R. Part 1065 and UN ECE R49)
- Overall calibration effort is reduced to as little as 60 minutes
- By returning fuel to the measurement device or fuel supply system, the calibration of measurement devices is done without wasting fuel



1 Inlet
2 Gear meter
3 Piston sensor
4 Magnetic sensor array
5 High-power magnet
6 Outlet

1 Inlet
2 Gear meter
3 Piston sensor
4 Piston
5 Bypass
6 Outlet
7 Servo motor
8 Encoder
9 Controller
10 Signal output



END-OF-LINE-TEST OF SMALL OFF-ROAD ENGINES

AVL SORE PLU 110 Fuel Consumption Measurement Unit

The AVL SORE PLU 110 fuel consumption measuring unit is especially useful in the testing of handheld small off-road engines (SORE). The unit is designed to measure even extremely small fuel flow rates and very low supply pressure on carburetor gasoline engines without return flow. The PLU measuring principle avoids interference with engine performance (Δp = 0) in a very large flow range. Installation close to the engine gives the PLU 110T flow meter a unique dynamic measurement capability and minimizes temperature influences. As a stand-alone flow measuring unit, AVL SORE includes a density meter, a data acquisition module and flexible interfaces.

MEASUREMENT PRINCIPLE

The PLU positive displacement meter combines a servo-controlled gear counter with a dynamic piston sensor. A gear meter (2) driven by a servo motor (7) with encoder (8) defines a geometric volume to pulse frequency ratio when gear rotation is adjusted to media flow. A bypass (5) ensures zero pressure difference (Δp = 0) between inlet and outlet, preventing leakage flow. Flow changes immediately displace a zero-friction piston (4) in either direction. A piston position sensor (3) and a servo controller (9) provide a fast gear speed control loop keeping the piston centered.

APPLICATION

AVL SORE PLU 110 is used in R&D, production and engine testing. End-of-line tests for two-stroke SI engines include carburetor adjustment for performance optimization and emission standards compliance. Test time minimization is a primary target of EOL test design. Due to its dynamic measurement capability, the AVL SORE PLU 110 accelerates adjustment of power limits significantly, so contributing to efficient engine testing.

BENEFITS AT A GLANCE

- Dynamic flow measurement due to high resolution and high accuracy even at extremely low fuel flow
- Cycle time reduction and quality improvement in end-of-line testing
- No influence on engine performance (no pressure drop; Δp = 0)
- Fast testbed integration, flexible use and convenient stand-alone functionality

MOBILE FUEL CONSUMPTION MEASUREMENT

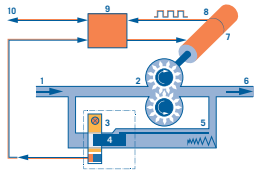
AVL KMA Mobile

The AVL KMA Mobile is an in-vehicle fuel consumption measurement system that sets standards regarding reliability, flexibility and precision. Due to the modular design, the measurement system can be adapted to the different requirements. For example, engines without return flow require only the measuring module while engines with return flow to the tank require the measuring and the conditioning module. Thanks to the three measurement ranges each system covers a large range of vehicles and engine types, from two-wheelers to large construction vehicles. Dynamic measurements combined with high measurement quality (accuracy, reproducibility) can be achieved due to very short response time (100 ms) and very short measurement time.

MEASUREMENT PRINCIPLE

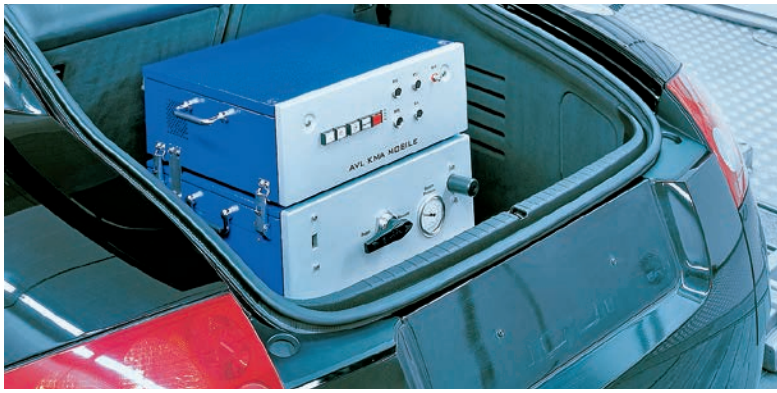
The AVL KMA Mobile measurement system uses the worldwide approved PLU measurement principle of the servo-controlled positive displacement meter ($\Delta p = 0$). The positive displacement meter is driven by a servo motor (7) so that the differential pressure across the meter is controlled to "zero". This differential pressure of zero between sensor inlet (1) and outlet (6) results in an absence of leakage flows within the PLU sensor that could affect the measurement result. As the sensor does not cause a pressure drop, wear and tear on the sensor are minimized.

1 Inlet
2 Gear meter
3 Piston sensor
4 Piston
5 Bypass
6 Outlet
7 Servo motor
8 Encoder
9 Controller
10 Signal output



APPLICATION

The universal fuel measurement system AVL KMA Mobile is used for fuel consumption measurement in vehicle road testing and at chassis dynamometer testbeds. The AVL KMA Mobile is available with different PLU sensors and, thus, allows for measuring flows between 0.16 l/h and 300 l/h. Hence, all applications from passenger cars to heavy commercial vehicles are covered.



BENEFITS AT A GLANCE

- Due to its universal applicability, the AVL KMA Mobile can be used with all common vehicle fuel delivery systems
- Reliable road test results are guaranteed by high measurement accuracy, reproducibility and robustness
- Due to engine supply and return pressure adjustment capability, the measurement system does not have any influences on the engine fuel system
- Simple handling due to modular design and the application of self-sealing quick couplers facilitates integration in the vehicle

PLUTRONIZE BEYOND LIMITS

AVL PLUtron™ CLASSIC

As a universal flowmeter AVL PLUtron™ CLASSIC is suitable for a very wide range of applications in the automotive sector. It impresses with a true "Plug & Play" usability in setup and operation, based on integrated sensors and onboard intelligence, enabling self-diagnostic functions. It simplifies all those flow measurement applications where experts are not available, yet reliable results must be produced quickly in changing or unknown environments. Users benefit from the advanced PLU measuring principle by a much larger dynamic range, no influence on the tested circuit ($\Delta p = 0$) and extreme robustness against vibration and shock. An optional integrated density meter also allows the direct measurement of mass flow with the PLU.

MEASUREMENT PRINCIPLE

PLUtron extends the traditional PLU dual sensor measurement principle. The gear head accurately measures the net flow rate, and flow rate variations are sensed by the piston sensor instantaneously. With PLUtron, this highly dynamic flow contribution is now added to the averaged flow signal of the gear head. Therefore, the response time of the electro-mechanical control loop of the servo drive is eliminated from the flow signal.

APPLICATION

AVL PLUtron™ CLASSIC is an ideal solution for in-vehicle testing on gasoline vehicles as passenger cars or motor cycles, where robustness against pressure pulsation and vibration is an increasingly important feature for achieving reliable results. Flow measurement in component production testing is another demanding field of application. The higher PLUtron resolution offers faster stabilization and shorter measurement time than all other devices. AVL PLUtron™ CLASSIC is an outstanding solution for many more applications on testbeds as well as in the lab, which focus on flexible use, simple setup and robustness. Please consult us for a detailed analysis of your needs and requirements. Optionally, mobile display and an integrated density meter are available.

BENEFITS AT A GLANCE

- Unique Plug & Play usability for optimized workflow
- Reliable results under rough conditions due to robust design and long-term stable calibration
- Higher flexibility due to large measuring ranges with highest resolution and accuracy
- Up to 15 % shorter test time in component production at affordable cost of ownership
- No influence on engine performance

1 Inlet
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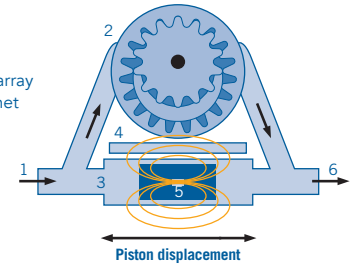


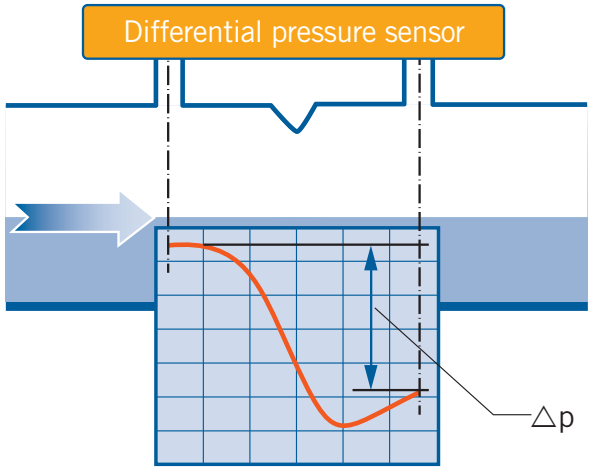
ENGINE CRANKCASE VENTILATION FLOW MEASUREMENT

AVL Blow by Meter

Blow-by measurement nowadays is standard on engine testbeds. To be able to comply with the emission legislation for new combustion engines today and in the future, the requirements for crankcase ventilation systems will continue to increase. In order to design these systems, knowledge of engine blow-by mapping is also required. This and the possibility of continuous measurement of the blow-by flow to monitor the engine condition make the AVL Blow By Meter an indispensable instrument for engine testing.

MEASUREMENT PRINCIPLE

For the determination of blow-by flow the orifice measurement principle (differential pressure measurement procedure) is used. A neck (orifice) in the tube cross-section provokes a pressure drop that is measured by means of a differential pressure sensor. The shape of the orifice of the AVL Blow By Meter means that it, on the one hand, ensures the accuracy in both flow directions and, on the other, prevents condensation at the orifice that might modify the cross-section. The selected shape of the orifice allows a broad dynamic range of 1:50.



Orifice Principle

APPLICATION

On the basis of the interchangeable measurement ranges between 0.2 and 2,400 l/min, the AVL Blow by Meter can be used from small-scale and single-cylinder engines to ships' diesel engines. The areas of application cover engine research and the optimization of the piston cylinder assembly. Furthermore, this system is used when designing crankcase ventilation systems and on quality and endurance testbeds.

BENEFITS AT A GLANCE

- The accuracy of 1 % FSO (optional) and the reproducibility of 0.1 % comply with the strict requirements of engine measurement technology
- Due to the minimum pressure drop, the blow-by behavior of the engine is hardly affected
- High reliability and constant measurement readiness are realized by low dirt sensitivity
- Correct detection even of reverse blow-by flows
- Simple integration and installation on the testbed

AIR CONSUMPTION MEASUREMENT

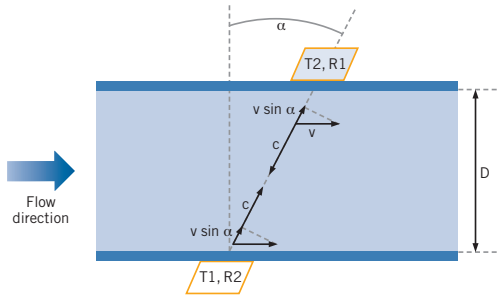
AVL FLOWSONIX™ Air

Along with fuel consumption, air consumption is another important parameter when developing combustion engines. In emission certification, air consumption is taken as a reference value. Consequently, air consumption is an integral part of AVL testbed solutions.

The AVL FLOWSONIX™ Air components are the measuring head, the evaluation unit and two very short inlet- and outlet pipes (< 5* DN each). Due to the large measuring span of 1:70, only two different pipe diameters are needed (DN 100, DN 150) to cover the full application range of up to ± 2,900 kg/h.

MEASUREMENT PRINCIPLE

The measurement principle is based on the ultrasonic transit-time differential method. Two ultrasonic pulses are sent simultaneously through the flowing medium from Transmitter 1 (T1) and Transmitter 2 (T2). One pulse is propagating into the flow and the other one against it. The interaction between the speed of sound c and the velocity of flow v accelerates the pulse on one of the paths and decelerates the pulse on the other path. This effective propagation velocity results in different transit times through the medium: The signal at Receiver 1 (R1) arrives faster than the signal arriving at Receiver 2 (R2). The device measures the speed of sound traveling either way, corresponding to t1 and t2.



T Transmitter
R Receiver
c Speed of Sound
v Flow Media Velocity
α Inclination Angle

APPLICATION

The combination of high levels of measurement accuracy, a large measurement range and short response time enables applicability of the air mass measurement in the following fields (of application): engine development, quality assurance, emissions development and emissions certification.

BENEFITS AT A GLANCE

- The unique AVL FLOWSONIX™ Air is impervious to contamination, which enables long maintenance intervals
- Marginal influence on the combustion engine due to small pressure drop in the measurement head
- Quick and easy installation for any engine type
- High availability of the measurement device due to extended calibration interval of one year
- One size fits all. Due to the wide measurement range, only two different instrument versions are required: light duty or heavy duty
- Little space required – just < 5*DN up-stream and down-stream tubing

Different measurement tubes up to 4,000 kg/h.

AIR CONSUMPTION MEASUREMENT

AVL Air Consumption Meter

Along with the fuel consumption, air consumption is another important parameter when developing combustion engines. In emission certification, air consumption is taken as a reference value. So the air consumption is an integral part of AVL testbed solutions.

The air consumption measurement system consists of the components of flow meter sensor (measuring tube), supply/evaluation unit and measuring section. The measuring tube is available in six different nominal widths of NW 25 up to NW 200 and is installed in the measuring section using quick release connections.

MEASUREMENT PRINCIPLE

The system works in accordance with the principle of the hot film anemometer. This measurement procedure is based on the fact that heat is withdrawn from a heated body by the air flowing around it. In the relevant measurement range, this flow-dependent cooling does not depend on pressure and temperature but on the type and number of air particles making contact with the heated surface. The procedure, then, directly represents the mass flow of the suction air. With this procedure, the measurement value is provided directly in the units of kg/h or the standard m^3/h.

APPLICATION

The combination of high levels of measurement accuracy, a large measurement range and short response times result in the use of air mass measurement in the following fields of application: engine development, quality assurance, emissions development and emissions certification.

BENEFITS AT A GLANCE

- The high levels of measurement accuracy across a large measurement range comply with the requirements of automatic engine calibration
- The short response time is a precondition for detecting quick engine load changes in the transient measurement range
- Simple handling due to modular design and the use of quick release connections facilitates the integration into the test facility

UREA CONSUMPTION MEASUREMENT

AVL PLUrea™

AVL PLUrea™ serves the specific requirements of SCR system applications in diesel engine exhaust after-treatment. Compliance with the challengingly low limits of future exhaust emission legislation requires maximum NO_x conversion ratios while avoiding ammonia slip. Successful urea dosing strategy development for a specific engine/SCR system/catalyst combination includes accurate dosing calibration over the entire engine map and comprehensive emission cycle testing. Enabling AVL measurement technology allows fast setup, easy handling, robustness and durability in addition to accurate and reliable measurement data.

MEASUREMENT PRINCIPLE

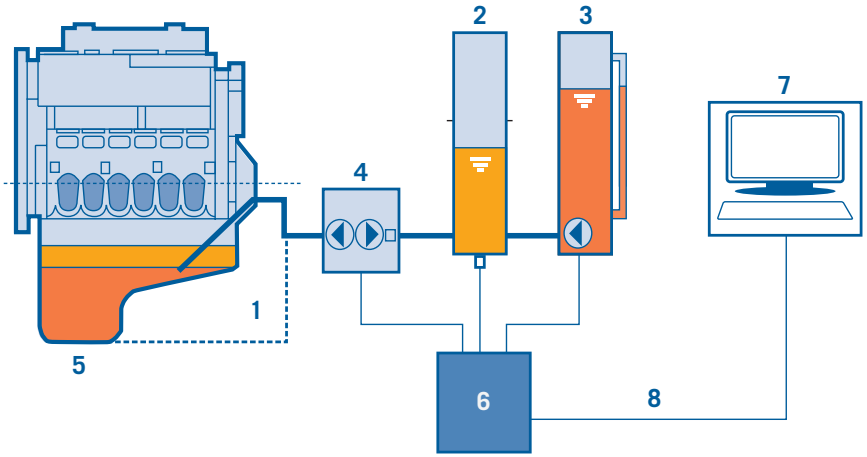
Extremely small flow quantities and high levels of flow dynamics require a measurement position in the direct vicinity of the injector to minimize temperature's influence on the results. Robustness to pressure pulsations resulting from the injection is, of course, an important precondition in this position. With their dual measurement principle PLU sensors are ideally suited to these measurement conditions.

APPLICATION

AVL PLUrea™ provides stationary urea flow metering as well as highly dynamic consumption measurement during transient test cycles. The system solution is used on engine or chassis dynamo testbeds as well as in vehicle testing. With accurate online measurement, AVL PLUrea™ contributes to efficient SCR system testing in all development stages of SCR system application and verification.

BENEFITS AT A GLANCE

- Efficient urea dosing strategy development due to dynamic correlation
- Optimized system solution for SCR-specific operational conditions
- Immediate detection of dosing deviations or SCR system malfunction and exact identification of corresponding operational conditions
- Fast testbed integration, flexible use and comfortable stand-alone functionality



1 Oil dip stick
2 Measuring tank
3 Refilling tank
4 Pump
5 Drain plug
6 Electronics
7 PUMA CDH – Task
8 Hybrid interface or serial interface via RS232

OIL CONSUMPTION MEASUREMENT

AVL Oil Consumption Meter

The determination of the lubrication oil consumption of state-of-the-art combustion engines is as important as ever because of stricter emissions regulations. These exhaust gas and particulate matter emissions limited by law confront the engine developers with a difficult task that can only be solved in the combination of combustion, exhaust gas after-treatment and oil consumption development.

MEASUREMENT PRINCIPLE

The measurement works using gravimetric principle. This means drawing the oil into a measurement tank, either completely or up to a defined level, using a modified dip stick or the oil drain plug. Afterwards, the weight is determined with the help of a high-precision pressure sensor. After the weight has been determined, the oil is pumped back into the oil pan of the engine. A measurement cycle consists of the three steps: pumping out, weighing and pumping back. The difference between two subsequent measurement cycles indicates the oil consumption.

APPLICATION

Thanks to the compact and mobile design, the measurement unit can be used in many applications. The areas of application in the field of engine development and research are the optimization of cylinder head seals, piston rings, the valve guides, as well as inspection of oil dilution or the reasons for oil consumption. In durability testing, the AVL Oil Consumption Meter can also be used for monitoring or refilling the consumed quantity of oil. On production testbeds the meter can be used to check the production quality of engines.

BENEFITS AT A GLANCE

- Up to 50 % time savings compared to traditional methods
- The integrated oil refilling unit allows extended test cycles
- The simple installation and testbed integration minimizes downtime
- The integrated operating panel on the device allows stand-alone operation
- Due to the fully-automated measurement procedure, there is no need to handle the oil