AVL ADVANCED COMBUSTION ANALYSIS SOFTWARE

The combination of classic combustion analysis with optical measurement and simulation technology

AVL

HIGHLIGHTS AT A GLANCE

- Complete software platform which combines classic combustion analysis with optical measurement and simulation technology
- Powerful data acquisition system for powertrain development applications with extensive online calculation capabilities
- Easy and proven integration into any test cell automation environment by means of well documented generic interfaces
- Maximum measurement accuracy and reliability with a perfectly matched measurement chain supported by plausibility check functions and AVL Sensor Data Management
- Professional gas exchange and combustion analysis with AVL GCA simulation software for a detailed understanding of the complete combustion process

COMBUSTION ANALYSIS CAN BE THAT EASY

Powertrain development is growing in complexity at an ever increasing rate. At the same time, the pressure on development costs and time is escalating. Understanding the combustion process and its influences on many engine parameters is essential to making modern engines more efficient. The use of robust and reliable test equipment and the ability to integrate state-of-the-art methodologies such as optical analysis or process simulation lead to trustable results and sustainable success in a competitive environment.

AVL sets new standards in terms of functionality, usability and reliability for high speed data acquisition and combustion analysis. The close cooperation with customers and in-house combustion experts and a CMMI® certified development process result in a product range tailored to customer needs and the highest quality standards for combustion and high speed data analysis software.

CMMI® … **C**apability **M**aturity **M**odel **I**ntegration in software engineering is a process improvement approach that provides organizations with the essential elements for effective process improvement.

AVL INDICOM – ADVANCED COMBUSTION ANALYSIS SOFTWARE

Functionality

Applications, ranging from standard combustion measurements to continuous combustion monitoring, model based calibration with AVL CAMEO™, cold start and in-vehicle testing, optical flame evaluation for the visualization of mixture preparation / flame propagation and even combustion and gas exchange analysis, can all be performed with IndiCom.

Powerful and versatile calculation tools like the unique and flexible graphical formula editor CalcGraf or even the use of Matlab™ runtime calculations provide the possibility to create user specific calculations to overcome current and future challenges.

User defined diagrams show measured and calculated values, turning data into a clear presentation of the investigated phenomena for analysis and reporting.

IndiCom makes advanced functionality easily accessible for every user. Powerful and flexible data acquisition, extensive calculation capabilities and professional graphical presentation make it the ideal solution for any application, from simple monitoring to the most sophisticated combustion investigations, today and in the future!

Usability

Workflow guidance: Handling all the different tools used in engine development can be a real challenge. To reduce training effort and increase productivity, IndiCom provides an optimized and intuitive graphical user interface which guides the user through the workflow and presents all relevant information in a clear and user-friendly manner.
Standardized layouts: Measurement tasks and calculations can be standardized, easily managed, shared and applied to different test and engine setups.
User level management: Provides complete flexibility to experts, and tailored simplicity to the everyday user. The results are reduced preparation time, assured compatibility and reliability of results, so that test engineers can focus on their development tasks.

Reliability

IndiCom provides built in parameter checks and online measurement plausibility monitoring. This enables increased measurement reliability and maximum productivity.
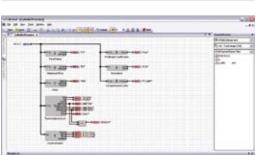

Top: Efficiency thanks to a workflow oriented user interface
Bottom: CalcGraf – graphical formula editor

Test environment integration

Efficient use of development tools requires well integrated measurement systems and devices. IndiCom offers seamless integration into any test bed environment.

IndiCom is also a key system for automated ECU optimization when used in conjunction with AVL CAMEO™. It additionally provides interfaces to CAN devices, time based acquisition cards, ECU data and the unique drivability assessment tool AVL DRIVE™. The combination of these tools makes the correlation between combustion and its various quality criteria clearly visible.

Integration platform

In addition to engine calibration work at the test bed, measurements and ECU calibration are also done in vehicles to verify the test bed results and to optimize the vehicle, especially in relation to its emissions and drivability. Getting the complete picture of all measured values in the vehicle requires an integration platform which can collect and evaluate data from various sources and which is compatible with the data acquired at the test bed. IndiCom has access to combustion and ECU information, fast time based data, drivability values, the vehicle's CAN bus and the interface to the ETAS calibration tool INCA so it is ideally suited to study the effects of driver inputs on internal combustion and thus the vehicle's responses.

Automatic data synchronization, powerful calculation possibilities, graphical analysis and compatibility with AVL CONCERTO™ post processing make IndiCom the ideal solution for all in-vehicle measurements.

Top: Test bed integration
Bottom from left to right: INCA OHI interface / in-vehicle testing / IndiCom parameter editor (IndiPar)

AVL VISIOLUTION SOFTWARE

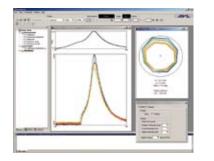## AVL optical combustion analysis at the test cell and on board

Indicating tools for analyzing the combustion process have been used for more than 100 years. But due to the engine's increasing complexity, pressure indicating alone is no longer sufficient; this is why optical analysis tools are applied. For many applications such as the visualization of mixture preparation, flame kernel monitoring, flame propagation or knock localization, AVL Visiolution Software is a perfect extension to pressure indicating to improve combustion stability, knock probability or the engine's exhaust pollution. Its features include data acquisition, the documentation of reference conditions and the calibration of light transmission. Furthermore, many comprehensive algorithms for evaluation are provided.
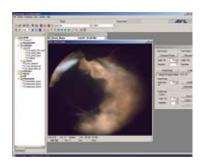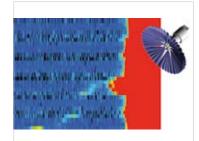
Efficient and robust

- Combustion optimization in transient operation: optical onboard technique supports calibration with cycle-based and cylinder-based emission formation data

- Mixture formation leaves a footprint in combustion: measurement of cylinder pressure, flame radiation and flame propagation provides fast information about emission and soot formation
- Knocking – ignition border line: optical spark plug sensors showing the formation of the flame kernel and knock distribution improve the engine's efficiency when developing knock
- Endoscope based technology: easy access for visualizing processes such as injection or combustion
- Optical flame temperature measurement: mostly nonintrusive and without delay, inside combustion chamber or exhaust system
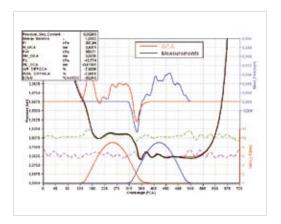

Top: Optical spark plug sensor
Botton from left to right: VisioFlame, evaluation of flame propagation / diesel flame / VisioKnock, irregular combustion

Top: Pressures and flows
Bottom: Residual gas content due to valve overlapping

AVL GCA – GAS EXCHANGE & COMBUSTION ANALYSIS

Understanding the whole engine process

One-dimensional thermodynamic calculation plays a central role in the development process of modern combustion engines. With its proven and robust simulation software BOOST, AVL offers a sophisticated tool for the one-dimensional simulation of the entire engine. GCA is based on BOOST and exploits in great detail parts of this simulation in combination with measurement values. Since both tools use the same calculation model the consistency of their result data is guaranteed. The software option GCA Gas Exchange & Combustion Analysis, fully embedded into IndiCom, is used for the detailed calculation and analysis of the whole cycle, the entire gas exchange and combustion process. When calibrating an engine the calibration process becomes more and more complex, therefore additional and reliable information is needed. GCA provides knowledge of the thermodynamic process directly at the test bed and delivers additional results that cannot be measured.

Standard input, high information output

For its analysis, GCA uses measured intake, exhaust and cylinder pressure curves and engine specific

values such as valve lift curves, flow coefficients and fuel parameters. The results include the rate of heat release, energy and heat balance, wall heat losses, mass flows, and residual gas content in the cylinder and gas exchange efficiency considering gas dynamic effects.

Calculation in dynamic operation

The investigation of the engine's behavior in dynamic operation is essential to reducing pollutant emissions. Especially for the engine cold start, high injection rates are needed, which can cause misfire and entail high pollutant emission levels. Therefore GCA provides a cycle-to-cycle analysis for engine calibration in transient operation.

GCA - the virtual sensor

- Provides information about the whole combustion process based on data that cannot be measured – even in transient operation
- Helps identify the potential for increased power or reduced fuel consumption
- Checks plausibility to confirm the accuracy of the combustion measurement

SUPPORT BY…

Productivity through traceability

Maximum productivity in engine testing requires efficient management of resources and confidence in the accuracy of the measured data.

AVL's SensorDataManagement SDM™ with patented automated sensor detection, sensor runtime tracking and a calibration database ensures the correct setup of the measurement chain with reduced parameterization effort.

The sensor database is a central digital repository for the administration of sensor specific data. It can be either a local or a network database. For each sensor all calibration data are stored, the total number of performed cycles or sensor runtime is monitored and service or calibration intervals can be scheduled according to the user's testing needs.

Quality assurance standards are supported by the traceable documentation of the complete measurement chain, which is stored in the measurement files (iFile format). Furthermore, integration into the AVL Test Field Management Suite TFMS™ is possible, which optimizes use of the available equipment.

Worldwide customers

Acting globally requires global communication and data exchange. IndiCom is ideally suited for locally and globally operating companies. It enables the exchange of result data, reports and calculation formulas with the support of an integrated unit conversion tool, a free iFile viewer, and compatibility with the powerful post processing tool AVL CONCERTO™.

Service

45 AVL affiliates worldwide with certified service personnel and an international application engineer pool provide quality service and application support close to our customers.

AVL CARE products allow customers to pick the desired level of support and service. To ensure optimal utilization of the equipment, CAREline phone support, software subscription, on-site support and even resident engineers can be offered.

And to benefit from the application know-how and continuous development at AVL, the AVL Skill Center offers professional training customized to participants' needs.

Top: SensorDataManagement
Bottom: Global service and support