A dark-colored car is shown from the side, positioned on a test rig. The car is elevated on a platform with a yellow dotted pattern overlay. The background is a solid yellow color. The text "Promotional catalogue of apparatus and laboratories of Poznan University of Technology" is located in the top right corner.

Promotional catalogue
of apparatus and laboratories of Poznan University of Technology

FACULTY OF MACHINES AND TRANSPORT

Information on the selected test equipment
at the Faculty of of Machines and Transport, Poznan University of Technology



The Faculty of Machines and Transport has a tradition of over 60 years in teaching students in the field of Mechanical Engineering and of 5 years in the field of Transport.

The mission of the Faculty is to provide education, preparing for life and functioning in society on the basis of knowledge in the area of current and future competences of the Faculty as well as to develop implementation potential for research and development work in response to market demands and the need of knowledge transfer.

This is possible as there are superbly equipped laboratories, which let carry out research work of basic character as well as application and research projects for industry.

These laboratories let carry out testing of motor vehicles, machinery, rail vehicles and a range of powertrains including combustion engines, power machines and mechatronic systems. Potential cooperation with industry is expanded with such areas as noise and vibration testing, surface layer issues, system dynamics, environmental issues, construction optimisation as well as logistics of transport systems.

The presented catalogue of the Faculty of Machines and Transport allows you to become acquainted with selected research equipment, with research areas of the faculty as well as potential cooperation in testing, giving expert opinions and technical services and consulting.

Professor Franciszek Tomaszewski, PhD BSc Eng.
Dean of Faculty of Machines and Transport

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Mobile vehicle kinematic data acquisition and storage facility



The facility enables non-damaging installation of sensors for measuring and real-time recording of the vehicle motion parameters, including acceleration and angular velocity in a three-dimensional coordinate system. The kinematic characteristics can be determined both during riding on flat surfaces, on curves, as well as during the elk test (evading sudden obstacles) and during driving over obstacles on the road surface such as tracks, speed bumps, ruts, etc. The system enables determining the Mean Fully Developed Deceleration (MFDD) parameter defining the road surface/ tyre interaction. The following parameters can also be determined: skid resistance (British pendulum tester), tyre rubber hardness (Shore hardness tester) and vehicle's centre of gravity (set of portable weight pads).

KEYWORDS

- MFDD (Mean Fully Developed Deceleration)
- vehicle safety
- surface roughness (skid resistance)
- acceleration measurements

APPLICATION:

- Vehicle motion investigations in particular in terms of traffic safety taking account different road surface and tyre parameters
- Testing the performance of ride comfort control systems, for example during running over surface obstacles. Measuring accelerations and forces acting on passengers (riding comfort) or cargo (safety from damage during transport)

Rapid Prototyping Laboratory

The laboratory enables fabricating elements featuring a complex geometry which would be very costly or even impracticable in the case of conventional fabrication methods. The laboratory equipment includes NC milling machines equipped with appropriate software. This enables obtaining curved surfaces with almost any shape. The bench is used for fabricating prototypes of machine parts. It is suited in particular for reproducing damaged (or lost) parts of machines for example on the basis of physical models or drawings. The fabrication materials include both metals and other suitable materials including wood and modelling boards/blocks, such as SIKa. The produced items can be used as visual models, presentation mock-ups or for testing.



APPLICATION:

- fabrication of machine parts prototypes
- reproducing of elements on the basis of physical models
- fabrication of models and mock-ups

KEYWORDS

- milling
- prototyping of machine parts
- CNC
- CAM

Suite of test facilities for testing thermo-mechanical properties of materials

Thermo-mechanical test facility

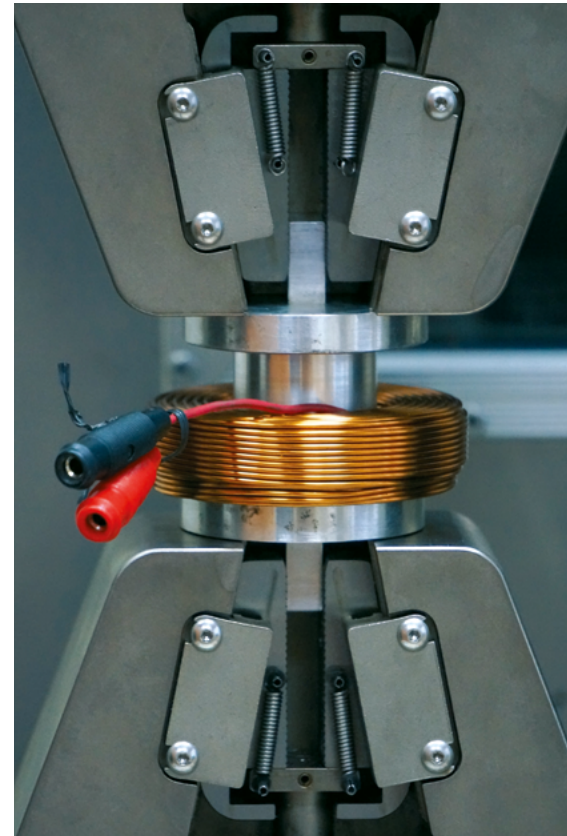
The test facility includes MTS Insight 50 testing machine equipped with a climate chamber designed for testing thermo-mechanical properties of different materials. There is also a constant climate chamber for conditioning specimens at constant environmental conditions and a METTLER Toledo moisture analyser for measuring weight and moisture content with 0.001g readability and a set of high-resolution extensometers for measuring displacements of specimens exposed to high temperature and high humidity conditions. The facility is used for determining strength parameters of various materials in particular under the effect of temperature and moisture. A special feature of the facility is a right angle jig to ensure that the compression force is applied perpendicular to the specimen cross-section.

KEYWORDS

- strength tests
- climate chamber
- thermo-mechanical properties

PARAMETERS :

- maximum test force – 50 kN,
- the climate chamber enables maintaining 98% relative humidity at temperatures up to 90° C or heating up the chamber to 250° C



APPLICATION :

- testing strength properties of materials – determination of material constants
- testing mechanical properties of materials under different temperatures and moisture contents
- testing fatigue resistance of connections

Special test facility for testing thermo-mechanical properties of shredded-compressed materials

It is a special test facility developed at the Chair of Basics of Machine Design. The facility is used primarily to investigate the process of pressure agglomeration of shredded materials and to determine maximum relative density as a function of the applied force and the distance of travel. Moreover, shear tests can be carried out including shear stress determination. These tests can be carried out at automatically controlled temperatures up to 250° C enabling determination of the effect of temperature on the analysed parameters. It is also possible to determine the coefficients of static and kinetic friction. The coefficient of friction can be determined for a wide range of surfaces differing in terms of roughness and also as a function of temperature.

PARAMETERS:

- maximum shear-friction force – 50 kN
- maximum compression force – 75 kN
- maximum heating temperature – 250° C

APPLICATION:

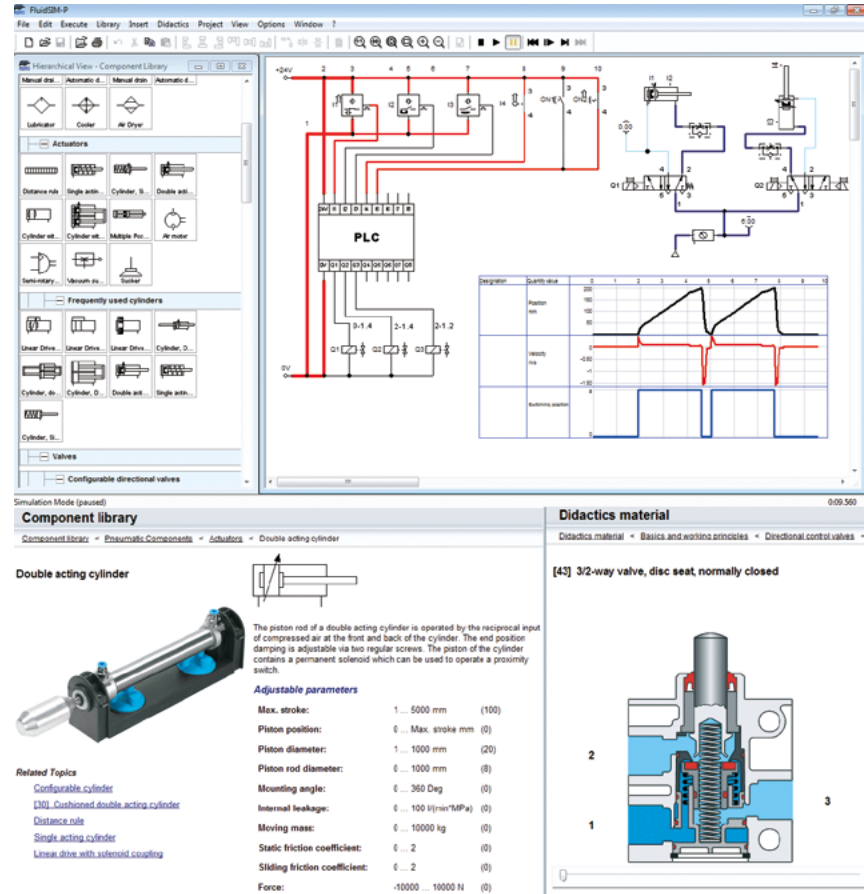
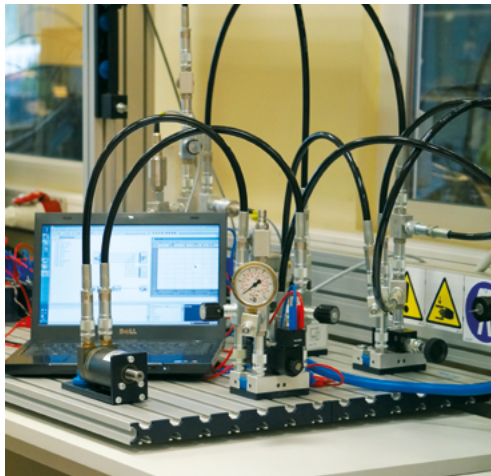
- testing strength properties of shredded materials
 - determination of the material constants
- testing the effect of temperature variation on the coefficient of friction.



KEYWORDS

- compression
- shredded materials
- determination of the coefficient of friction
- maximum relative density

Laboratory of Pneumatic and Hydraulic Systems



FluidSIM software package

FluidSIM is an application program developed by FESTO for simulating and displaying the hydraulic and pneumatic systems operation. The package includes libraries of standard symbols of hydraulic and pneumatic, electrical and digital electronic components, transducers and sensors. Using these elements one can build any system using fluid mediums including control systems and then simulate and verify operation of the built system. The program enables displaying operation of any system and recording of physical data. Moreover, FluidSIM includes an extensive teaching module which illustrates and explains in a simple manner the operation of components making up systems using fluid medium. These features and capabilities make the program a suitable tool for teaching hydraulic and pneumatic systems design and operation.

Hydraulics and pneumatics test benches



The hydraulics and pneumatics test benches enable testing electrically and pneumatically controlled fluid systems. Each test bench includes a set of valves, hydraulic and pneumatic tubing and electrical control components (including PLC's). On each bench it is possible to build any system, for example designed with FluidSIM, and then analyse its operation. The benches are also equipped with instrumentation for recording different physical parameters. Similarly to FluidSYM the test benches can also be used for teaching hydraulic and pneumatic systems design and operation

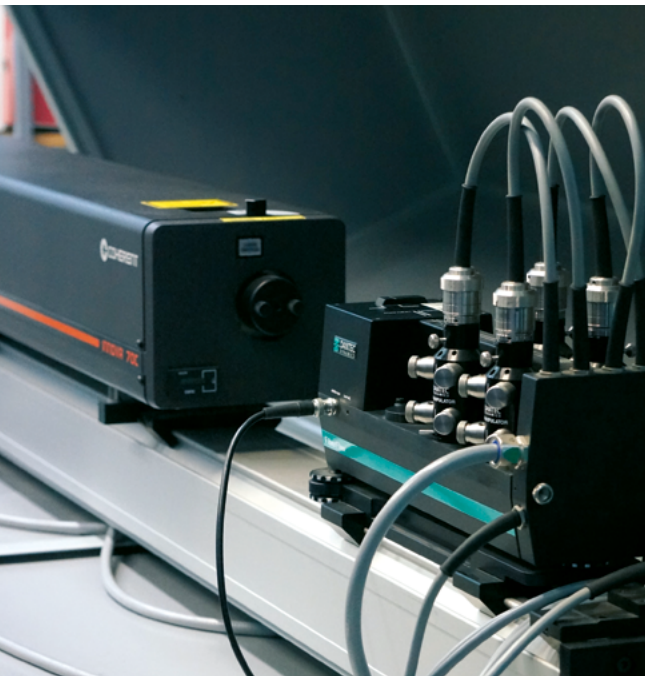
Hydraulic servo drive (vibration exciter) test facility

Vibration exciters are used mainly in academic and industrial laboratories specialising in strength and durability testing of newly developed complex parts and machine assemblies. They are used whenever determination of the strength and durability limits with traditional methods would be burdensome or even totally impracticable. Moreover, they enable physical verification of the strength and fatigue performance values obtained with simulation methods, such as FEM analysis. Electrohydraulic vibration exciters are used in the tests requiring high test loads accompanied with a high precision of load application. Owing to servo-valves and computer-based control system it is possible to generate force signals of any type, amplitude and vibration frequency (within the limits defined by the servo drive capability). The hydraulic servo drive test facility in the Laboratory of Pneumatic and Hydraulic Systems is designed for conducting strength and fatigue testing of members and nodes of structures, simulation studies, investigation of damping response in viscoelastic materials and determining the performance curves of vibration dampers. The test rig actuator is a specially designed vibration exciter mounted on appropriate base. Test bench parameters (indicative): 6 kN test load, +/- 40 mm max. amplitude, up to 35 Hz frequency.

KEYWORDS

- Fluid SIM
- hydraulic systems
- pneumatic systems
- simulation
- vibration exciter

Laser Doppler Anemometer



Flow speed measurement with the use of Laser Doppler Anemometry (LDA). Laser anemometers are non-contact optical devices used for examination of the structure of fluids – gases and liquids flow. These devices could be built owing to the invention of the gas laser, which occurred in the early sixties. Attempts to measure fluid velocity had been made earlier, but developing an effective optic anemometer was possible only when laser light of special spatial and temporal coherence properties was discovered. When compared with other instruments for flow measurement, laser anemometers have exceptional merits:

- non-invasive velocity measurement
- transient and turbulent flow measurement
- method not requiring calibration
- wide range of velocity measurement
- one-, two- and three-dimensional velocity measurement
- possibility of measuring in any distance from the surface limiting the measurement region
- measurement of negative velocity values
- instantaneous and averaged over time speed measurement
- high frequency of measured quantities sampling

LDA method is applied mainly to examine the structure of gas and liquid flow in geometrically complicated flow passages in machines and energetic facilities, such as turbines, pumps, compressors, burning chambers of gas-turbine engines, boilers, etc.

KEYWORDS

- fluid flow measurement
- gas flow measurement
- LDA (Laser Doppler Anemometry)

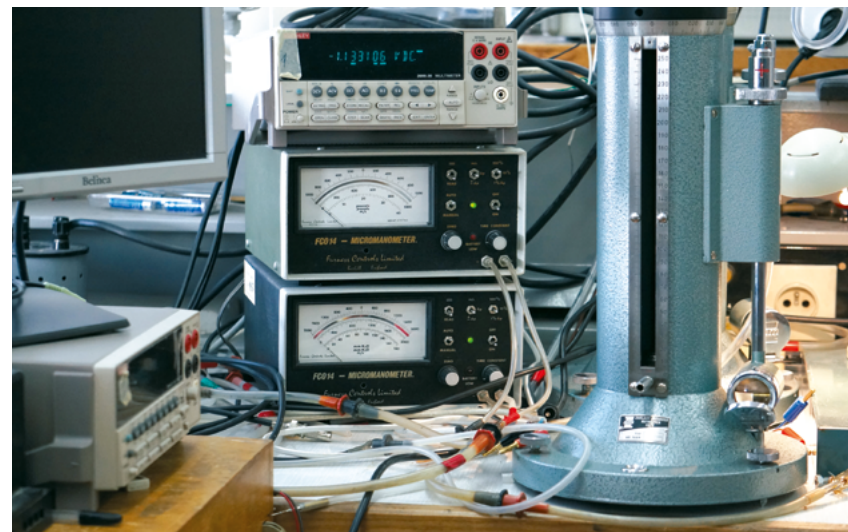
APPLICATION:

The presented measuring stand enables calibration of various velocity meters (vane, hot-wire, Pitot tube, and orifice meters) within the speed range from 0 to 60 m/s. It is possible to calibrate flowmeters of air flowing out from ventilator of ventilation systems. A characteristics of calibrated device is generated. Measuring stand enables calibration of electronic micro-manometers and manometers for overpressure, negative pressure and differential pressure measurements. Device calibration range: differential pressure 0-2.5 kPa, overpressure 0-120 kPa, negative pressure 0-60kPa.

TECHNICAL SPECIFICATION:

A core element of the calibration stand is an open aerodynamic tunnel generating air flow of variable speed within the range up to 60 m/s. Reference speed is determined based on dynamic pressure measurement with the use of electronic manometers calibrated with hydrostatic manometers. Pressure module of the facility enables calibration of electronic manometers for air pressure measurement in the range from 0 to 2.5 kPa and from -60 to +120 kPa. It is done with the use of hydrostatic manometers, in which water and mercury are manometer fluids.

Installation for calibration of air flowmeters, differential pressure meters and air volume flowmeters

**KEYWORDS**

- calibration of velocity meters
- calibration of electronic manometers
- calibration of electronic micro-manometers

List of PEMS type measuring equipment



The set of mobile measurement devices PEMS (Portable Emission Measurement Systems), for testing exhaust emissions in real traffic conditions of vehicles, includes:

SEMTECH-DS

This mobile device is used to measure the harmful and toxic components of exhaust gases (CO_2 , CO , NO_x , THC) as well as the exhaust mass flow rate and the O_2 concentration in real operation conditions. The analyzer also allows for reading data from the vehicle on-board diagnostic network and the global positioning system.



SEMTECH ECOSTAR

This mobile set analyzer is used to measure the harmful and toxic components of exhaust gases (CO_2 , CO , HC , NO , NO_2 , THC , PM) and the exhaust mass flow rate and O_2 concentration in real operation conditions. For determining the exhaust mass flow rate a high speed flowmeter can be used (high sample rate).



SEMTECH LASAR

Determination of secondary ammonia emissions from the tailpipe of the vehicle, equipped with a modern treatment system based on selective catalytic reduction SCR. This mobile device is used to measure NH_3 , N_2O and CH_4 emissions.



Laser Aerosol Monitor

This mobile device measures the concentration of particulates in road conditions of light and heavy duty vehicles.



M.O.V.E

This mobile set of analyzers is used to measure harmful and toxic exhaust gases (CO_2 , CO , NO , NO_2 , THC , PM) in real operation conditions. The measurement of the particulates in the exhaust gas is carried out by the gravimetric method, among others.



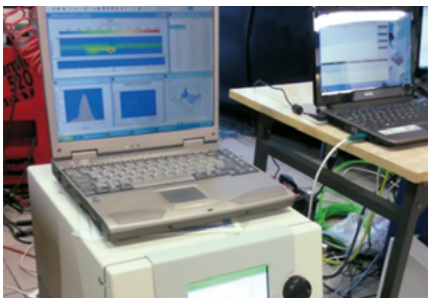
Micro Soot Sensor

This mobile device can be used to measure the mass and particle concentration in a diluted exhaust gas.



Particle Counter

This mobile device measures the number of particles in accordance with the R83 and MP requirements. The sample may be collected in the CVS exhaust tunnel or directly from the raw exhaust stream.



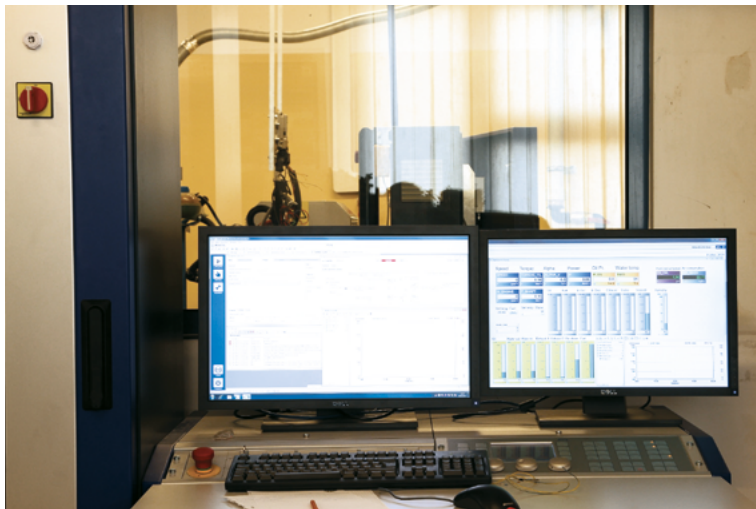
Engine Exhaust Particle Sizer 3090

This mass spectrometer is used to measure the diameter, the volume and the mass distribution of particulate matter. It enables, for example, to determine the value of PM emissions from the tailpipe of a vehicle equipped with a modern exhaust aftertreatment system in the form of a DPF (e.g. the measurement of emissions during the filter regeneration process).

Parameter	Measuring range		
	SEMTECH-DS	SEMTECH ECOSTAR	M.O.V.E
CO	0–10 %	0–8 %	0–15 %
HC/THC	0–10000 ppm	0–30000 ppm	0–10000 ppm
NO	–	0–3000 ppm	0–5000 ppm
NO_2	–	0–500 ppm	0–2500 ppm
$\text{NO}_x = (\text{NO} + \text{NO}_2)$	0–3000 ppm	–	–
CO_2	0–20 %	0–20 %	0–20 %
O_2	0–20 %	0–20 %	0–20 %

Dynamic engine dynamometer

AVLDyno Road 120 kW



TECHNICAL SPECIFICATIONS:

- voltage: 3 x 500 V
- frequency: 267 Hz
- maximum current: 159 A
- power: 120 kW
- number of poles: 4
- maximum torque: 509 N·m
- engine speed range: 0-8000 rpm
- power drain: 6400 W
- efficiency: 94,6 %

APPLICATION:

Dynamometer is used for conducting measurements in steady, transient, and especially in dynamic states. In addition, the test bench allows the simulation of the following parameters: shifting the gears, clutch characteristics, dimensions of the vehicle, the number and the angle of elevations, temperature, humidity and atmospheric pressure, etc. It also allows the transfer of parameters stored in real operation conditions onto engine connected with dynamometer.

KEYWORDS

- dynamometer research
- engine dynamometer
- set and transient conditions
- exhaust emissions



DYNOMite

Motorcycle Chassis Dynamometer



TECHNICAL SPECIFICATIONS:

- dynamometer type: water/AC
- maximum received power: 147 kW (200 KM)
- maximum received speed: 200 km/h
- dimensions: length/width/height: 2320/880/410 mm
- roll diameter: 16''
- software: DYNO-MAX™

APPLICATION:

It allows for readings of instantaneous power and torque to the wheels of the vehicle, the distance traveled, speed and acceleration. During the work station preparation procedure, input data on temperature and ambient pressure, humidity and corrector are added. The last parameter is specific for a particular motorcycle or scooter model. A large amount of input data has a positive effect on the obtainable result accuracy.

KEYWORDS

- dynamometer research
- chassis dynamometer
- set and transient conditions
- exhaust emission

AutoSim AS1200-6 driving simulator



TECHNICAL SPECIFICATIONS:

- the simulator is equipped with a platform allowing movement with six degrees of freedom
- spherical screen 220 degrees around the driver position
- rear view obtained with LCD mirrors
- ability to use on-line data in the simulator via LAN connection
- optional connection between the simulator and the test stationary engine dynamometer
- ability to integrate different measurement systems
- ability to register at least 35 variables directly related to the controlled vehicle simulation
- creation of simulation scenarios and new objects for the simulation needs
- ability to record the whole session as videos using a V-BOX set to reproduce the executed research scenario on the simulator

APPLICATION:

Educational equipment showing the possibilities of modern simulators that use realistic and virtual elements. The main tasks of the simulator are: virtual simulation of driving cars and trucks in the virtual world, simulation of physical phenomena associated with the movement of vehicles, driver training, stimulating the driver of the vehicle during the training course to examine his/her reaction/behavior, training instructor crew in simulator use and the carrying out of scientific research, comparing the virtual engines input and output data in relation to a real physical object, the science of planning experiments/research in different knowledge ranges.

KEYWORDS

- simulation research
- driving simulator
- driver reaction
- eco-driving

CKASMotionCor5 flight motion simulator

APPLICATION:

The device is designed for training in FNPT II MCC flight and navigation procedures

TECHNICAL SPECIFICATIONS:

Main features and elements:

- enclosed cockpit
- on-board equipment replica
- on-board instructor position
- electric motion system with six degrees of freedom (6DOF)
- screen with continuous image projection, in a 200° range horizontally and 40° vertically



KEYWORDS

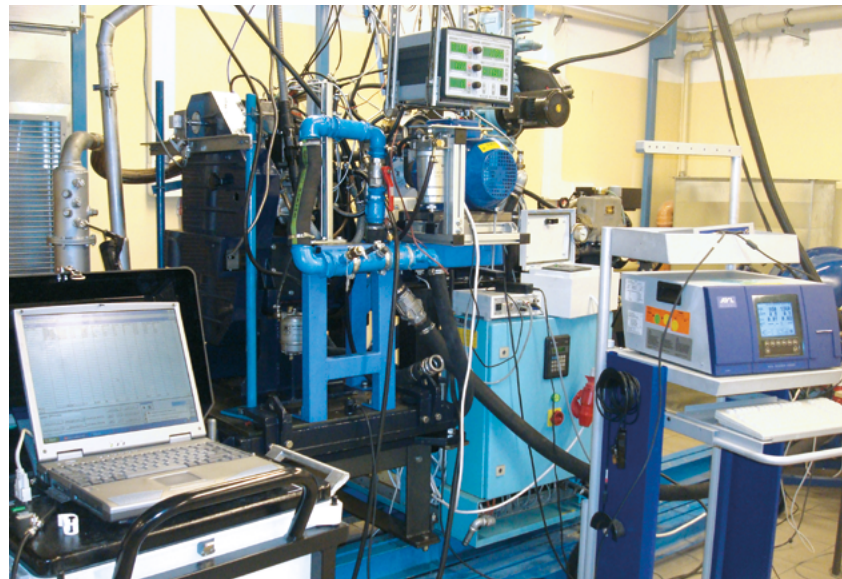
- simulation studies
- flight simulator
- FNPT

Engine dynamometer

AVL 5804

TECHNICAL SPECIFICATIONS:

The engine dynamometer consists of a single-cylinder research engine – AVL 5804 – coupled with an asynchronous electric dynamometer brake. It is a compression ignition engine with direct injection fuel system. The injection timing, injection advance and number of fuel doses can be freely controlled by computer. The engine is equipped with common rail system with injection pressure up to 200 MPa. The test stand is fitted with oil lubricant and water conditioning systems.



APPLICATION:

The test stand is a basic research object for analysis of the combustion in a compression ignition engine. The studied phenomena are fuel injection and combustion in terms of thermodynamic and emission analysis. The optical access in the cylinder head enables observation of the development of the flame in the cylinder.

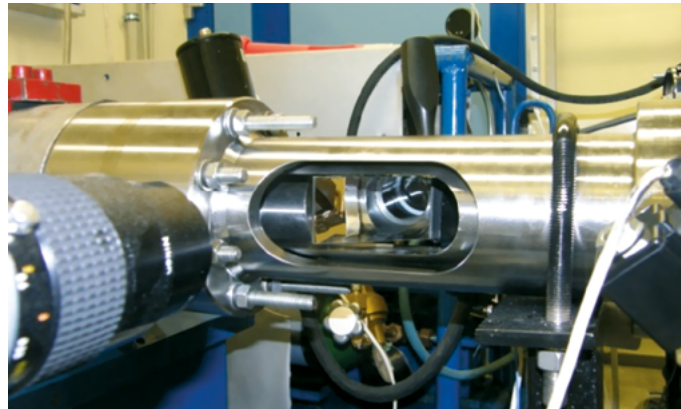
KEYWORDS

- combustion engine
- fast-varying research processes
- optical research

TECHNICAL SPECIFICATIONS:

- Piston stroke: 81 mm
- Piston diameter: 80 mm
- Cylinder volume: 407 cm³
- Volume of compression chamber:
SI - 66.5 cm³, CI - 46.6 cm³
- Method of air delivery: solenoid valves, with forced air turbulence
- Geometric compression ratio [-]:
SI – min. 6.8; CI – min. 11
- The real compression ratio [-]:
SI – 6,8-14; CI – 11-20
- Compression pressure:
SI – 0,85-2,0 MPa; CI – 3.0-4.5 MPa
- Ignition: SI – spark plug; CI – autoignition or glow plug (1250°C)
- Type of combustion chamber: SI
– hemispherical chamber + chamber in the piston, CI – chamber in the piston
- Method to force the piston movement: pneumatic
- The speed of movement of the piston: 30-70 m / s depending on the air pressure under the piston
- Piston seal: piston rings, Teflon seal
- Optical access: quartz glass 48 x 50 mm located from the bottom of the combustion chamber in the piston, also optionally in the cylinder head
- Realization of injection: SI – DI type, multi-phase, CI – direct CR, multiphase
- Fuel injection pressure – adjustable:
SI – 5-30 MPa, CI – 30-140 MPa
- Realization of combustion: SI – homogeneous or stratified fuel mixture

Rapid Compression Machine (RCM)



APPLICATION:

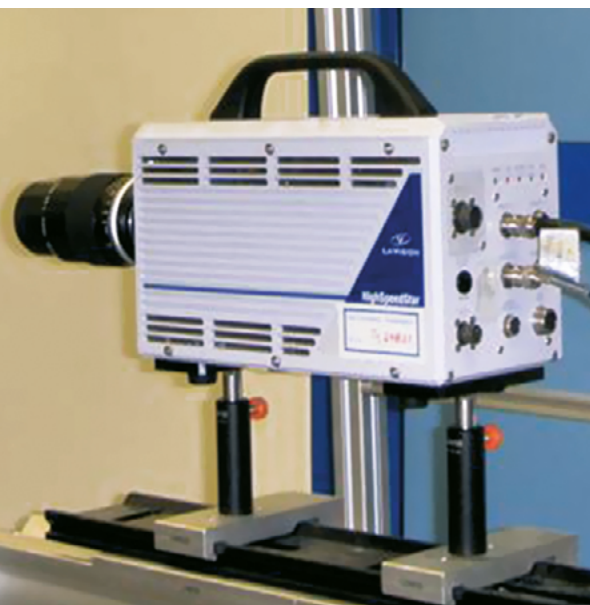
A Rapid Compression Machine allows the basic research in the area of a single operating cycle of the combustion engine, particularly with regard to fuel injection, charge motion, ignition and combustion process. It is built with cylinder where a piston is made in such a way that it is possible to gain optical access to the combustion chamber from the side of piston crown.

KEYWORDS

- combustion engine
- indicating studies
- optical research

High-speed camera

HSS 5



TECHNICAL SPECIFICATIONS:

- the type of image sensor: CMOS
- pixel size photocathode 17 μ m x 17 μ m
- maximum resolution: 1024x1024 pixels
- maximum speed of imaging:
 - 3 000 images/s with resolution of 1024 x 1024
 - 10 000 images/s with resolution of 512x512
 - 30 000 images/s with resolution of 256x256
 - 250 000 images/s with resolution of 128x16
- the spectral range of 380 nm to 800 nm, 190-380 nm when using the Image Intensifier

APPLICATION:

- Camera with modules of image processing and computer with specialized software Davis 7.2 is a system of registration and processing of fast-varying images. Studies with the use of high-speed camera include injection and fuel atomization – for determining the geometric parameters of spray. It also allows the qualitative determination of the fuel distribution in the stream of combustible fuel, as well as the estimation of flame velocity development. This technique also allows the determination of the temperature distribution in the combustion chamber with the use of double-optics techniques.

KEYWORDS

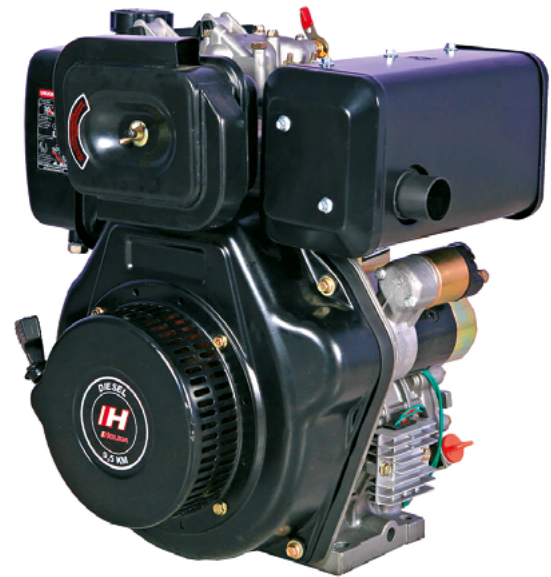
- camera
- optical research
- image analysis

Mobile engine dynamometer

- Autoelektronika Kędzia

APPLICATION:

The test stand is equipped with Holida 186F combustion engine operating with maximum power of 7 kW. This is a four-stroke single-cylinder compression ignition engine with 417 ccm capacity. The applied three-phase electric motor with a power of 7.5 kW allows for speed up to 2800 rpm before starting the engine. The system allows for loading of the combustion engine by an electric motor to a limited range.. This method has a limitation on recovering energy from braking, and therefore to generate brake loads uses eddy current brake. It has the ability to generate the load with the maximum braking torque of 70 Nm. For the brake control an AMX 211 driver is used, integrated, integrated with computer system (remote control mode is an option). The brake is equipped with a closed cooling system, therefore the test stand is independent of the access to water supply and allows to obtain constant, target temperature of coolant.



KEYWORDS

- combustion engine
- engine dynamometer
- mobile test stand
- fast-varying research processes

Mobile stand of hybrid powertrain

– Autoelektronika Kędzia



APPLICATION:

Mobile stand of hybrid powertrain (serial-parallel type) is made up of components from the Toyota Prius vehicle. The hybrid drive consists of a combustion engine (1 NC-FXE - working in the Atkinson cycle 4-cylinder, 1.5 dm³, 16-valve, equipped with variable valve timing VVT-i) connected to a planetary gear-box with two electric motors with permanent magnets. Other elements of the stand are two electric motors connected to the drive system to simulate the load, high-voltage battery and control panel. The test stand is used to determine the variable driving modes of hybrid drivetrain, it allows to simulate the loads of the drive and energy recovery, i.e. when driving uphill or in deceleration phases. Hybrid stand is equipped with an OBD-system that allows to check diagnostic parameters of drivetrain. It can be used for testing of fast-varying indicator pressure under steady and transient state.

KEYWORDS

- hybrid drive
- driving modes
- planetary gear-box
- indicating studies

Injector and pump test bench

– Autoelektronika Kędzia

SETTINGS:

- electric motor speed: $100 \div 2000$ rpm regulation: per 1 rpm
- adjustable fuel temperature: $20 \div 60^\circ\text{C}$ regulation: per 5°C
- revolution speed: $10 \div 9000$ rpm, per 5 rpm
- measuring range and accuracy:
- revolution speed: $50 \div 4000$ rpm $d = 1\% + 1$ rpm
- fuel pressure: $0 \div 0,2$ MPa ($0 \div 20$ bar) $d = 1\% + 0,01$ MPa
- fuel temperature: $0 \div 100^\circ\text{C}$ $d = 2\%$
- revolution count: $1 \div 10000 \pm 1$

APPLICATION:

Injector and pump test bench was developed for testing injection systems like Common Rail and systems which use BOSCH VE injection pump. Mainly it is designed for testing injectors and pumps, but tests of other system components are also available. A modular construction allows mounting of different types of components such as: injectors, pumps, regulation valves, pressure sensors, measuring burets for fuel dose and overflow. Test bench makes it possible to connect additional testers, which the test stand consists of and provides safe and complex tests of injection system components.

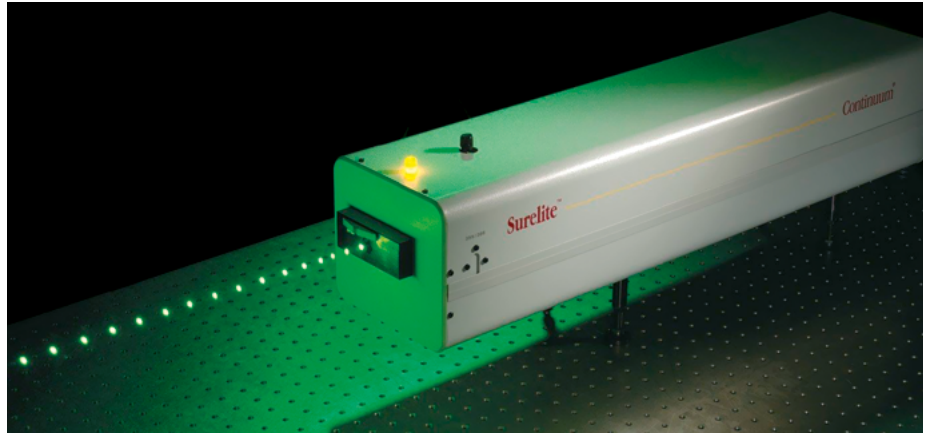


KEYWORDS

- injector flow characteristic
- common rail system
- direct injection

Laser Continuum

Surelite II-1



TECHNICAL SPECIFICATIONS:

Continuum Surelite II is a neodymium YAG laser generating a pulse light beam (frequency up to 10 Hz) with wavelength of 1064, 532, 355 and 266 nm (due to the wavelength divider). The energy of single impulse for the mentioned wavelengths equals accordingly: 650 mJ, 300 mJ, 160 mJ, 80 mJ.

KEYWORDS

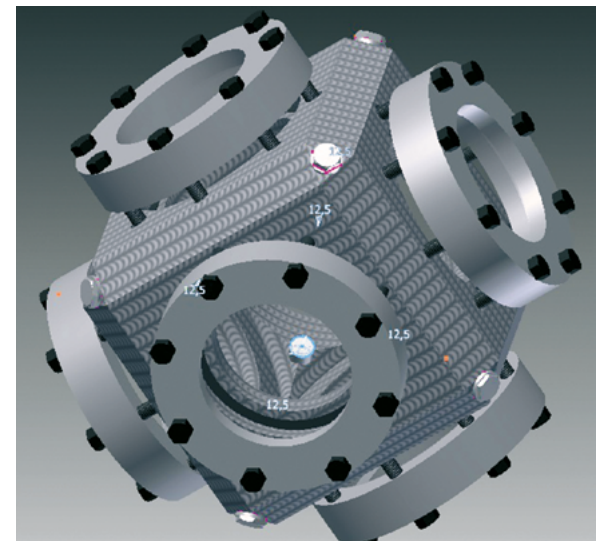
- laser
- Nd: YAG

APPLICATION:

- additional light source for recording of observations of the high-frequency processes like fuel injection or combustion
- proper setup configuration provides a distinction between gaseous and liquid phase of the fuel spray
- The velocity vectors distribution can be determined for the mediums with appropriate properties

Constant Volume Chamber

Constant Volume Chamber is a high pressure vessel to carry out an injection process in the chamber with charge under high pressure, as in the cylinder of piston engine. The injection process is executed due to the fuel supply system consisting of injector and the system to generate high pressure. High-speed camera is used to in-chamber view registration, which takes place through the optically accessible windows built in the walls of the vessel. The integrated light source can be used as well as laser light. The chamber construction provides the use of an external system to heat-up the charge. The maximal values of charge pressure and temperature equal 10 MPa and 600 K, accordingly. Fuel supply system, camera and the valves steering the charge movement are synchronized with computer software. Bottom lid with adjustable clamp enables investigation of different piston bowls shapes.



KEYWORDS

- research on injection
- fuel spray penetration and atomisation

Equipment for three-dimensional scanning

– 3D scanners:

ScanBright Professional, MicroScribe 3D,
PICZA LPX-600



SCANBRIGHT PROFESSIONAL
Smarttech – structural light 3D
scanner

measurement resolution:

- 0,05 mm

measurement volume
of single scan:

- 450 x 450 x 120 mm

accuracy:

- 30 μ m

APPLICATION:

Precise 3D structural white
light scanner fully compatible



MICROSCRIBE 3D
Immersion – contact sensor
3D scanner

measurement accuracy:

- 0,3 mm

range of measurement:

- sphere 1,2 m

APPLICATION:

Manual 3D digitizer built as a
measuring arm with 6 degrees



PICZA LPX-600 Roland
– laser 3D scanner

measurement resolution:

- 0,2 mm

volume of measurement:

- height 406 mm
- diameter 254 mm

APPLICATION:

3D Scanner LPX-600 is a laser
scanner for scanning objects

with the Geomagic Studio software, enables the entire process of reconstruction of geometry from data acquisition (3D scanning), to create a full digital 3D model of the object being measured. Created 3D model is described in a set of parametric NURBS surfaces, which are data format compatible to all CAD programs. The use of automatic merging (with markers), the single directional measurements and the ability to use automatic rotary table allow for easy measurement of technical and biomedical objects. The preferred size of the object being scanned is between 10 cm up to 2 m.

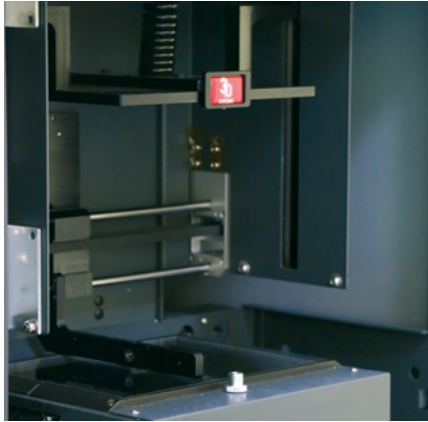
of freedom equipped with a contact sensor with a set of replaceable measuring heads. A characteristic feature of the device is the ability to transfer the measured data (e.g. the selected measuring points or entire contours of physical objects) directly to CAD systems and applications based on 3D models. The device is fully compatible with programs such as: Maya, 3ds max, LightWave 3D, RhinoCeros, AutoCAD, Inventor, etc.

in two different techniques: planar and rotational. These techniques optimally adjust the speed and quality of the scan depending on the shape of the scanned object. The data obtained from a scanner measurement are processed in integrated specialized reverse engineering software (Dr. PICZA3 and Pixform Pro) for design and modeling geometry of the scanned objects based on the points cloud.

KEYWORDS

- reverse engineering
- 3D scanning
- 3D digitalization
- three-dimensional measurements

Equipment for three-dimensional printing: V-Flash, Solido SD300, BFB 3D Touch



V-FLASH 3D
3D Printer using
SLA method

SLA (stereolithography)
working area:
• 228x171x203 mm
resolution (x,y):
• 768x1024 DPI
minimum layer:
• 0.102 mm
material:
• photopolymer resin



SOLIDO SD300
Solido 3D printer
using LOM method

PSL/LOM:
• laminating sheets of plastic
working area:
• 160x210x135 mm
resolution (z):
• 0.168 mm
minimum layer:
• 1 mm
material:
• PVC



BFB 3D TOUCH
Bits from Bytes 3D printer
using FDM method

FDM (fused deposition
modelling)
working area:
• 230 x 275 x 210 mm
precision:
• 0.2 mm
material:
• ABS, PLA (polylactide)

APPLICATION:

The device for rapid prototyping by means of SLA technology (stereolithography). By curing successive layers of epoxy resin with ultraviolet light plastic parts are formed with a smooth surface and faithfully reproduced detail.

KEYWORDS

- 3D printer
- sterolithography
- rapid prototyping

APPLICATION:

The printer creates strong and flexible options for combining sheets of plastic laminate PVC - SolidVC®. The accuracy and durability of products made using the printer Solido makes them suitable for each stage in the design cycle, the verification for testing functionality. Models after printing are suitable for machining, drilling and are low cost. The printer is dedicated to applications such as industrial production, medicine and dentistry, education, automation products, consumer product design and engineering.

KEYWORDS

- 3D printer
- laminated object manufacturing
- LOM
- rapid prototyping

APPLICATION:

The printed model is produced layer by layer by applying heat to the melting point of the material (ABS PLA). The head controls the flow of material and is moved automatically according to the instructions in the CAD program. The widespread availability of the material makes it one of the cheapest methods of rapid prototyping. The strength properties of the materials used allow the creation of requested parts.

KEYWORDS

- 3D printer
- fused deposition modeling
- FDM
- rapid prototyping

Laboratory of Integrated Diagnostic Systems

VIBROACOUSTIC MEASUREMENTS:

Measuring equipment:

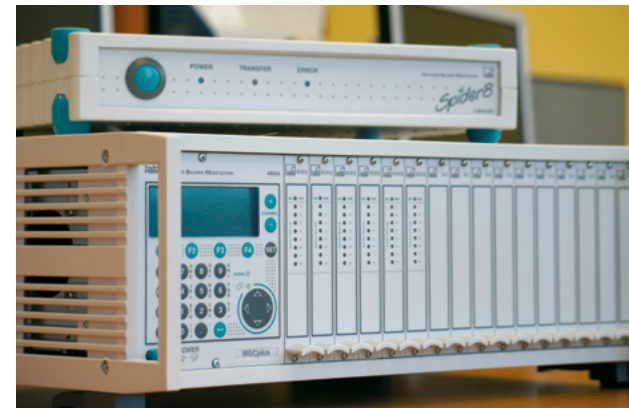
Brüel & Kjær human vibration analyzer Type 4447

This mobile measurer and analyzer is tailored for measurements in places of work and means of transport according to directive EU 2002/44/EC. Measurements of general and local vibration are carried out according to ISO 8041:2005 standard. This device performs simultaneous measurement and analysis of vibrations affecting human body in three directions with additional reading of reference signal. Analyzer Type 4447 can also work in dosimeter mode, which means it can be used to control exposure of worker-operator to vibration disease.

Multi-channel recording and analysis systems for vibroacoustic signals based on measuring platform Brüel & Kjær PULSE®

- 17-channel measurement case Type 3560-C,
- 12-channel measurement modular case Type 3053-B-12/0,
- 6-channel measurement modular case Type 3050-A-6/0.

The systems above are used for acquisition of high-frequency input, which can be used separately as independent measuring equipment or as a part of diffused measuring devices configuration. All the systems are characterized by high durability of construction dedicated to operate in conditions of working machines and vehicles. Modern technology of signal processor make it possible to achieve measurement dynamics exceeding 160 dB, which means the ability of simultaneous recording of seismic vibration and noise emitted by jet airplane during take-off without overdriving. The PULSE® environment of analyzer enables complex analysis of acoustic climate and mechanical vibration. The presented equipment may be used for vibroacoustic-based diagnostics and vibroacoustic activity assessment of machines and vehicles during normal operation.



Brüel & Kjær integrating sound level meter Type Mediator 2238

The device is applied mainly for measurements of magnitudes describing employee noise hazard in work place (according to standards currently in force) and monitoring of environmental and industrial noise.

Brüel & Kjær manual sound analyzer Type 2250A

Manual sound analyzer Type 2250A is used for point measurement and noise analysis. This device enables real-time analysis in time domain (levels of time doses) and frequency domain (1/1 octave spectrum and 1/3 octave spectrum) by defining characteristics of acoustic climate according to respective regulations, standards and directives. Furthermore, the analyzer performs measurement of duration of room reverberation.

Brüel & Kjær manual vibration and noise analyzer Type 2250HV

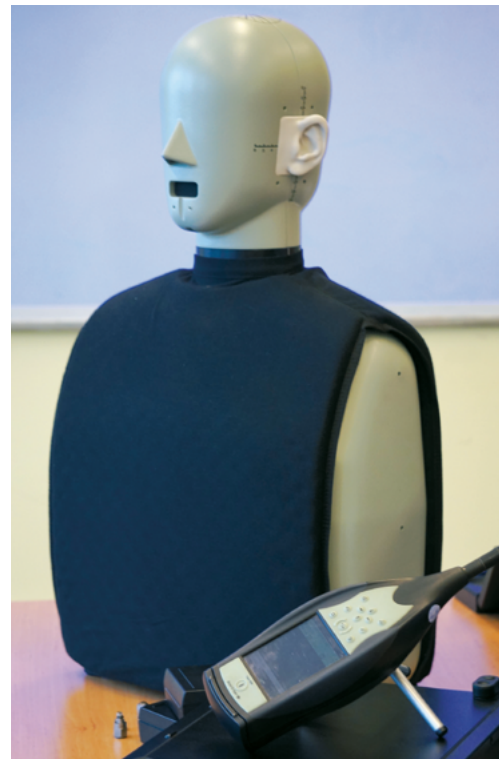
Apart from all characteristics of Type 2250A, analyzer Type 2250HV additionally measures and analyzes vibrations. Analysis of vibration and noise signals can be performed in time or frequency domain, with both relative constant (CPB) and absolute constant band width of analysis (FFT).

Brüel & Kjær order tracking analyzer Type 2145

This device carries out basic vibration and noise analyses in real time, it also identifies and localizes primary and secondary sound origins and measures their power. The main application of this analyzer is in factory rooms and offices. It can be also used for spatial mapping of sound distribution of single machines and devices for the requirements of quality control of final product or optimization of device at the stage of prototype testing.

a set of Brüel & Kjær binaural microphones Type 4101-A

This device is a supplement of measuring equipment for assessment of acoustic climate and noise quality analysis in vehicles. These microphones when placed in ear canals enable recording of noise received by the vehicle operator or passenger. Measurements performed with this device take into consideration individual attributes of particular user.



STRAIN GAUGE MEASUREMENTS:

Measuring equipment:

HBM set (Hottinger Baldwin Messetechnik GmbH)

The set enables multi-channel acquisition of data regarding construction point stress and displacement. Stationary version of the system allows to perform strength and fatigue tests and verification of design and manufacturing of particular constructions in chosen nodes based on stress distribution. Furthermore, one can validate construction loads in chosen acceptance tests. Mobile version of measuring amplifier HBM Spider8 is adapted to examinations demanding motion or maintaining mobility of elements of the set. Applying this equipment enables measurements of stress and displacement of construction in conditions of regular operation (e.g. vehicles in movement). Strain gauges included in the set are highly sensitive, accurate, rugged and very little.

THERMOVISION EXAMINAIONS:

Measuring equipment:

Advanced thermovision camera FLIR E60

This camera is used for contactless, non-invasive analyses and assessment of friction pairs in real and test-bench conditions. It allows to record thermovision signals while assessing the course of work processes with regard to heat energy flow between two examined elements. The device helps to visualize the temperature distribution on the whole surface of tested elements of mechanical or electrical appliances. The temperature data constitute invaluable source of supplementing information in vibration examinations. The combination of thermovision and vibroacoustic signals recorded simultaneously enables complex assessment of tribo-vibroacoustic processes.

Laboratory for testing refrigeration bodies

APPLICATION:

- determination of global heat-transfer coefficient for refrigeration and isothermal bodies; the coefficient constitutes the main criterion for classifying food transport in accordance with the international ATP agreement; the laboratory operates within the structure of UN stations monitored by the WP 11 international commission (laboratory accredited in PCA)
- certification of refrigeration and isothermal bodies for food transport, the activity realized on the basis of the decision of the Ministry of Transport and Maritime Economy
- cooperation with the largest Polish producers regarding the improvement of refrigeration and isothermal bodies, expert assistance concerning design with particular emphasis on the elimination of thermal bridges (assessment of thermal insulation properties of construction materials – intermediary wall method, thermal imaging diagnostics)
- testing cooling capacity of refrigeration units used in automotive bodies; promoting standards of selection for food transport appliances - training courses for transport and service companies.
- modeling heat exchange in refrigeration bodies in order to identify the causes of damage to food during shipment
- mobile test bench for testing the influence of construction parameters of both the body and the operating conditions on the temperature distribution of the transported load (i.e. “temperature mapping”); the research facility is a Fiat Doblo van with an isothermal body equipped with a refrigeration unit and a set of sensors for measuring temperature and humidity



KEYWORDS

- food transport
- refrigeration body
- load temperature map ping
- modeling heat-exchange

Refrigeration basics

laboratory



APPLICATION :

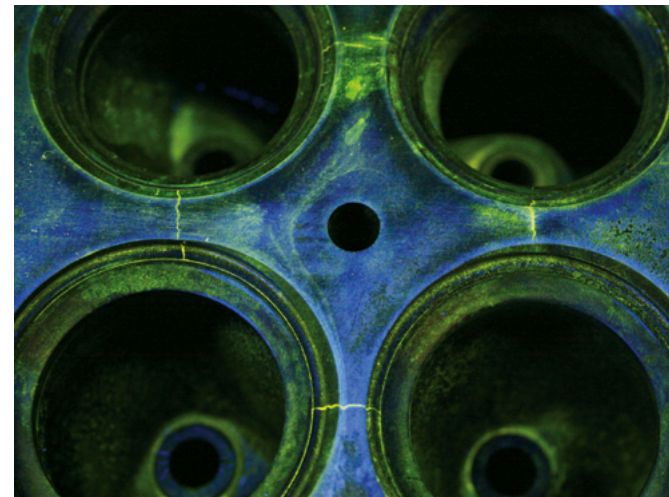
- designing special-purpose refrigeration installations; possibility of implementing calculations – with the use of our own software – concerning thermal balance and the selection of basic elements of the refrigeration chamber, designing compressed air refrigerated dryers with the exchanger of the “pipe-in-pipe” type, the cooling rate for fruit and vegetables.
- modeling the work of basic elements of a refrigeration installation, a comparative analysis of various approaches concerning adjustment (e.g. condensing pressure stabilization, powering evaporators, stabilizing temperature of the refrigerated environment); the possibility of providing training to refrigeration businesses
- modeling the work of selected refrigeration devices (e.g. a heat pump of the water-to-water type, a compressed air refrigeration dryer); the opportunity to assess the parameters of operation of a system for different operating conditions; the support of design process in the scope of verifying structural assumptions
- model testing concerning the wear process of the friction nodes in refrigeration compressors in the conditions of oil-refrigerant mixture lubrication; two test-benches (the block-on-ring node type tribometer and an adapted real compressor) enable simulating various unfavorable operating conditions of refrigeration equipment (refrigerant or oil leakage, dilution of oil with refrigerant); the support of selecting oils for new, ecological refrigerants

KEYWORDS

- refrigeration systems design
- thermal balance of the refrigeration chamber
- refrigeration automation
- operation of refrigeration systems

Non-destructive testing laboratory

The non-destructive testing laboratory specializes not only in standardized tests, but also – and above all – in innovative non-standardized testing by means of non-destructive methods which can be applied in production, repair and regenerating plants and the ones exploiting working machines and vehicles. The following methods are used in the research work: ultrasonic, magnetic particle, penetration, as well as a visual one. The scope of research includes both qualitative and quantitative assessment of welded joints of sheets and adhesive joints including glue-joints and the joints of the coating-substrate type, as well as measuring the thickness of elements which are single-side bonded (tanks, pipelines, boilers). Research conducted on the basis of original methods allows for, inter alia, non-destructive location of the adhesive in the weld and the assessment of its durability in real objects as well. Modern, fully digital ultrasonic equipment, which makes use of ultrasonic heads of the frequency ranging from 0.5 to 20 MHz enables testing elements of minimal thickness (even below 1 mm). The possessed equipment and staff expertise allow for precise non-destructive measurements of the thickness of paint coatings with a graphic representation of the pattern. The scope of research abilities includes planning the experiment, conducting pilot as well as principal research, and the implementation of ready-made technologies.



KEYWORDS

- non-destructive testing
- ultrasonic method
- adhesive joints
- adhesive and welded joints

Durability basics laboratory



The MATERIALS SCIENCE and SURFACE LAYER laboratory enables the study of layers created by means of innovative technologies of thermal and thermo-chemical processing with the use of, inter alia, laser techniques. The modern Seco/Warwick VTR retort furnace, which is at our disposal, allows for the formation of surface layers by ZeroFlow® - a new, more economical method of gas nitriding. We also own a CARL ZEISS JENA stationary profiler, as well as the mobile TAYLOR HOBSON SURTRONIC 3+ profiler. We offer a set of apparatus to test the BARKHAUSEN effect (Stresstech SCAN 500 analyzer, Mag-Lab MEB-2c meter), which enables studying magnetic properties of the surface layer, and indirectly, internal stress. We also have an AUGER electron spectrometer, and our own optical microscopes allow for macro- and microscopic analyses including quantitative metallography. In the TRIBOMETRY laboratory, research is conducted on tribological processes for various elements of machinery, which enables an analysis of their course and evaluation of the results. We also have a test bench for determining surface fatigue endurance of the elements of rolling bearings (STBL-02), designed in collaboration with Brno VUT. The laboratory also allows us to perform accelerated wear tests of slide bearings at the ZPG-IV test bench, where we can conduct a resistance assessment of oil film formation in the friction node. The laboratory is also equipped with benches which enable testing of tribological properties of lubricants and an analysis of wear processes. For this kind of testing, we use modernized AMSLER A135 and T-05 test benches.

KEYWORDS

- tribology
- ZeroFlow regulated nitriding
- surface geometric structure
- Barkhausen effect
- AUGER electron spectrometer

Road Vehicles

Dynamics and Control Laboratory

Road vehicle dynamics measurement system in road and field tests

COMPONENTS:

a data acquisition system, Datron software and sensors (non-contact, 2-axis vehicle speed sensors, wheel vector transducer for measurement of all wheel positions and orientations) and additional micromechanical acceleration sensors, wheel speed encoders, linear displacement sensors (wire and laser sensors) and pressure sensors, a system for strain measurements - bridges, amplifiers and strain gauges.

APPLICATION:

The basic use of the measurement system is a comprehensive measurement of the variables describing the road vehicle dynamics, the following types of measurements are possible:

- longitudinal vehicle dynamics – velocity, acceleration and the traveled distance, which enables testing automobile's performance concerning the intensity of acceleration and braking efficiency – deceleration value and braking distance
- lateral vehicle dynamics – the measurement of yaw rate, lateral velocity, sideslip angles and kinematic inputs on the steering wheel, which enables testing the handling characteristics and evaluation of automobile motion stability
- vertical vehicle dynamics – measurements of wheel and body vertical accelerations and suspension deflections, which enables the evaluation of the comfort and safety performance. It is also possible to perform measurements of additional variables such as



KEYWORDS

- road vehicle dynamics
- road and field testing
- braking distance
- speed measurement
- handling characteristics



the level of stress in selected structural points, inputs on the vehicle foot and hand controls or variables describing drivetrain dynamics (e.g. the measurement of torque of the angular velocity of drivetrain components enabling the evaluation of power).

Prototyping platform for electronic control systems in vehicles and machines

COMPONENTS :

Hardware systems: stationary DS1103 and mobile DS1005 with expansion cards, including HIL2211, ControlDesk and Matlab/Simulink software

APPLICATION :

Modeling, rapid prototyping and real-time testing of control algorithms in motor vehicles and machines applied in the implemented projects of semi-active suspension controllers, dynamic dynamometer for powertrain with automatic gearbox testing, developing real-time simulation environment with hardware feedback (HILS - Hardware in the Loop Simulation) for testing ABS and in the developing of advanced measurement and control systems.

TECHNOLOGY DEMONSTRATOR TEST STATIONS :

Dynamic dynamometer for powertrain with automatic gearbox testing – a specialized educational-research bench to conduct simulations reproducing the actual driving cycles and simulations of prognostic dynamics of the passenger car drivetrain with automatic transmission. The test bench control system has been developed in Matlab/Simulink and dSpace systems. A physical model of a quarter-car semi-active suspension – a specialized educational-research bench to perform tests concerning an analysis of vertical dynamics of suspension and prototyping and testing damping control algorithms in semi-active and adaptive suspension. The test bench control system has been developed in Matlab/Simulink and dSpace systems.

KEYWORDS

- road vehicle dynamics
- control systems
- semi-active suspension
- ABS
- automatic transmission
- dynamic dynamometer for powertrain testing

Contact

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6 **Test facility for testing thermo-mechanical properties of materials**

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12 **List of PEMS type measuring equipment**

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14 **Dynamic engine dynamometer
AVLDyno Road 120 kW**

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15 **DYNomite Motorcycle Chassis Dynamometer**

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16 **AutoSimAS1200-6 driving simulator**

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17 **CKASMotionCor5 flight motion simulator**

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18 **Engine dynamometer AVL 5804**

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19 **Rapid Compression Machine (RCM)**

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20 **High Speed camera HSS 5**

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21 **Mobile engine dynamometer**

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22 **Mobile stand of hybrid powertrain**

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- 23** **Injector and pump test bench**
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- 24** **Laser Continuum Surelite II-1**
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- 25** **Constant Volume Chamber**
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- 26** **Equipment for three-dimensional scanning**
– 3D scanners: ScanBright Professional,
MicroScribe 3D, PICZA LPX-600
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- 28** **Equipment for three-dimensional printing: V-Flash,**
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- 30** **Laboratory of Integrated Diagnostic Systems**

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