OZM RESEARCH

Testing Instruments

for Hazardous Flammable Materials

PRODUCT CATALOGUE

2019/2020

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FLAMMABLE MATERIALS AND SAFETY ENGINEERING

TESTING EXPLOSIBILITY OF INDUSTRIAL FLAMMABLE MATERIALS

Unstable or sensitive explosive materials are not the only materials producing explosion hazard in process industries. Flammable materials in a form of gas, vapors, aerosols, liquids or dusts could under specific conditions create explosive atmospheres capable of causing devastating effects after accidental ignition.

OZM Research produces instruments applied for characterization of physical properties and explosion parameters of flammable and explosible materials used in process industries. These tests are very important for safe production, handling, transportation and storage of industrial materials together with implementing measures preventing and mitigating consequences of industrial explosions. These instruments are designed in accordance with the appropriate standards of testing.

INSTRUMENTS FOR FLAMMABLE MATERIALS AND SAFETY ENGINEERING

● Applicable

○ Limited usage

Test Method	OZM Instrument	STATE OF THE SUBSTANCE				APPLICATIONS		
		Liquid	Solid, Dust	Gas	Hybrid Mixtures	GHS and CLP (using and storage)	ATEX Directives	Transport (ADR, RID, ADN)
High Pressure Autoclave	**HPA 1500**	●	●			●		●
Time Pressure Test	**TPT Series**	●	●			●		●
Autoignition Temperature	**AIT 551**	●				●	●	
Dust Layer Ignition Temperature	**LIT 400**		●			●	●	
Minimum Ignition Temperature	**MIT 1000**		●			●	●	
Relative Self-Ignition Temperature	**RSIT 400**	○ *)	●			●		
Sustained Combustibility Test	**SCT 100**	●						●
Self Heating Substances Test	**SHT 150**	○ *)	●			●		●
Thermal Stability Determination at 75 °C	**TST 75**	●	●			●		●
Concentration limits of flammability	**FRTA I**	●						
Minimum ignition energy of dust dispersions	**MIE-D 1.2**		●				●	
Maximum explosion pressure	**CA 20L, CA 1M3**	●	●	●	●		●	
Maximum rate of pressure rise	**CA 20L, CA 1M3**	●	●	●	●		●	
Flammability limits measurement	**CA 20L, CA 1M3**	●	●	●	●	●	●	
Limiting oxygen concentration measurement	**CA 20L, CA 1M3**	●	●	●	●		●	
Equipment's compliance for use in explosive atmospheres	**ATEX Chambers**	●		●			●	

*) High viscosity

Typical testing programs for hazardous materials safety

Protection of people working with hazardous substances and products is covered by two major regulations in the European Union. The first one is the EC regulation No. 1272/2008 "Classification, Labeling and Packaging", incorporating the classification criteria and labeling rules agreed at the United Nations level, in the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). The second one is the European Union regulation "Registration, Evaluation, Authorization and Restriction of Chemicals" (REACH). REACH addresses the production and use of chemical substances, and their potential impacts on both human health and the environment. Both regulations require to characterize hazardous properties of materials. Autoignition temperature of liquid chemicals can be determined by the **AIT 551**. The self-heating test (**SHT 150**) characterizes ability of substances to self-oxidative heating and decomposition. The **RSIT 400** (Relative Self-Ignition Temperature for Solids) instrument is used to measure self-ignition temperature of solid chemicals. The **FRTA I** is designed to determine the lower and upper concentration limits (LFL, UFL) of flammability of chemicals having sufficient vapor pressure to form flammable mixtures in the air at the barometric pressure at the test temperature. Flammability limits of gases, vapors, dusts and hybrid mixtures can also be determined using explosion chambers of various volumes, such as 20 L (**CA 20L**) and 1 m^3 (**CA 1M3**).

Protection of workers against explosion as one of the major industrial hazards is covered by the Directive 1999/92/EC of the European Parliament and of the Council on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres, known as ATEX 153 directive. Hazardous properties of materials presented at the workplace need to be properly characterized according to that directive. For the flammable gases and vapors, ignitability and flammability limits (**FRTA I**, **CA 20L**, **CA 1M3**) should be determined. Measurement of autoignition temperature by **AIT 551** is the next test. Ignitability can be characterized by the minimum ignition energy measurement in **MIE-D 1.2** together with flammability limits in **CA 20L** and **CA 1M3** explosion chambers. Maximum explosion pressure and maximum rate of pressure rise together with the limiting oxygen concentration can also be measured in **CA 20L** or **CA 1M3** explosion chambers. Risk analysis at workplace also requires knowledge of a minimum temperature of a hot surface which may lead to a dust cloud ignition (**MIT 1000**). Knowing the minimum temperature of ignition of a dust layer (**LIT 400**) provides another important information for the prevention of fires in the process industries.

Directive 2014/34/EU of the European Parliament and of the Council (ATEX 112) sets requirements on equipment and protective systems intended for use in potentially explosive atmospheres. Such equipment must be properly tested in real explosive atmospheres, for which the explosion chambers **CA ATEX** of various sizes are specifically designed. The appropriate testing methodologies are specified in the EN 60079 standard series.

Storage and transport classification

International treaties for transport of dangerous goods reflected in the UN Recommendations for the Transport of Dangerous Goods ("UN Orange Book") define tests and their criteria for assuring minimum standards for safe storage, handling and shipping of dangerous materials and articles. They also classify the substances and articles into hazard classes with different safety restrictions, which are directly reflected in higher of lower costs connected with their storage and transport.

The prescribed classification procedures cover thermal stability (**TST 75**), sensitivity to impact (**BFH Series**), friction (**FSKM 10**), shock wave (various cap sensitivity and gap tests), confined heating (time/pressure test **TPT SERIES**), sustainable combustion (**SCT 100**) and the specific energy of a substance (**HPA 1500**).

Research and development

The safest and easiest way of examination of detonation and deflagration processes is the use of optical methods. Precise measurement of detonation or burning front velocity in exploding gases or dust clouds can be performed using advanced optical instrument **OPTIMEX 64** which allows to use up to 64 fiber optic probes to acquire light intensity signals with extreme time resolution. **VeloreX PDV** is a laser interferometric system capable to remotely track positions or speeds of objects such as detonation chamber walls, blast loaded buildings or just vibrating parts of machinery.

Explosion or combustion heat of hazardous materials could be measured in **BCA 500**, which is an instrument designed specifically for calorimetry of energetic materials.

MIE-D 1.2

MEASUREMENT OF MINIMUM IGNITION ENERGY OF DUST DISPERSIONS

The MIE-D 1.2™ is an apparatus for measurement of minimum ignition energy of dust dispersions according to EN 13821.

The minimum ignition energy (MIE) of a combustible substance is the lowest value of the electrical energy stored in a capacitor, which upon discharge just suffices to ignite the most readily ignitable fuel/air mixture of the tested material (fuel) at the atmospheric pressure and room temperature.

APPLICATIONS

The minimum ignition energy of dust dispersions is one of the key parameters for an assessment of the hazard situation in process plants. The MIE test determines the amount of energy required for an electric spark to cause ignition of dispersed dust sample. This testing method is an essential part of a standard set of tests used by certified bodies, Universities and other research organizations to characterize the dust explosibility.

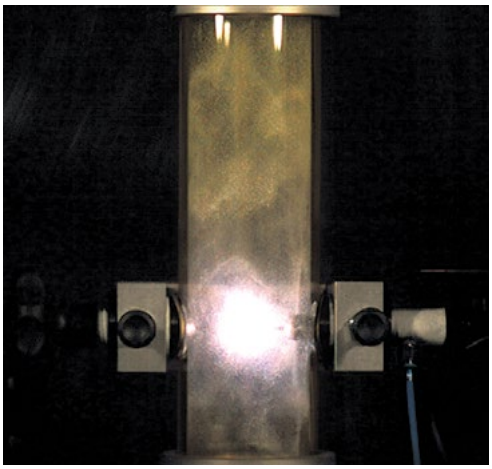
ADVANTAGES & FEATURES

- Standard measurement on seven pre-set energy levels up to 1 J, but optionally also on any user specified levels in the range of 1 mJ to 10 J with 1 mJ step
- Optional measurement of energy balance throughout the spark generating circuit and spark gap
- Three modes of spark triggering: high-voltage switch, moving electrode or triggering by dust cloud itself
- Automatic operation – pneumatically driven opening of the tube and withdrawal of the electrodes
- Automatically controlled and pneumatically operated instrument
- User interface with TFT panel
- Resistant stainless-steel case
- Optionally, the instrument can be equipped for Lower Explosive Concentration (LEC) measurement
- Optionally, stainless-steel version for explosion pressure determination suitable for non-standard measurements with small sample amounts can be delivered

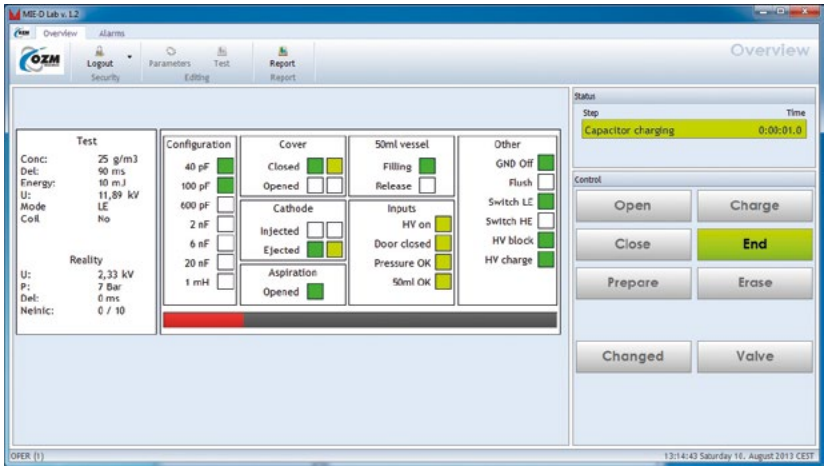
MIE-D experiment after ignition of a sample

COMPLIANCE

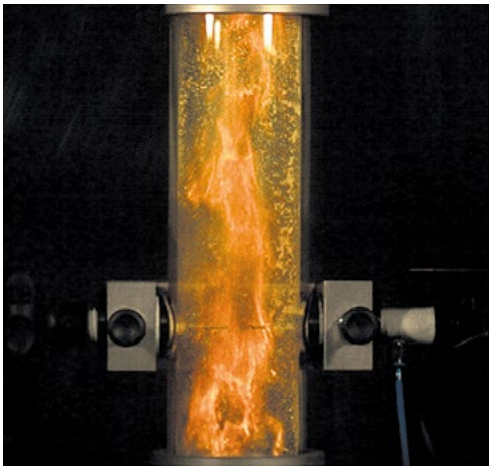
- **EN 13821**
- **ASTM E 2019**
- **IEC 61241-2-3** - replaced by ISO/IEC 80079-20-2:2016
- **ISO/IEC 80079-20-2**:2016



Spark ignition of dried milk



Screenshot of the control window



Burning of dried milk

CA 20L / CA 1M3

EXPLOSION CHAMBERS FOR GASES AND DUSTS

Explosion chambers are used for measurement of explosion characteristics of flammable dusts, gases, vapors and hybrid mixtures, such as maximum explosion pressure, maximum rate of pressure rise, lower and upper explosibility limits and limiting oxygen concentration. There are two standardized sizes of the explosion chambers for testing dust explosions – 20 liters (our CA 20L™) and 1 m³ (our CA 1M3™). The explosion chamber for gases and vapors has to be larger than 5 liters, so our CA 20L is recommended for this purpose.

APPLICATIONS

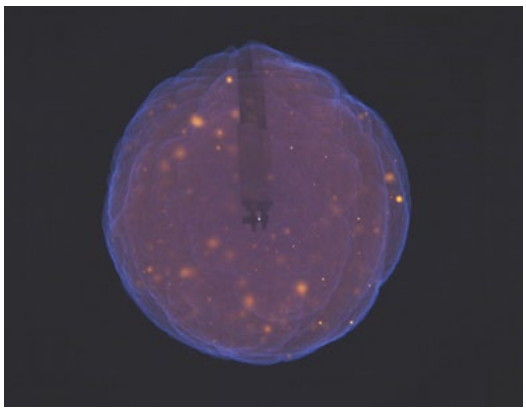
Testing methods using the explosion chambers are an essential part of a standard set of tests used by certified bodies, universities and other research organizations to characterize the hazard properties of dusts, gases and vapors. The information received from these tests is critical for design of mitigating and protective measures, such as explosion venting devices, automatic suppression or partial inertization.

ADVANTAGES & FEATURES

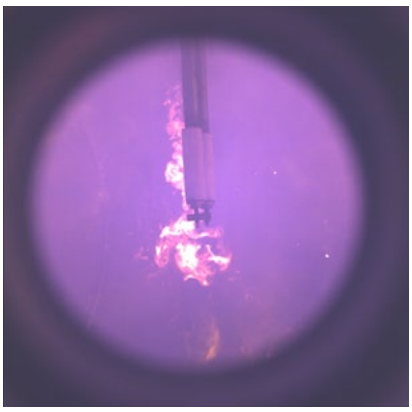
- Manual or fully automatic operation
- Robust design with working pressure up to 30 bar, test proofed up to 40 bar
- Three types of ignition systems: chemical igniter, adjustable capacitive spark up to 10 J and adjustable permanent spark
- Automatic procedure for dosage of gas samples
- Large opening for easy cleaning of the chambers
- K-type thermocouple embedded in the chamber
- Two dispersion systems embedded in 1 m³ chamber
- Optical probe for flame light intensity measurement
- Optionally equipped for operation with elevated initial temperatures up to 200 °C
- Instrumentation suitable for measurements of hybrid mixture explosions

COMPLIANCE

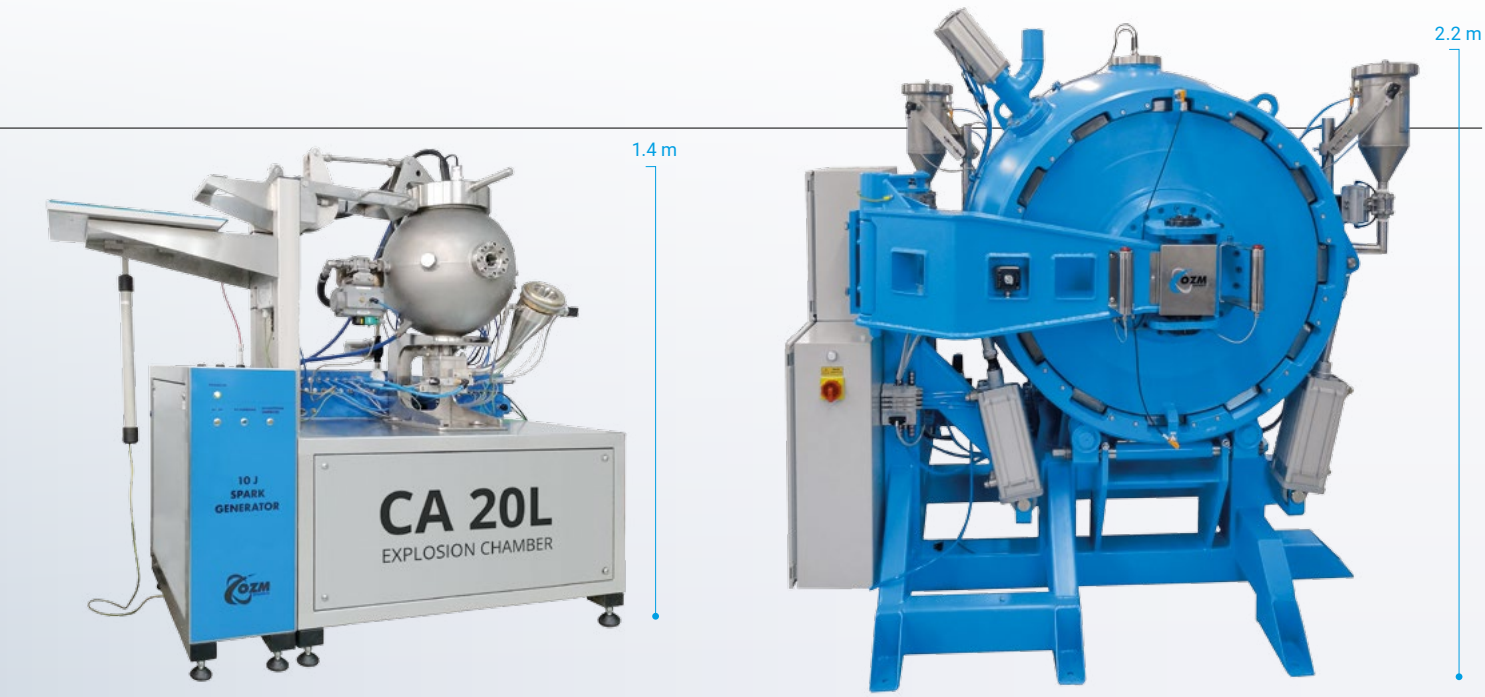
- **EN 14034** (1-4)
- **VDI 2263**
- **ISO/IEC 80079-20-2**: Part 20-2
- **ASTM E1226**
- **ASTM E1515**
- **EN 15967**
- **EN 14756**
- **EN 1839**



Downward spreading of the flame for 9.5 % by vol. of methane in air

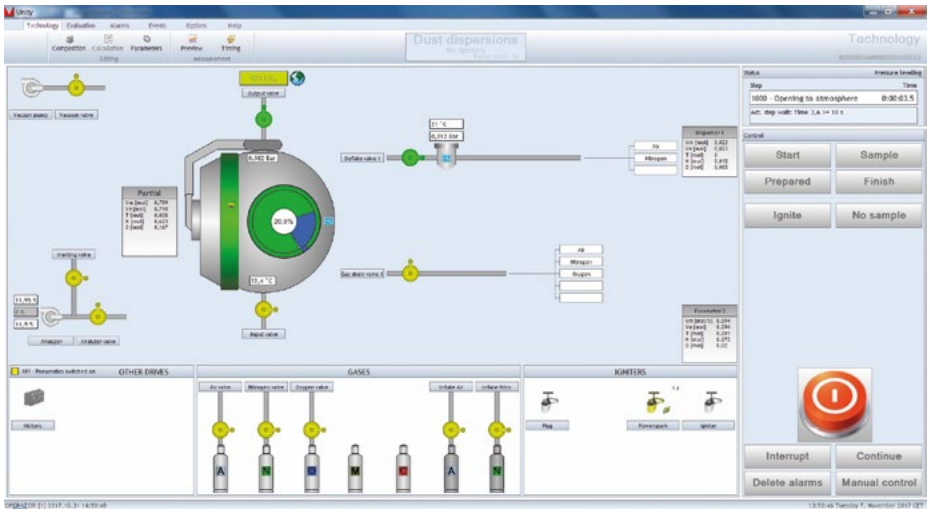


Afterburning of 9.5 % by vol. of methane in air

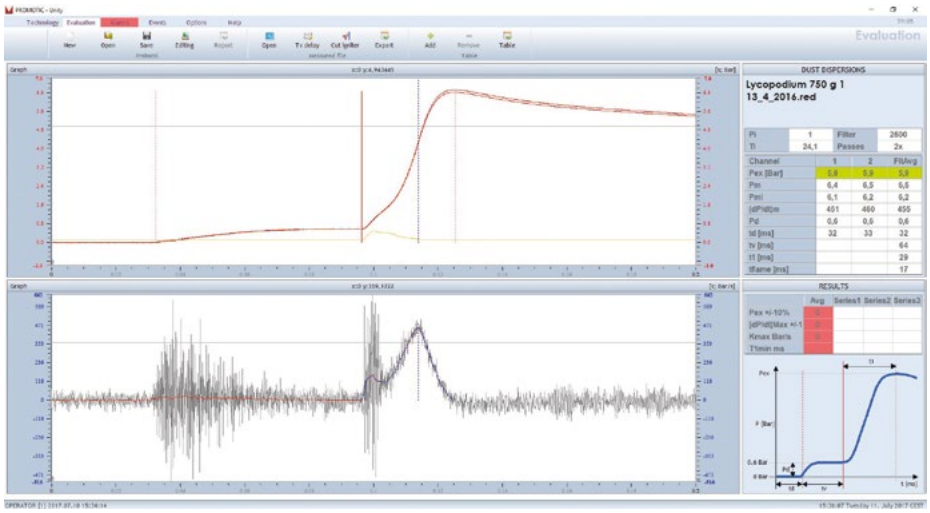


CA 20L explosion chamber

CA 1M3 explosion chamber



Technological window used for monitoring and/or control of test setup



Evaluation of measured pressure-time curve (upper window) and dp/dt-time plot (lower window)

AIT 551

AUTOIGNITION TEMPERATURE OF LIQUIDS APPARATUS

Autoignition temperature is the lowest temperature at atmospheric pressure at which a substance will burst into flame in the absence of an external source of ignition (spark or flame). The AIT 551™ (Autoignition Temperature Tester) is used for the determination of the autoignition temperature of liquid samples using visual observation and sample temperature measurement.

APPLICATIONS

The measurement of the autoignition temperature is an essential input for hazard 'analysis in industries and technologies employing flammable liquids. Liquid materials exposed to elevated temperatures may create flammable vapors which ignition may lead to an explosion. The **AIT 551** is a necessary tool for hazard analysis of new technologies, operational safety control, research and development. The results obtained are used for the classification of temperature class of liquid chemicals.

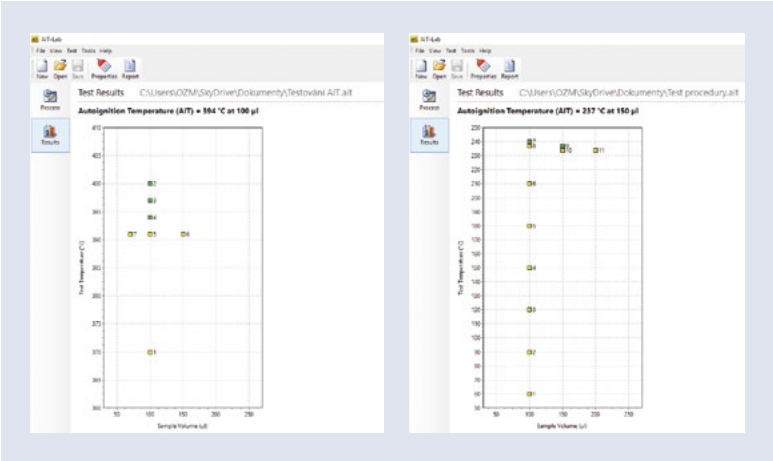
ADVANTAGES & FEATURES

- Freely mounted thermocouples allow for the use of several different types of flask
- Automatic detection of ignition of the sample in the flask
- Specially designed oven door for easy handling of the flask
- Corrosion resistant stainless steel case
- Testing temperature up to 850 °C
- Software evaluation of temperature records

COMPLIANCE

- **ASTM E659-78**: Standard Test Method for Autoignition Temperature of Liquid Chemicals
- **NFT 20-036** Chemical products for industrial use. Determination of the relative temperature of the spontaneous flammability of solids

AIT-Lab software – measurement of auto-ignition temperature



AIT-Lab software – results of measurements

MIT 1000

MINIMUM IGNITION TEMPERATURE TESTER

The MIT 1000™ (Minimum Ignition Temperature Tester) is used for determination of minimum temperature of a hot surface which leads to thermal degradation or ignition of dispersed dust particles.

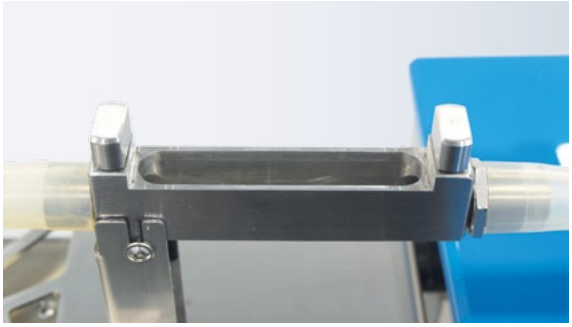
design by Jan ERMIS

APPLICATIONS

Knowledge of minimum temperature of a hot surface which will lead to a dust cloud ignition provides important information for risk analysis, safety planning and prevention of fires or explosions in industries where flammable dusts can be found together with sources of heat.

ADVANTAGES & FEATURES

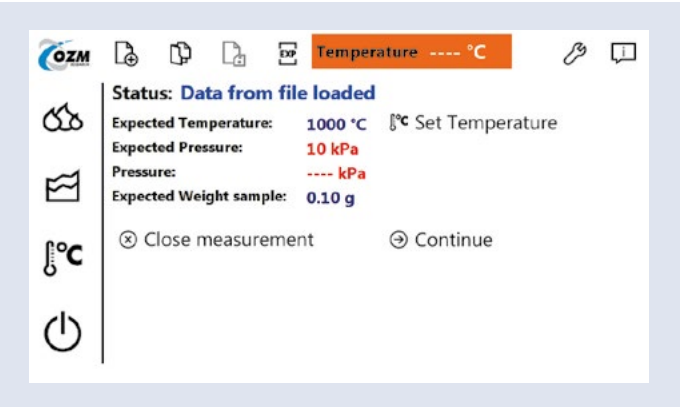
- Robust stainless-steel case
- Special dust sample container
- Automatic electronic system and control software
- Flexible mirror for identification of the ignition of dispersed dust
- Recording, archiving and data analysis on PC
- Automatic pressure dosing system



Special dust sample container

COMPLIANCE

- **EN 50281-2-1** Methods of determining minimum ignition temperature



MIT-Lab software

MIT device with remote controller and jet air

LIT 400

DUST LAYER IGNITION TEMPERATURE TESTER

The LIT 400™ (Dust Layer Ignition Temperature Tester) is used for determination of minimum temperature of a hot surface leading to thermal degradation or ignition of dust layers of a defined thickness.

design by Jan ERMIS

APPLICATIONS

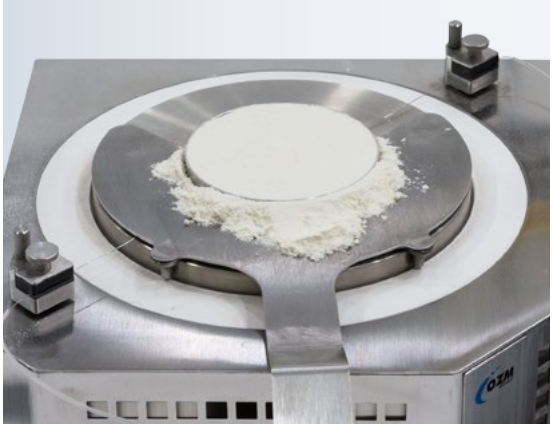
Spontaneous ignition of dust layers is a great risk in industries where flammable dust particles can get accumulated. Knowledge of minimum temperature of a hot surface which will lead to dust layer ignition provides important information for risk analysis, safety planning and prevention of fires or explosions in process industries.

ADVANTAGES & FEATURES

- Hot surface working temperature range up to 450 °C
- Stable temperature conditions ± 2 °C
- Hotplates designed with a non-corrosive abrasion-resistant surface or aluminum plate
- Four types of stainless steel rings as sample holders for the dust layers
- Stainless steel set for easy dosing and cleaning
- Recording, archiving and data analysis on PC
- Robust stainless steel case

COMPLIANCE

- **EN 50281-2-1** Methods of determining minimum ignition temperature
- **ASTM E2021** Hot-Surface Ignition Temperature of Dust Layers



Sample preparation of the measurement

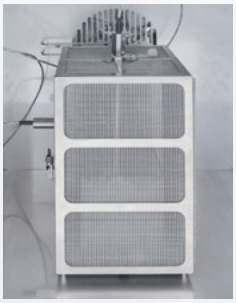
Measurement of temperature uniformity on the hotplate

Cleaning of the hotplate

SHT 150

SELF-HEATING SUBSTANCE APPARATUS

The SHT 150™ (Self Heating Substances Tester) is used for determination of a substance's self-heating characteristics. The SHT 150 analyses exothermal decomposition of a sample being directly exposed to hot air. Substances with self-heating potential can self-ignite even at moderate temperatures when stored in large amounts over long periods of time.



APPLICATIONS

The **SHT 150** is applied for the characterization of flammability of solid substances and/or mixtures, necessary for their transport classification according to the UN standards.

ADVANTAGES & FEATURES

- Reusable testing container
- Stand for mounting the thermocouple in a defined position in the container
- Accuracy of temperature: ±2 °C
- Different sample volumes: (typically 15.63 cm^3 and 1,000 cm^3)
- An observation port in the oven allows for optical control
- Software evaluation of temperature records

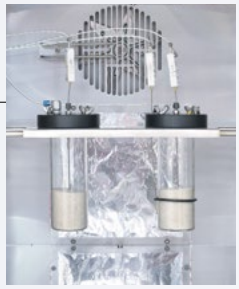
COMPLIANCE

- **UN Recommendation on the Transport of Dangerous Goods, Manual of Tests and Criteria**, [Test L.2]
- **European agreement concerning the international carriage of dangerous goods by inland waterways** (ADN) (2017)
- **Convention concerning International Carriage by Rail** (COTIF) **Regulations concerning the international carriage of dangerous goods by rail** (RID) (2017)

TST 75

THERMAL STABILITY TEST AT 75 °C

Thermal stability test using the TST 75™ apparatus characterizes response of energetic materials to thermal shock. This test detects exothermal decomposition of a sample heated in an oven at a constant temperature of 75 °C.



ADVANTAGES & FEATURES

- Stand for mounting the thermocouple in a defined position in the container
- An observation port in the oven allows for optical control
- Software evaluation of temperature records
- Robust stainless steel case

COMPLIANCE

- **UN Recommendation on the Transport of Dangerous Goods, Manual of Tests and Criteria**, [Test 3(c)]
- **EN 13631-2**

RSIT 400

NEW DESIGN

MEASUREMENT OF RELATIVE SELF-IGNITION TEMPERATURE FOR SOLIDS

The RSIT 400™ (Relative Self-ignition Temperature for Solids) device is used to measure self-ignition temperature of solid substances – the lowest possible ambient temperature at which a substance will spontaneously self-ignite.

design by Jan ERMIS

APPLICATIONS

Self-ignition temperature of a substance is a very important parameter for carrying risk analysis of handling, storing and transporting solid materials.

ADVANTAGES & FEATURES

- External stand for a simple sample application
- The possibility of forced ventilation
- Reusable testing container designed from resistant steel
- Safety features ensure a high level of safety in operation
- Software evaluation of temperature records
- Robust stainless steel case

COMPLIANCE

- Regulation **(EC) No 1272/2008** of the European Parliament and of the Council on classification, labeling and packaging of substance and mixtures
- **NFT 20-036** – Chemical products for industrial use. Determination of the relative temperature of the spontaneous flammability of solids

SCT 100

SUSTAINED COMBUSTIBILITY TESTER

The SCT 100™ (Sustained Combustibility Tester) determines the ability of a substance to sustain combustion after its ignition by approaching flame when preheated to a specified temperature.

APPLICATIONS

The **SCT 100** is used to test paints (including water-borne paints), varnishes, paint binders, solvents, adhesives, fuels, petroleum or related products for classification of their flammability.

ADVANTAGES & FEATURES

- Measuring range for the flammability of liquids: 25–75 °C
- Safe remotely controlled ignition and movement of the testing burner
- Robust stainless steel surface

COMPLIANCE

- **UN Recommendation on the Transport of Dangerous Goods, Manual of Tests and Criteria**, [Test L.2]

FRTA I

INSTRUMENT FOR DETERMINATION OF CONCENTRATION LIMITS OF FLAMMABILITY

The FRTA I™ (Instrument for Concentration Limits of Flammability Determination) is designed to determine both the Lower Flammability Limit (LFL) and the Upper Flammability Limit (UFL) of various flammable gases or volatile liquids. The FRTA I applies high voltage electrical ignition and visual observations of flame propagation.

APPLICATIONS

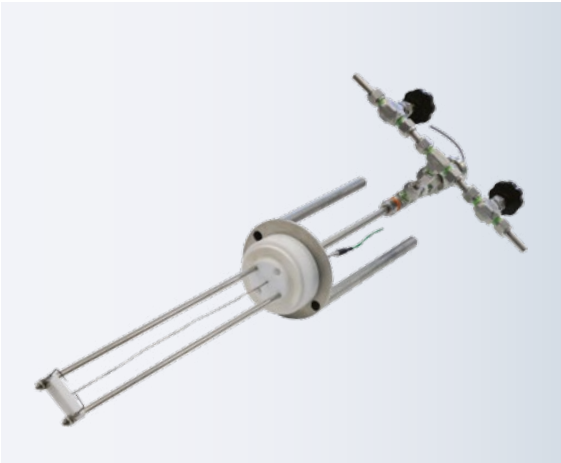
The **FRTA I** is used to measure lower and upper flammability limits of gases and vapors in the air at defined temperatures and pressures. The flammability limits are necessary for preparation of guidelines for safe handling of flammable chemicals and their fire hazard assessment.

ADVANTAGES & FEATURES

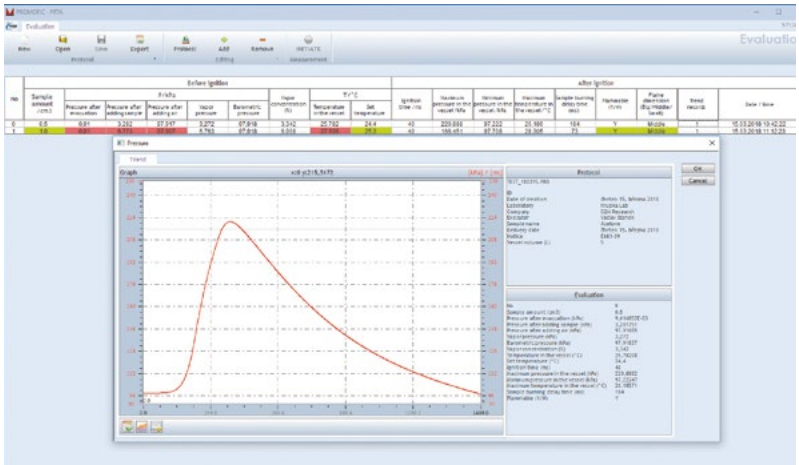
- Precise settings of experimental conditions (high voltage, pressure and temperature)
- Recording and display of pressure time curve after ignition for easy evaluation of results
- Safe operation of the **FRTA I** equipped by safety glass window and bursting membrane for the evacuation of fragments and pressure wave generated by explosion/implosion of glass testing vessel
- Remotely controlled firing (high voltage spark ignition)
- The maximum operating temperature of the **FRTA I** is 150 °C
- Autonomous operation not needing an external computer

COMPLIANCE

- **ASTM E 681-09**



FRTA I electrodes



Results of the flammability test – pressure-time record

ATEX CHAMBERS

TESTING ELECTRICAL DEVICES USED IN EXPLOSIVE ATMOSPHERE

Chamber for the testing of an electrical device's compliance with some standards in European EN 60079 series, which lay down the requirements for electrical installations which might be used in an explosive atmosphere.

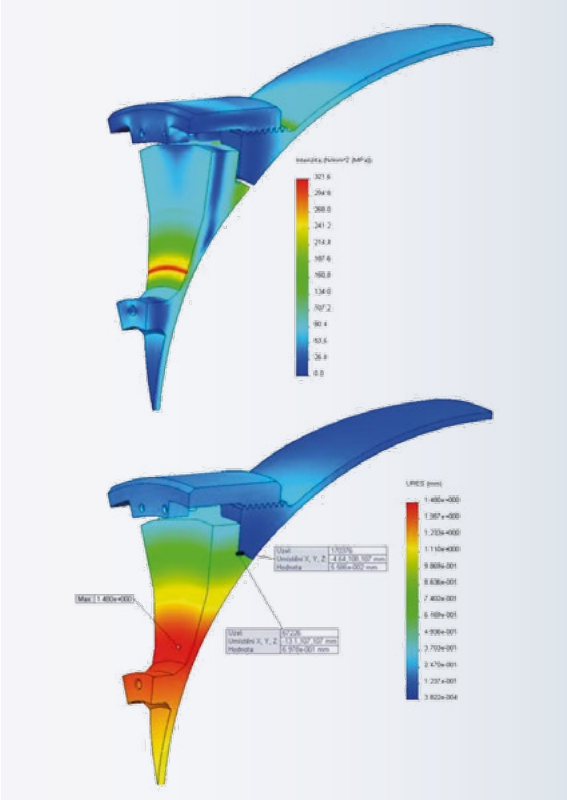
Desired composition of the explosive mixture of gases is specified through PC interface. The concentration of the flammable mixture is measured by automatic gas analyzers in the loop. The measured signal containing an information about the composition of the mixture is transferred to the PLC control, which compares the current composition against desired. Strength calculations are done using both standard calculations and Finite Element Method (FEM).

APPLICATIONS

The **ATEX Chambers**™ (CA ATEX) are a technology designed for testing suitability of the customer´s equipment (typically electrical devices or machinery) for use inside explosive gas atmospheres according to EN 60079. It is used by certification bodies or by manufacturers themselves during development and testing of the electrical devices or machinery.

ADVANTAGES & FEATURES

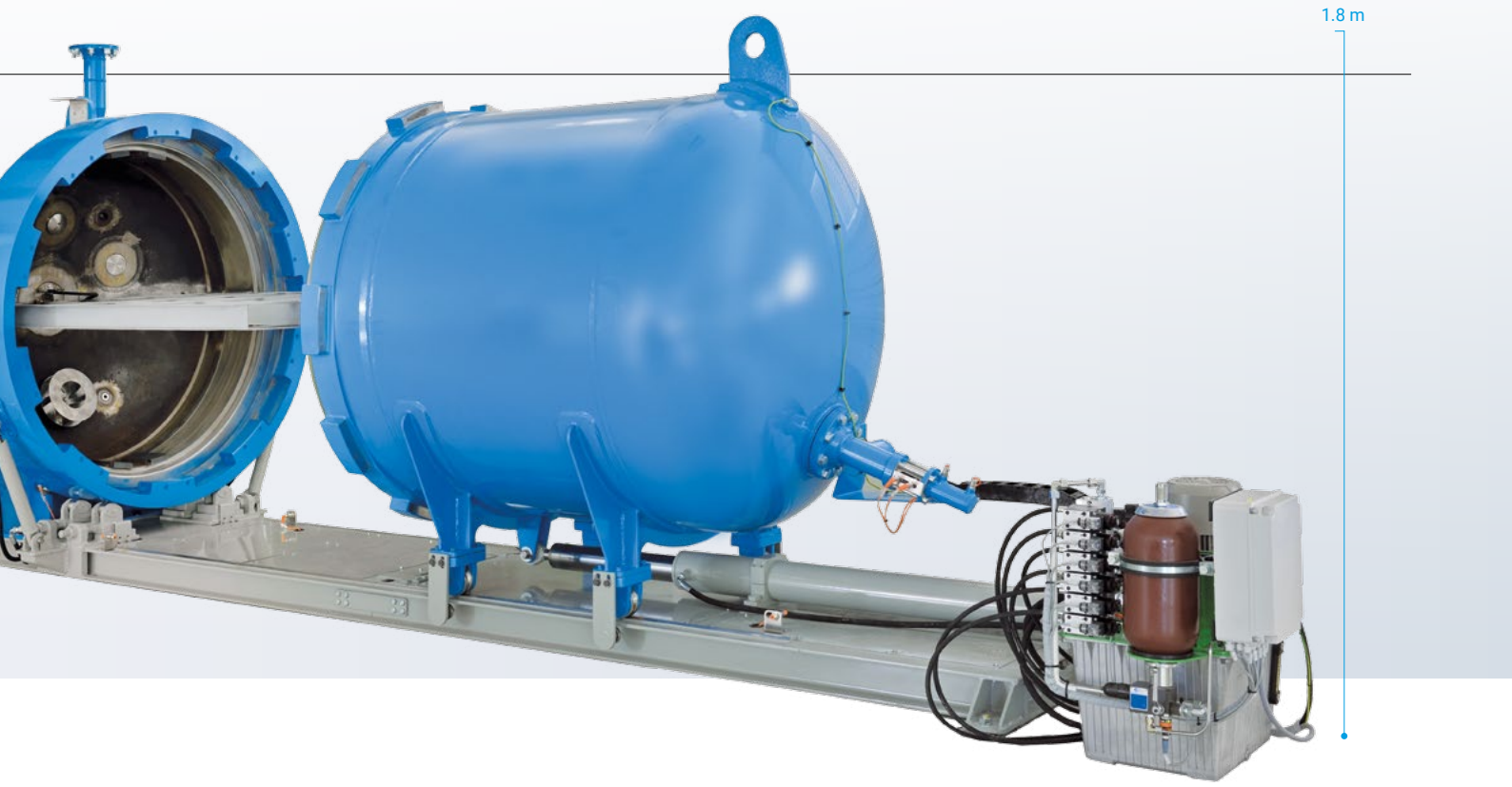
- Different chamber sizes available: 1–1.4 m³, 1.7–3 m³ and 10–20 m³, or according to customer's specifications
- Robust chambers with working pressure up to 50 bar and testing pressure of 70 bar
- Resistant to gas detonations at initial atmospheric pressure
- Fully automated operation
- Possibility of multi-component flammable mixture preparations
- Working table with limited movement preventing damage of cables and supply lines

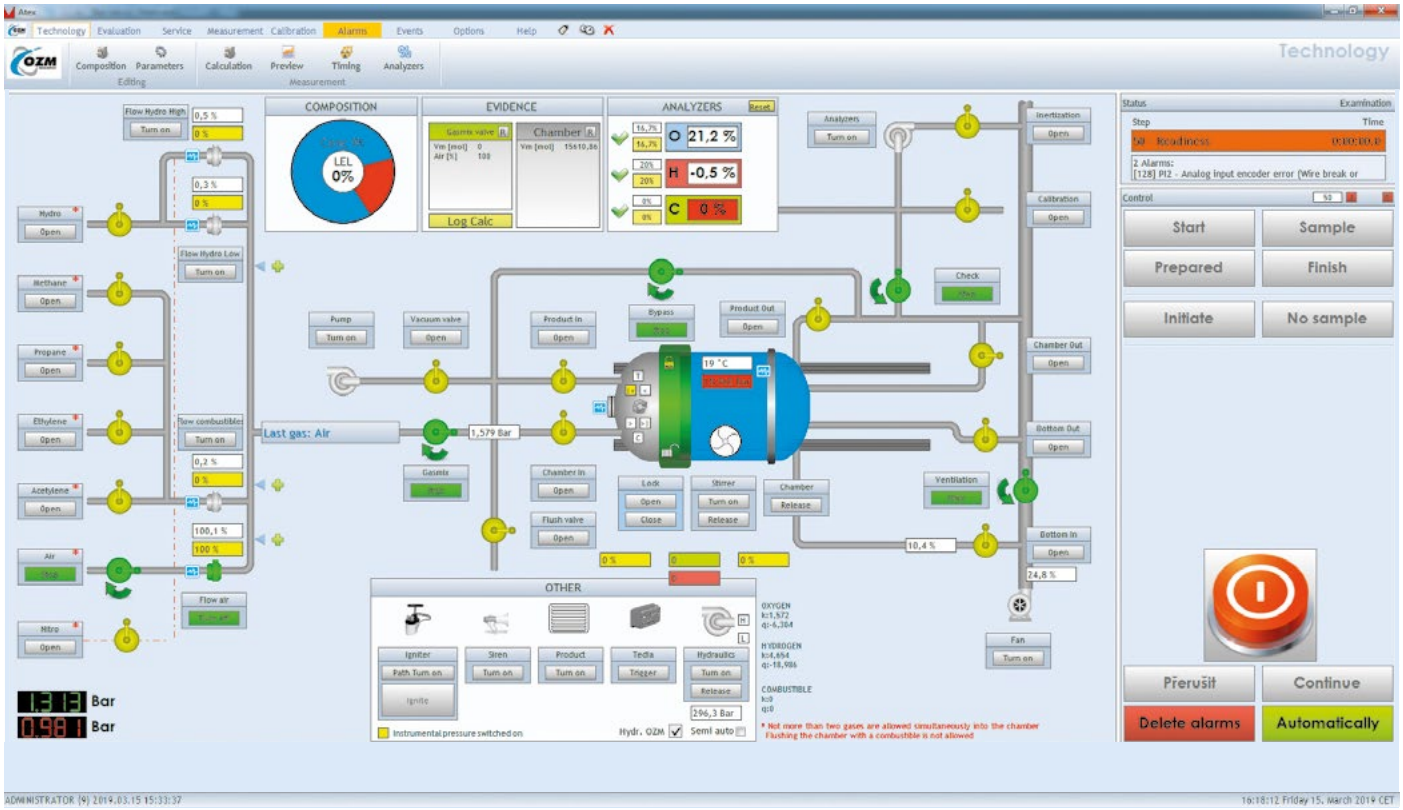


Example of strength calculation using FEM

COMPLIANCE

- **EN 60079-1** Electrical apparatus for explosive gas atmospheres – Part 1: Flameproof enclosure "d"
- **EN 60079-7** Explosive atmospheres – Part 7: Equipment protection by increased safety "e"
- **EN 60079-11** Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "I"
- **EN 60079-15** Explosive atmospheres – Part 15: Equipment protection by type of protection "n"





Screenshot of technological window for chamber and test control

TPT SERIES

TIME-PRESSURE TEST APPARATUS / TEST FOR OXIDIZING LIQUIDS

The TPT Series™ (Time-Pressure Test Apparatus) is used for the hazard classification of dangerous substances (flammable, oxidizing and energetic materials) according to the UN Recommendations on the Transport of Dangerous Goods. The test is based on ignition of a tested substance in a semi-closed vessel and measurement of the resulting pressure-time profile.

APPLICATIONS

Determination of the burning characteristics (tendency to ignition-to-deflagration transition and its violence) under confinement is an important parameter for hazard assessment of energetic chemicals in production, handling and transportation in chemical and explosives industries. Results obtained by standardized tests (max. pressure and pressure rise time etc.) provide safety information about violence of decomposition. Specific energy determines the amount of mechanical energy released by tested substances.

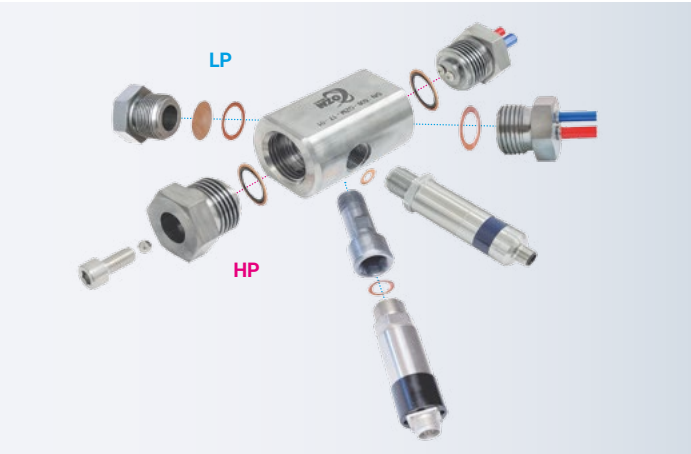
ADVANTAGES & FEATURES

- Two stainless steel testing vessels containing a set of adapters for different testing procedures are available:
  - / standard **TPT** semi-closed testing vessel with working pressure up to 100 bar
  - / **TPT 3000** semi-closed or closed testing vessel for high pressure testing up to 3,000 bar
- Precise pulse power source for ignition by an electric fuse or a hot wire
- Strain-gauge pressure sensors with a tailored data acquisition system
- Test results: pressure vs. time profile, maximum pressure and specific energy
- Simple operation, control, measurement, calibration and data evaluation by **TPT-SW** software

There are two versions of **TPT Series** vessels available:

Version	(Standard) TPT vessel	TPT 3000 vessel
Maximum working pressure	100 bar	3,000 bar
Vessel design	Semi-closed	Semi-closed or closed
Testing according to UN/EU standards	YES	YES
Determination of specific energy	NO	YES

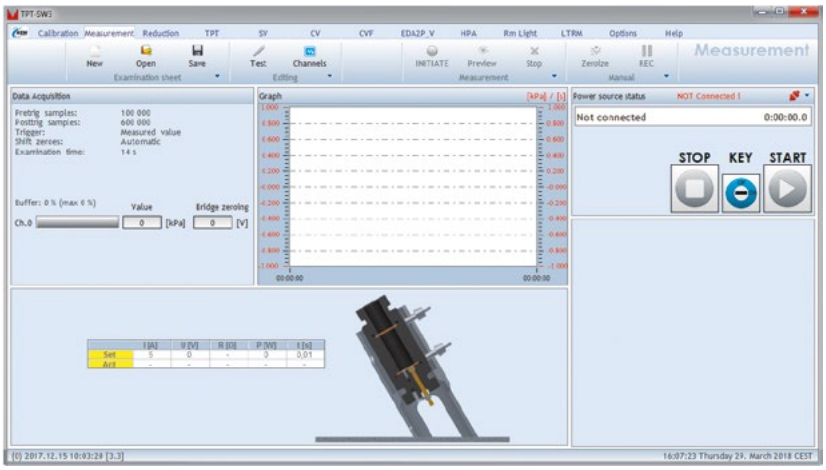
Standard TPT vessel parts



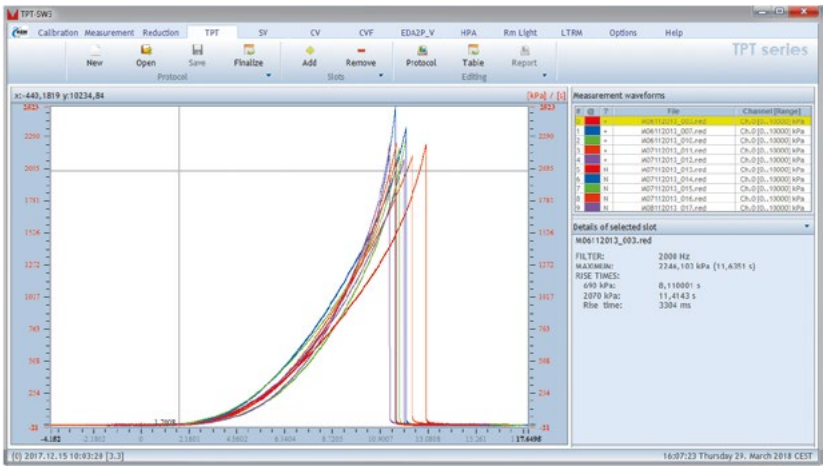
TPT 3000 vessel parts: **LP** up to 100 Bar • **HP** up to 3,000 Bar

COMPLIANCE

- **UN Recommendation on the Transport of Dangerous Goods, Manual of Tests and Criteria**, [Test 1(c)(i)], [Test 2(c)(i)], [Test C.1: Time/pressure Test], or [Test O.2: Test for Oxidizing Liquids]
- **European Commission Directive 2004/73/EC** –The Classification, Packing and Labeling of Dangerous Substances, Method A.21: Oxidizing properties (Liquids)
- **UN Recommendation on the Transport of Dangerous Goods, Manual of Tests and Criteria**, [Appendix 7: HSL Flash Composition Test]
- **UN Recommendation on the Transport of Dangerous Goods, Manual of Tests and Criteria**, [Test O.1: Test for Oxidizing Solids]



Measurement window in TPT-SW3 software



Evaluation procedure for Oxidizing Liquids Tests in TPT-SW3 software – Graph and Table

HPA 1500

HIGH PRESSURE AUTOCLAVE

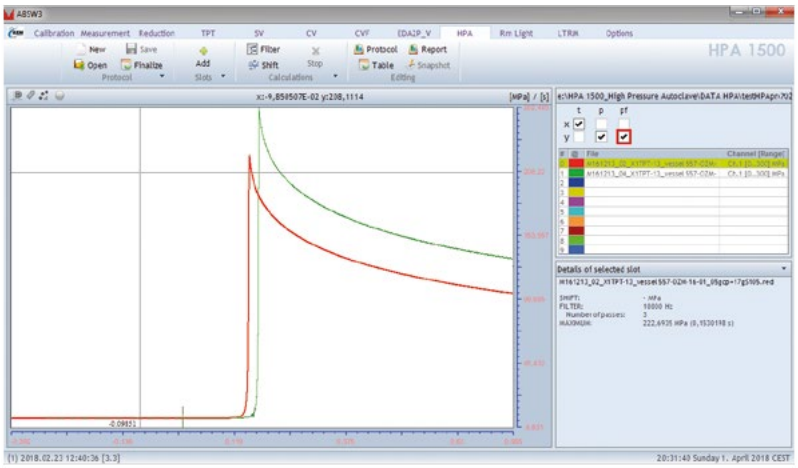
The HPA 1500™ High Pressure Autoclave is a standardized instrument designed to measure a specific energy of energetic chemical substances for their hazard classification according to the UN Recommendations on the Transport of Dangerous Goods.

APPLICATION

Compact laboratory instrument containing testing vessel, pressure transducer, a control unit with in-built precise pulse power ignition source, transducer conditioner, data acquisition unit and all-inclusive software.

Determination of specific energy (amount of energy released by the tested substance) is an important parameter for hazard assessment of energetic chemicals for their safe production, handling and transportation in chemical industry.

Obtained results (max. pressure, pressure rise time, burning rate, etc.) usually serve for the safety classification of energetic materials.



HPA software screenshot

ADVANTAGES & FEATURES

- Ignition source with voltage and current feedback generates a precise constant power impulse
- Standardized 96 cm³ volume stainless steel testing vessel with working pressure up to 2,000 bar
- Test results: pressure vs. time profile, maximum pressure and specific energy
- Two different control units designed for using different pressure transducers
- Simple operation, control, measurement, calibration and data evaluation by **TPT-SW** software

There are two versions of the control unit available:

Version	TPT-MCU	EDAL
Stain-gauge pressure transducer	YES	YES
Dynamic piezoelectric transducer	NO	YES
Number of optional inputs	1	4

COMPLIANCE

- **UN Recommendation on the Transport of Dangerous Goods, Manual of Tests and Criteria** [Test F.5 High Pressure Autoclave]

ENERGETIC MATERIALS

TESTING INSTRUMENTS FOR THERMAL STABILITY, SENSITIVITY AND PERFORMANCE TESTS

Characterization of properties of energetic materials is extremely important when considering their manipulation safety or long-term storage. OZM Research provides complete solution for explosive testing laboratories.

Sensitivity testing provides information about energy sufficient for initiation of explosive samples by impact, friction, spark, heat or shock wave stimuli.

Chemical and thermal stability testing is important for evaluation of service life of energetic materials to protect against accidental explosion during long-term storage.

Performance tests allow to evaluate how good certain explosive is for a particular mission. Determination of combustion and detonation heat, detonation velocity or other performance properties is very important for assessment of high explosives in industrial or military applications.

Solid gun and rocket propellants are subjected to the series of interior ballistic tests. Closed vessels of different volumes serve for determination of burning vivacity and maximum working pressure of gun propellants. Burning rate of the solid rocket propellants can be measured directly in real or subscale rocket motors or in specially developed Stojan Vessel®.

INSTRUMENTS APPLICATIONS REFERENCE TABLE

● Applicable

○ Limited usage

	Test Method	OZM Instrument	EXPLOSIVE MATERIALS							APPLICATIONS					
			Primary Explosives	Military High Explosives	Industrial Explosives	Pyrotechnics	Gun Propellants	Rocket Propellants	Explosive Devices	Research & Development	Qualification for service	Product quality control	In-service surveillance	Storage & transport safety	Ammunition demilitarization
Chemical and Thermal Stability Tests	Abel Test	**ABT**			●		●	●		○		●	○		●
	Accelerated Ageing	**HBA, Heating Blocks**	●	●		●	●	●	●	●	●		●		
	Bergmann-Junk Test	**BeJu**					●	●		○		●	●		●
	Differential Thermal Analysis (DTA)	**DTA 552-Ex**	●	●	●	●	●	●		●	●	●	●	●	●
	Dutch Weight Loss Test at 90 °C (Holland Test)	**HOLLAND TEST**					●	●		○		●	●		●
	Explosion (Ignition) Temperature Test	**AET 402**	○	●	●	●	○	○		○	●	●	○		○
	Heat Storage Test at 100 °C	**CH 100**					●	●		●		●	●		
	Compatibility/Reactivity by DTA	**DTA 552-Ex**	●	●	●	●	○	○		●	●				
	Compatibility/Reactivity by VST	**STABIL VI**		●	●	○	●	●		●	●				
	Methyl Violet Test	**MVT**					●	●		○		●	●		●
	Time-to-Explosion Test	**AET 402**	●	●	●	●	●	●		●					
	Vacuum Stability Test (VST)	**STABIL VI**	○	●	●	○	●	●		●	●	●	●		●
Sensitivity to External Stimuli Tests	Friction Sensitivity Test	**FSKM 10 (FSA 12)**	●	●	●	●	●	●		●	●	●		●	●
	Gap Tests (shock wave sensitivity)	**Water & UN GAP Test**	○	●	●	○	○	○	○	●	●	●		●	
	Impact Sensitivity Test	**BFH 10, BFH 12 , BFH 12A, BFH 12R**	○	●	●	●	●	●	○	●	●	●		●	●
	Impact Sensitivity Test	**BFH PEx**	●			●				●	●	●		●	●
	Sensitivity of Electroexplosive Devices to Electrostatic Discharge	**ESDEX 25**							●	●	●				
	Large Scale Electrostatic Discharge Sensitivity Test	**ESD LS30**		●		○	●	●		●	●				
	Small Scale Electrostatic Spark Sensitivity Test	**X SPARK 10, LSPARK**	●	●	●	●	●	●	○	●	●			●	●
	Minimum Burning Pressure Test	**MBP**			●					●	●	●		●	
	Explosibility at confined heating	**TPT Series, HPA 1500, KT 300**		●	●	○	○	○		●	●			●	

INSTRUMENTS APPLICATIONS REFERENCE TABLE

● Applicable

○ Limited usage

	▼ Test Method	▼ OZM Instrument	EXPLOSIVE MATERIALS							APPLICATIONS					
			Primary Explosives	Military High Explosives	Industrial Explosives	Pyrotechnics	Gun Propellants	Rocket Propellants	Explosive Devices	Research & Development	Qualification for service	Product quality control	In-service surveillance	Storage & transport safety	Ammunition demilitarization
Explosive Performance Tests	Underwater Blast Test	**UWB**	●	●	●				●	●	●	●			
	Explosive Strength (power)	**Ballistic Mortars**	○	●	●				○	●	○	●			
	Explosive Strength (power)	**Trauzl Test, Detonation Chambers**	○	●	●				○	●	○	●			
	Explosive Brisance Tests	**Hess Test, Kast Test, Detonation Chambers**	○	●	●				○	●	○	●			
	Detonation Velocity	**VOD 815, Detonation Chambers**	○	●	●				○	●	●	●	●		
	Detonation Velocity, Burning Rate	**OPTIMEX 8 and 64, Detonation Chambers**	●	●	●	○	○	○	●	●	●	●	●		
	Cylinder Expansion Test, Flyer Plate Test, Fragment Velocity	**VELOREX PDV**	●	●	●				●	●	●	●			
	Prediction of Detonation and Burning Parameters	**EXPLO5**	●	●	●	●	●	●		●					
	Heat of Detonation	**DCA 25, DCA 100**	●	●	●	○	○	○		●	●				
Interior Ballistic Performance Tests	Closed Vessel Tests	**TSV Series**				●	●		●	●	●	●	●		
	Closed Vessel Tests	**RB Series**					●			●	●	●	●		
	Heat of Combustion/Explosion	**BCA 500**		●	●	●	●	●		●	●	●	●		
	Burning Rate Tests	**SV-2**						●		●	●	●	●		
	Burning Rate Tests	**SSB**						●		●	●	●	●		
	Burning Rate Tests	**LTRM**						●		●	●	●	●		
	Burning Rate Tests of Pyrotechnics	**OPTIMEX 64**				●				●	●	●	●		
	Sub-scale Rocket Motor Tests	**TRM 50**						●		●	●	●	●		
	Rocket Motor Burning Parameters	**RMM**						●	●	●	●	●	●		
	Electro-explosive Device Analyzer	**EDA**				●	●	●	●	●	●	●	●	●	

BFH SERIES

BAM FALL HAMMER SERIES

BFH 12A

The BAM Fall Hammer (also known as BAM Impact Tester or BAM Drop Hammer) is designed to determine the sensitivity of explosive materials to the impact stimuli by a falling drop weight in accordance with the BAM procedure.

OZM Research manufactures four types of standard BAM Fall Hammers for measuring impact sensitivity of solid or liquid energetic materials (primary and secondary high explosives, propellants, pyrotechnics) and also other substances potentially sensitive to impact stimuli in the range of impact energies between 0.25 J and 100 J. Sensitivity of the most sensitive substances such as primary explosives or highly sensitive pyrotechnics can be measured in the range of impact energies from 0.025 J to 20 J on a specially developed BAM Fall Hammer BFH PEx.

APPLICATIONS

The sensitivity to impact stimuli is one of the most important characteristics of energetic materials defining their safety in handling, processing or transportation. Its determination is a necessary part of characterization of new explosives, modified formulations or manufacturing conditions. It is also used for defining influences of impurities or ageing, in the quality control of manufactured explosives, in surveillance of in-service explosives and in transport/storage classification of explosive materials.

ADVANTAGES & FEATURES

- Unique Drop Weight Exchange Window for safer, quicker and more convenient exchange of drop weights (**BFH 12A** and **BFH 12** only)
- Automated Lifting Mechanism remotely executes positioning, drop and collection of Drop Weight (**BFH 12A** only)
- Wide range of impact energies from 0.25 J to 100 J (six drop weights from 0.25 kg to 10 kg)
- Drop weights are equipped with brass grooves to lower sliding friction
- High corrosion resistance of the critical parts
- Protective housing as a standard accessory
- Wide range of accessories

Drop Weight Exchange Window

COMPLIANCE

OZM Research manufactures several modifications of this instrument in order to better fit different classes of explosive materials and different standards of testing, such as:

- **UN Recommendation on the Transport of Dangerous Goods, Manual of Tests and Criteria** – [Test 3(a)(ii)]
- **EN 13631-4:2002**
- **Council Regulation (EC) No 440/2008**; A.14
- **GB/T 21567-2008**
- **STANAG 4489**
- **MIL-STD-1751A**, Method 1015
- **EMTAP**, Manual of Tests, Test No 43
- **GOST 4545-88** (**BFH 12R** only)

Drop weights for BFH 12

BFH 10
BAM FALL HAMMER

The **BFH 10**™ is a standard BAM Fall Hammer for the customers who are looking for economic but still high-quality solution. The **BFH 10** fully complies with all relevant international standards listed above.

BFH 12
IMPROVED BAM FALL HAMMER

The **BFH 12**™ is an improved version of standard BAM Fall Hammer. It is equipped with a unique Drop Weight Exchange Window for safer, quicker and more convenient exchanges of the drop weights.

BFH 12A
AUTOMATED BAM FALL HAMMER

The **BFH 12A**™ is the high-end version of BAM Fall Hammer supplied by OZM Research. It has design features of the innovated **BFH 12** and furthermore it is equipped with automated remotely controlled lifting mechanism for positioning, drop and collection of the drop weight. The **BFH 12A** also introduces a unique Drop Weight Exchange Window for safer, quicker and more convenient exchanges of the drop weights.

BFH 12R
BAM FALL HAMMER GOST TYPE

The **BFH 12R**™ is modified version of standard BAM Fall Hammer. Its design and functionality fully complies with Russian standard GOST 4545-88. It is also equipped with a unique Drop Weight Exchange Window for safer, faster and more convenient exchanges of drop weights.

BFH PEx
SMALL BAM FALL HAMMER

For testing of highly sensitive materials as primary explosives and pyrotechnics.

FSKM 10

BAM FRICTION APPARATUS

The BAM Friction Apparatus FSKM 10 is designed to determine sensitivity to friction stimuli of tested substances in the wide range of frictional loads between 0.1 N and 360 N.

The FSKM 10 has a robust stainless-steel frame and it is equipped with a unique interchangeable loading arm mechanism. Thanks to that mechanism, all types of energetic materials can be tested on this single device.

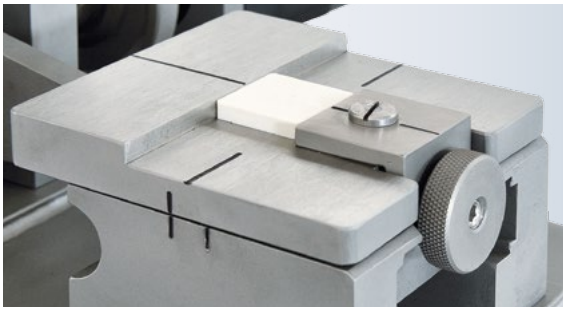
FSKM 10 equipped with safeguard

APPLICATIONS

Friction between hard surfaces is one of the most frequent causes of accidental explosions. The friction sensitivity of a tested substance is determined in accordance with the standardized BAM procedure using this BAM Friction Apparatus **FSKM 10**.

ADVANTAGES & FEATURES

- Unique interchangeable loading arm concept
- Standard 6-position loading arm accompanied by two sets of weights generating loads between 0.5 N and 360 N
- Lightweight 3-position loading arm, specially designed for testing highly sensitive substances, accompanied by two sets of weights generating loads between 0.1 N and 98 N
- Protective shield to protect personnel against potential fragments of a porcelain plate or a peg
- Digitally controlled stepper motor for high precision movement of the porcelain plate carriage
- Working table with a stainless-steel frame covered by a conductive surface
- Variable speed of porcelain plate carriage between 20 and 300 RPM
- Safeguard
- Remote control
- Wide range of accessories
- Premium quality consumables at affordable prices



Porcelain plate carriage

COMPLIANCE

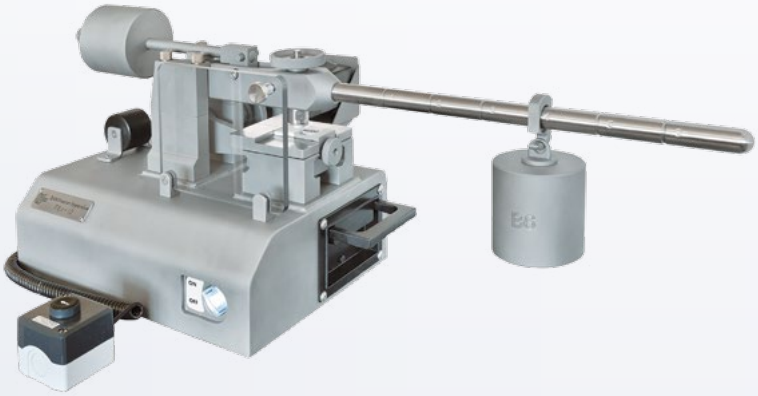
- **UN Recommendation on the Transport of Dangerous Goods, Manual of Tests and Criteria**, [13.4.2 Test 3(b)(i)]
- **EN 13631-3:2004**
- **Council Regulation (EC) No 440/2008**; A.14
- **GB/T 21566-2008**
- **STANAG 4487**
- **AOP 7** Ed. 2, 201.02.006
- **MIL-STD-1751A**, Method 1024
- **US ARMY TB 700-2**, Section 5-3d
- **EMTAP**, Manual of Tests, Test No 44

6-position loading arm BAM 6A (dismantled)

FSA 12

BAM FRICTION APPARATUS

FSA 12™ is a portable version of the BAM Friction Apparatus FSKM 10 which can be placed and operated on a standard laboratory working table or supplied working table with conductive surface. FSA 12 is used to determine the friction sensitivity of all types of energetic materials in accordance with BAM procedure. Due to the unique design of two interchangeable loading arms, the applicable load can vary from 0.1 N to 360 N (from 0.01 kg to 36 kg).



APPLICATIONS

Friction between hard surfaces is one of the most frequent causes of accidental explosions. The friction sensitivity of a tested substance is determined in accordance with the standardized BAM procedure using this BAM Friction Apparatus **FSA 12**.

COMPLIANCE

- **UN Recommendation on the Transport of Dangerous Goods**, **Manual of Tests and Criteria**, [13.4.2 Test 3(b)(i)]
- **EN 13631-3:2004**
- **Council Regulation (EC) No 440/2008**; A.14
- **GB/T 21566-2008**
- **STANAG 4487**
- **AOP 7** Ed. 2, 201.02.006
- **MIL-STD-1751A**, Method 1024
- **US ARMY TB 700-2**, Section 5-3d
- **EMTAP**, Manual of Tests, Test No 44

BIT 132

BALL DROP IMPACT TEST

The Ball Drop Impact Test BIT 132 is designed to determine the impact sensitivity of various types of energetic materials ranging from the most sensitive primary explosives to less-sensitive high explosives and pyrotechnic mixtures. It uses steel balls with diameters from 0.5 inch (8.35 grams) to 2 inches (534.7 grams) as the drop weights.

ADVANTAGES & FEATURES

- Entire corrosion-proof design
- Unique design of the ball tracks
- Drop height up to 100 cm (40 inch)
- Wide range of impact energies from 67 mJ to 5329 mJ
- Wide range of accessories

COMPLIANCE

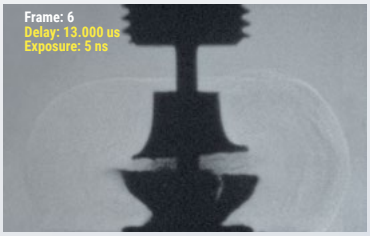
- **AOP-7** Ed.2; 201.01.002
- **MIL-STD 1751A**, Method 1016

X SPARK 10

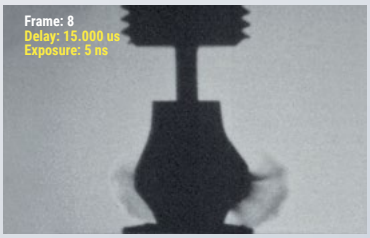
ADVANCED ELECTROSTATIC SPARK SENSITIVITY APPARATUS

The X SPARK 10™ is the newest generation of the universal testing instrumentation designed for the precise evaluation of the sensitivity of energetic materials to electrostatic spark in the range of discharge energies from 25 µJ to 17.5 J and voltages between 500 V and 10 kV.

Testing of electrostatic spark sensitivity together with testing sensitivity to both impact and friction, are crucial methods for the determination of safety parameters. The X SPARK 10 provides the precise measurement of spark energy of initiation for a wide range of crystalline energetic materials from primary explosives to low sensitive plastic explosives.



Ignition – detonation of a primary explosive



Ignition – burning of a pyrotechnic mixture

APPLICATIONS

Electrostatic discharge is one of the most frequent and the least characterized causes of accidental explosions of energetic materials. Together with friction and impact sensitivity, it provides the necessary information for safe handling and manufacture of the energetic materials.

Reliable data on the electrostatic spark sensitivity of energetic materials is thus critical for their manufacture, quality control, explosives processing, loading, transportation, storage, demilitarization and research and development of the new explosive materials.

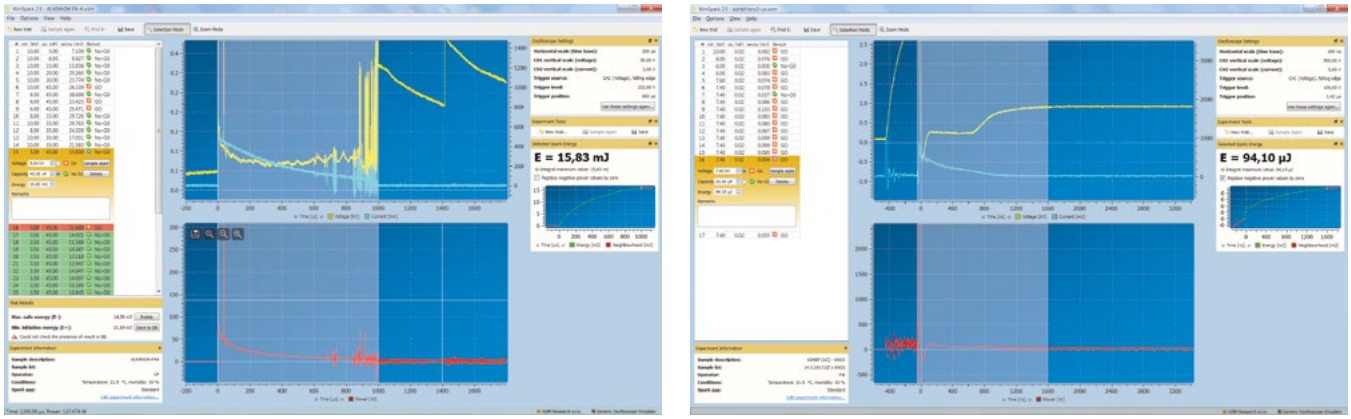
ADVANTAGES & FEATURES

- Unique compact design
- Replaceable spark gaps
- Several models of automatically operated testing stands according to different international standards including stands with fixed electrodes and with an approaching anode
- Consumables at affordable prices
- Modified designs of the spark gap assemblies according to the requirements of other standards or testing methods are available upon request
- External testing assemblies are designed for up to 500 mg explosive samples
- Wide selection of capacitors in the capacitor bank for testing with wide ranges of spark energies
- Easy implementation of the Standard Operation Procedures (SOP) and tailoring the testing procedures to the specific requirements


Approaching needle testing stand

COMPLIANCE

- **EN 13938-2** Explosives for civil uses – Propellants and rocket propellants – Part 2: Determination of resistance to electrostatic energy
- **MIL-STD-1751A** Safety and Performance Tests for the Qualification of Explosives – Methods 1031, 1032 and 1033
- **STANAG 4490**



Winspark software screenshots

Other available versions of spark testers

LSPARK™

Electrostatic spark sensitivity tester

ESD LS30™

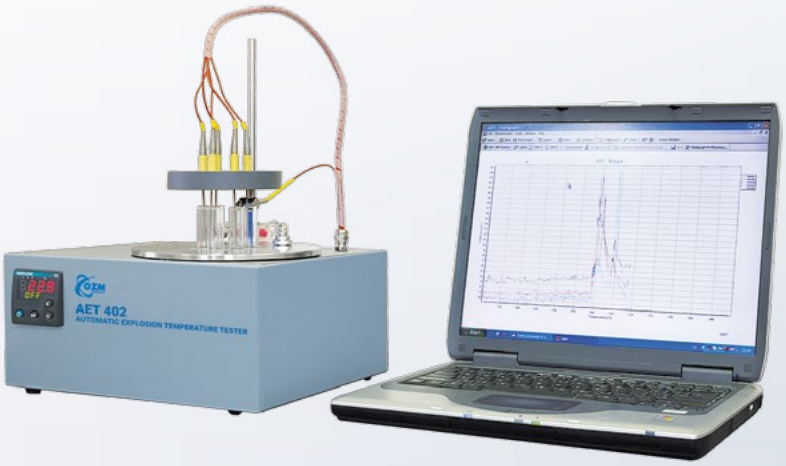
Large-scale electrostatic discharge sensitivity tester

AET 402

EXPLOSION TEMPERATURE APPARATUS

The AET 402™ (Explosion Temperature Apparatus) is used for the determination of the explosion (ignition) temperature of energetic materials submitted to heating.

The AET 402 instrument is equipped with sensors and an automatic data acquisition unit for the automatic registering the explosion effects. This unique feature helps the operator to fully replace visual observation and provides exact testing results free of human errors.



APPLICATIONS

The **AET 402** is designed for the determination of the explosion (ignition) temperature at constant heating rates or a time-to explosion in isothermal (constant temperature) mode.

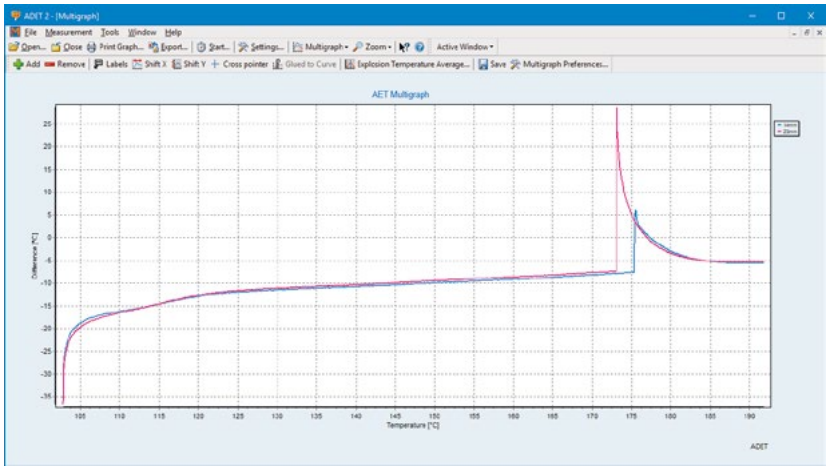
The **AET 402** is the most frequently used as a quality-control instrument in the manufacture of explosives, pyrotechnic mixtures and propellants.

ADVANTAGES & FEATURES

- Robust design capable of withstanding an explosion of up to several hundred milligrams of explosives
- Recognizes the decomposition regardless if it is accompanied by sound or light emission unlike classic instruments
- User-friendly software for data acquisition, analysis and archiving
- Low costs of investment and operation

COMPLIANCE

- **STANAG 4491**



ADET software – evaluation of results

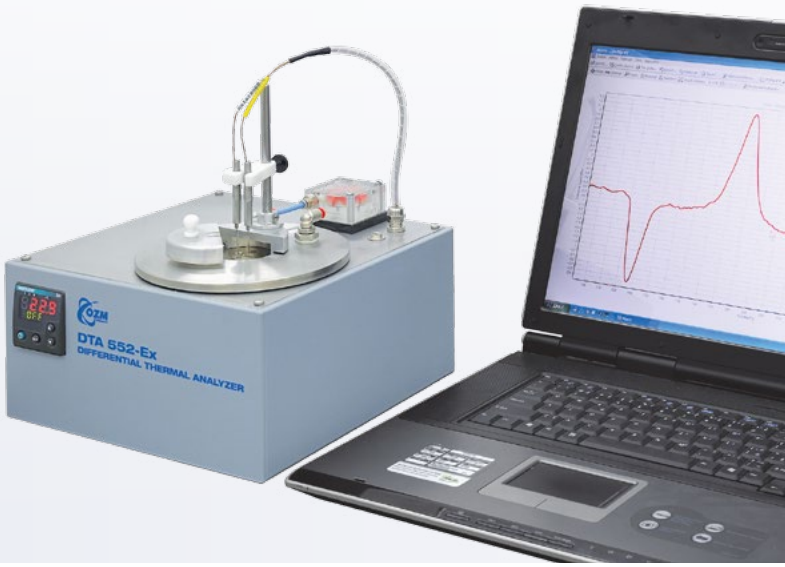
AET 402 – detail of the furnace

DTA 552-Ex

DIFFERENTIAL THERMAL ANALYZER

The DTA 552-Ex™ (Differential Thermal Analyzer) was developed specifically for the evaluation of thermal stability, purity (melting point), compatibility and decomposition parameters of all types of energetic materials including primary explosives or other hazardous exothermic substances.

The robust design of the DTA 552-Ex makes it the ideal instrument for the characterization of explosive materials, which explosive decomposition would damage or destroy conventional thermal analyzers.



APPLICATIONS

The **DTA 552-Ex** detects and analyses thermal changes (melting, polymorph transformation, evaporation and thermal decomposition) occurring in the sample and allows for the evaluation of the thermal stability, purity, compatibility and the thermal decomposition parameters of all types of energetic materials.

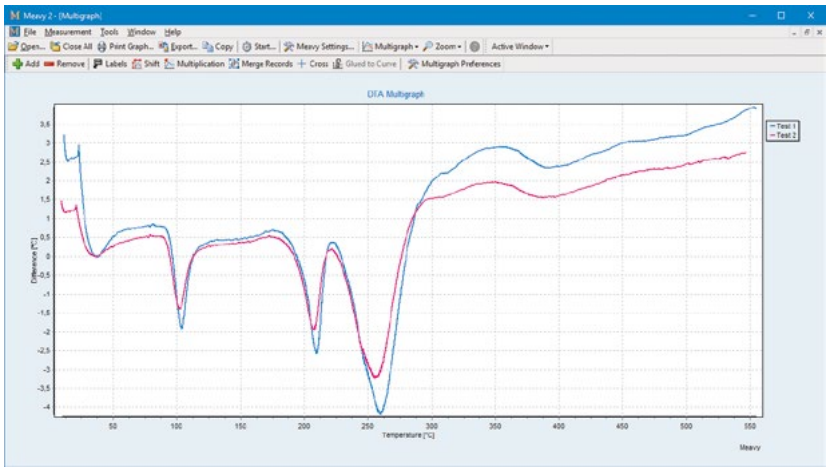
The **DTA 552-Ex** is an essential instrument for quality control of energetic materials or raw materials, characterization and qualification of new compounds, in-service surveillance, research and development and many other testing programs.

ADVANTAGES & FEATURES

- Larger quantities (up to several hundred milligrams) provide a truly representative sample for analysis
- Variability of applicable substance forms (paste, liquid, foam and corrosive)
- High sensitivity – direct contact of the thermocouple with the sample
- User-friendly software for data acquisition, analysis and archiving
- Low costs of investment and operation

COMPLIANCE

- **STANAG 4515**



MEAVY software – evaluation of results

DTA 552-Ex – detail of the furnace

OPTIMEX

OPTICAL ANALYZER OF EXPLOSIVE PROCESSES

UPGRADE

design by Jan ERMIS

The OPTIMEX™ is a multipurpose instrument used for the measurement of detonation velocity and other detonation parameters using multiple fiber optic probes along with the continuous recording of light signal intensity.

The battery powered portable OPTIMEX 8 is best suited for field measurements. The OPTIMEX 64 is an extended version primarily designed for stable installations. It can be rack-mounted and has the ability to accommodate up to 64 measurement channels. With such a high number of fiber optic probes, the instrument's capabilities resemble those of a high-speed streak camera.

APPLICATIONS

The **OPTIMEX** instruments have all the application capabilities of the **VOD 815** and many others. They can handle measurements of detonation velocity of energetic materials in advanced research, industrial, military, educational or engineering applications.

Tasks for **OPTIMEX 8** may include determination of:

- Detonation velocity, a basic parameter of all explosives
- Detonation wave curvature, a measure of an explosion's ideality
- Shock velocities in inert materials, useful for the estimation of Chapman-Jouguet detonation pressure

Additionally, **OPTIMEX 64** may also cover:

- Shock or detonation wave tracking in complex explosive initiation trains
- Basic cylinder expansion testing where the wall velocity is a measure of explosive strength (a less precise and less expensive alternative to the **VeloreX PDV**)

Detonation velocity measurement of a blasting cap

ADVANTAGES & FEATURES

- Up to 64 independent measurement channels
- Glass or plastic fiber optic probes
- Full light intensity-time profiles available
- Immune to stray currents and EM disturbances
- Automated data evaluation routines
- Touch screen LCD display
- WiFi module (optional)

There are two versions of OPTIMEX analyzer available:

Version	OPTIMEX 8	OPTIMEX 64
Measurement channels	8	8 – 64 (user defined)
Power supply	rechargeable internal battery	standard AC mains

COMPLIANCE

- **EN 13630-11** Explosives for Civil Uses – Detonating cords and safety fuses - Part 11: Determination of velocity of detonation of detonating cords
- **EN 13631-14** Explosives for Civil Uses – High explosives, Part 14: Determination of Velocity of Detonation
- **EN 13763-23** Explosives for Civil Uses – Detonators and relays – Part 23: Determination of the shock-wave velocity of shock tube

VELOREX PDV

NEW INSTRUMENT

PHOTONIC DOPPLER VELOCIMETER

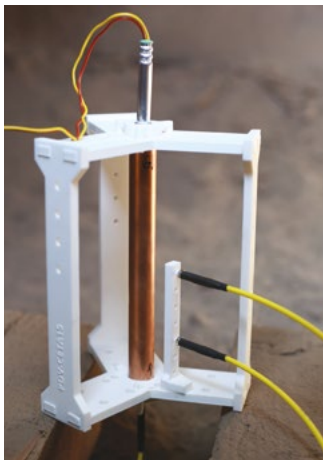
The VeloreX PDV™ is an advanced instrument used for the measurement of the continuous velocity-time profiles of high speed moving objects. It can be used for the determination of various detonation properties of energetic materials as well as for any other tasks where high precision in velocity or displacement measurements are crucial.

The VeloreX PDV is capable of tracking target velocities in order of kilometers per second with nanosecond time resolution. The measurement procedure is simple and robust with practically no constraints regarding the quality of the target surface. The use of the instrument is not limited to the characterization of explosives but includes ballistics, rocket motors, explosive welding, high energy physics, plasma physics, construction and engineering.

APPLICATIONS

The measurement of the velocity profiles of explosively accelerated materials can be used for inferring the key properties of the high explosives. Unlike the traditional Hess or Kast tests, which are used for the relative determination of brisance, the **VeloreX PDV** allows direct measurement without the need of an immediate comparison with standard samples. Compared to the piezoelectric pin or high-speed streak camera instrumentation, the **VeloreX PDV** offers dramatically increased measurement resolution.

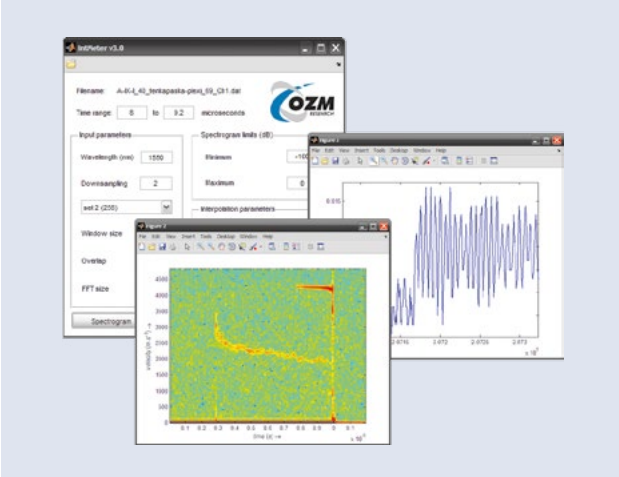
The **VeloreX PDV** is especially useful for civilian and military research and the development of explosives and explosive devices. It may also be employed in quality control or the qualification of ammunition. In the research of explosives the measurement of velocity profiles of explosively accelerated materials can be used for inferring key properties of high explosives such as detonation pressure, particle velocity, the Gurney energy and the parameters of Jones-Wilkins-Lee equation of state of detonation products.



Cylinder expansion test assembly

ADVANTAGES & FEATURES

- Up to 4 measurement channels
- Maximum velocity limit tailored according to the customer's needs (up to 10 km/s)
- Various probes available for a wide range of applications
- Advanced trigger options
- Eye safety thanks to all-fiber design
- Simple operation and evaluation

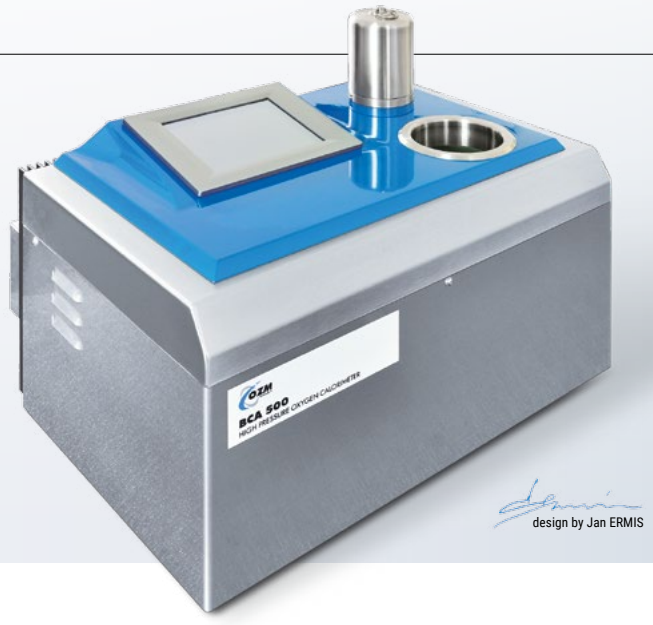


IntMeter evaluation software

BCA® 500

HIGH PRESSURE BOMB CALORIMETER

The BCA® 500 (High Pressure Bomb Calorimeter) is an advanced isoperibolic combustion calorimeter designed for the rapid determination of the calorific values of solid and liquid samples. Compared to other commercial calorimeters, the BCA 500 incorporates a high pressure bomb allowing to safely determine combustion heats of energetic materials under a wide range of conditions.



APPLICATIONS

The **BCA 500** is well suited for the combustion heat characterization needed for further performance calculations of high explosives, pyrotechnics and propellants in their research, development, manufacture and in-service surveillance and as well it can be used for performance characterization of various fuels (coal, wood etc.).

The **BCA 500**'s precision and performance allow it to be used in quality control systems and in the most demanding research and development applications. Typically, coal mines, power plants and explosive production plants find the **BCA 500** indispensable. The tailored design of the **BCA 500**'s accessories and consumables provides an excellent solution for any application especially in the industries of fuels and energetic materials; however, please note the **BCA 500** is not designed for the testing of materials in a detonation regime, for which **DCA** calorimeters are suited.

ADVANTAGES & FEATURES

- The compact design affords a small footprint requiring less space than other standard devices
- Easy operation with no special personnel requirements
- Superb resolution of the thermometers: 0.00001 K
- Results reproducibility as low as 0.1 %
- The **BCA 500** needs no continuous water supply – all process water is stored inside inner tanks
- Two tanks allow for non-stop testing thereby reducing the operation time
- Advanced water management with integrated chillers provides precise dosing and conditioning
- Easy to operate interface with LCD touch screen, wireless keyboard and mouse
- Fully automated data acquisition, evaluation and management with remote access features

Inbuilt water conditioning system

Calorimetric standard and high pressure bomb

COMPLIANCE

- AS 1038.5
- ASTM D240
- ASTM D4809
- ASTM D5468
- ASTM D5865
- ASTM E711
- CSN EN 14918
- DIN 51 900
- IS 1350-2
- ISO 1928
- JIS M 8814

ADVANCED TESTING INSTRUMENTS

KT 300

SENSITIVITY TESTING / KOENEN TEST

MBP

SENSITIVITY TESTING / MINIMUM BURNING PRESSURE APPARATUS

STABIL VI

STABILITY TESTING / MODERNIZED VACUUM STABILITY TEST APPARATUS

HEATING BLOCKS

STABILITY TESTING / FOR TESTING THERMAL STABILITY

DCA 25 / DCA 100

EXPLOSIVE PERFORMANCE TESTING / DETONATION CALORIMETERS

UWB

EXPLOSIVE PERFORMANCE TESTING / UNDERWATER PRESSURE WAVE MEASUREMENT SYSTEM

BM

EXPLOSIVE PERFORMANCE TESTING / BALLISTIC MORTAR

VOD 815

EXPLOSIVE PERFORMANCE TESTING / VELOCITY OF DETONATION PORTABLE TESTER

DETONATION CHAMBERS

EXPLOSIVE PERFORMANCE TESTING / LABORATORY AND INDUSTRIAL DETONATION CHAMBERS

EXPLO5

EXPLOSIVE PERFORMANCE TESTING / THERMOCHEMICAL COMPUTER CODE

TSV SERIES, RB SERIES

INTERIOR BALLISTIC & ROCKET PROPELLANTS TESTING / CLOSED VESSELS

EDA, EDA LIGTH

INTERIOR BALLISTIC & ROCKET PROPELLANTS TESTING / ELECTRO-EXPLOSIVE DEVICES ANALYZERS

SV-2

INTERIOR BALLISTIC & ROCKET PROPELLANTS TESTING / BURNING RATE MEASUREMENT OF SOLID ROCKET PROPELLANTS IN A CLOSED VESSEL

SSB

INTERIOR BALLISTIC & ROCKET PROPELLANTS TESTING / BURNING RATE MEASUREMENT OF SOLID ROCKET PROPELLANTS

LTRM, TRM 50, RMM

INTERIOR BALLISTIC & ROCKET PROPELLANTS TESTING / ROCKET MOTORS TESTING

PROTECTIVE TESTING CONTAINER

INTERIOR BALLISTIC & ROCKET PROPELLANTS TESTING

POLLUTION ABATEMENT SYSTEM

INTERIOR BALLISTIC & ROCKET PROPELLANTS TESTING

STORAGE CONTAINERS & MODULES

SAFE STORAGE AND TESTING IN LABORATORIES

EXPLOSIVES HANDLING WORKBENCHES

SAFE STORAGE AND TESTING IN LABORATORIES

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