OZM RESEARCH
Instruments & Technologies for Energetic Materials

CA 20L

INSTRUMENT FOR MEASUREMENT OF EXPLOSION PARAMETERS OF COMBUSTIBLE DUSTS, GASES, VAPORS AND HYBRID MIXTURES - FULLY AUTOMATED VERSIONS

Product Datasheet

TEST PRINCIPLE

Spherical explosion chamber with the internal volume of 20 liters is typically used for the measurement of explosion parameters of dust dispersions. Dust sample is dispersed from its reservoir into the evacuated explosion chamber by an air pulse and the created dust dispersion is ignited with the defined delay. Build up of the pressure inside the explosion chamber is measured and evaluated for the maximum pressure and maximum rate of pressure rise. Using the Cubic Law, maximum measured rate of the pressure rise is converted into K_{st} value. Varying the dust concentrations allows for finding out the maximum values of measured parameters together with the lowest dust concentration still producing an explosion after ignition – Lower Explosion Limit (LEL). Besides the dust explosions, the unique design of this instrument allows for measurement of the explosion parameters of gases, vapors and hybrid mixtures as well. Fully automated version of this equipment provides for the maximum convenience in its operation.

APPLICATIONS

Testing explosion parameters of dusts, gases, vapors or hybrid mixtures in the 20 liter explosion chamber is critical for correctly preparing safety procedures and designs of explosion – proof equipment and technologies processing these combustible materials. Recorded maximum explosion pressure shall be reflected in design of the equipment to survive the accidental explosions without damage. Maximum rate of pressure rise is important for design of fast ventilation or explosion mitigation means limiting the damage from the accidental explosions. The possibility of dust explosion could be eliminated by ensuring that LEL is not exceeded. The testing is usually done by certified bodies, universities, research organizations and processing plants.

OZM Research s.r.o
Bližňovice 32, 538 62 Hrochův Týnec, Czech Republic, European Union
Tel: +420 608 742 777, Fax: +420 469 692 882, E-mail: ozm@ozm.cz

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TESTING STANDARDS

The instrument complies with the following standards:

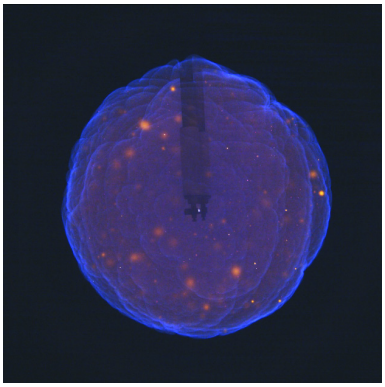
- **EN 14034 (1–3)** for measurement of maximum pressure, rate of pressure rise, lower explosion limit (LEL) and limiting oxygen concentration (LOC)
- **ISO/IEC 80079–20–2:** Explosive Atmospheres – Part 20–2: Material characteristics – Combustible dusts test methods
- **ASTM E1226:** Standard Test Method for Explosibility of Dust Clouds
- **ASTM E1515:** Standard Test Method for MEC – minimum explosible concentration of combustible dusts
- **VDI 2263:** Dust Fires and Dust Explosions (Hazard – Assessment – Protective Measures)

Optionally equipped also to comply with:

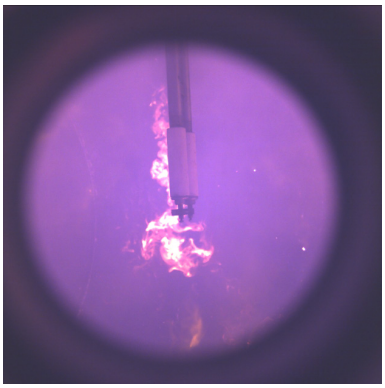
- **EN 14034–4** for measurement of limiting oxygen concentration (LOC)
- **EN 15967** (maximum pressure and rate of pressure rise) – gas and vapors
- **EN 14756** (LOC) – gas and vapors
- **EN 1839** (explosion limits) – gas and vapors

MAIN FEATURES AND ADVANTAGES

- The chamber can be used not only for dust explosions, but with the optional equipment also for gases, vapors and hybrid mixtures.
- Fully automated and remotely controlled machinery provides much higher precision and repeatability of gas dosing than can be achieved with simpler dosing with manually–operated valves and human control.
- The higher dosing precision and repeatability provided by the automated version is critical especially for LOC measurements, gas and hybrid explosions, where it strongly influences the relevancy of the results.
- Robust design with a large entry with a diameter of 145 mm for comfortable cleaning of the chamber´s internal surface.
- Stainless–steel arm with pneumatic support for easy opening and closure of the lid.
- Cooling or heating jacket and a labyrinth in the lid for experiments up to temperature of 200 °C.
- Vacuum pump for chamber evacuation prior to dust dispersion or gas atmosphere preparation.
- Thermocouple for measurement of the temperature in the chamber necessary for checking of the Standard or set conditions.
- 10 J capacitive spark generator as an optional alternative for chemical ignitors of dust explosions.
- Optional permanent spark generator for igniting gases, vapors and hybrid mixtures.
- Optional measurement of the explosion flash duration and intensity by optical sensors, helpful for ignition time and ignition quality monitoring.



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



Afterburning of 9.5 % by vol. of methane in air

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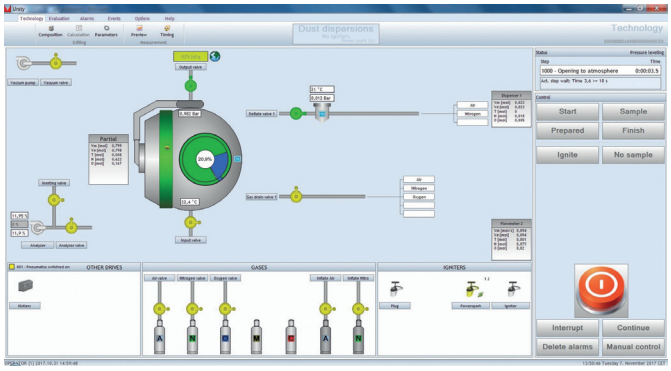
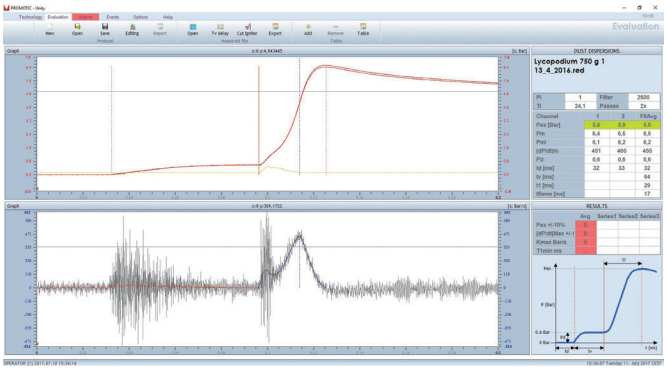


Technological window used for monitoring and/or control of test setup



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

TECHNICAL PARAMETERS

Explosion chamber:	spherical stainless–steel double–walled, 20 litre volume
Operating (dynamic) pressure:	up to 30 barg
Static testing pressure:	42 barg
Maximum rate of pressure rise:	at least 4000 bar/s
Maximum initial pressure:	2 bara
Allowed oxygen concentration:	up to 25 %
Electronic and pneumatic control:	Siemens PLC Simatic
User interface:	PC with software for test preparation, measurement, data evaluation and storage
DAQ:	4 channels, sampling rate up to 800 kilosamples/s/channel; recording time > 5 s for recording pressure, temperature and explosion flash optical output
Fast outlet valve opening time:	less than 20 ms
Ultimate vacuum (standard configuration):	70 mbar
Adjustable ignition delay allowing for the measurement under different initial turbulence levels	
Pressure–resistant glass window for observation of the experiments	

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STANDARD INSTRUMENT PARTS

Part No.:	Description:
CA20L-A	20-LITRE EXPLOSION CHAMBER Spherical pressure chamber (stainless steel): 20 l ◦ lid with a safety lock ◦ jacket for vessel temperature control ◦ electrodes ◦ pressure gauge ◦ thermocouple for temperature measurement inside chamber Supporting stand with lid manipulator Dust dispersion system including pressure vessel for the dust sample, pressure gauge, fast acting valve for dust dispersion, rebound and dispersion tube nozzles Firing module for chemical igniters Strain-gauge pressure measurement unit including 2 pressure sensors, amplifiers and 4-channel DAQ Electronic and pneumatic control panel Pneumatic valves Diaphragm vacuum pump Software for measurement setup, data recording and evaluation Accessories
DAEU-17HD	Notebook PC with the following minimum specification: Intel Pentium Dual Core Processor 2.0 GHz, Microsoft Windows 10 x64, 4 GB RAM, 17" full HD display, 500 GB HDD, DVD RW, WLAN 802.11 b/g/n, LAN 10/100/1000, USB 2.0/3.0, USB mouse, one license of Acronis True Image (a professional backup software),64 GB USB flash drive

OPTIONAL EQUIPMENT COMMON FOR ALL EXPERIMENTS

Part No.:	Description:
CA-LOC	LOC measurement: pneumatic valves for nitrogen dosage into dust reservoir and chamber pressure reducing valves
CA-Oxy	Oxygen concentration measurement: oxygen detector, filter, pump, flow meter, nitrogen inertization
CA-OPT	Flash duration measurement unit
AQP-Kistler	Piezoelectric pressure measurement unit of Kistler

OPTIONAL EQUIPMENT FOR DUST EXPLOSIONS ONLY

Part No.:	Description:
IGN-10J	10 J spark generator – alternative to chemical igniter: adjustable in the range of 1 – 10 J, PLC controlled
Ju-F250	Thermostatic cooling unit

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OPTIONAL EQUIPMENT FOR GAS/VAPORS AND HYBRID MIXTURES EXPLOSIONS ONLY

Part No.:	Description:
IGN-PSG	Permanent spark generator: HV supply, electronics with processor
CA 20L-GLA	System for gas/vapor atmosphere and hybrid mixture preparation: connections to chamber equipped by pneumatic valves, stirrer with electric drive Automatic system for vapour explosion atmosphere preparation: pressure container for liquids together with dispersing nozzle for liquids
CA-Heat	System for jacket´s temperature control: depending on the customers request

CONSUMABLES

Part No.:	Description:
HV-E	HV electrode (tungsten) – 100 pcs for 10 J spark generator and/or permanent spark
JU-TBF	Thermal bath fluids: depending on the customers request

INSTALLATION REQUIREMENTS

Testing site:	
Working room requirements:	Width x Length x Height: 230 x 230 x 260 cm
Weight of the instrument:	approx. 400 kg
Acess path:	Width x Height: min. 90 x 200 cm
Temperature and humidity:	21 °C ± 5 °C, RH 20 – 80 %, non-condensing
Source of pressurized air:	1) min. 7 bar, 20 l/min for instrument control 2) min. 22 bar, 25 l/min as a dispersion air (dried and oil-free)
Source of nitrogen (only for LOC measurements):	min. 22 bar and 25 l/min
Stable electric power source:	230 V / 50 Hz, 1 x 16 A, 3680 W (110 V / 60 Hz, 1 x 30 A, 3000 W upon request)
The explosion chamber together with electric distributor must be placed on the safe place and controlled remotely to protect the operator	
Fume hood or local exhaust connection for ventilation of explosion products from the chamber	
Source of cooling water (minimum flow of 0,5 liters/min) or (optionally) closed-circuit chiller for repeated experiments at laboratory temperature	

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INSTALLATION REQUIREMENTS

Control room for operators:

Safe place within 10 m from the chamber, with an office furniture	
Temperature and humidity:	21 °C ± 5 °C, RH 20 – 80 %, non–condensing

Space for sample preparation:

Instruments for weight and (optionally) density and particle size measurement of samples	
Measurement of barometric pressure, laboratory humidity and temperature	

Sample ignition:

Chemical igniter in accordance with EN 14034, e.g. Sobbe, Simex (if not using optional 10 J spark generator or permanent spark generator)	

MANUFACTURING NOTE

The product is manufactured according to relevant EU directives and manufacturing standards.

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