KSEP20L-CAN

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History

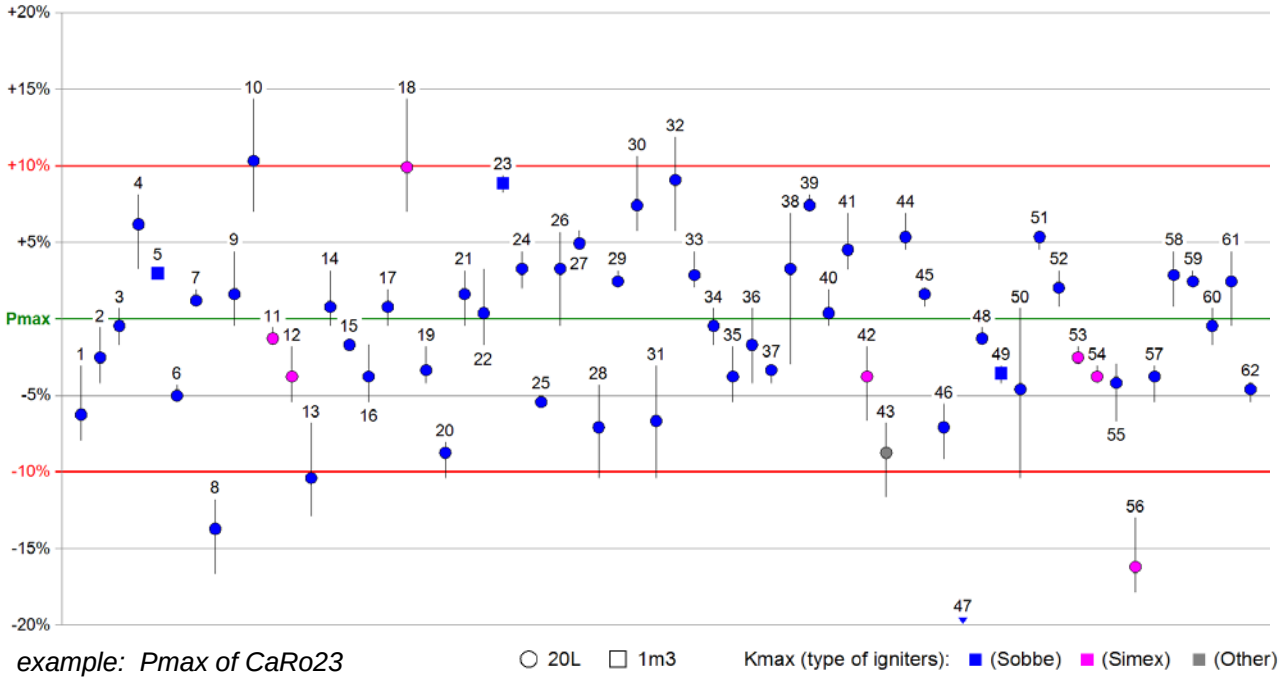
The 20-liter apparatus was developed in collaboration with Ciba-Geigy (Lütolf, Bartknecht, Siwek). This is why it is also known today as the Siwek sphere. The test method was developed by Ciba-Geigy and the apparatus by Kühner AG (Cesana). Our 20-liter apparatus quickly found its way into the following standards:

ASTM E1226: Explosibility of Dust Clouds
ASTM E1515: Minimum Explosible Concentration MEC of Combustible Dusts
ASTM E2931: Limiting Oxygen Concentration LOC of Combustible Dusts
EN 14034-1: Determination of max. explosion pressure Pmax …
EN 14034-2: Determination of max. rate of explosion pressure rise $(dP/dt)_{max}$ …
EN 14034-3: Determination of the lower explosion limit LEL …
EN 14034-4: Determination of the limiting oxygen concentration LOC …
EN ISO/IEC 80079-20-2: Material characteristics. Combustible dust methods

Kühner AG discontinued the production of safety testing equipment at the end of 2016. These products will be continued by Cesana AG and, from 2025, together with REMBE© Research+Technology Center GmbH.

Calibration-Round-Robin CaRo

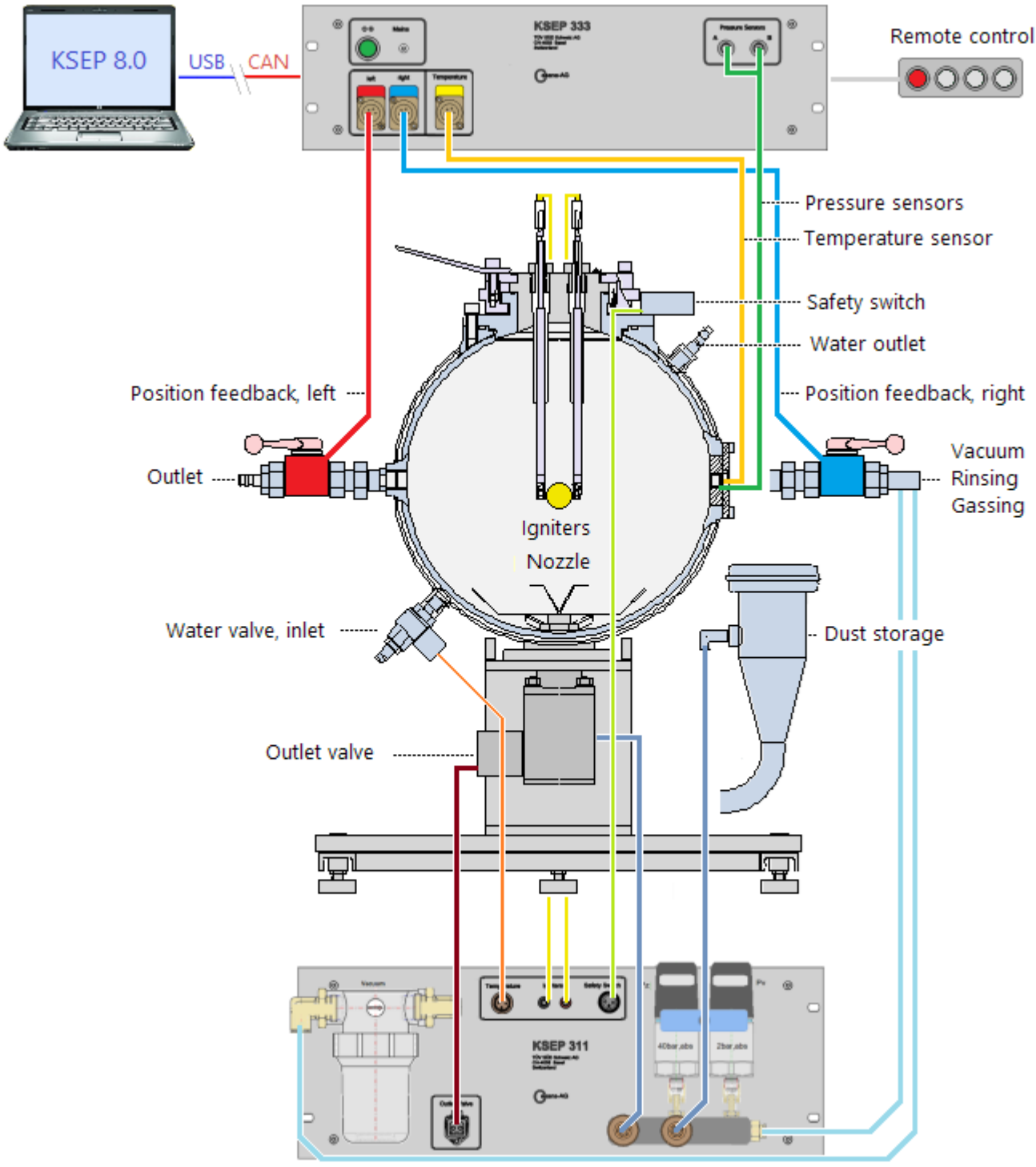
According to the standards, the 20-liter apparatus must be calibrated at regular intervals. For this reason, we have been carrying out an international calibration round robin (CaRo) periodically since 1993. Our experience with the calibration round robin was the guideline for the development of the new 6th generation instrumentation: improved test quality and simplified operation.



example: Pmax of CaRo23

New instrumentation for 20-liter apparatus

Over the almost 5 decades, the instrumentation has always been adapted to the state of the art. The aim has always been full backwards compatibility. Equipment from 1976 onwards can be brought up to date.

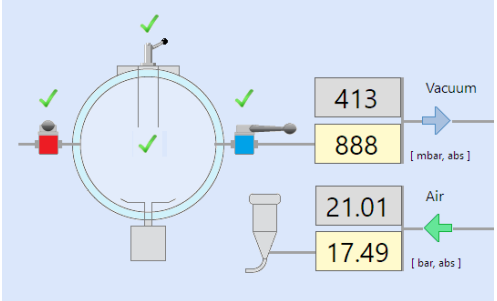


Principle of new instrumentation

Absolute pressure measurement

The explosion parameters Pmax and Kmax are proportionally influenced by the initial pressure **Pi**, the pressure at the time of ignition. According to the standards: *Pi = 1013 mbar = normal pressure.*

The scattering of Pmax in the image "Pmax of CaRo23" is mainly due to deviations from Pi.



Instead of the analog and relative pressure display for sphere and dust storage, **absolute** and **digital** measurements are now used. Errors caused by the barometric ambient pressure are eliminated.

Evacuation of the sphere and filling the dust storage take place automatically

The results of the preparation are displayed in addition to the explosion characteristics. The absolute initial pressure Pi is calculated from the measured values of Pv and Pz.

dP/dt Test: 49 (3) 125 [g/m3]

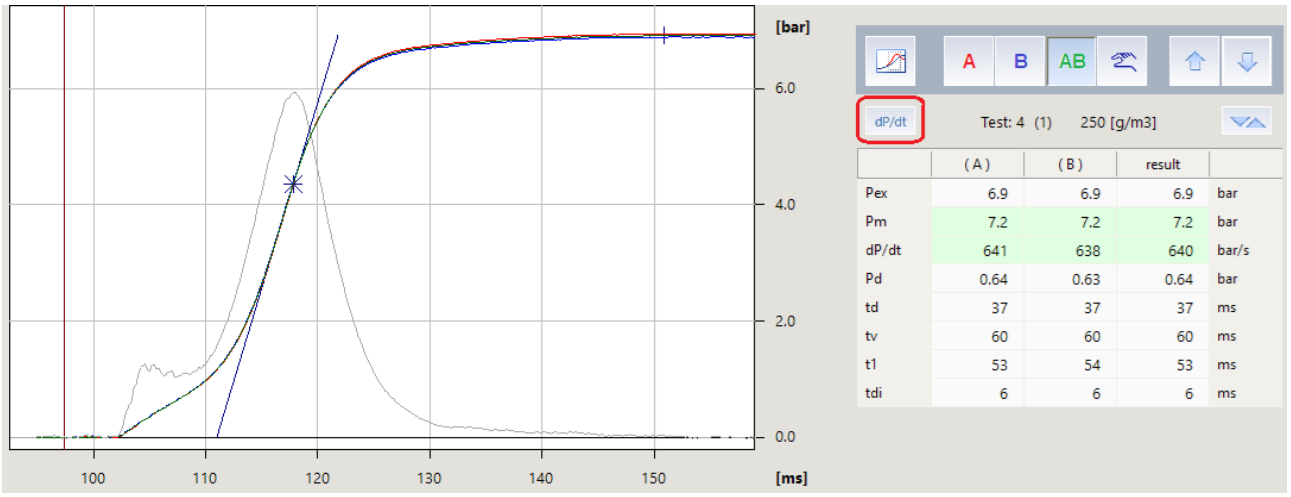
	setpoint	effective	FS [%]
Pv vacuum [mbar]	413	410	-0.3
Pz air [bar]	21.01	21.07	0.3
Pi calculated* [mbar]	1013	1012*	

Dynamic pressure measurement

Although the pressure curves are still measured relatively using the robust and proven Kistler piezo pressure transducers, the absolute initial pressure is known and is taken into account during recording. The new Kistler charge amplifiers have a digital design and communicate with the KSEP333 via IO-Link.
As before, the Pex and Pm values are given as gauge pressure. However, they can be related to a normal pressure of 1013 mbar.

Pressure rise dP/dt

For the decision "ignition / no ignition" for LEL and LOC, the representation of dP/dt can be useful (see ASTM standards) and helps to differentiate between "igniter" and "dust explosion".



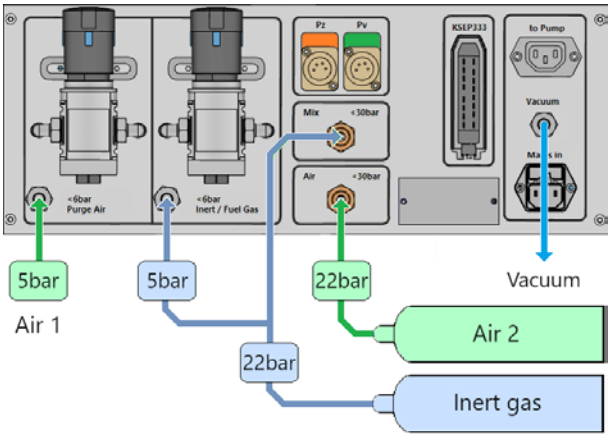
	(A)	(B)	result	
Pex	6.9	6.9	6.9	bar
Pm	7.2	7.2	7.2	bar
dP/dt	641	638	640	bar/s
Pd	0.64	0.63	0.64	bar
td	37	37	37	ms
tv	60	60	60	ms
t1	53	54	53	ms
tdi	6	6	6	ms

Limiting Oxygen Concentration (LOC)

Thanks to the precise and absolute pressure measurement in the sphere and dust storage, it is possible to produce the desired air/inert gas mixture using the partial pressure method.

Only one inert gas cylinder is required. Favorable inert gas cylinders contain a residual oxygen content. This is taken into account in the calculation.

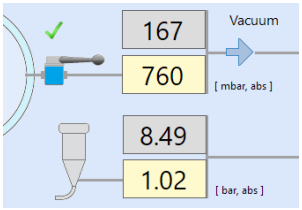
The gas mixtures are created automatically.



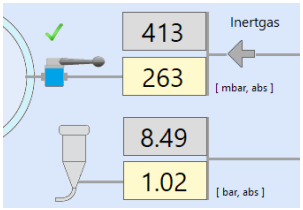
Example:
Set point O_2 = 9% (Inertgas oxygen = 1%)

Sphere (Pv) | Dust storage (Pz)

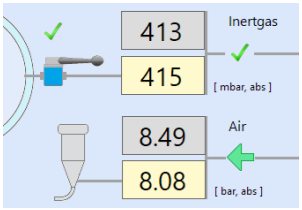
1. evacuate



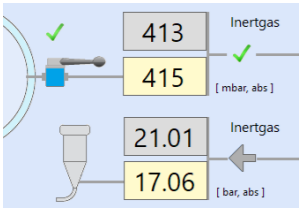
2. fill inertgas



3. fill air



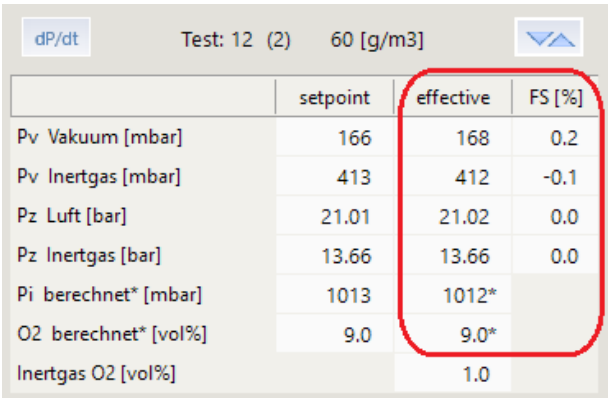
4. fill inertgas



Inaccuracies during preparation and leaks in the sphere can influence the mixture. The effective gas mixture can be calculated by precisely measuring the absolute pressures in the sphere and dust storage.

In contrast to the previous partial pressure method, the same mixture is now prepared in the dust storage and sphere.

This also applies to the "hybrid mixture" and "gas" test methods.



	setpoint	effective	FS [%]
Pv Vakuum [mbar]	166	168	0.2
Pv Inertgas [mbar]	413	412	-0.1
Pz Luft [bar]	21.01	21.02	0.0
Pz Inertgas [bar]	13.66	13.66	0.0
Pi berechnet* [mbar]	1013	1012*	
O2 berechnet* [vol%]	9.0	9.0*	
Inertgas O2 [vol%]		1.0	

Temperature control

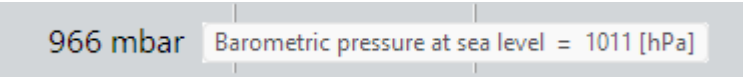
According to ISO/IEC 80079: Initial temperature = 20°C ± 5°C
The jacket temperature is continuously measured, controlled and transferred to the table for each test.
Connection for an external solenoid valve for simple on/off control of the cooling water flow and thus the jacket temperature. This significantly reduces the consumption of cooling water.

Safety

By monitoring the position of the two ball valves (outlet and vacuum), the operator is guided through the test sequence and protected against incorrect operation.

Calibration of static pressure measurement „Pv“

When installing the software, the altitude above sea level of your device must be entered. The current static pressure is then converted to sea level and displayed. Calibration is carried out by comparison with the current meteorological data.



Calibration of pre-chamber pressure „Pz“

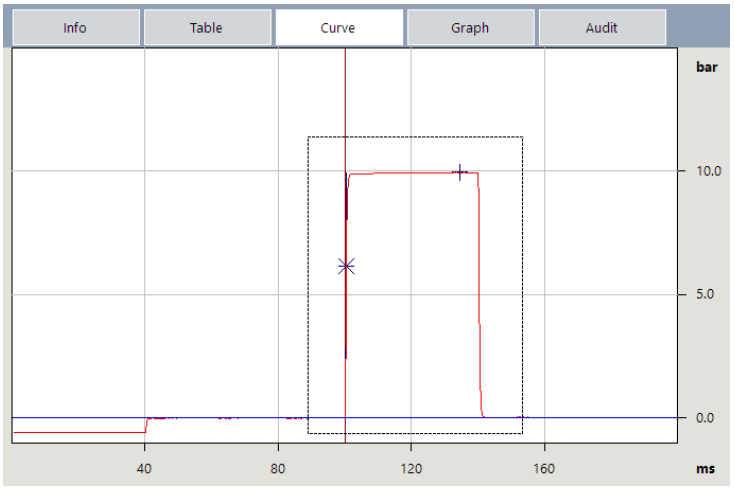
After an empty test without dust and igniter, Pi = 1013 mbar = normal pressure must be present in the sphere. This is measured with the static pressure measurement (Pv). Calibration chain: Meteodata → Pv → blank test → Pz

Calibration of dynamic pressure measurement

The sensitivity of the pressure sensors [pC/bar] is set digitally via IO-Link.

The system consists of 2 independent measuring channels. As long as both match, it can be assumed that the measured values are correct. If they do not match, the charge amplifier can be easily checked:

A generator for testing with a rectangular charge signal is built in.

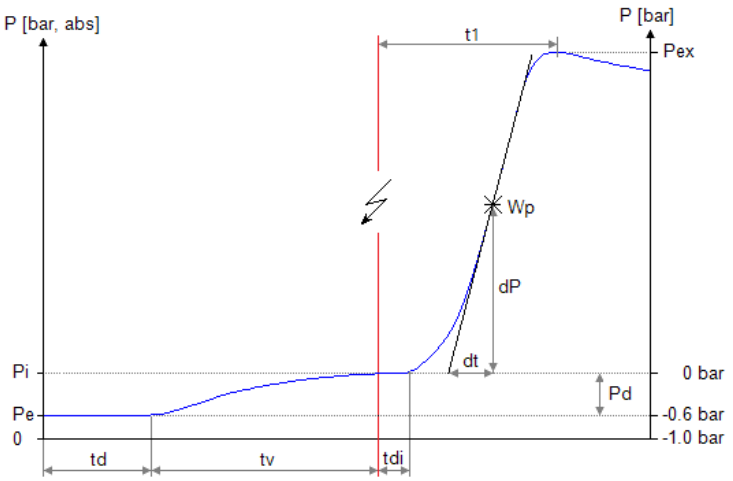


New control parameter „tdi“

Time delay of the ignitors = time difference between the electrical energization of the ignitors and the first pressure raise.

Carbonized coating on the electrode rods is a poor conductor and reduces the current flow to the ignitors. As a result, the ignition pills are activated with a delay. If the maximum permissible time delay is exceeded, an error message is issued.

Unfortunately, this error is often observed when evaluating CaRo ring tests.



Technical data:	20-l-Sphere
Material of construction No.:	1.4435
Volume of sphere:	20 liters
Volume of water jacket:	1,5 liters
Design pressure of sphere:	30 bar (60°C)
Design pressure of jacket:	10 bar (60°C)
Test pressure of sphere:	42.9 bar
Test pressure of jacket:	15.8 bar
Design temperature:	60 °C
Bayonet ring aperture Ø:	96 mm
Cleaning aperture Ø:	140 mm
Sight glass Ø:	30 mm

Control unit KSEP333	
PC-Software	KSEP 8.0
Dispersion pressure (Pz)	absolute, digital
Pressure in the sphere (Pv)	absolute, digital
Measurement pressure curve	relative, digital
Temperature measurement	digital
Charge amplifiers	Kistler 5028A
Interface to PC	CAN - USB
Mains connection	100 … 240VAC

Order data

SP3003	Complete test equipment KSEP20L-CAN
SP30031	Upgrade: KSEP20L → KSEP20L-CAN comprising: Electronics unit KSEP333-CAN Pneumatic unit KSEP311 Accessories
SP30333	Upgrade: KSEP33x → KSEP333-CAN Without pneumatic unit KSEP311. (No absolute pressure measurement)

References

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Siwek. R.	Explosion Characteristics and Influencing Factors, International Symposium on Control & Prevention of Dust Explosions, Basel, 1982
Siwek. R.	Reliable Determination of the Safety Characteristics in 20-l-apparatus. Symposium on Flammable Dust Explosion; St. Louis Missouri, USA, 1988
Cesana C. Eiche M. Schwaninger M.	Quality Management in the Determination of Safety Characteristics Chemical Engineering Vol.75, 2019
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