

MIKE 3 CAN



TÜV SÜD Schweiz AG (Distribution)
 Mattenstrasse 24, CH-4002 Basel, Switzerland
www.tuev-sued.ch products.bs@tuev-sued.ch

Cesana AG
 Baiergasse 56, CH-4126 Bettingen, Switzerland
www.cesana-ag.ch info@cesana-ag.ch

Author: Christoph Cesana

Apparatus for determining the minimum ignition energy:

MIKE 3 CAN New and improved version of the previous MIKE 3
 Test condition: atmospheric

MIKE 4 Extended apparatus for tests under the following conditions:
 Atmospheric, high temperature, reduced oxygen content

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Please read this note!



Attention: Please read this safety instruction carefully!

1. Fundamentals

1.1 Introduction

For an assessment of the hazard situation in dust-processing installations, knowledge of the minimum ignition energy is indispensable. This value can possibly determine the extent and hence the cost of protective measures.

The minimum ignition energy (MIE) is understood to mean the lowest energy value of a high-voltage capacitor discharge required to ignite the most ignitable dust/air mixture. The dust concentration and the ignition delay time must be systematically varied until a minimum value of the ignition energy is found. With MIKE 3 CAN all tests are performed at atmospheric pressure and room temperature.

1.2 Influencing quantities

Detailed investigations have shown that the minimum ignition energy of a combustible dust is influenced by the following parameters:

1.2.1 Inductance in the discharge circuit

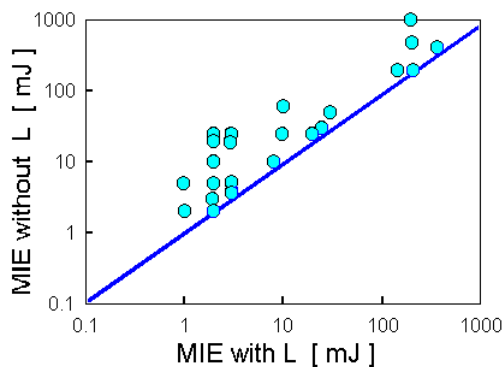


Fig. 1.2.1:
Influence of the Inductance on
the minimum ignition energy

By definition, minimum ignition energy data refer to protracted capacitor discharges. These are generally clearly more incendive than purely capacitive discharges. The results obtained under such conditions can only be applied to operational conditions if the capacitors occurring in plant installations are also discharged via an inductance. Hence, if the incendivity of electrical discharges -especially of electrostatic discharges - with regard to dust/air mixtures is to be assessed, the minimum ignition energy must also be determined without an inductance in the discharge circuit. As Fig. 1.2.1 shows, the effect of this influencing factor is not straightforward, but varies and is dependent on the type of dust.

1.2.2 Turbulence, ignition delay time

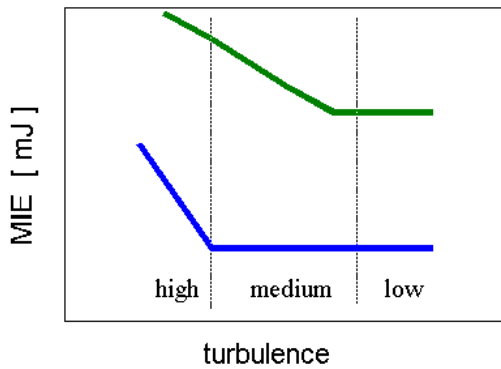


Fig. 1.2.2: Influence of ignition delay time on the minimum ignition energy

Easily the simplest measure of the turbulence of the dust/air mixtures is the ignition delay time t_v between actuation of the outlet valve and the sparkover. Short ignition delay times result in a high turbulence, long delay times in a low turbulence. The determination of the MIE should be performed with as low a turbulence as possible. If times are too long, separation of the dust can occur and the result is no longer meaningful.

The optimum ignition delay time which results in the lowest value of the MIE is not constant, but depends on the dust sample. The ignition delay time must therefore be varied step by step until the minimum value of the ignition energy is found.

1.2.3 Particle size, median value

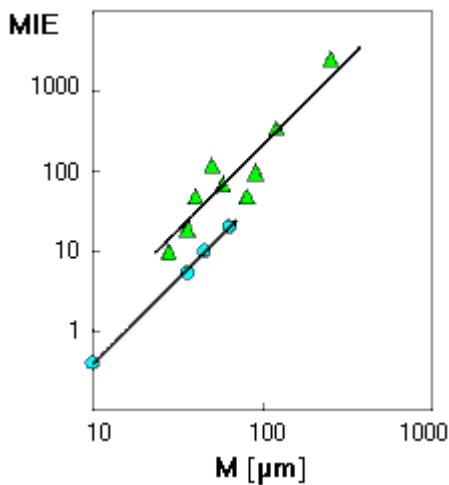


Fig. 1.2.3: Influence of the median value on the minimum ignition energy

The particle size or the median value can have an appreciable influence on the minimum ignition energy. This energy limit value increases with the cube of the median value of a dust. The finer a dust, the easier it can be ignited.

This model calculation has only limited applicability. The following estimation is more conservative and in practice produces a better agreement with the experimental results:

$$MIE_2 = MIE_1 \cdot (M_2 / M_1)^{2.5}$$

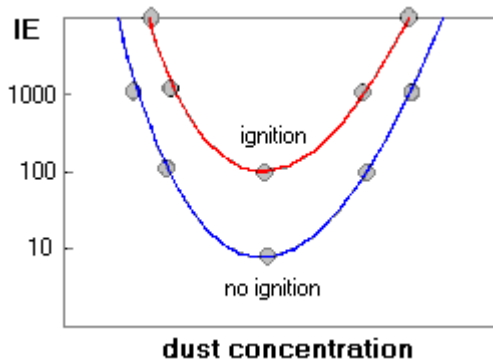
Index 1: measured

Index 2: estimated

see MIKE-Software:

[Calculate / MIE - influence of Median](#)

1.2.4 Dust concentration



There is a parabolic relation between the dust concentration and the ignition energy. The MIE has therefore to be determined over a wide range of dust concentrations.

Fig. 1.2.4: Influence of the dust concentration on the ignition energy

1.2.5 Temperature

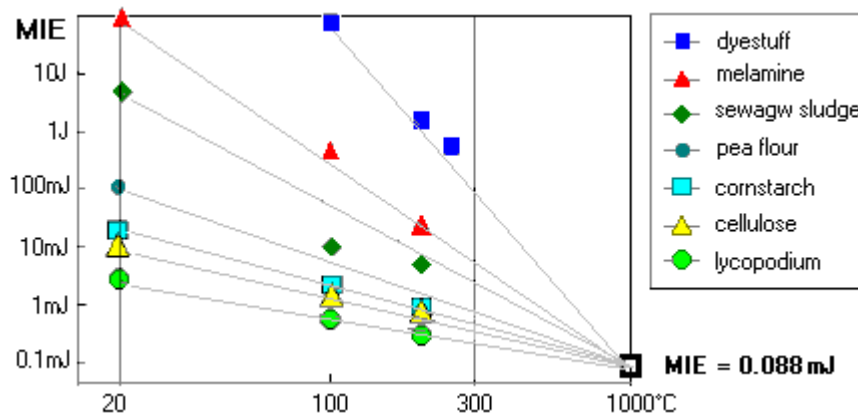


Fig. 1.2.5: Influence of the temperature on the minimum ignition energy

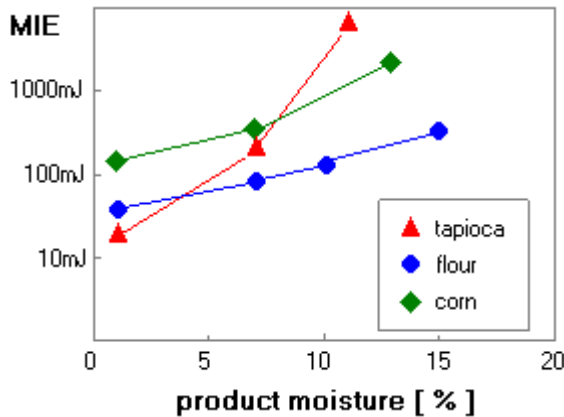
The minimum ignition energy is also influenced by temperature. It is lowered by an increase in temperature to an extent which depends on the ignitability of the dust. A dust which is difficult to ignite shows a more pronounced effect than one which is readily ignited. As a result, a log-log plot comprises straight lines which meet at a point (1000°C; 0.088 mJ). If the minimum ignition energy of a dust is known at room temperature, a straight line connecting this point with the intersection point mentioned above thus describes the temperature dependence of the minimum ignition energy of the dust up to temperatures of 300°. The following equation can be used to estimate the MIE in a temperature range from 25 to 300°C:

$$MIE(T) = 10^{-4.056 + (1.873 - 0.624 \log T) \cdot (\log MIE(25^\circ\text{C}) + 4.056)}$$

T [°C], MIE [J]

see MIKE-Software: [Calculate / MIE - influence of Temperature](#)

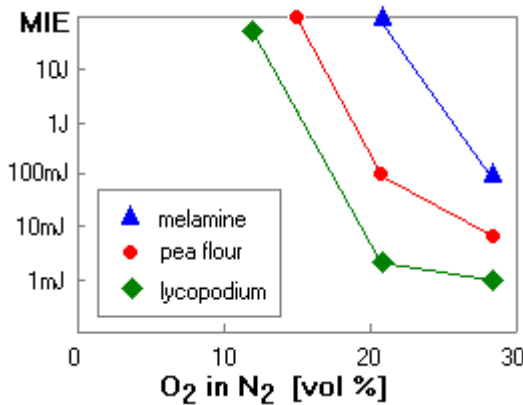
1.2.6 Product moisture (water content)



As the adjacent plot shows, the influence of the moisture content on the minimum ignition energy of a dust depends on the dust. In general, it appears that below 5% the influence is slight, whereas above 10% the value of the minimum ignition energy is increased by around 1 (one) power of ten or more.

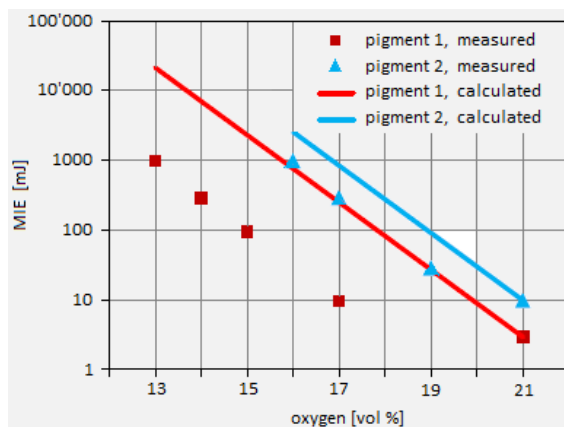
Fig. 1.2.6: Influence of the moisture content on the minimum ignition energy

1.2.7 Oxygen concentration



The O₂ content of the combustion air has a decisive influence on the minimum ignition energy (see adjacent plot). In a semi logarithmic plot, the MIE rises linearly, especially at low oxygen concentrations. This rapid decrease in the ignitability or increase in the MIE is primarily due to the addition of nitrogen, which has an inerting effect. With increasing oxygen concentration, on the other hand, the curves tend to flatten out reflecting a lowering of the rate of decrease of the minimum ignition energy.

Fig. 1.2.7a: Influence of the O₂ content of the combustion air on the MIE



Studies on the behavior of the minimum ignition energy under oxygen-reduced atmospheres were published by Glor and Schwenzfeuer. They examined 22 different types of dust in a MIKE 3 and developed an estimation method for this purpose.

see MIKE-Software:
[Calculate / MIE - influence of Oxygen](#)

Bild 1.2.7b: Influence of the O₂ content of the combustion air on the MIE

1.2.8 Addition of flammable gases

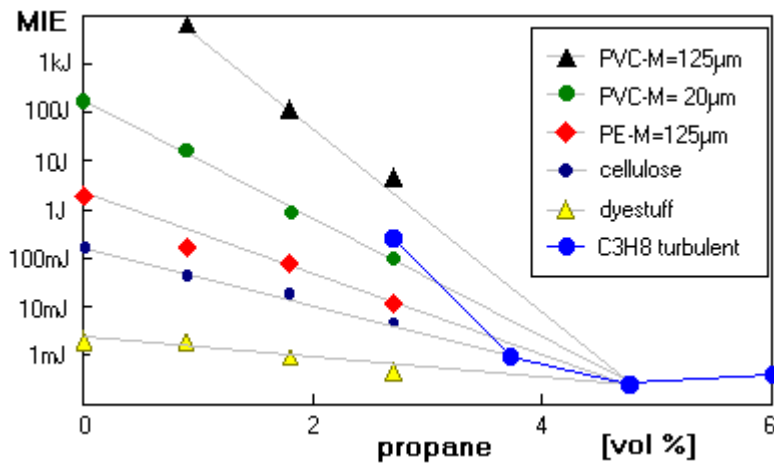


Fig. 1.2.8: Influence of the addition of flammable gas on the MIE

The addition of flammable gases (solvent vapours) to the combustion air lowers the minimum ignition energy of combustible dusts and this lowering is greater the more difficult they are to ignite. A semi logarithmic plot of the MIE against the added flammable gas content results in straight lines which meet at a point characteristic of the minimum ignition energy of the particular flammable gas.

see MIKE-Software:

[Calculate / MIE - influence of Gas](#)

1.3 Test procedure

International agreement has been reached regarding the test procedure for the determination of the minimum ignition energy:

1.3.1 Test procedure, general

The energy just sufficient to ignite the dust under investigation is determined. This ignition energy is then successively halved with **variation** of the **dust concentration** and the **ignition delay time** (turbulence) in a series of tests until no ignition takes place in **at least 10** successive experiments. The minimum ignition energy MIE lies between the lowest energy value (E2) at which ignition occurred and the energy (E1) at which in at least 10 successive experiments no ignition was observed.

The energy range thus determined is called the minimum ignition energy of a combustible dust in admixture with air. However, for purposes of simplification often only the lower limit value (E1) is specified as the minimum ignition energy MIE.

$$E1 < MIE < E2$$



To assess the ignition hazard for dust/air mixtures due to operational spark discharges, especially electrostatic discharges, the minimum ignition energy MIE must be determined with a purely capacitive spark discharge (without inductance) by the method described above.

In the case of fuel gases, the inductance generally has no influence on the MIE. Highly flammable dusts often show the same behavior.

1.3.2 Statistic energy (Es)

For the purpose of comparison between different apparatus, only one statistic MIE value (Es) instead of the energy range (E1, E2) should be used. This single value (Es) can be estimated by the use of the probability of ignition as follows:

$$Es = 10^{(\log E2 - I[E2] \cdot (\log E2 - \log E1) / ((NI+I)[E2] + 1))}$$

where is: $I[E2]$ = number of tests with ignition at the energy E2.

$(NI+I)[E2]$ = total number of tests at the energy E2.

e.g.

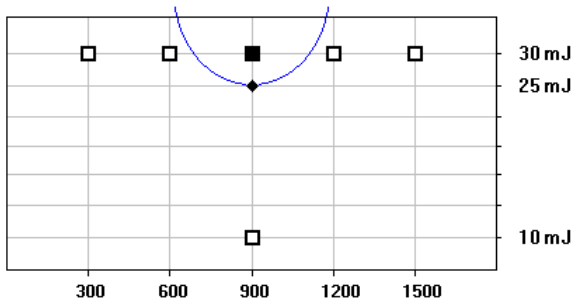
IE \ mg	300	600	900	1200	1500	probability
E2 = 30 mJ	NI	I	I	I	NI	→ 3 of 5
E1 = 10 mJ		NI	NI	NI		

$$Es = 10^{(\log E2 - 3 \cdot (\log E2 - \log E1) / (5 + 1))} = 17 \text{ mJ}$$

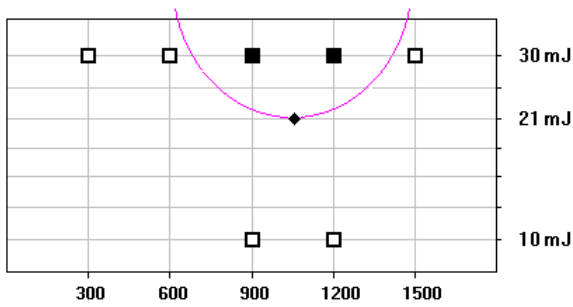
where is: **I** = ignition of dust

NI = no ignition of dust in 10 trials

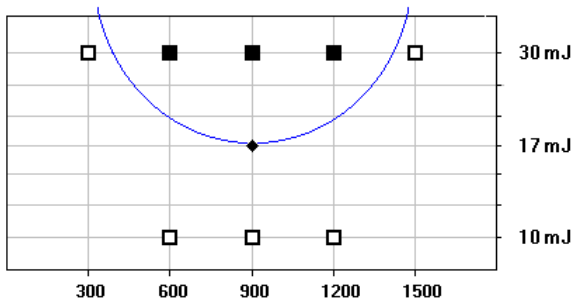
1.3.3 Examples for test procedure and statistic energy (Es)



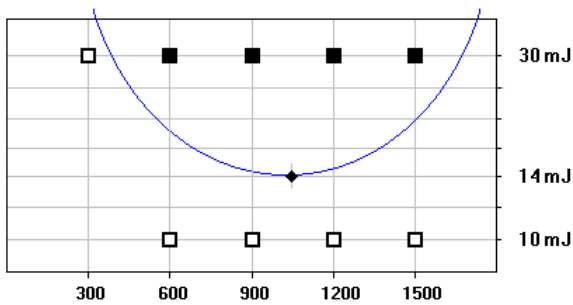
$E2 = 30\text{mJ} / E1 = 10\text{mJ}$
 probability of ignition = 1 of 5
 $E_s = 25\text{mJ}$



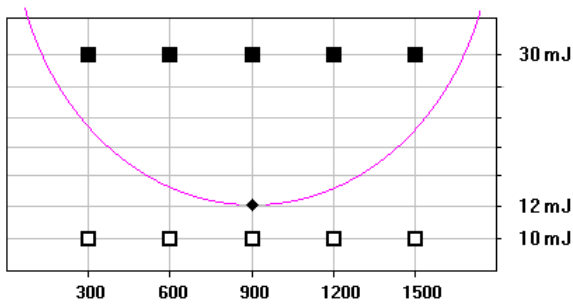
$E2 = 30\text{mJ} / E1 = 10\text{mJ}$
 probability of ignition = 2 of 5
 $E_s = 21\text{mJ}$



$E2 = 30\text{mJ} / E1 = 10\text{mJ}$
 probability of ignition = 3 of 5
 $E_s = 17\text{mJ}$



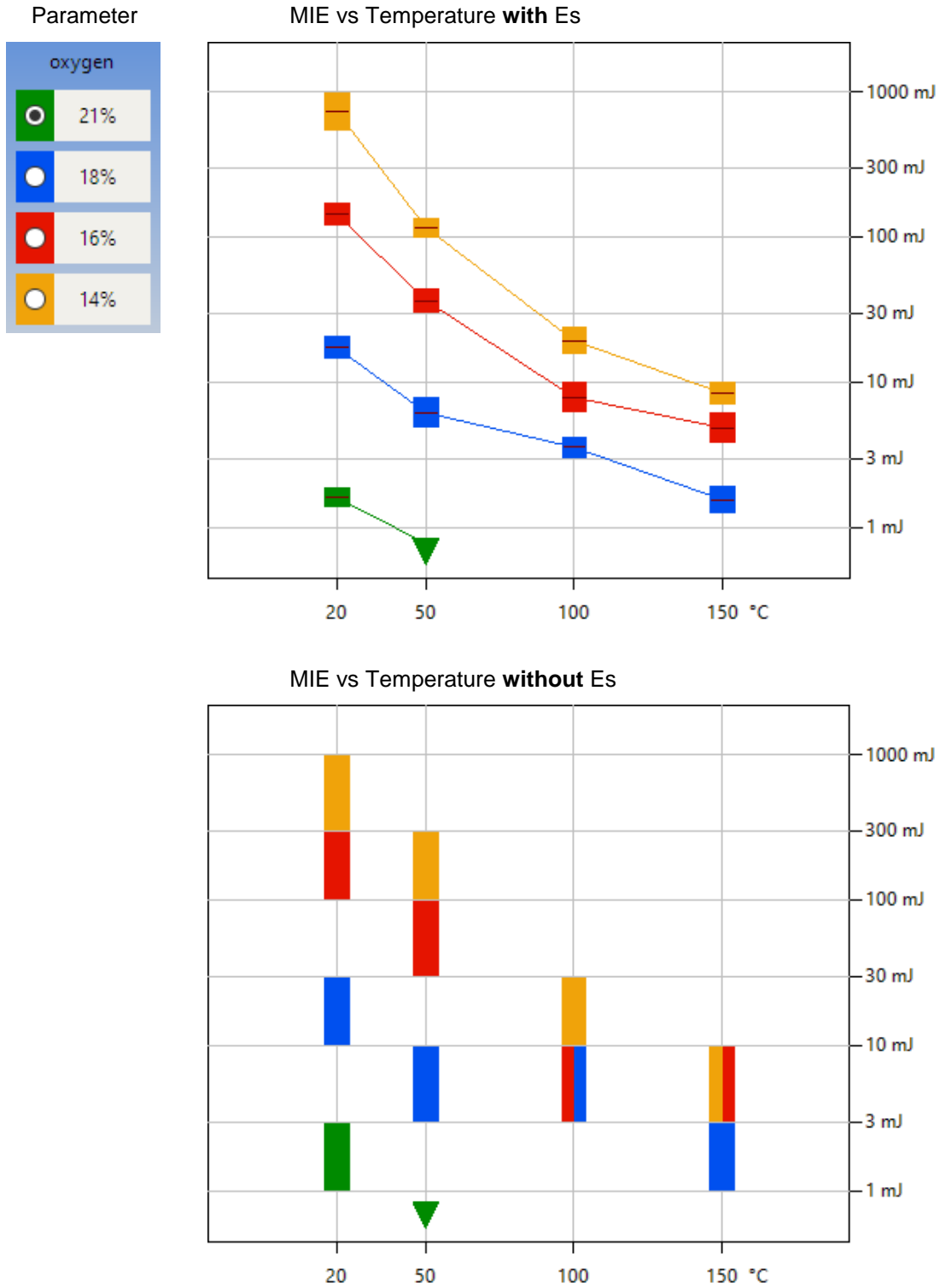
$E2 = 30\text{mJ} / E1 = 10\text{mJ}$
 probability of ignition = 4 of 5
 $E_s = 14\text{mJ}$



$E2 = 30\text{mJ} / E1 = 10\text{mJ}$
 probability of ignition = 5 of 5
 $E_s = 12\text{mJ}$

1.3.4 Statistic energy (Es) under non-atmospheric test conditions

The following series of measurements with the CaRo test dust Niacin show very nicely the advantage of the statistic energy Es for the representation of the minimum ignition energy under non-atmospheric test conditions.



1.4 Test apparatus MIKE 3

Based on the findings discussed in section 1.2, it has been internationally agreed that an apparatus for the determination of the minimum ignition energy of combustible dusts must fulfill the following minimum conditions:

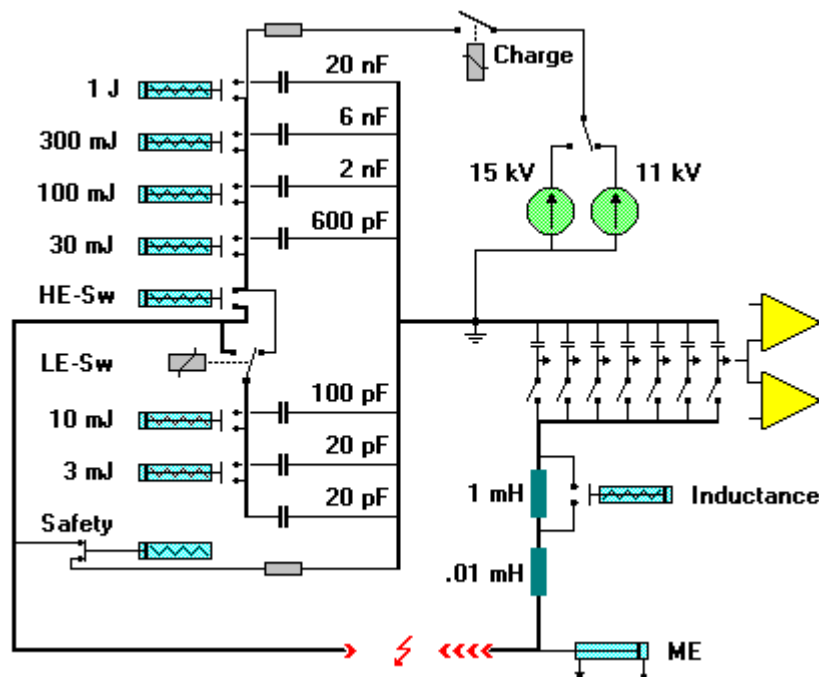
- with an inductance in the discharge circuit: $L = 1 \text{ mH} - 2 \text{ mH}$
- without an inductance in the discharge circuit: $L \leq 0.025 \text{ mH}$
- electrode material: tungsten or stainless steel
- electrode diameter: $d = 2 \text{ mm}$
- electrode spacing: at least 6 mm

A modified Hartmann tube made of glass with a volume of 1.2 liter is used as the explosion vessel. The dust dispersion system at the base of the tube is of the "mushroom-shaped" type around which the sample is loosely scattered. A blast of compressed air at 7 bar is used to disperse the dust in the glass cylinder where it is ignited by a spark between two electrodes.

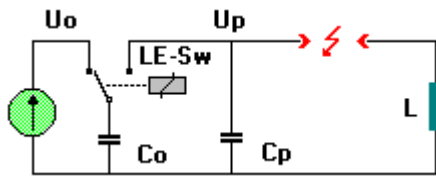
Experiments have shown that dust/air mixtures can easily have MIE values less than 10 mJ. The measurement range of the MIKE 4 has thus been specially designed for the lower energy values. Due to pneumatically actuated high-voltage switches, the parasitic capacitances have been reduced by an order of magnitude.

A further improvement of the test equipment has been achieved by direct assembly of the capacitor discharge apparatus with the modified Hartmann tube. Long supply leads are thus avoided. The high-voltage unit and the explosion vessel are arranged in the same Faraday cage.

1.4.1 Schematic circuit diagram



1.4.2 Discharge circuit for 1 mJ , 3 mJ - Triggering by high-voltage relay



U_o = charging voltage
 U_p = discharge voltage
 C_o = discharge capacitor
 C_p = parasitic capacitor (electrode holder)
 L = inductance (0.01mH / 1 mH)
 LE-Sw = high-voltage relay

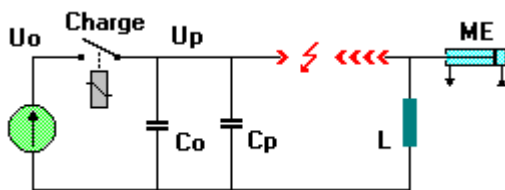
The discharge capacitor C_o is given the charge $Q_o = U_o \cdot C_o$. After switching of the relay "LE-Sw", the **charge** is retained, on the other hand the voltage U_o is lowered to U_p in accordance with the following equation:

$$U_p = U_o \cdot C_o / (C_o + C_p)$$

This results in a reduced spark **energy** E_p according to the MIE definition of:

$$E_p = 0.5 \cdot (C_o + C_p) \cdot U_p^2$$

1.4.3 Discharge circuit for 10 mJ ... 1 J - Triggering by moving electrode



U_o = charging voltage
 U_p = discharge voltage
 C_o = discharge capacitor
 C_p = parasitic capacitor
 L = inductance (0.01mH / 1 mH)
 ME = moving electrode
 Charge = charging relay

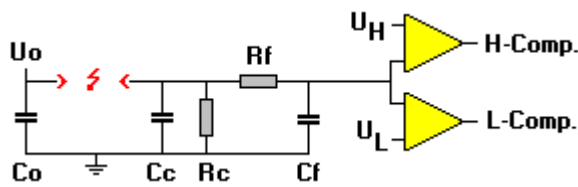
At the start, the moving ground electrode is in its home position. The electrode gap is then ca. 25 mm. Even with a charging voltage $U_o = 15$ kV, the breakdown voltage is by no means reached. After opening the charging relay "Charge", the electrode is moved rapidly by the pneumatic system to the set minimum electrode gap of 6 mm. Sparkover occurs before the end position is reached. The spark energy E_p is calculated according to the MIE definition by the following equation:

$$U_p = U_o$$

$$E_p = 0.5 \cdot (C_o + C_p) \cdot U_p^2$$

1.4.4 Spark monitoring

In the determination of the minimum ignition energy, tests are performed for the absence of ignition. It is therefore essential that reliance can be placed on the correctness of the energy value of the discharge spark which just fails to ignite the dust/air mixture. The charge transferred by the spark is measured in every ignition experiment and a check is made for compliance with limit values.



H-Comp = upper limit value

L-Comp = lower limit value

C_o = discharge capacitor

C_c = measuring capacitor

R_c = leakage resistance

C_f, R_f = filter

The charge of the discharge capacitor C_o is transferred to the measuring capacitor C_c . The slowly increasing corona current occurring before the sparkover is also collected in the measuring capacitor C_o , but is discharged by resistor R_c . Only the charge transfer of the actual spark with its high transient current is recorded by this circuit.

The voltage characteristic across C_c corresponds, like the spark current, to a damped oscillation. The subsequent filter (C_f, R_f) now uses this to calculate the mean value for the spark monitoring. The peak value of this charge measurement must lie within the limits U_L and U_H to be recognized as a valid value.

1.4.5 Energy range

By definition, the MIE is represented by the energy stored in a capacitor. However, the charge of the capacitor and hence the spark energy is lowered not only by the corona current flowing before the sparkover; dirty insulators and possibly conductive dusts can also result in the dissipation of considerable charge.

Energy data which refer only to the initial charge of the capacitor are misleading. The actual energy value of the spark is **always less than** this theoretical maximum value and is thus unfortunately on the wrong side from the viewpoint of safety considerations. For example, a spark which just ignited a dust would actually have a lower energy than that specified!

Nominal	Maximum	Minimum	Triggering	Voltage
1 mJ	1.8 mJ	0.7 mJ	relay	15 kV
3 mJ	4 mJ	1.8 mJ	relay	15 kV
(10 mJ)	13 mJ	7 mJ	relay	15 kV
10 mJ	* 18 mJ	7 mJ	moving electrode	15 kV
30 mJ	40 mJ	18 mJ	moving electrode	11 kV
100 mJ	133 mJ	70 mJ	moving electrode	11 kV
300 mJ	400 mJ	230 mJ	moving electrode	11 kV
1 J	1.33 J	650 mJ	moving electrode	11 kV

Maximum = theoretical maximum value (worst case)

Minimum = lower limit of spark monitoring



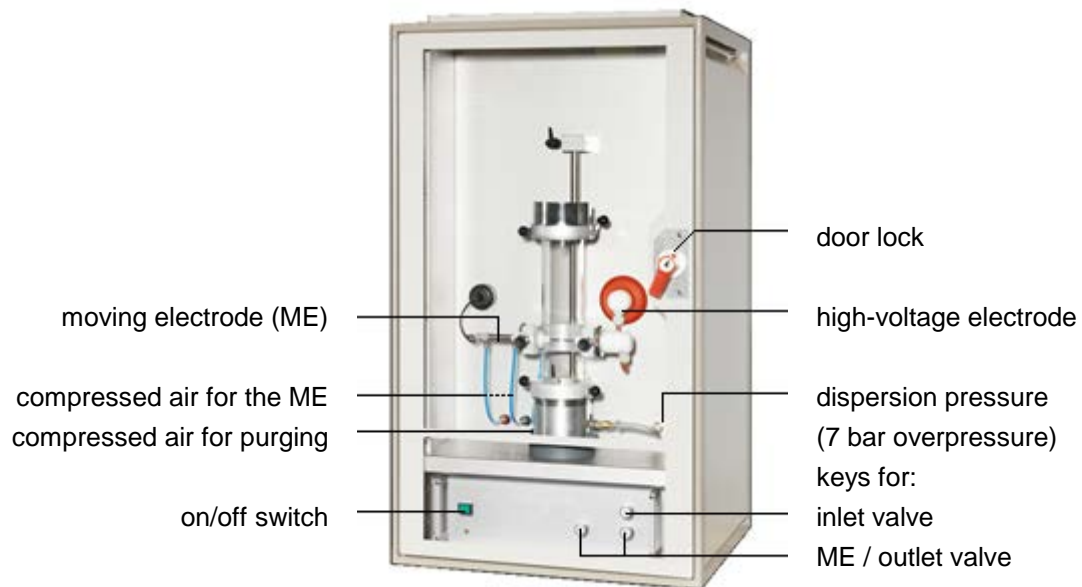
10 mJ (ex factory = moving electrode)

* relatively large corona losses must be anticipated.

2. Installation

2.1 Apparatus

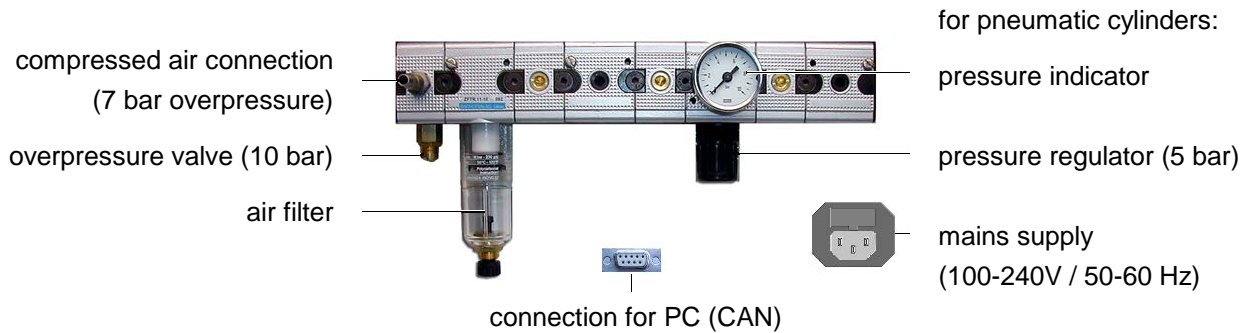
2.1.1 Controls (front side)



Functions of the **door lock** with 3 positions:

1. Door open (electrode adjustment and cleaning):
The high voltage is switched **off** and the keys are **enabled**.
2. Door closed (purging with air after test)
The high voltage is switched **off** and the keys are **enabled**.
3. Door closed (MIKE is ready for a test)
The high voltage is switched **on** and the keys are **disabled**.

2.1.2 Connections (back side)



Compressed air supply:

Compressed air is used to power the pneumatics and the dust dispersion.
Nominal value = **7 bar overpressure = 8 bar absolute**.

Only **normal compressor compressed air** may be used. With the use of synthetic compressed air MIE-values which are clearly different were obtained.

2.1.3 Safety instructions



Usually the MIKE is set up in a ventilated laboratory hood. When connecting the exhaust directly to the ventilation, the pressure of the blast as well as flames have to be considered.



For safety reasons, when manipulating with the electrodes, the plug of the high voltage electrode (on the right-hand side) must be **unplugged**.
The moving electrode (left-hand side) is always grounded and therefore safe.

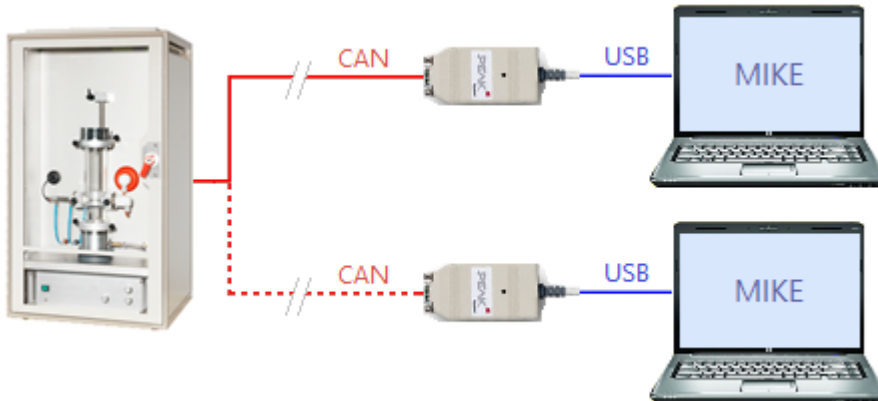


Before making the electrical connections, please compare the information on the rating label with the data of your mains supply.

2.2 PC-Hardware

Concept: The CAN bus (Controller Area Network) is a serial bus system. The CAN bus originally developed by the Bosch company for the automobile industry in 1983, is internationally standardized and is now widely used in industry as a fieldbus under various designations and data protocols. This bus is characterized by its robustness. Even cable lengths of up to 100m between MIKE and CAN-USB adapters are possible.

Connection of a MIKE to one or more PC's:



Personal Computer (PC):

Operating system Windows 10, 8.1, 7 (32/64-bit)

USB port (USB 3.0, USB 2.0 or USB 1.1) on the computer

Monitor resolution at least 1200 x 800

Connection options MIKE - PC:

Cable DSUB 9 pin
default



optical fiber
(Option)



Ethernet
(Option)

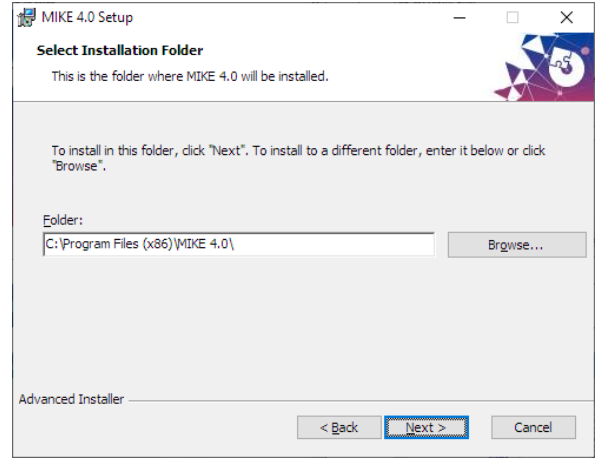
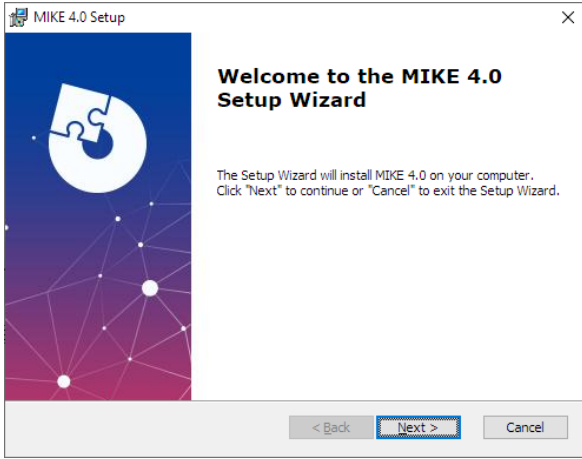


WLAN
(Option)



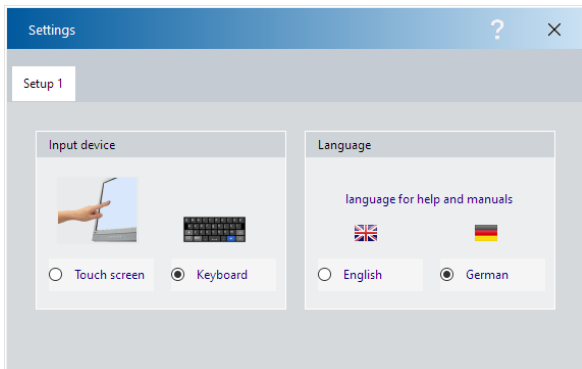
2.3 PC-Software

Installation: Please run the following setup-file: **MIKE40_setup.msi**
 For the installation of the CAN driver, **Administrator rights** are required.

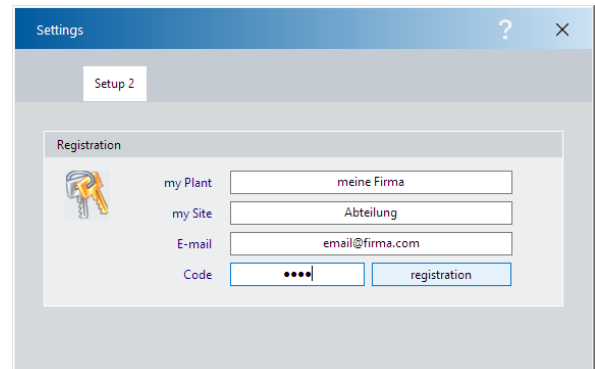


Start the MIKE-Software and follow the instructions:

1. Keyboard, language



2. Company, registration



For the registration code, please send an email to: **info@cesana-ag.ch**
 Without registration, the function of the MIKE is only simulated.
 However, you can view, evaluate and print MIKE files.

3. Administrator

4. Apparatus



MIKE file names (*Identity*)

Automatically generated file names always start with this "*Identity*", followed by the date the file was opened. The following letter differentiates files that were created on the same day.

Example: Lab_200730A.MIE

These automatically generated file names are only a suggestion. Of course you can enter your own file name (e.g. order number).

The extension of the file name is always ".MIE" and is added automatically.

5. CAN-Driver

You need administrator rights for the installation. However, no special rights are required for later use.

Please do not use an USB extension cable between the CAN-USB adapter and the PC. This does not comply with the USB standard and can lead to malfunctions.

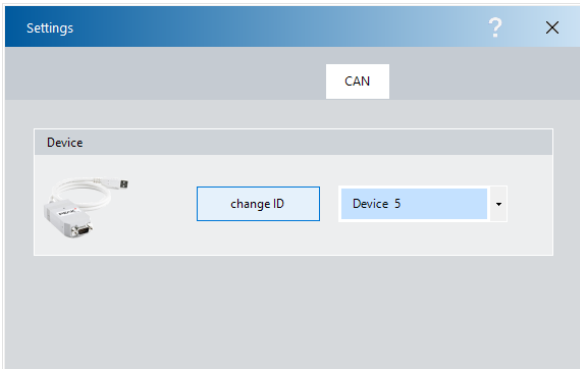


- a) Do **not** connect the CAN-Adapter.
- b) Install the **Peak** driver.
- c) Connect the CAN-Adapter to an USB-Port.
- d) Windows will notify you of the new hardware.
- e) Restart the MIKE program.



The CAN-USB adapter has a status LED:

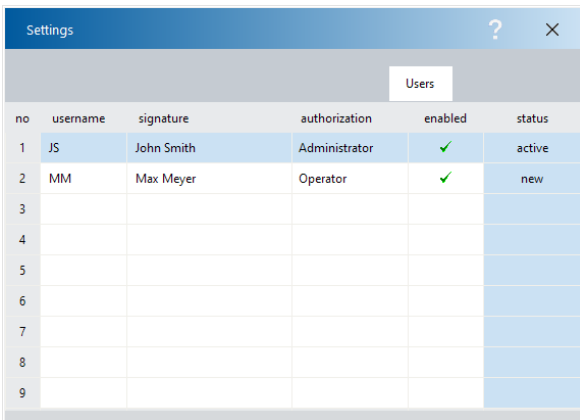
Always on: connected with Windows
 Slow flashing: connected with application
 Fast flashing: data is transmitted



6. Device-ID

If several equipment with CAN adapter are connected to your PC, these adapters must be clearly identified.

With a new adapter, this number is usually 255 (0xFF). However, you can easily change this number: *change ID*



7. User

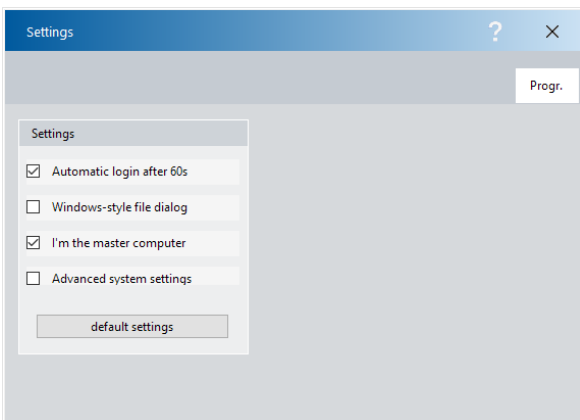
The main administrator is defined in step 3. More users can be added here:

- "Administrator" for the user management.
- "Service" for calibration and maintenance.
- "Supervisor" for process monitoring.
- "Operator" for all other users.



8. Rights

The rights of the 4 user groups can be defined here by the administrator.



9. Settings

Automatic login ...

Automatic program start after 60s.

Windows-style ...

File dialogs are in Windows style.

Master ...

If several PCs are connected to the MIKE, just one PC should be defined as primary PC.

Advanced ...

Allows access to service-programs.

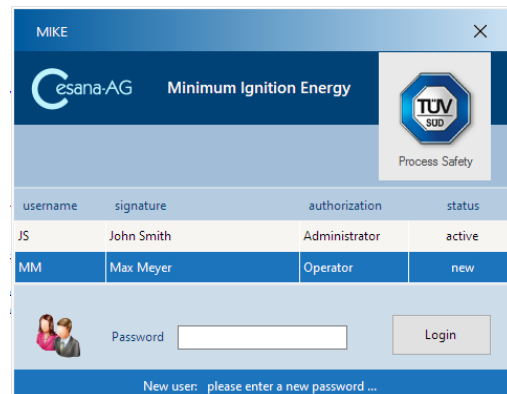
3. Operation

3.1 Program start



After starting the program,
select the desired user.
See: 2.3 PC software (7. user)

New users first need to enter here
their own password.



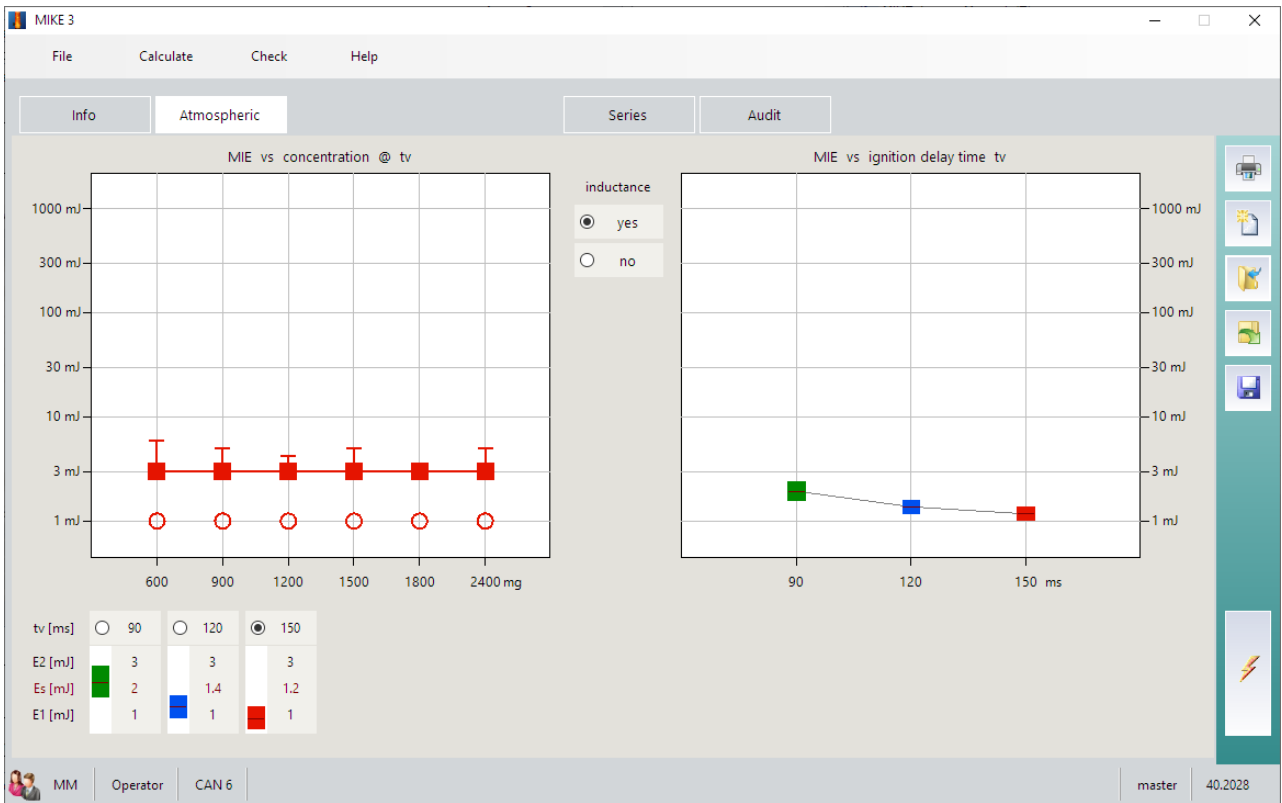
3.2 Main screen

3.2.1 Info

E1 [mJ]	Es [mJ]	E2 [mJ]	tv [ms]	Induct.
1	1.2	3	150	yes

1. The actual user
2. Access rights of the user
3. CAN-interface
4. Access rights to the MIKE
5. Software: version, year, week

3.2.2 Atmospheric



MIE vs dust concentration
parameter = ignition delay time t_v

MIE vs ignition delay time t_v

3.3 MIKE - Files

3.3.1 New Product, new File



At the start of a test with new dust, a new file is opened. The file name is automatically allocated by the program (**A**) or given by you (**B**):

A: Automatic generated filenames starts always with the identity (see: 2.3 PC-Software, 3. Administrator), followed by the date when the file is opened. The subsequent letter distinguishes files which are generated on the same day.

example 1: Identität_201122A.MIE

example 2: Identität_201122B.MIE (generated on the same day as example 1)

B: example 3: my_product.MIE (maximum length of filename = 126 characters)



In the past the filename was limited by the operating system to only 8 characters. An assignment filename - product was difficult. With modern operating systems this restriction becomes unnecessary. The filename can be much longer and can also contain the designation of the product. It is up to you to choose between the two versions A or B.

3.3.2 Existing product, open file



An index of MIKE-files is shown with filename and product. You can sort the fields ascending or descending by a click on the corresponding (*filename, date, product*).

Open Mike-file		
E:\PROGNET_C\MIKE4\bin\MIKEDAT\		
filename	date	product
Demo_Atmospheric.MIE	18.08.2020	Niacin CaRo18
Demo_Temperature_Oxygen.MIE	17.08.2020	Niacin CaRo18

Each MIKE file contains a list of users. If you are a member of this list, you have access according to your authorization (Administrator ... Operator).



unlocked

You have full access: you can add series, manipulate data and add comments.



locked

All manipulations of data are locked, except view, export and printout. However, you can import the data. See: 3.3.3 Import in a new file.

All authorized users of a file are displayed on the "Audit" page:

username	signature	authorization
JS	John Smith	Administrator
MM	Max Meyer	Operator

3.3.3 Existing product, import in a new file



Locked MIKE data can be imported into a new file. The data are then freely accessible and you can edit them and add further series.

3.3.4 Save files



All data is always backed up **automatically**.

If necessary, however, you can save the entire recording in a separate file with a new file name.

3.3.5 Copy files



An easy-to-use file manager for copying MIKE files is built in.
Only MIKE files are displayed.

3.4 Test procedure

3.4.1 Sample preparation

The lowest values of the MIE of a product are obtained if the sample is tested when it is dry and containing a fine particle size fraction. The product preparation is thus immensely important.

The product should be carefully dried by one of the following methods:

- a) 24 h at 50°C under vacuum
- b) 24 h at 75°C under atmospheric pressure



The sample must be prepared so that the median value **M** is less than **63 µm**.

Due to the big influence of the particle size distribution on the MIE (see 1.2.3) the particle size distribution and the corresponding median value M must be measured and indicated in the report.

In justified exceptional cases the dust can also be tested as supplied.

3.4.2 Test conditions



Electrode spacing = 6 mm

Move the moving electrode using the „ME“ (moving electrode) key to the working position and adjust the gap between the moving and fixed electrode with the gauge supplied to 6 mm (screw adjustment of the fixed electrode).

International guidelines require an electrode gap of at least 6 mm.



Dispersion pressure $P_z = 7$ bar (over pressure)

The compressed air for dispersion of the dust and for the pneumatic system of the moving electrode must be set to 7 bar +/- 0.5 bar (manometer gauge = 7 bar).

3.4.3 Procedure

1. Start with a dust sample weight of 900mg, an ignition delay time of 120ms and an ignition energy with a high ignition probability e.g. 100mJ.
2. Lower the energy until the dust no longer ignites in **10** successive tests.
3. At energy (**E2**), where an **ignition** occurs, continue testing with higher and lower dust concentrations.
4. All dust concentrations with an ignition at an energy (E2) must be confirmed by „**10 no ignitions**“ at an energy level (E1).



The entire procedure must then be repeated with different ignition delay times (in steps of 30ms) to find the actual lowest ignition energy at the optimum ignition delay time for the dust under test.




The entire test sequence is performed twice for every dust: Once **with** an inductance, where the spark is protracted, and once **without** an inductance - if requested.

3.4.4 General test procedure



Open the window „Next Series“ by a click on this button or by pressing the „enter“-key.

1. Enter the parameters of the new series on the screen.
(Concentrations that have already been tested are highlighted in gray)
2. Take out the base and distribute the dust evenly around the mushroom-shaped nozzle
Alternative: Add the dust from above to the tube. However, it is necessary to ensure that the amount of dust adhering to the electrodes is kept at a minimum.
3. Close the door and lock.
4. Start the series by clicking  or pressing the „Enter“ key.
5. Observe the test.

The dust was ignited:

6. Inform the computer of this by clicking „Yes“ or press the „Y“-key.
7. Release the door lock of the MIKE (this enables the keys for manual operation).
8. Roughly pre-clean the apparatus with compressed air through repeated, alternate opening of the inlet (I) and outlet (O) valves.
9. Open the door. Vacuum off the residues and clean the tube, the mushroom-shaped nozzle and the electrodes.

The dust was not ignited:

6. Start the next test by clicking „No“ or pressing the „Enter“ key. The remaining dust is again dispersed and possibly ignited.



If the dust was not ignited a little dust has escaped through the hinged cover. In addition some dust adheres to the tube wall and the electrodes. As a result, the dust concentration gradually decreases. Experience has shown that with the same dust filling up to 4 tests can be done. The dust concentration in the MIKE-apparatus is just a relative parameter. We recommend, independent from the dust concentration, to proceed as follows:

3 tests (see 6.)
 - cleaning (see 7. - 9.)
 - fresh dust sample (see 2.)

3 tests (see 6.)
 - cleaning (see 7. - 9.)
 - fresh dust sample (see 2.)

4 tests (see 6.)

Error messages:

Charge too low ? No spark ?

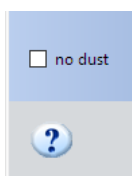
No sparkover occurred or the spark energy was too low. Clean the electrodes and insulators thoroughly and check the electrode gap if need be. Electrostatic charged dust can also influence the sparkover with its electric field . The sparkover occurs too late and the energy is too low due to the corona current . Clean the glass tube with water (this lowers the resistance of the surface). Then start the next test with a new dust filling.

Deviation of $t_v > 10$ ms

In triggering by the moving electrode, the mechanical system is probably dirty and stuck. Clean the piston rods and apply a little oil if necessary. Actuate the piston several times with the „ME“ key.

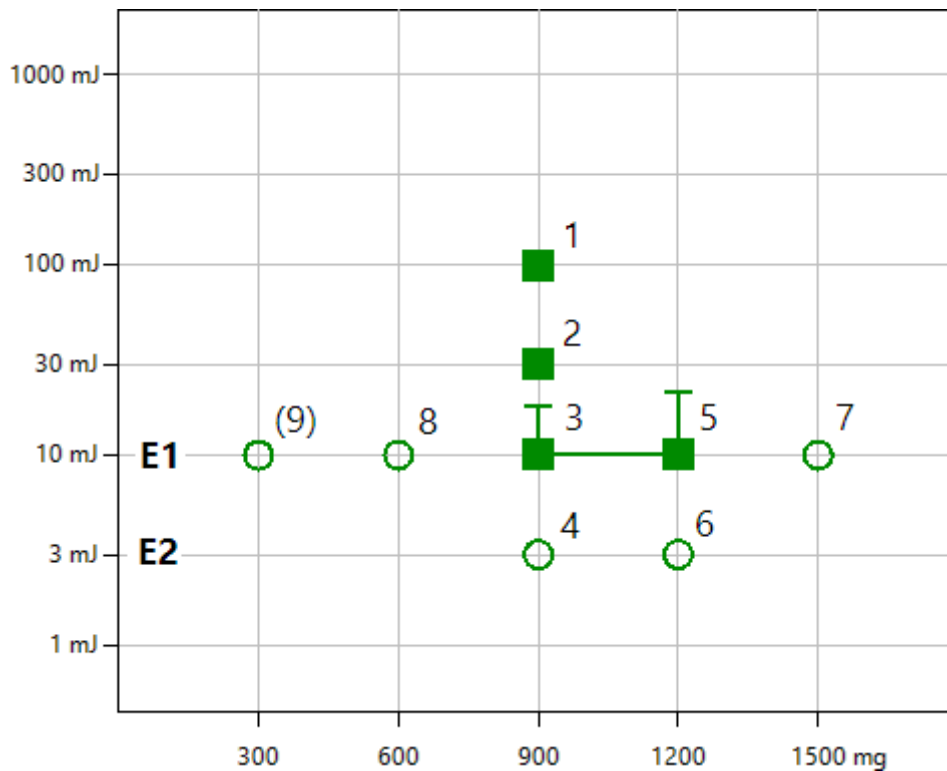
In triggering by the high-voltage relay, electrostatic charges are probably the cause of the delayed sparkover. Clean the glass tube with **water** (this lowers the resistance of the surface). Then start the next test with a new dust filling.

Checking the sparkover:




To test the sparkover, you can interrupt the normal test procedure at any time by selecting „spark only“. The dust is then not dispersed - and need not be vacuumed off. Select „with dust“ to return to the normal test procedure.

3.4.5 Graphics



The series **with ignition** of the dust (**solid squares**) and the series **without ignition** of the dust (**outline circles**) are displayed each time. The vertical pointers (T-shaped) indicate how many single tests were necessary until the dust was ignited (low ignition probability). If the dust was ignited in the first test (high ignition probability), no vertical pointer appears.

Example for the test procedure

- 1 Start with a dust sample weight of 900 mg, an ignition delay time of 120 ms and an ignition energy with a high ignition probability e.g. 100mJ.
 - 2,3,4 Lower the energy until the dust no longer ignites in **10** successive tests.
 - 5,7,8 At energy (**E2**), where an **ignition** occurs, continue testing with higher and lower dust concentrations.
 - 4,6 All dust concentrations with an ignition at an energy (E2) must be confirmed by „**10 no ignitions**“ at an energy level (E1).
 - <9> For the calculation of the probability of ignition, a **minimum of 5** dust concentrations are needed.
-  The entire procedure must then be repeated with different ignition delay times (in steps of 30ms) to find the actual lowest ignition energy at the optimum ignition delay time for the dust under test.

3.4.6 Series

Info		Atmospheric				Series		
	sn	conc.	IE [mJ]	tv set	tv eff	induct.	I (NI)	comment
<input checked="" type="checkbox"/>	1	900	100	120	121	1	1	
<input checked="" type="checkbox"/>	2	900	30	120	121	1	1	
<input checked="" type="checkbox"/>	3	900	10	120	121	1	5	
<input checked="" type="checkbox"/>	4	900	3	120	121	1	(2)	

Designations:

sn	= consecutive numbering of the test series
conc.	= weight of dust sample in mg
IE [mJ]	= ignition energy
tv set	= set ignition delay time (set value)
tv eff	= measured ignition delay time (actual value)
induct	= inductance (0 mH or 1 mH)
I	= ignition in specified experiment
(NI)	= no ignition of the dust after: (Number of Non-ignitions)

Editing the table:

- this series are valid and will be evaluated. (to change, click on this field).

3.4.7 Audit

Info		Atmospheric				Series	Audit		
no	date	time	cause	event	value	username	signature	authorization	
1	18.08.2020	10:33	MM	New file created		JS	John Smith	Administrator	
2	18.08.2020	10:33	MIKE	MIKE serial.unit	22001 . 1	MM	Max Meyer	Operator	
3	18.08.2020	10:34	MM	Series added	1				
4	18.08.2020	10:34	MM	Series added	2				

All activities are automatically recorded. An example:

- 1 *MM* starts a new file and with it a new audit.
- 2 Firmware and serial number of the MIKE-apparatus are included.
- 3 ... Each added series will be recorded.



The data of the audit are stored manipulation proof in the MIKE-file.

3.5 Calibration

According to international standards, the equipment for determining the minimum ignition energy must be calibrated at regular intervals (at least every 12 months or after every major maintenance or repair). Therefore, Cesana AG conducts an international round-robin test (CaRo) every year.

- EN 13821: Determination of the minimum ignition energy of dust / air mixtures
- ASTM E2019-03: Standard Test Method for Minimum Ignition Energy of a Dust Cloud in Air

Calibration method: For each parameter of the CaRo dust, the mean value from the test results of the participating laboratories is calculated as a standard value with a scatter range. All apparatus whose results are within the given tolerance band meet the calibration and receive a certificate from us. In the case of systems with strongly deviating results, we will again be able to find and eliminate the causes of errors based on the experience with previous round robin tests.

Procedure: The test dust is selected, homogenized, packed and dispatched by Cesana AG. The test results received are continuously evaluated and published on the Internet. After the test period has expired, a detailed overall evaluation is carried out with the calculation of the standard values and the associated tolerance band. Those laboratories that have fulfilled the calibration receive a certificate. All results are then (anonymously) summarized in a table and sent to the participants.

Sample preparation for the calibration:

The results can only be compared when the sample preparation is the same. Therefore the test dust has been milled, homogenized and tightly packed.

Please keep the container closed whenever possible.



For the calibration: please test the sample „**as delivered**“.
By no means, prepare the sample additionally.



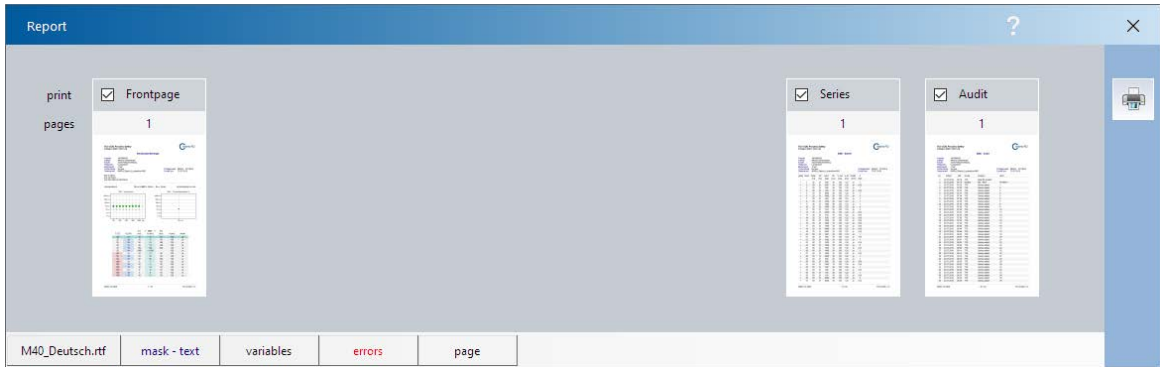
For the calibration, only tests **with** inductance ($L = 1\text{mH}$) must be carried out.

4. Utilities

4.1 Report



First select a mask for the report. The program then automatically inserts the product information, the test results, the graphics and the comment into the mask and a report is created from this. The next step is to select the pages to be printed.




TÜV-SÜD Process Safety

Prüflabor WRO 1055-5.50

Mindestzündenergie

Produkt: Niacin CaRo18
Auftrag: 18-0255-04
Kunde: Cesana AG
Prüfgrund: Test of MIKE 3
Medianwert: 21um
Vorbereitung: tel quel
Dateinamen: Demo_Atmospheric.MIE



Prüfapparatur: MIKE3 22001.1
Erstellt am: 18.08.2020

Atmosphärisch
1 mJ < MZE < 3 mJ / Es = 1.2 mJ
mit Induktivität L=1mH

MZE / Konzentration

MZE / Zündverzögerungszeit tv

E1 [mJ]	< MZE <	E2 [mJ]	tv [ms]	Indukt.
	Es [mJ]			
1	1.2	3	150	ja

4.1.1 Report - Mask



Some sample masks are attached to the MIKE program. These masks can easily be adapted to your needs. Open one of these forms with a text editor that supports the **rich text format (.rtf)**. We recommend the **WordPad** program for this (in the Windows accessories).

An excerpt from the mask:

```

3 ··· 2 ··· 1 ··· 1 ··· 2 ··· 3 ··· 4 ··· 5 ··· 6 ··· 7 ··· 8 ··· 9 ··· 10 ··· 11 ··· 12 ··· 13 ··· 14 ··· 15 ··· 16 ··· 17 ··· 18 ···
@:Definitions
{Type}           MIKE
{Version}        4.0

{LogoName}       Logo_MIKE.png
{LogoWidth}      20

{MIE}            Mindestzündenergie
{MIEshort}       MZE

3 ··· 2 ··· 1 ··· 1 ··· 2 ··· 3 ··· 4 ··· 5 ··· 6 ··· 7 ··· 8 ··· 9 ··· 10 ··· 11 ··· 12 ··· 13 ··· 14 ··· 15 ··· 16 ··· 17 ··· 18 ···
@:Frontpage
#Plant
#Site

                                Mindestzündenergie

Produkt:           #Product
Auftrag:           #Order
Kunde:             #Customer
Prüfgrund:        #Reason
Medianwert:       #Median
Vorbereitung:     #Preparation
Dateinamen:       #Filename

                                Prüfapparatur: #Appar
                                Erstellt am:  #CreDate

```



The masks are divided into **sections**, these begin with an "**@: - control code**". Please do not change these codes under any circumstances.

Definitions are in curly brackets {...}, followed by the value or translation.

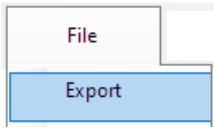
Variables are identified by a "**# control code**".

The MIKE picture (*Logo_MIKE.png*) is only a suggestion and can be replaced by your company logo. To do this, copy your logo into the MIKE directory, define the desired width and paste the file name into the mask.

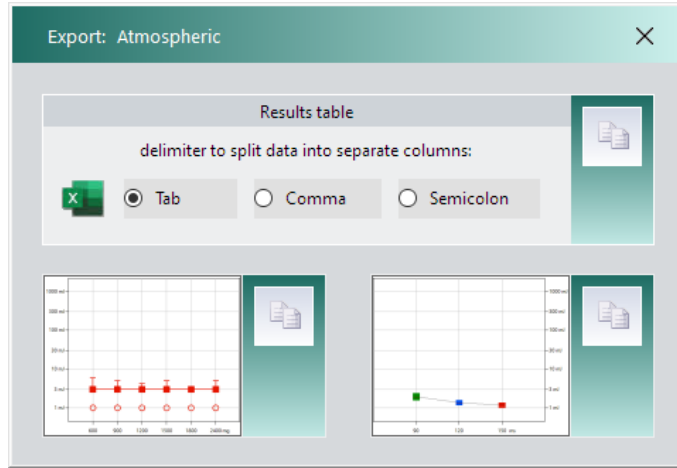


No distinction is made between upper and lower case letters in the codes.

4.2 Export

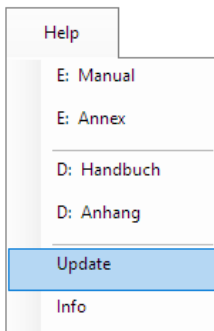


Data and graphics can be easily exported to other programs. First select the page to be exported (*Info, Atmospheric, Series, Audit*). See: "File / Export".



The data is copied to the Windows clipboard according to your specifications and can be easily pasted from there into other Windows programs. e.g. Excel, Word.

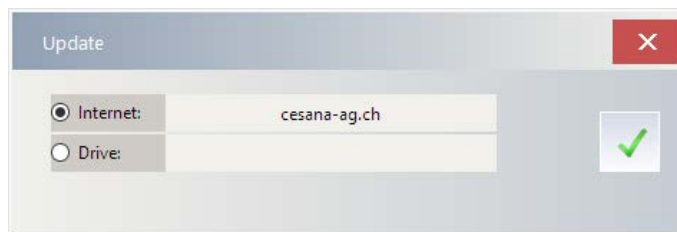
4.3 Update



The "Help - Update" menu is only available to users with administrator or service rights. It is advisable to check the MIKE software periodically for updates.

Internet: Your PC is connected to the internet. The update can be carried out directly.

Drive: Your PC is not connected to the internet. Participants in the annual CaRo calibration round-robin test receive a USB stick with the latest software updates. Enter the directory with the USB stick.e.g. *G: \ Updates* in the Drive field and start the update.



The update will start automatically. Previous software settings are retained.

4.4 Check the MIKE

4.4.1 Ignition sparks (Check / Ignition)

Check the sparkover, without dust, at different ignition energies and with and without an inductance:

A distinction is made between the specified ignition delay time (delay tv = **tv set**) and the time measured when the spark occurs (eff. Ignition delay = **tv eff**). The bottom field informs you about the type of triggering and the charging voltage of the capacitors.



Sparkover:

With the lowest ignition energies (1 mJ, 3 mJ) and triggering by the high-voltage relay, the energy of the spark may occasionally be too low (message: charge too low ? No spark ?). Excessive charge has been lost owing to the corona current. Or, even in the absence of any disturbing influences, the spark energy was actually too low and the emitted error message has correctly reported this. In the practical application of the MIKE - with dust - this appears much less frequently as sparkover is facilitated by the dust/air mixture. With higher ignition energies, 100% sparkover may be expected.



Error messages:

- **Door open:** Door is not shut properly.
- **Pressure too low:** Check the compressed air connection (7 bar ?)
- **Charge too high ?** Upper limit of spark monitoring exceeded.
- **Charge too low ?** Are the electrodes and insulators clean ?
- **Deviation of tv** Triggering by high-voltage relay:
If tv eff is too large, the delayed sparkover was probably caused by electrostatic charge on the surface of the glass tube. Clean the glass tube with water (this lowers the resistance of the surface).
- **Deviation of tv** Triggering by moving electrode:
If tv eff is too large, the cause usually lies in the movement of the ME cylinder being too slow. Clean piston rod and if need be lubricate with a little oil.
- **Check: Cylinder ...** The position of the cylinder is monitored. The specified cylinder is not in the correct position. Check compressed air for the cylinders (5 bar).

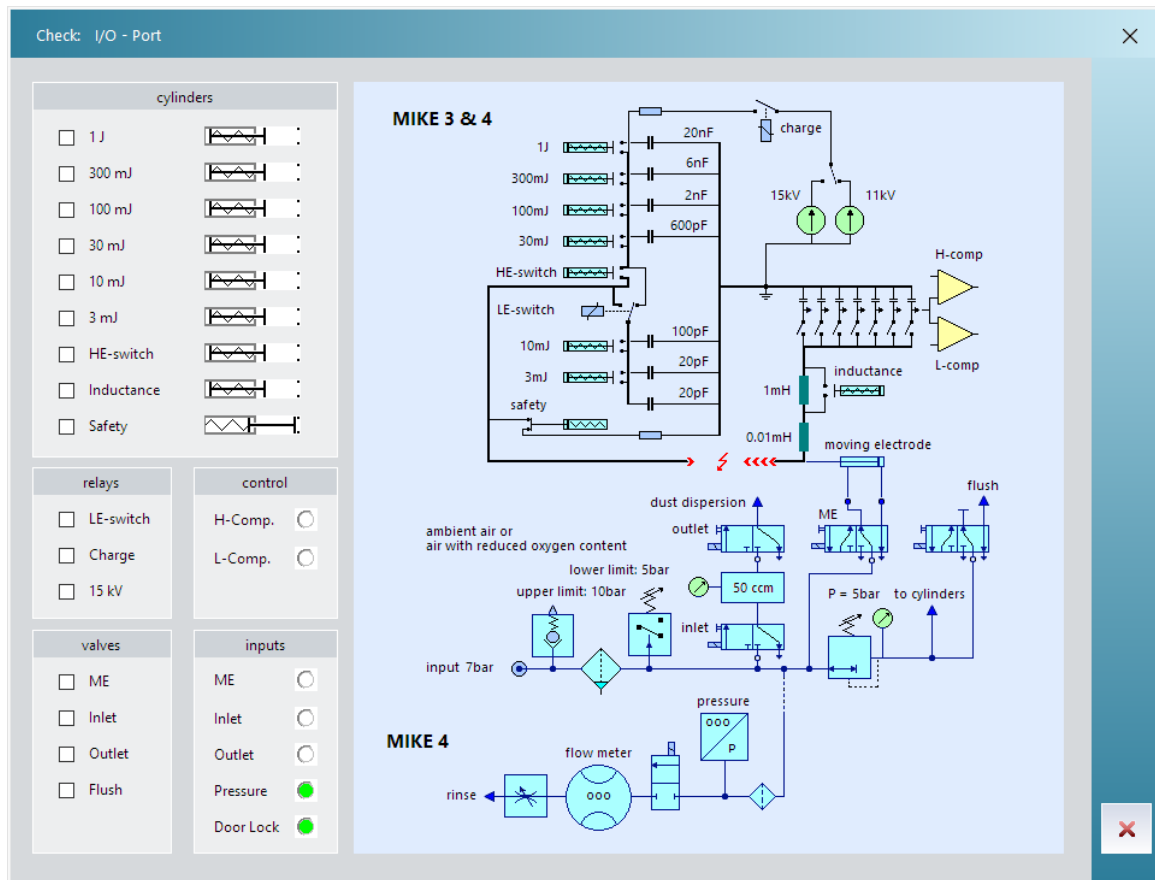


Options:

- **Single tests:** Select between single or continuous testing.
- **Energy fixed:** Energy and inductance are as specified.
- **Dust dispersion:** Select between with or without dust dispersion.
- **Check of cylinders:** The position of the pneumatic cylinders is monitored.
- **Recording:** Protocol in a text-file "ignition.txt".
- **Change Triggering:** In principle, the type of triggering can be changed at low energy
- **Change Voltage:** Values (1...10 mJ). But retention of the pre-set values is advisable

4.4.2 IO-Port (Check / IO - Port)

With this test program for detailed troubleshooting, you have direct access to all cylinders, valves and relays of the MIKE.



Group "cylinders"

Safety:	Inverse cylinder: In the home position, the HV output is grounded.
Induct.:	High-voltage switch for jumpering the 1 mH inductance.
HE-Sw.:	High-voltage switch: 30mJ...1J busbar / HV output.
3 mJ....1 J:	High-voltage switch for the particular energy level. (The capacitor for the 1 mJ spark is always connected)

Group "relays"

LE-Switch:	High-voltage relay
Charge:	Charging relay
15 kV:	Switch: 11 / 15 kV

Group "control"

H-Comp.:	Upper limit
L-Comp.:	Lower limit

Group "valves"

ME:	Moving electrode
Inlet:	Inlet valve
Outlet:	Outlet valve
Flush:	Purging

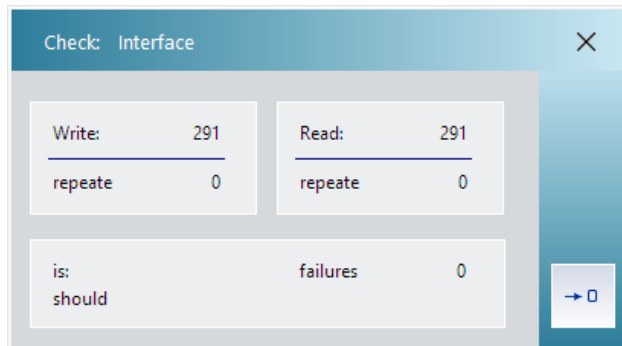
Group "inputs"

ME:	Moving electrode
Inlet:	Inlet valve
Outlet:	Outlet valve
Pressure:	Pressure monitoring
Door Lock:	Door locking

4.4.3 Interface (Check / Interface)

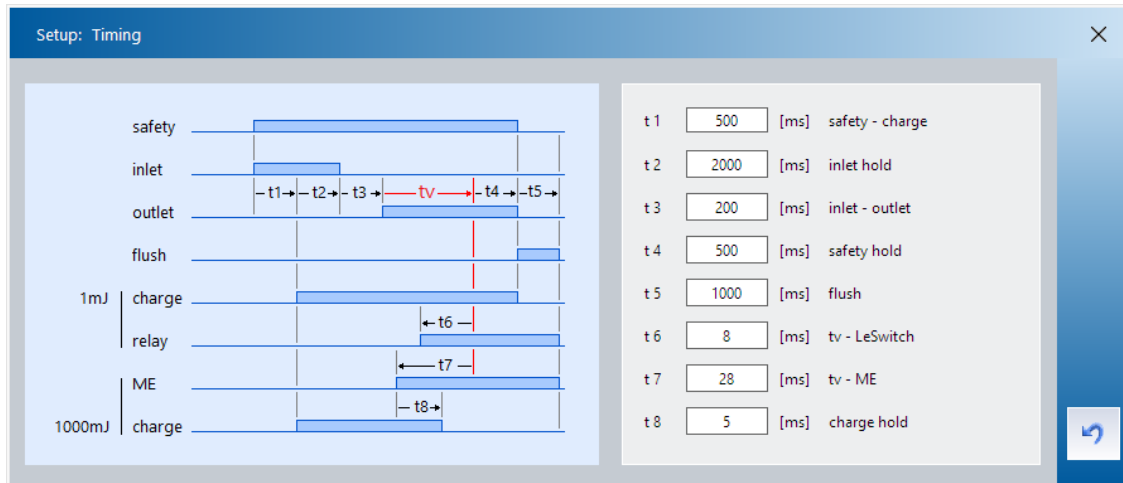
This test program checks the serial connection between PC and MIKE. Data is sent to the MIKE (write), read by the MIKE again (read) and compared with the data sent (failures).

If you have problems, first check the settings in 2.3 PC-Software.



4.4.4 Timing (System / MIKE - Timing)

The times in the test sequence of the MIKE are freely definable over a wide range. Under normal circumstances, there is no necessity to change these times as optimum settings have already been selected. Use the "Default" button to reset settings to their default values at any time.



- t 1** Start of cycle: After this time has elapsed, all pneumatic cylinders must have reached their correct position.
- t 2** Opening time for the inlet valve (Inlet): At the same time, charging time of the capacitors. This time must be sufficient to allow filling of the pressure vessel and also ensure reliable charging of the largest capacitor.
- t 3** Delay time inlet-outlet valve (Inlet-Outlet): The inlet valve must be completely closed before the outlet valve opens.
- t 4** Hold time of the outlet valve.
- t 5** Purging (Flush): The holder of the moving electrode is cleaned with compressed air.
- t 6** Triggering by high-voltage relay: This time-entry compensates the switching time of the relay so that sparkover occurs at the desired tv-time.
- t 7** Triggering by moving electrode: This time-entry compensates the mechanical movement time of the electrode so that sparkover occurs at the desired tv-time.
- t 8** Charge relay hold: This time-entry compensates the delay in the mechanical movement of the electrode so that the loss of charge due to corona current is reduced.

5. Troubleshooting



5.1 Error message: Charge too low? No spark?

Thoroughly clean the electrodes and insulators and, if necessary, check the electrode spacing. If electrostatically charged dust adheres to the glass tube, the resulting electrical field makes the spark more difficult. The spark jumps with a delay and its energy is often too low due to corona losses. The glass tube must be rinsed with water (to reduce surface resistance). Then repeat the experiment with a fresh dust filling.



5.2 Error message: Charge too high?

The internal spark monitoring system reports that the charge transferred by the spark and thus the energy was too high. If this error occurs repeatedly and with only one energy value, there is a suspicion of a defective high-voltage capacitor!



5.3 Error message: Deviation of $t_v > 10$ ms

When triggered by moving electrodes (10mJ ... 1J), the mechanism is probably dirty and stuck together. Clean the piston rod and, if necessary, oil them a little. Press the "ME" key several times.. When triggered by the high-voltage relay (1mJ, 3mJ), the cause of the delayed spark jump must be sought in the electrical field that has built up. The glass tube should be rinsed out with water (to reduce surface resistance). Then repeat the experiment with a fresh dust filling.



5.4 Error message: Check: Cylinder ...

Each cylinder has a position sensor and the position of the cylinder is monitored. For further diagnosis use the program [3.4.3 Tools / Check: IO - Port](#) activate and deactivate the cylinder in question. Does the position display change?

- a) The position sensor is misaligned or defective.
- b) The cylinder does not reach the required position.

A visual inspection is recommended for further diagnosis. See: [Service - Manual](#)



5.5 The MIE is higher than expected

Do you use synthetic compressed air? This is not allowed!

Has the dust sample become agglomerated or moist? See: [4.3.1 Sample preparation](#)

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EN 13821	Potentially explosive atmospheres - Explosion prevention and protection Determination of minimum ignition energy of dust/air mixtures November 2002