

## MIKE4-CAN

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### Introduction

Minimum Ignition Energy (MIE) is a key characteristic of powders for risk assessment in production and pilot plants in the framework of the European ATEX regulation. It is well known that MIE depends on a number of experimental parameters. In view of the practical implications, the most important factors are:

- Temperature (e.g. for drying processes)
- Oxygen concentration (e.g. for inerting)

The dependence of MIE on temperature and oxygen concentration has been analyzed in a number of publications e.g. Glarner (1983), Bartknecht and Zwahlen (1993), Glor and Schwenzfeuer (1996). Nonetheless, the experimental determination of MIE under non-standard conditions is complex and no routine equipment is available. Moreover, these investigations either focused on the oxygen dependence at room temperature or on the temperature dependence of normal air. So far combinations have not yet been studied extensively.

Therefore, an extension of the MIKE3 apparatus is presented that will allow to measure MIE at elevated temperatures and under oxygen concentrations in ranges below and above standard condition. The set-up ensures a high homogeneity of the temperature and gas mixture inside the Hartmann tube without causing negative impact on turbulence, which again has an influence on MIE. The upgraded MIKE3 is hereafter referred to MIKE4.

### The new test setup

It is important that the atmosphere is homogeneous in terms of temperature and gas composition at the time of ignition.

In order to ensure high temperature homogeneity, it is necessary to heat both the metallic base and the Hartmann tube itself to the desired temperature.

The gas composition inside the Hartmann tube and in the pressurized gas reservoir for dust dispersion must be identical. The gas mixture is blown into the Hartmann tube using a ring-nozzle at the bottom of the tube.

For tests under different oxygen concentrations, we use gas mixtures of defined composition stored in a gas cylinder.

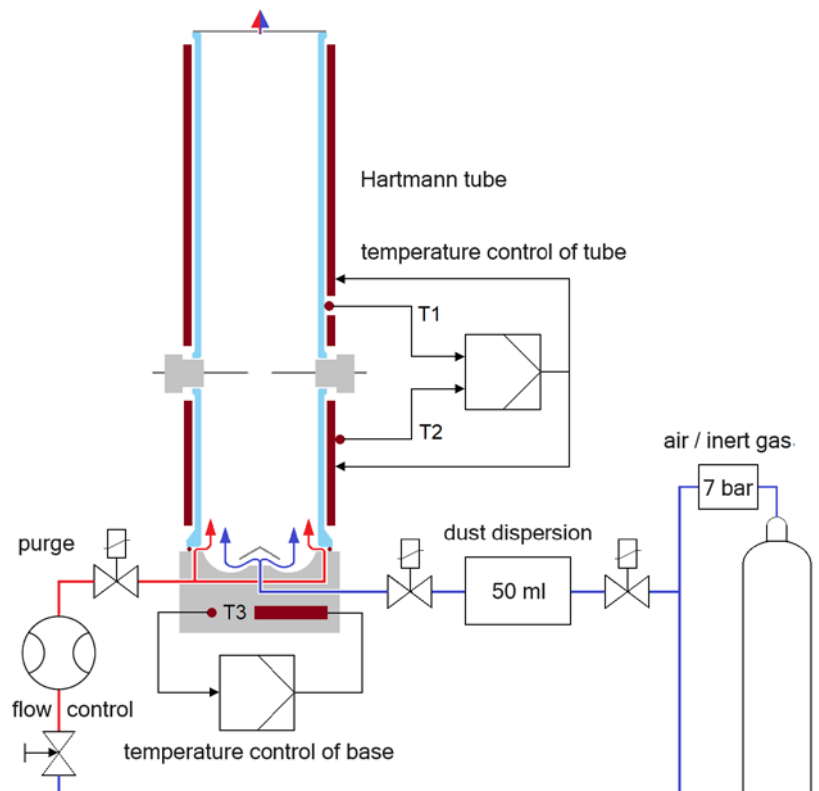


Figure 1: test setup

### The Control Unit

While the gas composition is controlled externally using cylinders with premixed gases, the temperature of the base and the tube is controlled by the MIKE4. The new control unit allows the determination of MIE for defined conditions simply by feeding the appropriate gas mixture into the apparatus and selecting the desired temperature on the panel.

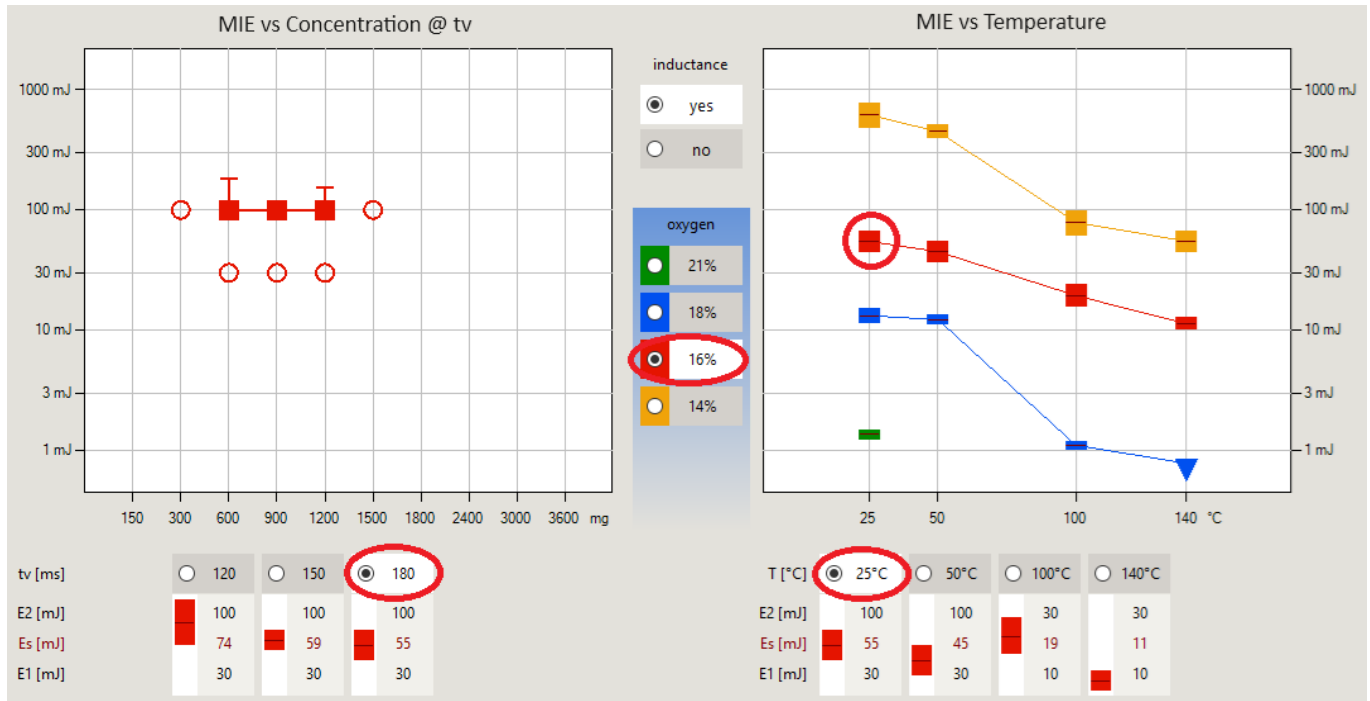


Figure 2: Screen of the MIKE 4 for measurements under “non-atmospheric” conditions. The “uncertainty” is indicated by the vertical size of the symbols. The triangle pointing down at 140°C and 18% O<sub>2</sub> indicates MIE < 1mJ. Alternative MIE vs O<sub>2</sub> concentrations may be shown on the right side. (Data of CaRo-dust “Niacine” are shown).

### Results (Niacine, the test powder used for Caro Round Robin testing, was used as an example)

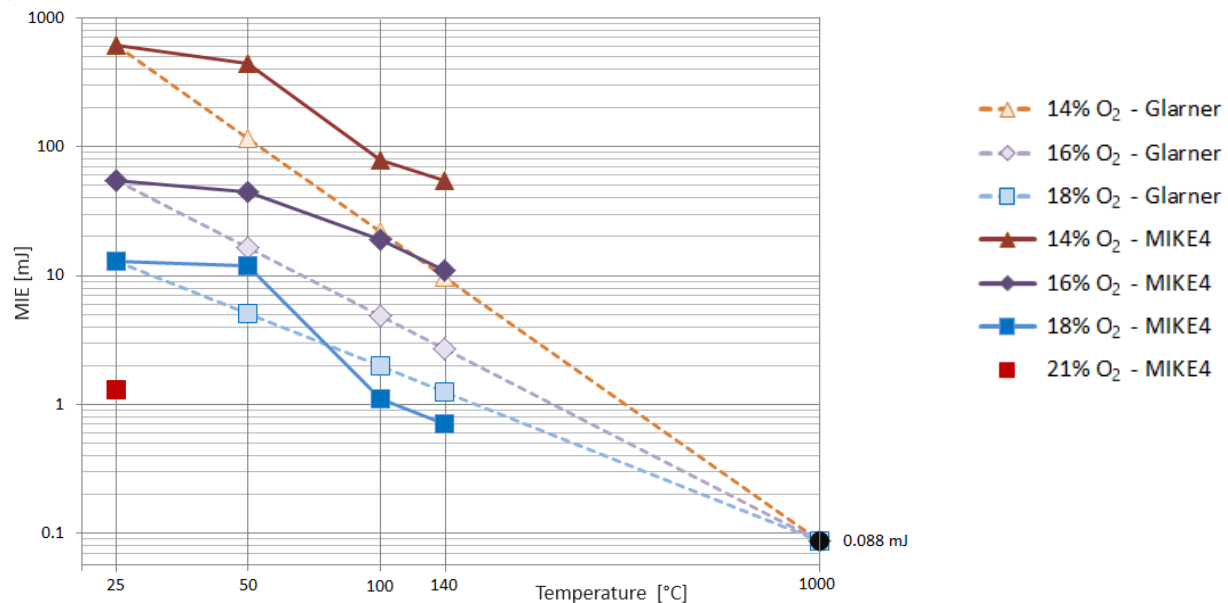


Figure 3: Temperature dependence of MIE of Niacine for different temperatures on a double logarithmic plot. The values calculated with Glarner’s formula are shown as dashed curves.

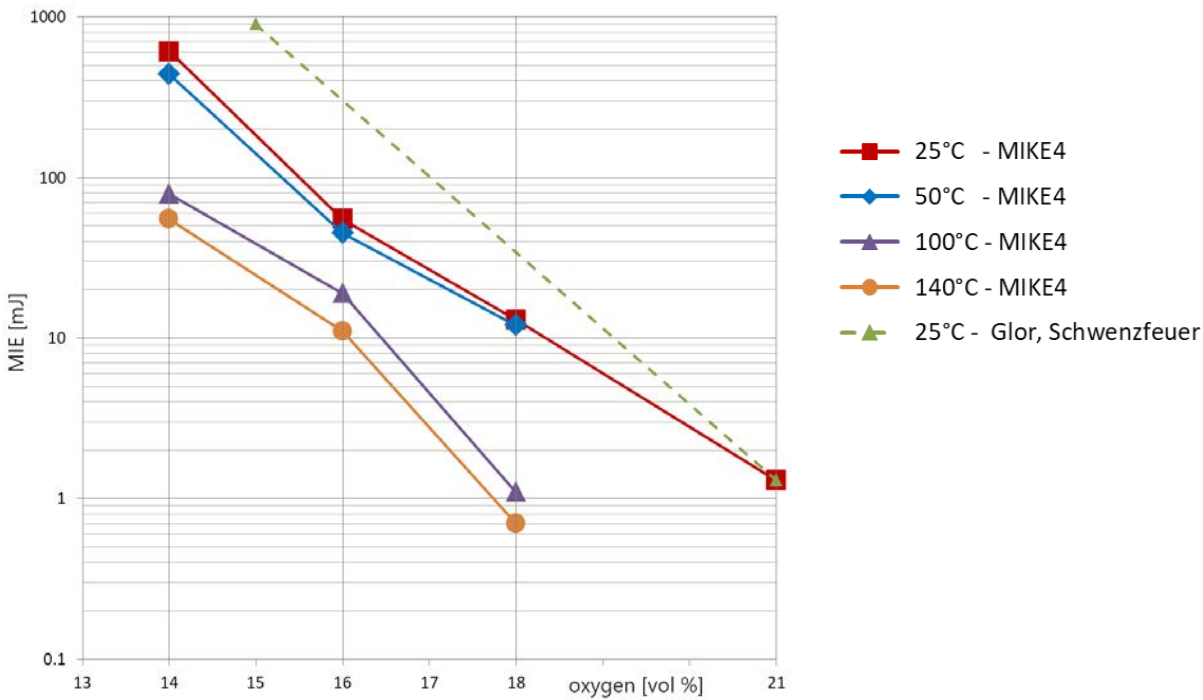


Figure 4: Dependence of MIE of Niacine for different oxygen concentrations. The values calculated with the Glor and Schwenzfeuer formula are shown as a dashed curve. Notice that the calculated values are not conservative, i.e. MIE values obtained are too high.

### Temperature control

The temperature of the metallic base of the dust distribution is easy to regulate. Achieving a homogeneous temperature distribution in the glass tube, on the other hand, is very complex. This cannot be achieved with a simple heating jacket around the glass tube. The MIKE4 therefore uses aluminum heating shells with a defined air gap to the glass. The surface temperature of the glass is measured and controlled in cascade to the heating shell temperatures. For a quick change of the glass tube, the front heating tray can be turned to the side.

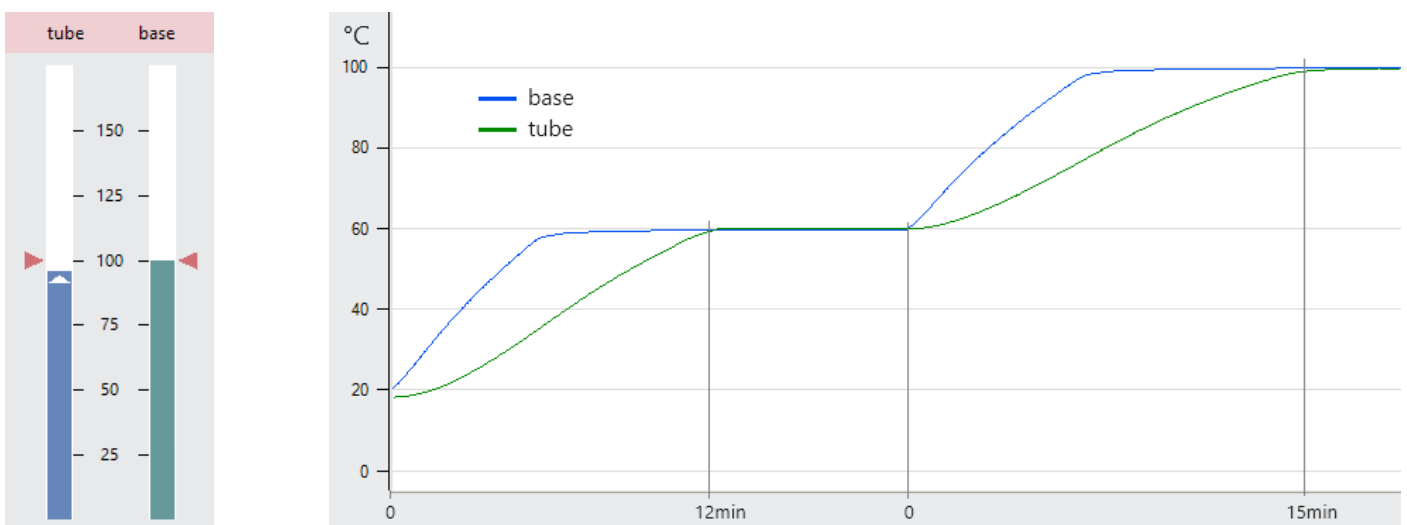


Figure 5: The current temperatures are displayed numerically and graphically (left). The MIE test can only be started when the temperatures are correct. The MIKE4 program contains a temperature recording (right).

### Oxygen setting

Gas mixtures of defined composition stored in gas cylinder are used for tests under different oxygen concentrations. Thus, the operators can focus their attention on MIE tests and do not have to pay attention to the stability of the gas mixture. The gas mixture is injected with a ring nozzle at the bottom of the Hartmann tube (1.2L) and purged with a total of 3L from below. Measurements with an optical O<sub>2</sub> probe from Presens showed that with 5L/min and a total volume of 3L, the desired concentration is quickly achieved. In practice, the measuring delay of the probe does not have to be taken into account and flushing with a higher flow rate is permitted. Between the tests without ignition, it is not necessary to flush with the full quantity of 3L. The MIKE4 calculates the refill quantity and thus saves gas mixture and time.

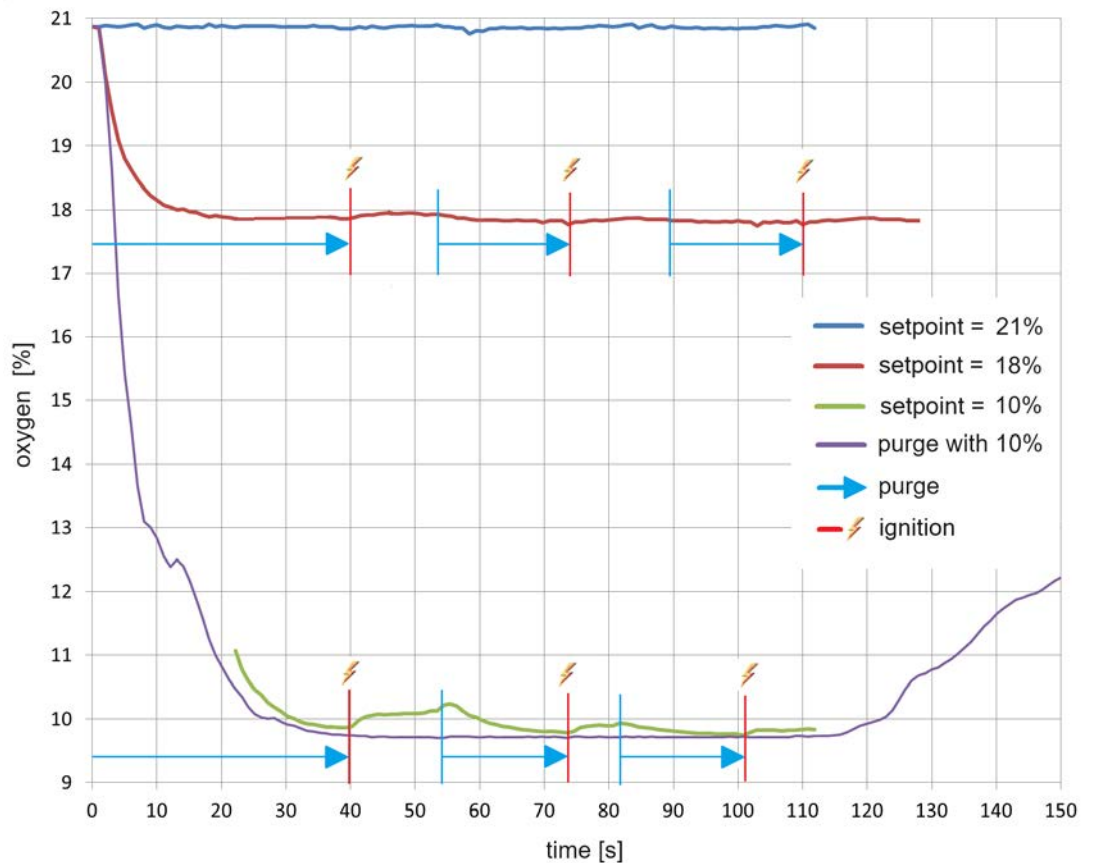
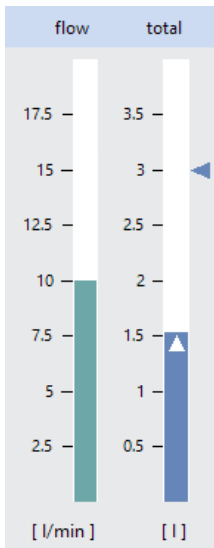
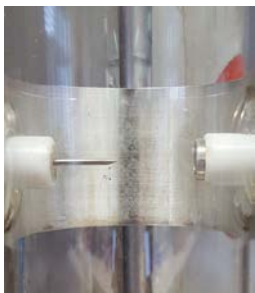


Figure 6: Presens probe (top left). In each case 3 tests without ignition of the dust (right). The current status of the gas filling is always displayed (bottom left).

### Conclusions

The new features will facilitate the use of MIE values evaluated under conditions prevailing in production, without applying the extrapolations from standard conditions used so far.

First results obtained with the CaRo Round Robin standard powder indicate that the formulas of Glarner, Glor and Schwenzfeuer may deviate significantly from the experimental results, and are in some cases not conservative, as mentioned also by Hesener et al. (2015). In this respect the easy determination of MIE for elevated temperature and reduced oxygen provides a true added value when it comes to explosions risk assessments and the development of explosion protection concepts.

### Technical Specifications of MIKE4-CAN

Explosion vessel:	Mod. Hartmann tube, V = 1.2 l
Energy range:	1mJ, 3mJ, 10mJ, 30mJ, 100mJ, 300mJ, 1J
Spark energy monitoring:	Integrated and independent measuring system
Charging voltage (1 mJ...10 mJ):	15 kV
Charging voltage (30 mJ ... 1 J):	11 kV
Triggering (1 mJ, 3 mJ):	High-voltage relay
Triggering (10 mJ ... 1 J):	Moving electrode
Inductance (with):	1.0 mH
Inductance (without):	0.01 mH
Compressed air connection:	7 bar (over pressure)
Temperature range:	ambient ... 150°C
Oxygen content:	given by gas cylinders
PC-Software:	for Microsoft Windows 7...11
Power supply:	100-240 VAC / 600 VA / 50-60 Hz

### Order data

SP3704 Minimum ignition energy apparatus MIKE4-CAN

*MIKE3 devices built in 1992 or later can be converted to MIKE4-CAN:*

SP37041 Conversion kit MIKE3 to MIKE4-CAN contained:

- Control module (is replaced as a whole)
- Electrode holder adapted to glass tube heater
- Base with heating and flushing
- Glass tube heating system
- Pull-out table with lift
- Interface CAN-USB opto

### References

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