Physikalisch-Technische Bundesanstalt
National Metrology Institute

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Safety characteristics of hybrid mixtures for explosion protection

Determination methods capable for standardization (NEX-HYS)

Motivation

In this joint project, standardized measurement methods for hybrid mixtures are developed, which serve to determine safety characteristics for explosion protection.

A hybrid mixture is a multi-phase system consisting of fuel gas or vapor, as well as air and flammable dust. This combination can occur for instance in drying processes or during heterogenous reaction processes.

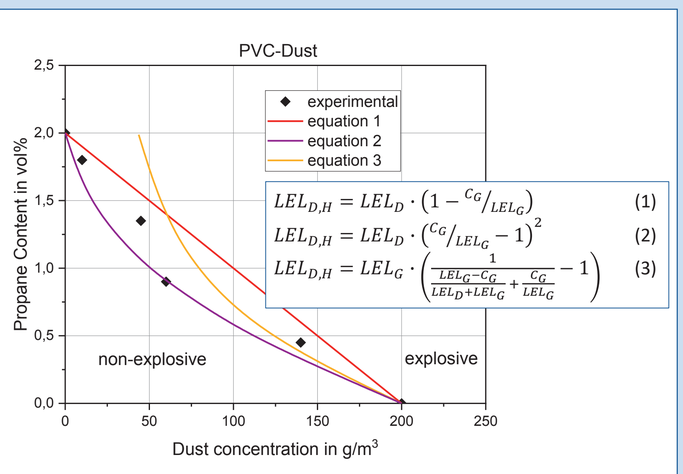
Existing standards are not suitable for determining the safety parameters of hybrid mixtures. These standards treat gaseous and solid flammable substances separately, due to their disparate explosion properties. The design of the ignition vessels, the ignition sources and the test procedure for fuel gases and dusts differ considerably.

The principal purpose of the project is the adaption of setups and measurement procedures to hybrid mixture demands.

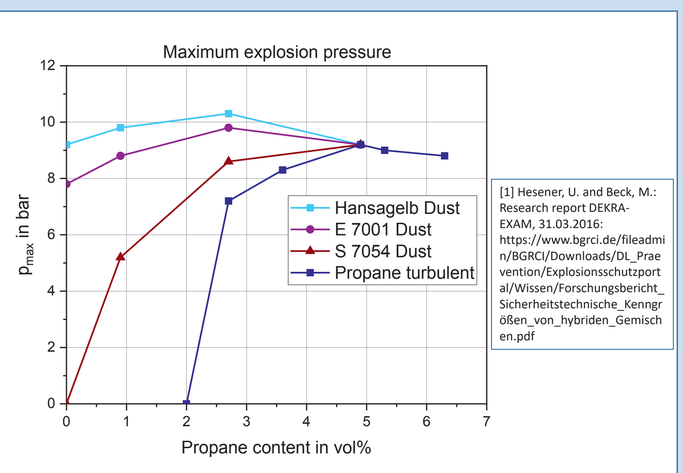
Background

It is known from previous research that some of the hybrid mixtures are more sensitive to ignition than their individual flammable components [1]. The hybrid mixture may have a wider explosion range and the effects of explosions may be more severe.

A simple linear interpolation would overestimate the lower explosion limit to the unsafe side. Other calculation methods also lead to improper values:



The maximum explosion pressure of the mixture can be higher than for the individual components:



[1] Hesener, U. and Beck, M.: Research report DEKRA-EXAM, 31.03.2016: https://www.bgrci.de/fileadmin/BGRCI/Downloads/DL_Praevention/Explosionsschutzportal/Wissen/Forschungsbericht_Sicherheitstechnische_Kenngrößen_von_hybriden_Gemischen.pdf

For the purposes of a hazard assessment it is not satisfactory to rely on a combination of the safety-related characteristics of the individual components. Determination methods are now to be developed and brought to standardization maturity for the most important characteristic parameters of hybrid mixtures.

Impact

The results will be published as a pre-standard of the German Institute for Standardization (DIN). This pre-standard enables test institutes and industry to assess explosion hazards when operating technical plants with hybrid mixtures and thus to control processes both more safely and more efficiently. Standardization at the international level is supposed to be initiated.

Working Plan

Run time from March 2019 to 2021

Ignition sources such as chemical igniters, electric sparks or exploding wires are tested to determine the influence of type and energy.

Mixture formation in the test apparatuses is investigated and a reproducible procedure is developed.

Explosion effects are assessed by maximum explosion pressure and maximum rate of pressure rise.

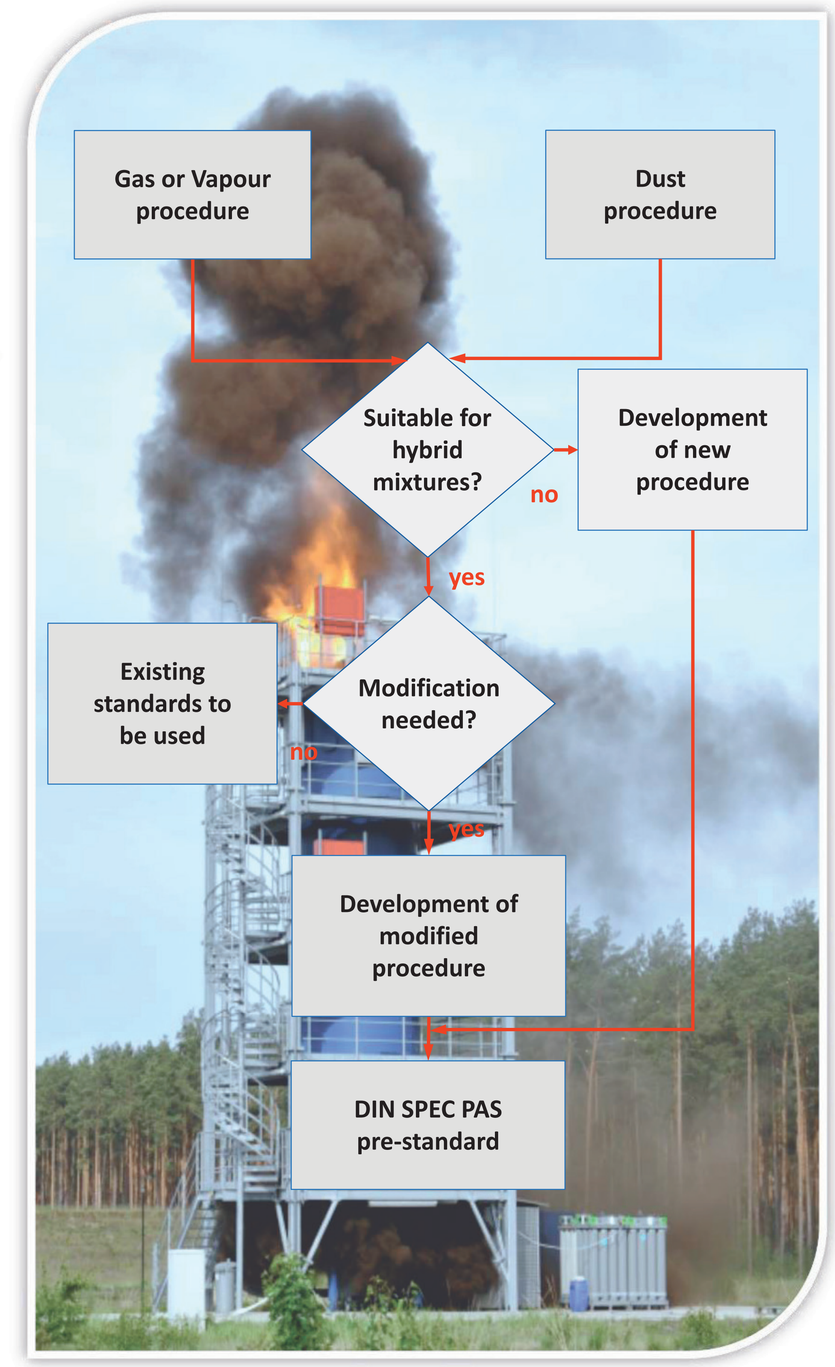
Explosion limits are measured in terms of lower explosion limit and limiting oxygen concentration.

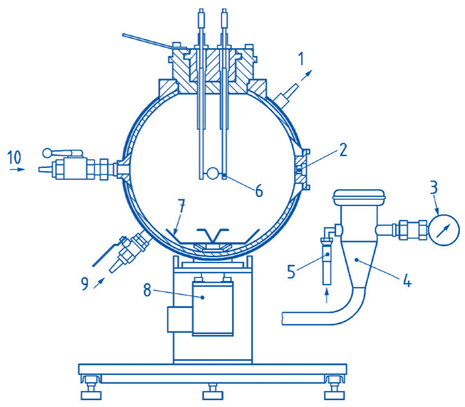
Comparative tests on the laboratory scale and on the pilot scale (20 L-Sphere, 1 m³ -Vessel) are performed.

Autoignition temperatures are determined in a modified Godbert-Greenwald furnace.

Measurement uncertainty consideration leads to a budget for associated uncertainty from procedure and comparative tests .

Documentation and Standardization are implemented in the form of Standard Operating Procedures and a pre-standard from working group at DIN.





Key

1	water outlet	6	ignition source
2	pressure sensor	7	rebound nozzle
3	manometer	8	fast acting valve
4	dust container (0,6 dm³)	9	water inlet
5	air inlet	10	outlet (air, reaction products)

Testing equipment 20 L-Sphere

Funding

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WIPANO

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Partners

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