Is the "70%-rule" valid?

First experimental test in a high speed mixer

For a long time it is assumed that the concentration of dispersed powder at a filling level of 70 Vol-% exceeds the upper explosion limit after short time in a highspeed mixer. This assumption never has been verified.

The Swiss Institute of Safety and Security cooperated with Roche, Novartis and MSE Meili to conduct a first measuring campaign to find an efficient way obtaining reliable concentration data.

MSE Meili's Labasys® 100, the measuring system for simultaneous determination of local concentrations and velocities in multiphase flows, allowed to build a reliable data basis by the guidelines of the new ATEX 137 directive.

Measuring Task

Overview

- Task: **Reliable measuring data at varying and difficult conditions**
- Target Sizes: **Local concentration (Velocity)**
- Motivation: **Underlay guidelines of new ATEX 137 directive**
- Solids Conc.: **0.001-20 kg/m^3**
- Temperature: **20-30°C**
- Particle Size: **10-25 µm, Ø 15 µm**

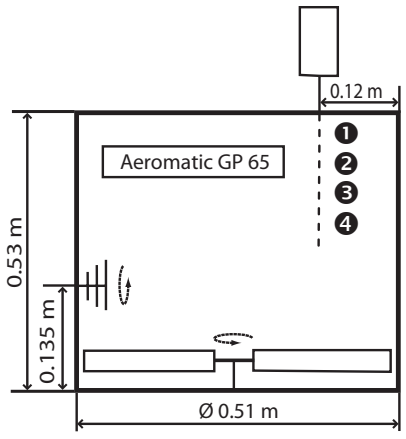

Fig. 1: Schematic drawing of the high speed mixer Aeromatic GP 65

The test was made in an Ex-environment. The inside of the mixer was classified as zone 20, whereas the outside was not classified.

Since all electric components are located in the body of the Labasys®100, the light and signals are transmitted by passive optical fibers into the reactor. Therefore additional Ex-protection measures were not necessary, what reduced the effort substantially. Other important parameters were the designated volume, 65 l, as well as the used test powder, the fine and sticky material maize starch.

MSE Meili specialized since more than 15 years in reliable measuring systems. The cleaning unit of Labasys® 100 is integrated in the probe tip. Sticky products tend to soil the optical sensors, which makes the patented cleaning unit necessary. In addition the special design and the adjustable pressure reduces the disturbance of measuring data to a minimal level. So that reasonably precise measuring data may be obtained even under difficult conditions.

Fig. 2: 3-channel probe tip with patented pneumatic cleaning unit keeping the sensors clean of sticky maize starch.

Depending on the product flow pattern and concentration, test products may cover the front of the sensor despite of the cleaning unit and herewith cause shifts of signal level. A visual review of the raw data time series only allows for a clear identification of such soiled data to sort it out.

Thanks to the three independent channels, reliable concentration data could be obtained, despite partial soiling (Fig. 3).

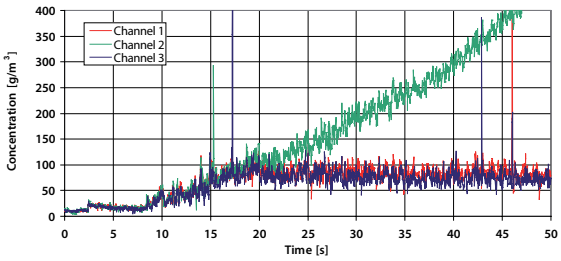

Fig. 3: Example for "data soiling": Two channels remain stationary while the third (soiled outlier) starts to rise.

Realisation

Key Success Factors

- Operations in zone 20 without costly Ex-protection
- 3 redundant concentration signals
- Measures fine maize starch at difficult conditions (up to 20 kg/m^3)

The 1:1-calibration was conducted in the MSE Meili Labatories (Switzerland). 1:1-calibration means that during calibration identical process-conditions are prepared as in the final operation.

Fig. 4: Test arrangement at Roche's with Labasys®100 (left) and the inside of the high speed mixer (right) .

Provided that this process was performed before the actual measurement, an early understanding and a clear picture of the final test arrangement were apparent. For this purpose the wide range of concentrations (from 0.001-20 kg/m^3) and the stickiness of maize starch had to be understood and handled previously. Therefore different configurations of MSE Meili's calibration unit were necessary to generate dilute and dense flow patterns for similar flow conditions.

At the end the calibration parameters result in pretty well matching concentration data of the three laser-backscattering channels with the calibration data.

In order to implement this measuring procedure at a Roche Laboratory in Basle the measuring procedure had been applied and the measurements were taken at/under different positions, filling levels (Vol.-%), Impeller / Chopper speed and mixer operation modes.

Results

Products and Services used

- **Labasys®100** – 3 channel-instrument for concentration and 1 dimensional velocity determination including **the pneumatically operated cleaning unit (pat.)**
- **Dilute and dense flow calibration** at MSE Meili Laboratories (Switzerland)
- **Labasoft** – Windows™ based (98/NT/2000/XP) data acquisition and analysis Software for analysis and reporting of elaborate data
- Specific project management close to customer

«We are convinced of the dust concentration detection technology provided by MSE Meili, which exceeded our expectations and proved that Labasys®100 is feasible to deliver reliable results even under difficult measuring conditions.»

Dr. Georg Suter, SWISSI Process Safety GmbH

The mixer was started approx. 4 seconds after the measurement, what had immediate impact on the powder velocity. The concentration at the sensor rises first slowly and then steeper to reach the average concentration of stationary operation faster after approx. 5 seconds (Fig. 5). The mixing tools produce a flow showing some -not very regular- periodic fluctuations in the range of 2-4 seconds. The sporadic (negative) velocities against the impeller direction and the quite wide concentration range of 1-5 kg/m^3 reveal.

Not until the time of analysis it was discovered that the filling levels were significant lower as planned at first. The mistaken parameter was the mixer volume: A first test run was made with a filling height of 42%. The results are shown in Fig. 5.

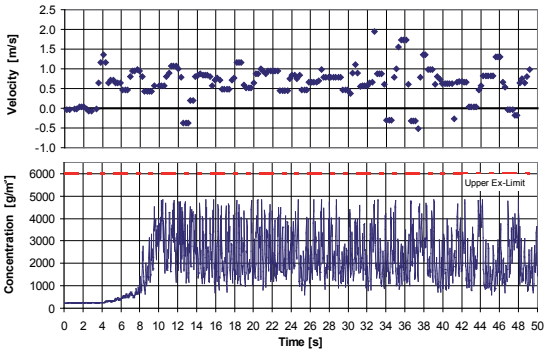

Fig. 5: Concentration time series of mixer start-up: Good 5 s after start of the mixing tools the stationary concentration of ca. 2.5 kg/m^3 is reached (bottom).

Finally the operations showed that (Fig. 6)

- the measured concentration data available seems to support the "70% rule".
- at a filling level of 44 vol.-% an explosive dust atmosphere is still present at most of the measured positions.
- an effective cleaning unit is essential to obtain reliable data at higher concentrations.

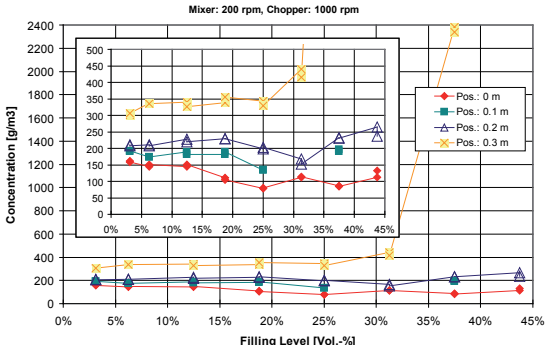

Fig 6: Overview chart: At 31 vol.-% the concentrations start to raise steeply for the lowest measuring positions.

Further measurements will be needed to strengthen these first results. Especially measurements at higher levels and in varying mixer models may be helpful. Following this way there could be established firm guidelines to warrant safe and efficient operations of highspeed mixers in accordance to the new ATEX 137 directive.