SIMULATION-BASED ASSESSMENT OF EXPOSURES WITH HAZARDOUS SUBSTANCES

SYNERGISTIC APPLICATION OF FIRE ENGINEERING MODELS

Risk assessment of hazardous substances

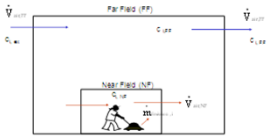
Measurement | **Calculation** | **Analogous Review**

$$ppm_A = \frac{P_{evap}}{P_{air}} \cdot 10^6$$

Simple estimations (i.e. SVP-model)

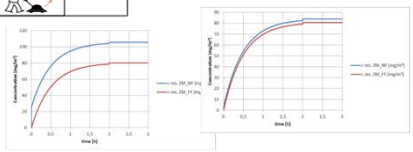
Emission (i.e. Mackay / Matsugu)

$$\dot{m}_i = 2{,}65 \cdot 10^{-6} \left(\frac{M_i \cdot p_{s,i} \cdot v_{air}^{0,78}}{\Delta x^{0,11} \cdot Sc^{0,67} \cdot T} \right)$$



Concentration in air (i.e. box models)

$$c_i = \left(\frac{\dot{m}_i}{\dot{V}_{air}} + c_{i,ex} \right) \cdot \left(1 - e^{-\lambda(t_i - t_0)}\right) + c_{i,0} \cdot e^{-\lambda(t_i - t_0)}$$



Application scope? Local concentration in breathing zone? Validity?

U. Eickmann: Messungen der Emission und Bewertung chemischer Expositionen am Arbeitsplatz

Fire Engineering: Smoke Management Simulation

i.e. Computational Fluid Dynamics

Validated for fire scenarios

Smoke as Mixture of substances

Calculation of local concentration in air

Applicability in Occupational Safety Studies?

Calculation model: gaseous dispersion in air

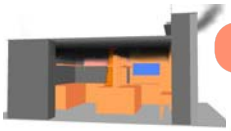
Geometry

Ambient conditions

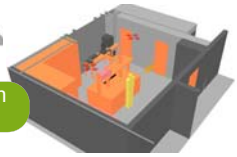
Fire

Substance

Emission

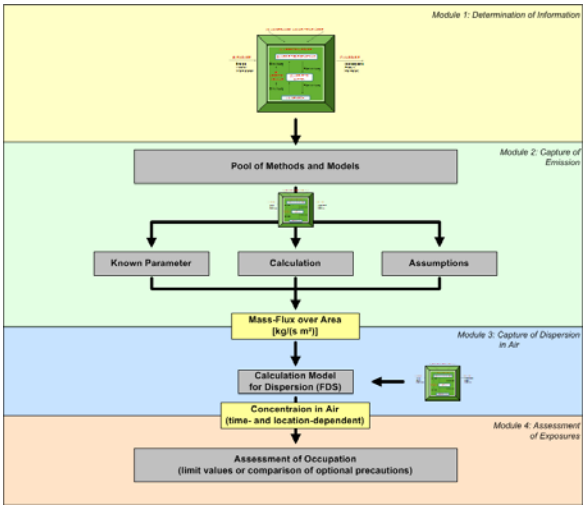


Smoke transport, temperature etc.



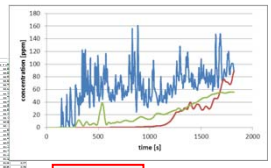
Local concentration (time-dependent)

Integrated assessment concept



Computational results

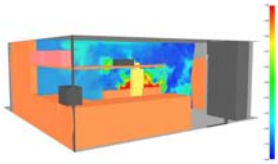
Quantitative time series (local-dependent)



C_{max} = 162 ppm

λ_{Room} = 2,5 h⁻¹

Relation to limit values
Basis for design selection



Qualitative visualisation

Functionality? | **Application Scope?**

Validity for Occupational Safety Studies?

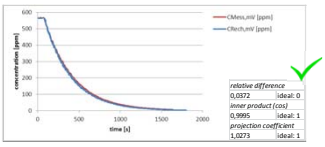
Validation studies

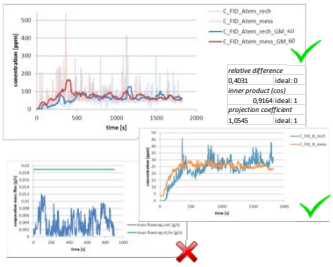
Defined conditions (variied scenarios)

Data of „IPA Exposition Labor“

DGUV-funded research project

Comparison of calculation results with measured data





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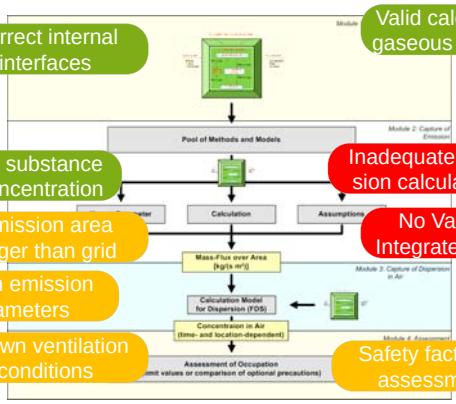
Applicability and practical scope

Correct internal interfaces

Valid calculation of gaseous dispersion



Varible substance and concentration

Inadequate emis-sion calculations

Emission area larger than grid

No Validity for Integrated concept

Known emission parameters

Known ventilation conditions

Safety factors in assessment

Potential to be applied in Occupational Safety Studies

- Individual cases
- Configuration guides
- Forensic analysis

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