

Review of the thesis entitled
„Sudden release of toxic gas in a built-up environment“
by the dissertant: Mgr. Hana Chaloupecká

Current topic of the thesis:

The thesis of Mgr. Hana Chaloupecká focuses on the study of a sudden release of toxic gas in the urban area, where the main subjects of theoretical and experimental research were: cloud arrival time, cloud departure time, other derived characteristics, and modelling of density functions of probability distribution of cloud characteristics. The thesis is divided into six chapters. In the first chapter, the dissertant presented the accidents that were caused by sudden release of toxic gases. It also described a summary of recent findings in the field of gas release research - in the form of mathematical models, field campaigns and wind tunnel experiments. The next chapter provides an evaluation of a new method for determining the puff arrival time in the form of a threshold method using residual concentration. The dissertant compared the results with other commonly used methods of determining the time of puff arrival. In the following chapters, the dissertant deals with the departure time of a gas cloud and other puff characteristics. The dissertant describes a new method for determining the departure time of a gas cloud using the envelope method. Then, she presents the new puff model equations for the idealized urban canopy and utilizing of the function of the probability distribution of the puff characteristics.

The subject of the presented work is very current and ambitious. The studies show a diligent and highly professional approach of the dissertant to solving the given problems by thorough study of the literature as well as careful implementation of demanding experiments and theoretical interpretation.

Aims of the thesis:

The thesis sets the following aims:

- investigation of short-term gas releases in urban canopy using wind-tunnel modelling
- specific definitions of puff characteristics
- application of various definitions of puff arrival time on the same datasets and performing comparison
- sensitivity of puff characteristics to maximum-concentration-based definition of departure time
- modelling of probability density functions
- outputs in the form of the probabilistic density of puff characteristics in an operational model

Appropriate methods for the implementation of the above mentioned aims have been proposed and tested. Main part of the thesis was focused on experimental and theoretical studies and on the achievement of the stated aims. The thesis is in the form of four papers: “Evaluation of a new method for puff arrival time as assessed through wind tunnel modelling” (Journal Process Safety and Environmental Protection 111, 194-210, 2017 - impact factor 3.44), “Sensitivity of puff characteristics to time-based definition of the time of departure” (Journal of Loss Prevention in the Process Industries 56, 242-253, 2018 - impact factor 1.98), „Model of arrival time for gas clouds in urban canopy“ (book Air Pollution Modeling and its Application vol. XXVI., 2019), and „Equations of a new puff model for idealized urban canopy“ (journal Process Safety and Environmental Protection, submitted, impact factor 3.44).

The results of this thesis and the relevant articles clearly demonstrate the achievement of the chosen objectives.

Methods:

The chosen methods of thesis were dependent on the set of aims. The methods mainly involved experimental techniques, instrumentation and theoretical processing. It follows that the dissertant had to cope the methodological aspect at a high interdisciplinary level both in its own fields of physical modelling and in the field of instrumentation.

Results and benefits of the thesis:

The result of this thesis is a new method of finding the arrival time of a cloud within a concentration time series. The next result shows how changes in the value of the parameter in the departure time affect its values and the values of derived puff characteristics. The new method uses the fact that levels of concentrations vary considerably and often when a gas cloud is present at a sampling position. Further result dealt with the arrival of gas clouds. It proposed the new model for the construction of the probability density function of the arrival time within the idealized urban canopy.

The main results of the thesis introduced new equations of a puff model for the idealized urban canopy. The equations are used in the model for recalculation of the results found for the continuous source by a model to those valid for the short-term source. As the outputs of the proposed model, the probability density functions (pdfs) of the puff characteristics are constructed. This output in the form of pdfs is the main feature that stands out in the model, apart from the models usually used during an accident, in which only the ensemble-averaged puff outline and concentration field can be predicted.

Importance for practice and development of the field Atmospheric Physics:

In the thesis, the dissertant presents her publishing activity directly focused on the chosen topic of dissertation: 4 publications in total. The dissertant is involved in discussion and confrontation with the international scientific community by the development of the mentioned methodology and experimental basis, by analyses and evaluations of the sudden release of toxic gas in the built-up environment, both in terms of physical modelling and of application potential, by corresponding tests and experimental studies, also by publishing a number of results in this field in impacted journals. This definitely contributes to the development of the scientific field in which she works.

Formal modification of the dissertation and its language level:

In my opinion, the thesis I had to review is very well presented, structured, and written. The English, is of a high quality. Figures and Tables are clear, together with the captions. The work is logically and very clearly arranged and has a nice layout.

Comments:

I do not have fundamental criticism to the thesis, but I have a few questions:

How strongly affect the results of the thesis on the applied theory of similarity?

Can not cause the used valves the additional turbulences?

What role does the temperature play in aerodynamic tunnel experiments?

As a final evaluation comment of the thesis, I would like to highlight the developed model of density function of the probability distribution of the cloud characteristics.

Concluding remarks:

I can say that the dissertant Mgr. Hana Chaloupecká has decidedly demonstrated the ability for scientific work. Consequently, regarding the quality of the thesis I had to review, the very original scientific results presented and already published, I am very favourable to her PhD defence.

In Prague, 7.2.2019

prof. Ing. Zdeněk Zelinger, CSc. - the opponent of the thesis

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