Review of doctoral thesis

Title of the thesis: Urban Ventilation Dependence on Geometric Configuration

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Content of the thesis

The presented thesis is written in the form of annotated set of papers.

The papers are preceded by introduction providing an overview of the candidate's substantive area of inquiry, related literatures, and research methods.

The topic of the thesis is physical modelling of a pollutant dispersion in modelled atmospheric boundary layer and urban geometry.

The thesis consists of the three parts: Summary, Published Papers and Overview Lists.

In Summary structure of the thesis is specified. Methods are described briefly. Main results are mentioned and conclusion of the research is given in the end.

In the part Published Papers the seven papers already published in journals and conferences are presented. All of them deal with physical modelling of pollutant dispersion using experiments in a wind tunnel. One paper includes also results of mathematical modelling using LES method.

Overview Lists includes list of figures and tables, list of symbols and abbreviations and list of author's publications.

Subject topicality

The thesis main subject concerns traffic pollutant spreading process in typical urban areas. This problem is very important from practical point of view with applications in urban area shaping, verification of ecological situation and possible its improvement.

The subject is interesting also from the theoretical point of view, dispersion of pollutant is modelled within complex geometry. Both convection and turbulent diffusion is taken into account.

Significance for the field, theory and applications

The submitted doctoral thesis represents itself compact experimental work. It includes design of physical model of the case, development of original experimental techniques and procedures and original results.

The developed experimental technique could be used in many different cases to get comparative information on pollutant dispersion. However the research relies on physical modelling of the real situation in experimental facility – the wind tunnel.

The experiments solve a specific case of urban terrain, however results could be applied on similar cases as well. General conclusions are given in the thesis indicating contribution to the diffusion process theory.

Methods and procedures

The physical modelling is used in the thesis. In general, experiments are necessary for successful mathematical modelling validation and boundary conditions definition. The methods are chosen and implemented properly in my opinion.

The pollutant flux evaluation is made on the basis of unique apparatus consisting of LDA velocimetry and FFID concentration measurement. The measurements is conducted simultaneously in a single point in space and with high frequency. Correlations of velocity components and concentration are evaluated.

The theory of turbulent events based on "bursting phenomenon" characterizing turbulence regeneration is adopted. This approach is modified on the case of velocity-concentration correlations. The quadrant method is used for evaluation defining 4 events: venting of polluted air, entrainment of polluted air, entrainment of clean air and venting clean air respectively. Analysis is based on statistics of the events occurrence and correlation with bursting phenomenon to describe the pollutant dispersion process in details.

Combination of the physical and mathematical modelling would the optimal approach in the presented field, however it is used in one paper no. 5, however there is still emphasis on the experimental side.

Achievements, results, fulfilment of the goals

The goals are not defined explicitly in the thesis, however reader could find the relevant information in the text. However formulation defines rather field of interest than particular goals.

The main goal of the thesis is the investigation of the impact of urban geometry on the urban ventilation using both the mean and turbulent pollution fluxes and wind-tunnel techniques. The partial goals cover development simultaneous velocity and concentration measurement technique for evaluation of correlations and reliable method for pollutant flux assessment.

The above defined goals have been fulfilled on high level. The new, original techniques and evaluation method have been defined and original results on pollutant dispersion within the complex geometry have been achieved.

Conclusions reflect the obtained results and define their place in general context of diffusion process physics.

Form of the thesis

The theses is written in English. Formal side is on a good level. The quality of English language is good in my opinion, however not being a native speaker I am not the competent person to approve that.

Figures are of the standard quality. Due to the thesis form, many figures are shown multiply times in the papers.

I recognized careful redaction of the manuscript with minimum misprints.

Strong and weak points

New experimental method for pollutant dispersion experimental evaluation is presented. Original results on pollutant diffusion are shown.

On the other hand, it is not evident which part of the work is accomplished by the doctorate student and which is a collective result, as there are 5 coauthors of the papers. No of them is attributed solely to the student.

Student's publications

The publications with direct link to the thesis subject are included in the thesis itself. The full list of student's publications includes 17 papers, 7 of them are in journals, rest in conferences. The student's publication activity is adequate in my opinion.

Conclusion

The doctoral student has shown good knowledge of state-of-art in the field of pollutant dispersion and key physical phenomena behind this process. He attested his ability of systematic and accurate research work. The dissertation proves the applicants readiness for independent scientific work.

I recommend acceptance of the thesis and after successful defense to confer the title PhD to the student.

Notes and questions:

- The list of quantities definitions with explanations is needed, as some quantities, especially dimensionless, are strange (e.g. "vertical dimensionless turbulent scalar flux" is only half-dimensionless).
- The quantity "turbulence intensity" is defined in the literature as the square root of nondimensional turbulent kinetic energy, i.e. a scalar. In the thesis the same quantity is considered to be a vector, no definition given. Please define your version of the "turbulent intensity".
- Every newly introduced experimental method needs to be analyzed for possible errors and uncertainties. Indicate that for the pollutant flux evaluation from correlation evaluation.

Please take into account different space and time resolution of the velocity and concentration simultaneous measurements.

- In formula (5.5) time averaging is missing and it is inconsistent – should be divided by mean concentration.
- What is in your opinion influence of discrepancy in Reynolds number (reality against physical modelling) in context of turbulent diffusion process?
- The theory of turbulent events (sweep and ejection) is based on description of "bursting phenomenon" defined in the classical literature, however this term is not used in the thesis. Why?

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