UNIVERSITY OF
CHEMISTRY AND TECHNOLOGY
PRAGUE

Institute of Thermomechanics, Czech Academy of Sciences

**Department of Waves in Solids**

# Air flow in the urban area of Hsinchu city

REPORT FROM THE STUDENT INTERNSHIP

| | |
|---|---|
| AUTHOR | **Ing. Tomáš Hlavatý** |
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# Summary

Abstract of the report will be there

## Acknowledgements

Acknowledgements for supervisors and the NARLabs.

# Contents

# 1 Introduction

Introduction here

# 2 Theoretical part

Theoretical part here

# 3 Used computational evironment setup

NCHC servers use singularity container [**singularity**].

## 3.1 Preparation of the singularity container

Assuming you have super-user permission and singularity installed, a preparation of the singularity container image from docker ubuntu:latest release and with openfoam.org/v10 and other useful applications installed inside can be done as follows:

- New container (`./ubuntu`) is created from ubuntu docker repository, `--sandbox` flag allows to write into it later:

  ```
  sudo singularity build -sandbox ./ubuntu docker://ubuntu:latest
  ```

- Shell inside container is opened with `--writable` flag to install necessary stuff into container:

  ```
  sudo singularity shell -writable ./ubuntu
  ```

- Installation of the basic applications and openfoam.org/v10 into container:

  ```
  apt update
  apt install python3 python3-pip wget vim software-properties-common
      python3-tk
  pip3 install matplotlib
  sh -c "wget -O - https://dl.openfoam.org/gpg.key >
      /etc/apt/trusted.gpg.d/openfoam.asc"
  add-apt-repository http://dl.openfoam.org/ubuntu
  apt update
  apt install openfoam10
  ```

- If you want to compile custom openfoam solver, source openfoam in container:

  ```
  .  /opt/openfoam10/etc/bashrc
  ```

- and compile it using `wmake` in prepared solver directory (in our case in `./01_codes/OF_cases/03_customSolvers/pollutionFoam`).

- When everything is installed, the `.sif` container file can be build using:

  ```
  sudo singularity build ubuntu.sif ./ubuntu/
  ```

Following the above listed guideline, singularity container image `ubuntu.sif` is created. This can be deported to NCHC servers and used.

# 4 Model description

Models description here.

# 5 Numerical experiments

Some nice results her.

# 6 Conclusions

And conclusion here

# 7 Nomenclature

| | | |
|---|---|---|
| $c_i$ | ......... | Molar concentration of $i$-th molar specie |
| $c_{\mathrm{T}}$ | ......... | Total molar concentration |
| Co | ......... | Courant number |
| $d$ | ......... | Diameter |
| $D_i$ | ......... | Molar diffusivity of $i$-th molar specie |
| $D_i^{\mathrm{eff}}$ | ......... | Effective molar diffusivity of $i$-th molar specie |
| $\boldsymbol{d}_{\mathrm{PN}}$ | ......... | Vector connecting centroids of P and N |
| $f$ | ......... | Face of the cell |
| $\boldsymbol{f}_b$ | ......... | Body forces acting on cell |
| $\boldsymbol{g}$ | ......... | Gravitational acceleration |
| $h$ | ......... | Specific enthalpy |
| $I$ | ......... | Time interval |
| $I^h$ | ......... | Discretized time interval |
| $m$ | ......... | Number of discretized FV cells |
| $M$ | ......... | Molar mass |
| $n$ | ......... | Number of species |
| $\boldsymbol{n}$ | ......... | Outer normal vector |
| $\boldsymbol{n}_f$ | ......... | Outer normal vector of the face $f$ |
| $p$ | ......... | Pressure |
| $p_{\mathrm{ref}}$ | ......... | Reference pressure |
| $\tilde{p}$ | ......... | Kinematic pressure |
| $Q$ | ......... | Computational domain |
| $r_i$ | ......... | Reaction source of the $i$-th molar specie |
| $\mathrm{R}^{\mathrm{g}}$ | ......... | Universal gas constant |
| Re | ......... | Reynolds number |
| $s_\phi$ | ......... | Source of the $\phi$ |
| $\boldsymbol{S}_f$ | ......... | Face area vector |
| $t$ | ......... | Time |
| $T$ | ......... | Temperature |
| $T_{\mathrm{ref}}$ | ......... | Reference temperature |
| $\boldsymbol{u} = (u, v, w)$ | ......... | Velocity |
| $y_i$ | ......... | Molar fraction of the $i$-molar specie |
| $\alpha$ | ......... | Heat transfer coefficient |
| $\varepsilon$ | ......... | Porosity |
| $\Gamma_\phi$ | ......... | Diffusivity of $\phi$ |
| $\kappa$ | ......... | Permeability |
| $\lambda$ | ......... | Heat conductivity |
| $\mu$ | ......... | Dynamic viscosity |
| $\nu$ | ......... | Kinematic viscosity |
| $\Omega$ | ......... | Domain |
| $\Omega^h$ | ......... | Discretized domain |
| $\Omega_P^h$ | ......... | Cell $P$ |
| $\delta\Omega_i^h$ | ......... | Volume of the cell |
| $\partial\Omega$ | ......... | Domain boundary |
| $\phi$ | ......... | Intensive tensorial quantity |
| $\phi_P$ | ......... | Value of $\phi$ in the cell centroid of cell $P$ |

| | | |
|---|---|---|
| $\phi_f$ | ......... | Value of $\phi$ in the face centroid of face $f$ |
| $\mathbf{\Phi}_\phi$ | ......... | Flux intensity of $\phi$ |
| $\mathbf{\Phi}_{\phi,\mathrm{conv}}$ | ......... | Convective flux intensity of $\phi$ |
| $\mathbf{\Phi}_{\phi,\mathrm{diff}}$ | ......... | Diffusive flux intensity of $\phi$ |
| $\rho$ | ......... | Fluid mass density |
| $\Sigma$ | ......... | Total stress tensor |
| $\tau$ | ......... | Tortuosity |
| $\boldsymbol{\tau}$ | ......... | Viscous stress tensor |
| $\nabla$ | ......... | Nabla differential operator |

Potencial appendix here.