# COMSOL Multiphysics® Models as the Design Guidance in the Selected Transport Phenomena Problems

S. Y. Spotar
Department of Chemical and Materials Engineering, Nazarbayev University , Astana, Kazakhstan

## INTRODUCTION:

Transport phenomena models in review:

1. Design of the pilot convective air dryer for the apple ring, Figure 1;
2. Development of the inlet ventilation unit for the focusing of the extraction air flow, Figure 2;
3. Radon diffusion in the dwellings, Figure 3.

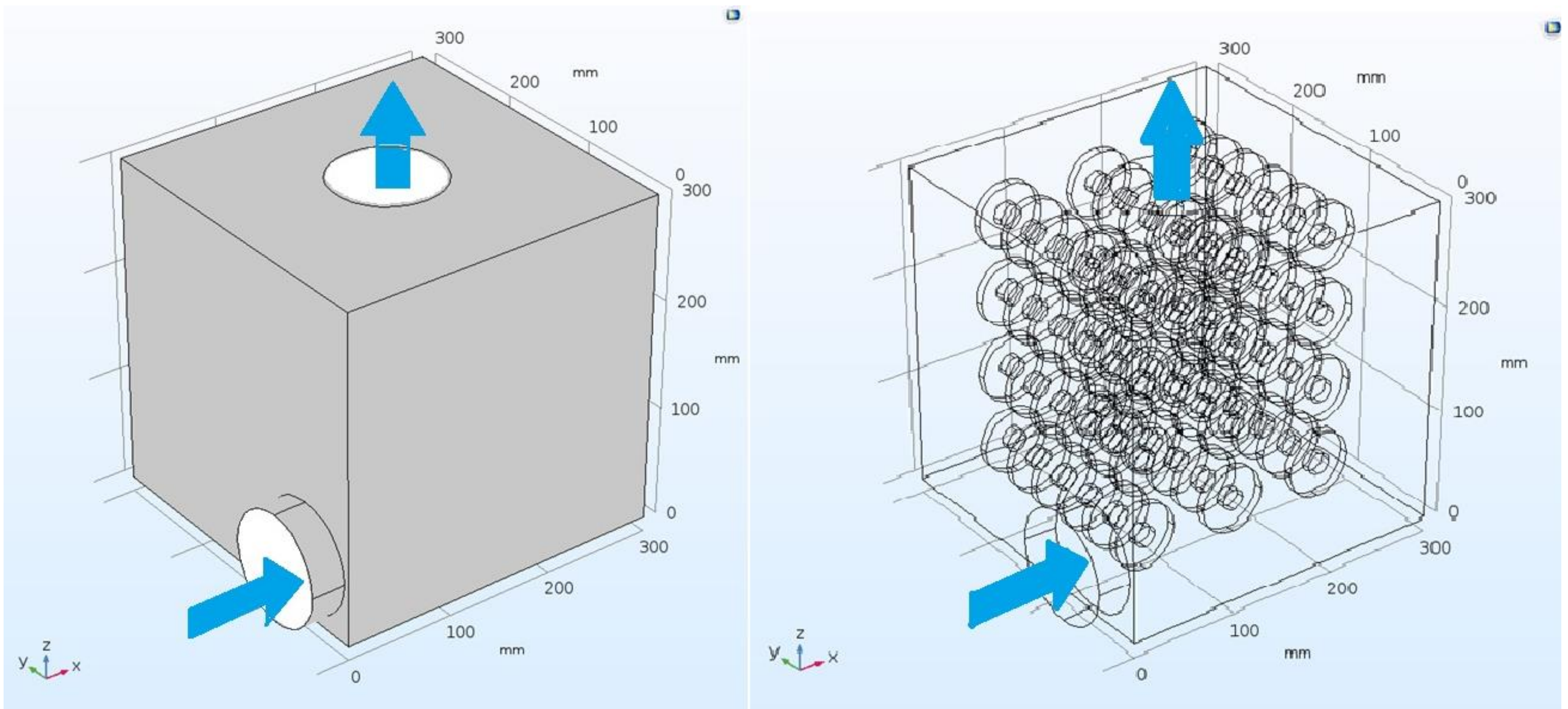

**Figure 1**. Vortex dryer prototype geometry

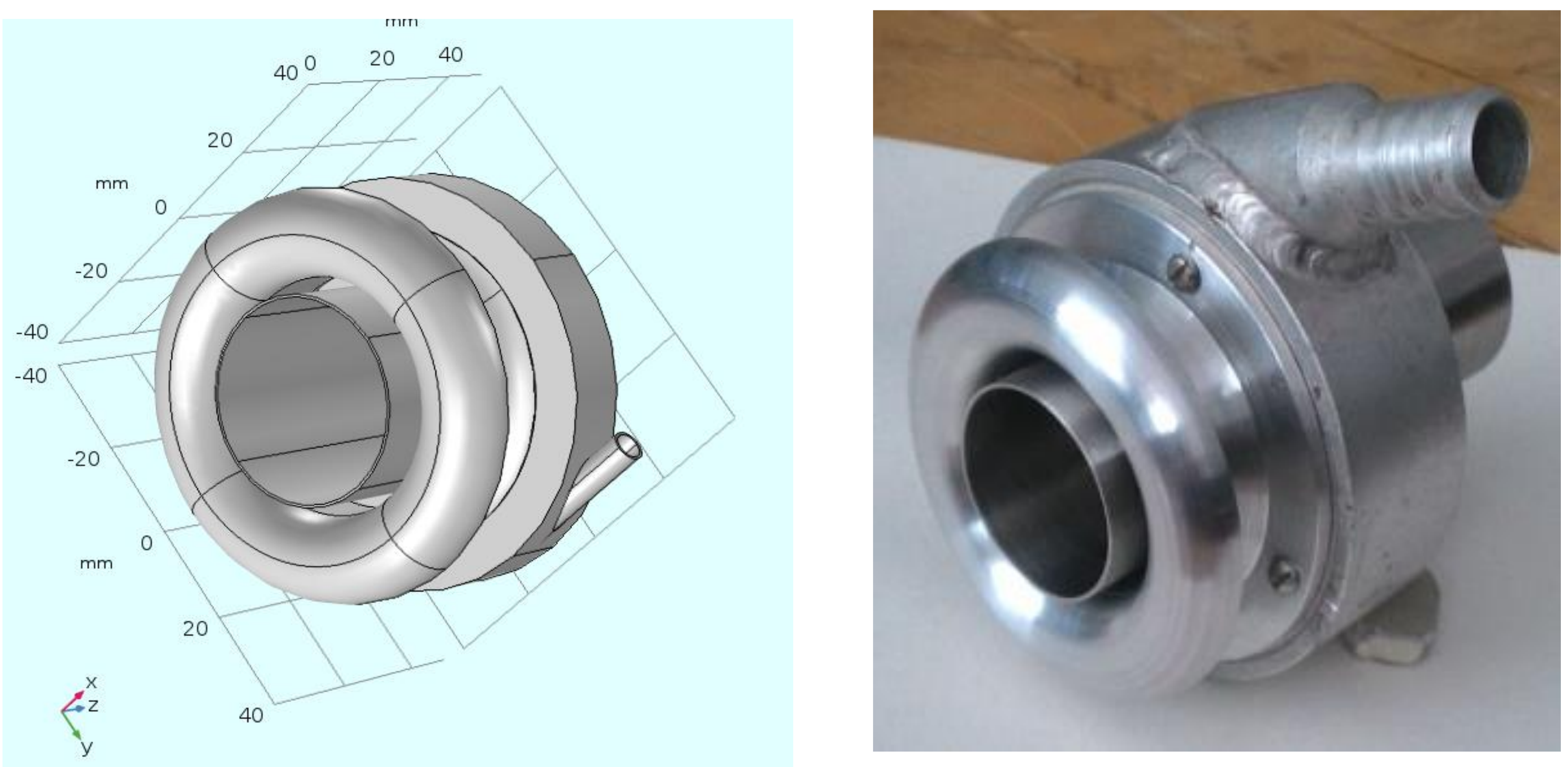

**Figure 2**. The unit for the focusing of the extraction flow [1]

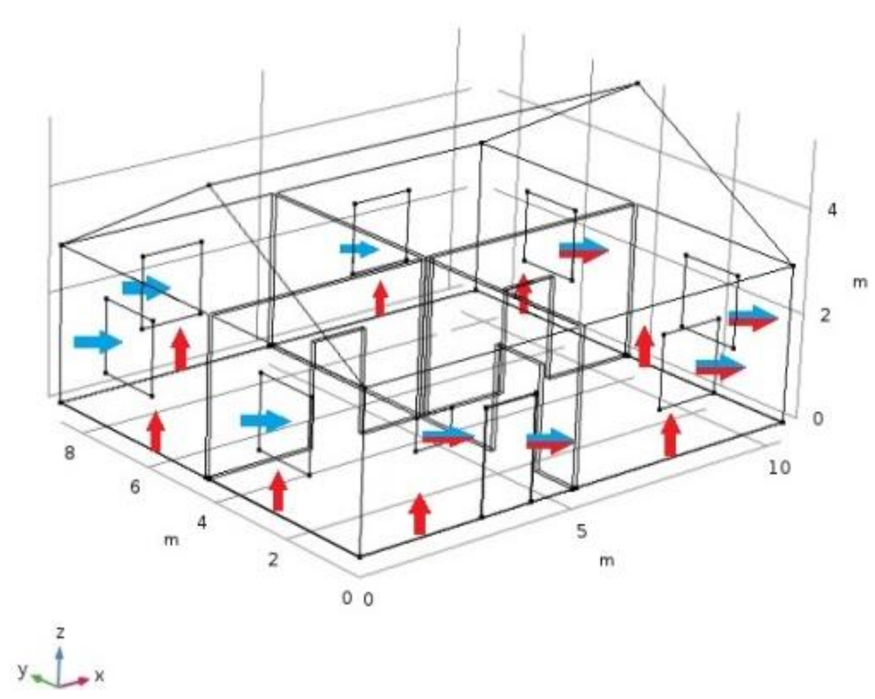

**Figure 3**. Schematic of air flow and radon entry

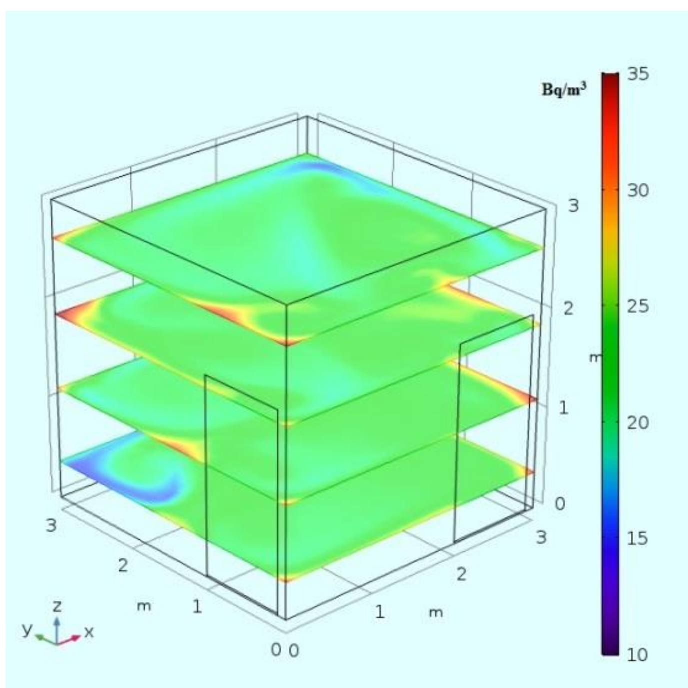


**Figure 4**. Exhalation of radon from the walls [2]

## COMPUTATIONAL METHODS:

Physics: 'Turbulent Flow' or 'Laminar Flow' and 'Transport of Diluted Species', Turbulence model: k-ε; Typical mesh: 'Fine'; Study: 'Stationary', relative tolerance: 0.001. The algorithm implies a numerical solution for the coupled RANS and convective diffusion equations [3]. The radon radioactive decay process was presented by a pseudo-reaction term. Whether it was possible the workability of the model were tested with available experimental data, Figure 4.

## RESULTS:

| Location | Radon concentration, Bq·m$^{-3}$ | | | | |
|---|---|---|---|---|---|
| | CFD, [2] | Active measurement [2] | Passive measurement [2] | CFD laminar flow (this paper) | CFD turbulent flow, $k$-ε model (this paper) |
| Corner 1 | 20 | 27 | 30 | 30.8 | 33.0 |
| Corner 2 | 21 | 24 | 30 | 33.2 | 34.2 |
| Corner 3 | 27 | 27 | 30 | 36.4 | 32.5 |
| Corner 4 | 13 | 18 | 8 | 16.3 | 21 |
| Center | 23 | 22 | 42 | 21.5 | 26.8 |

**Table 1**. Comparison of simulation results with study [2]

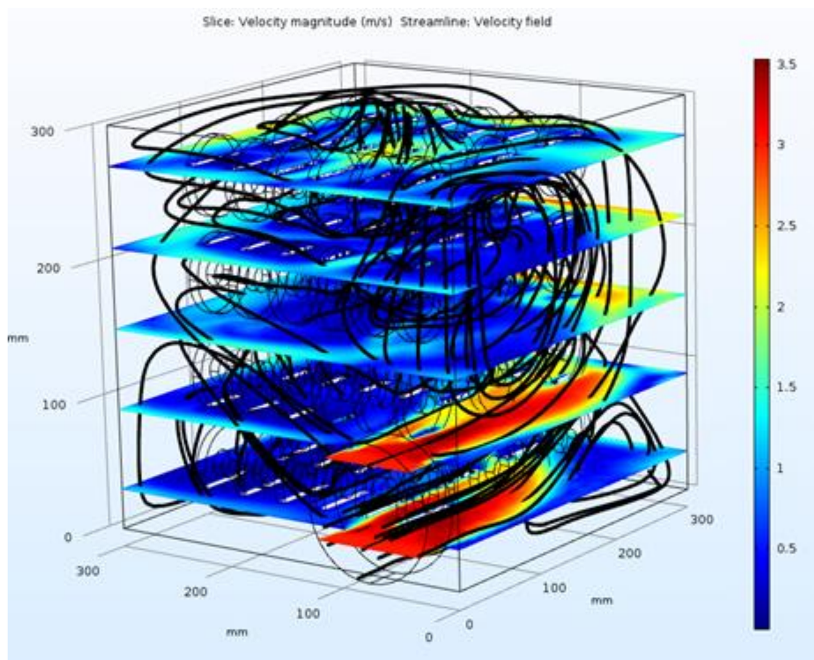


**Figure 5**. Flow in the vortex dryer

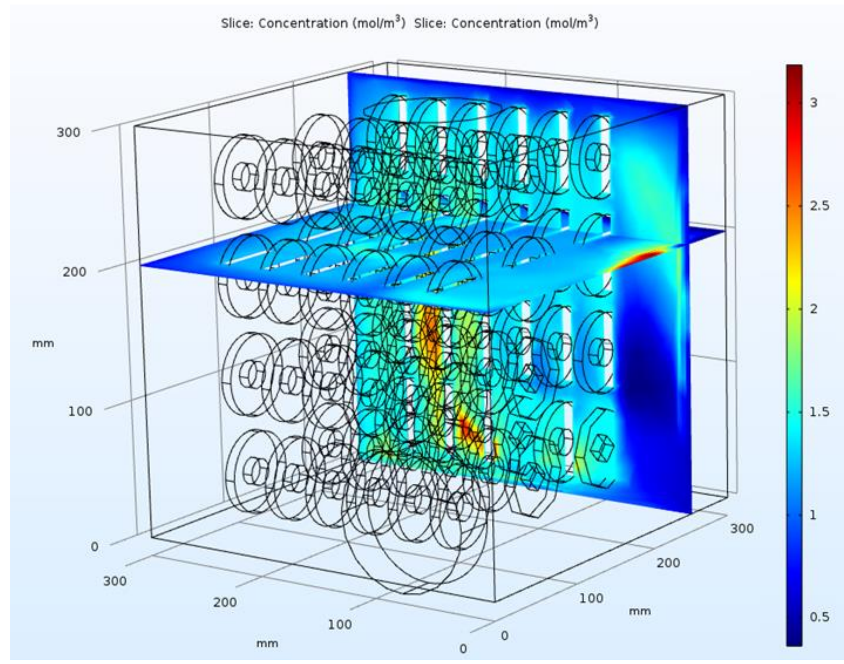


**Figure 6**. Water vapour concentration

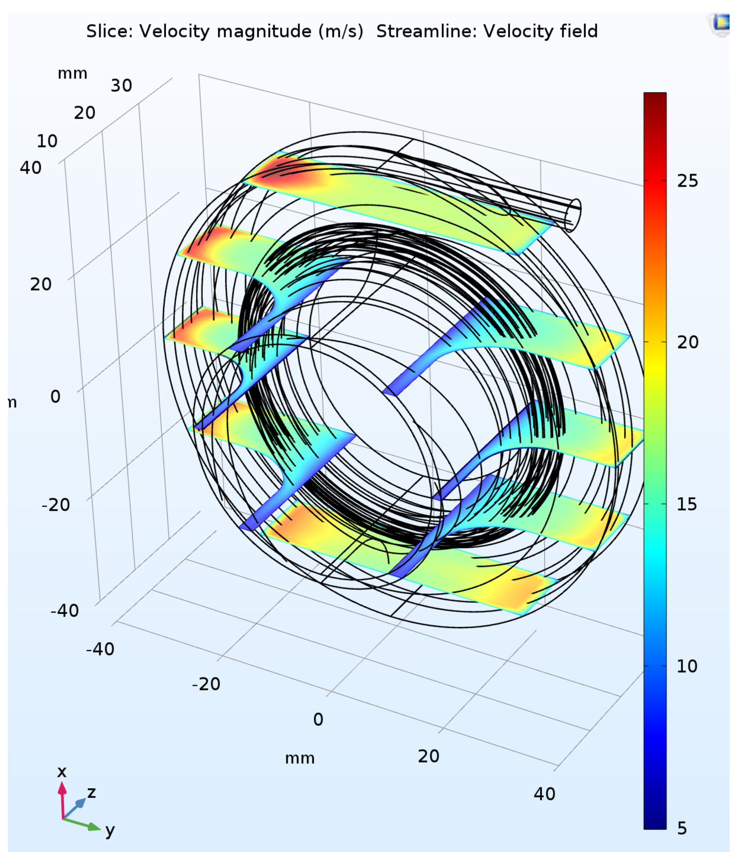


**Figure 7**. Velocity field in the unit

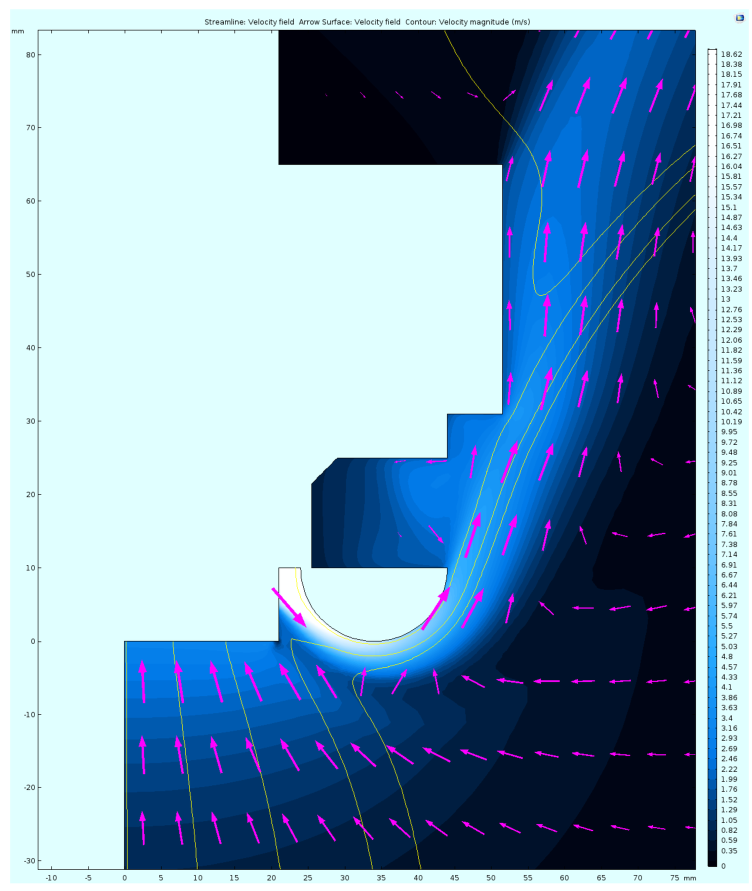

**Figure 8**. Generated near-field flow

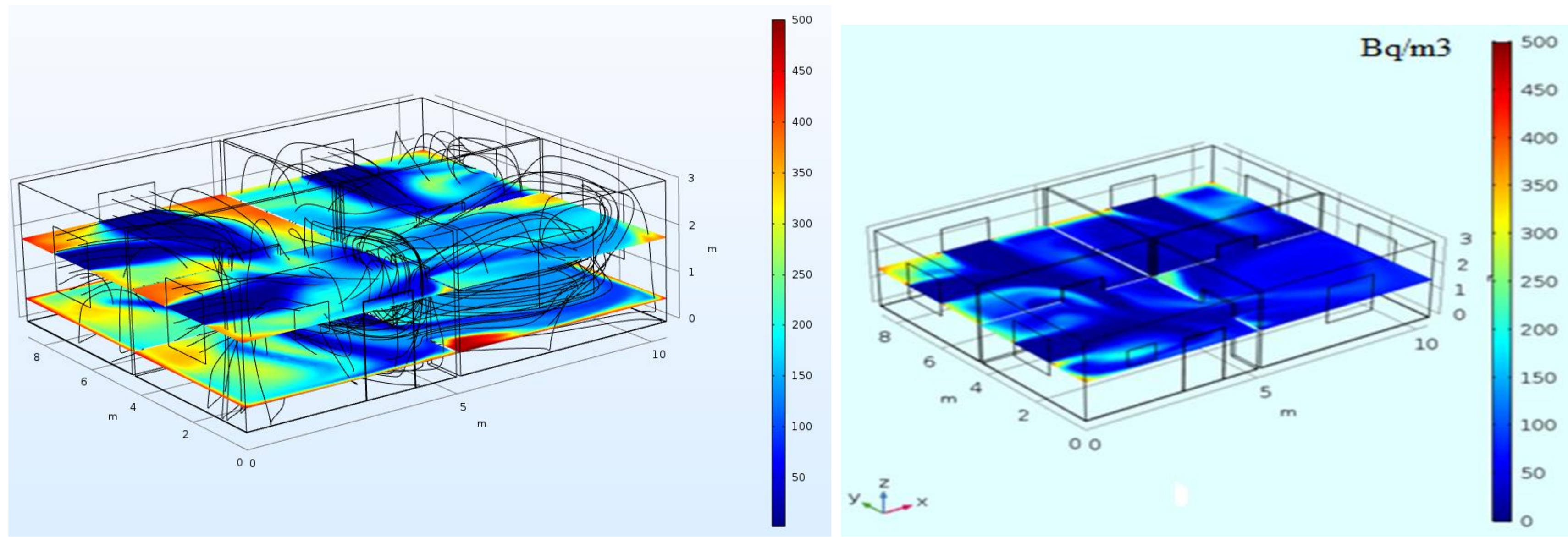


**Figure 9**. Radon concentration in at 0.17 and 0.51 1/h air exchange rate

## CONCLUSIONS: Modeling via COMSOL® makes possible:

1.Design of the vortex dryer with uniform distribution of convective mass transfer parameters;

2. Design the ventilation unit with a double a capture distance;

3. Show the way for 'smoothening' the impact of radon diffusion in dwellings.

## ACKNOWLEDGMENTS:

This research was supported by SRGS at NU (090118FD5323) and ORAU (129-2017/022-2017)

## REFERENCES:

1. S.Y. Spotar and A.L Sorokin, Focusing of the Flow Capture for Local Exhaust Ventilation System, American Journal of Applied Sciences, 7(6), 732-738, (2010).
2. Chauhan N., Chauhan R.P., Joshi M., Agarwal T.K., Aggarwal P., Sahoo B.K. *Study of indoor radon distribution using measurements and CFD modeling*. Journal of Environmental Radioactivity 136,105-111, (2014).
3. CFD *Module User's Guidance, COMSOL Multiphysics ® v.5.3*, 44-174, 417-447,(2017).