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

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Abstract

This paper demonstrates experience of using the COMSOL Multiphysics® transport phenomena models in design practice, particularly at the early stage of design when there is might be too many possible design suggestions relying on the shell balance equations, and engineering intuition. Therefore, it is desirable to narrow the set of the potential variants of apparatus design characterized by the chosen geometry, rate parameters, boundary conditions, and other inputs.
The proclaimed theme is illustrated by the details came from working up the following problems:
1. Design of the pilot convective air dryer for the apple rings;
2. Development of the inlet ventilation unit for the focusing of the extraction air flow;
3. Assessment on the radon concentration distribution in the dwellings.
In the course of the works on the pilot apple rings dryer design it was necessary to sort out between the vortex, spiral and 'conventional' type of apparatus to achieve a reasonable level of uniformity of the drying rate of the product. Evaluation of the mass transfer coefficients for the specified ring geometry and position and determination of the pressure drop loss over the dryer were required to develop the rationale of the pilot dryer design concept.
Focusing of the flow capture for local exhaust ventilation systems has been achieved with employment of the vortex suction device (VSD). The original VSD comprises of circular and annular ducts, a tangential duct, a vane type vortex generator and an ultradiffusor employed to stabilize the unlocked vortex jet operation mode. Such concentrated inflow makes possible the fume capturing from the extended distance in application to the localized sources of emission. Under attempt to simplify the original VSD framework it has been proposed to replace the vane vortex generator with a single tangential input accompanied by a contraction section. Herewith the circumferential uniformity of the axial and tangential velocity profiles of the shielding jet serves as the essential criteria of the workability of the proposed assembly of the unit.
The majority of researchers used a shell balance model for the estimation of radon concentration in houses which assumes the complete mixing of radon entering into the building. However, the experimental observations indicate that radon concentration in living areas might markedly deviate from average values. It is also worth to include into the analysis of the radon propagation process the impact of the external environment (i.e. atmosphere as air wind velocity, permeability as a characteristic of soil) on the radon entry into houses. The variety and interplay of different factors affecting the level of radon concentration in living areas motivates researchers to further scrutinize the details of the

phenomena. The intermediate result of the study was to point out the existence of stagnant zones where the concentration of radon is substantially higher than the average values.
The key helpful information required to advance in design aspects in the above problems has been obtained by developing the appropriate 3-D transport phenomena models; Chemical Species Transport, Heat Transfer and Fluid Flow interfaces were used in this study.