A COMSOL Multiphysics® Study of the Temperature Effect on Chemical Permeation of Air Supply Tubes

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Abstract

Permeation and transport of chemicals into the walls of air supply hoses is a noteworthy problem in a chemical industry. A simple method based on the mathematical equivalence of filling a homogenous hose with a chemical, to immersing it in a chemical, has been developed. The model proposed tries to investigate the effects of a non-isothermal environment on the diffusion through the tube wall.The experimental method using 10 cm long Esdan PVC air supply hose with a diameter of 18 mm and a wall thickness of 4 mm was selected. This method was designed by filling the hose with methyl ethyl ketone (MEK), plugging it with steel ball bearings, and inserting it into an isothermal test rig flushed with air to remove any excess permeant from the outer wall.
The geometry of the hollow PVC air supply tube is created in the COMSOL Multiphyiscs® software. The following equations are used to predict the results :

The first assumed boundary condition is at the inner radius of the tube, r = Ri, where it is assumed $\omega A = 1$ since the tube is completely filled with MEK. The second boundary condition is at the outer radius, r = Ro, where it is assumed $\omega A << 1$ due to presence of the air flow which sweeps away any permeant and maximizes the gradient. Since the model will include a time-dependent study, the time step chosen will be 1 hour with the range of study going from 0 -24 hours. Results of the simulation will be compared to literature data.

Reference

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