INSTITUTE OF CHEMICAL TECHNOLOGY PRAGUE

Gas and vapor transport in dense membranes: outline of recent developments

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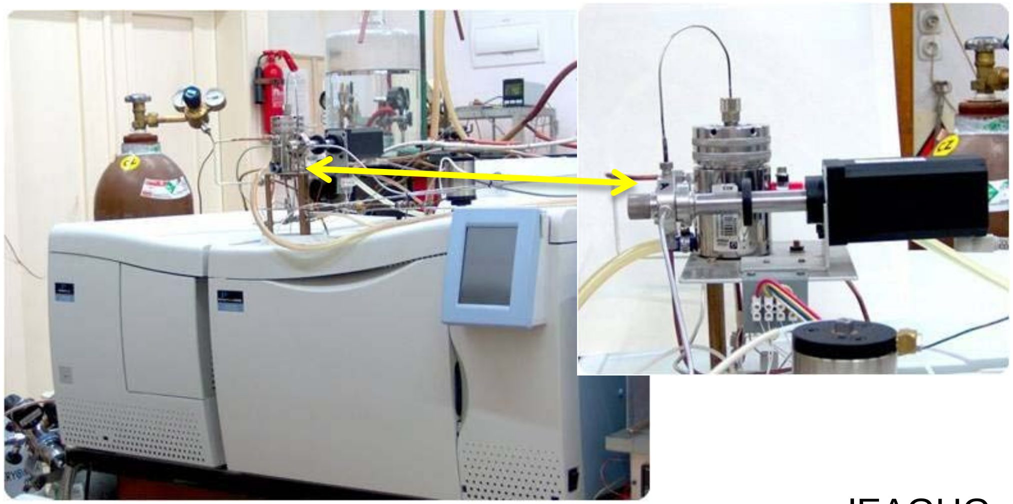
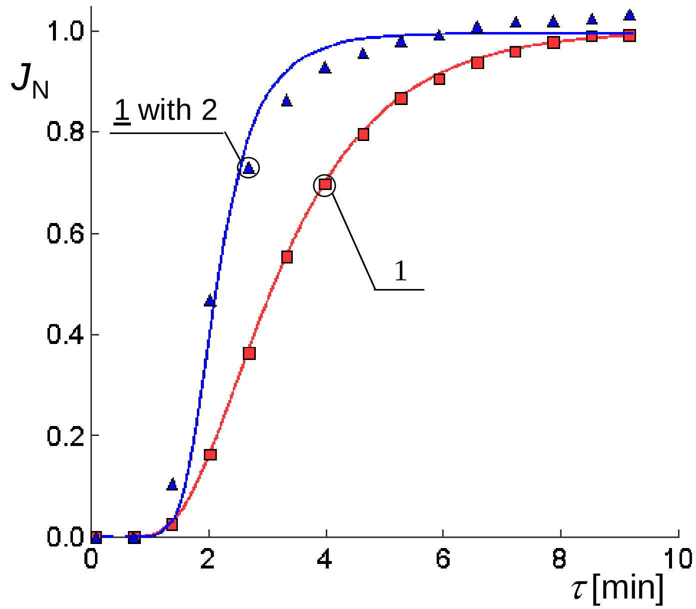
What we do

- Characterization of dense membranes
  - Sorption and permeation techniques
    - Vapors and gases
    - Transient and steady-state measurements
    - Modeling of transients, diffusion of mixtures
- Novel approaches
  - Flow permeameter with fast GC/MS detection
    - Time-resolved compound-specific detection
    - Transient regime permeation of mixtures, coupling effects
  - Transient sorption in RTIL-PDMS membranes

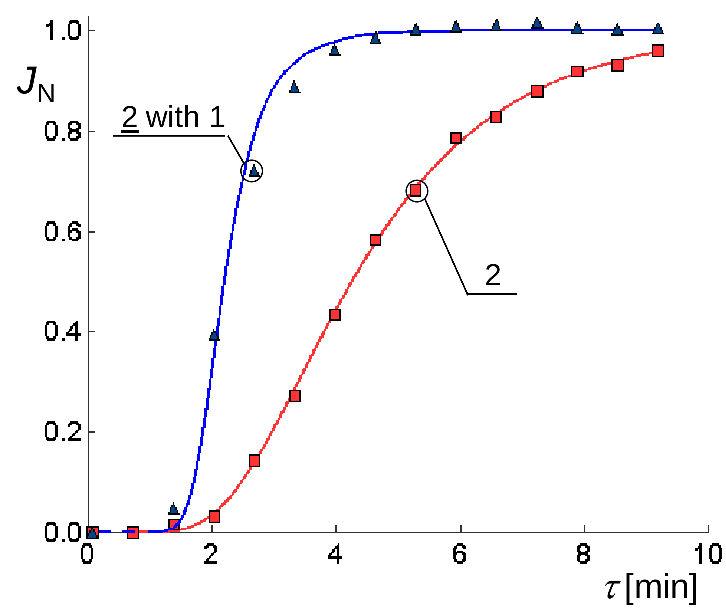


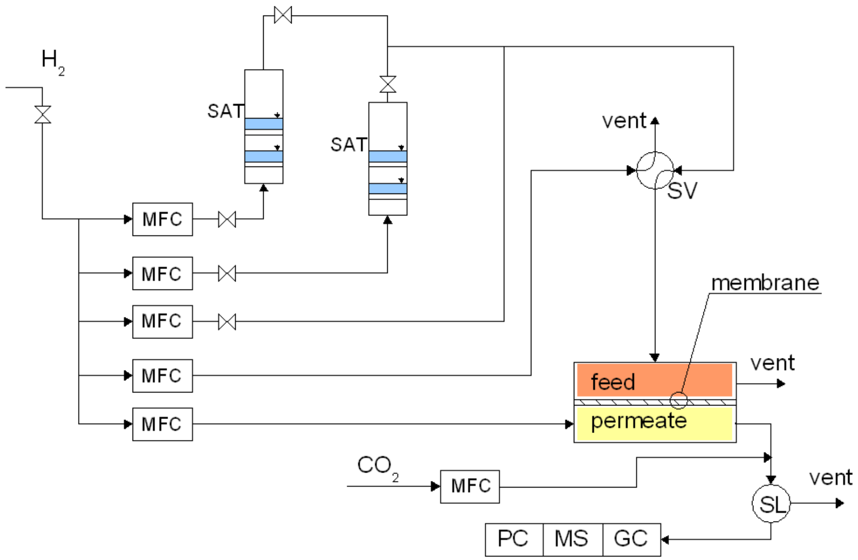
Transient regime permeation of mixtures

p-xylene (1), *p*-xylene with octane (2); LDPE



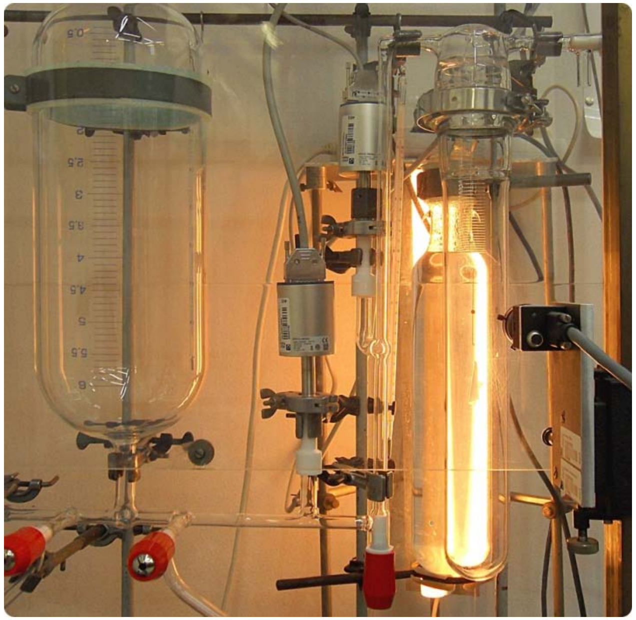
octane (2), octane with *p*-xylene (1); LDPE



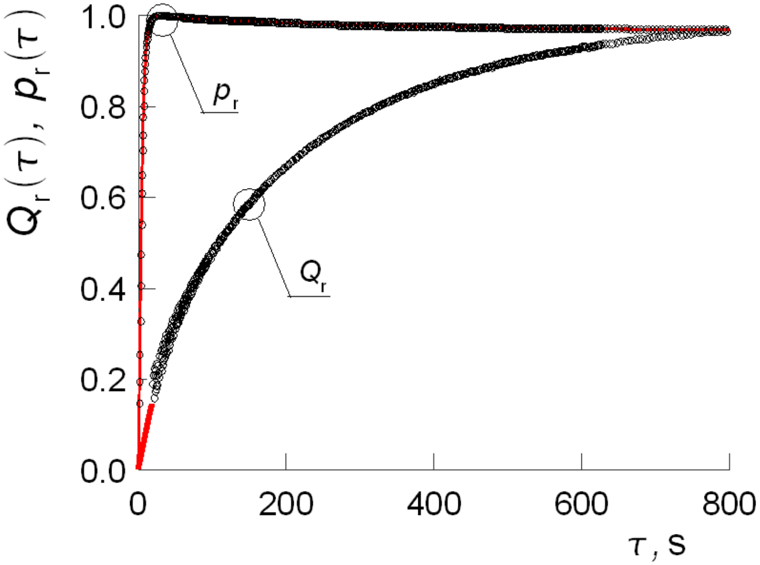


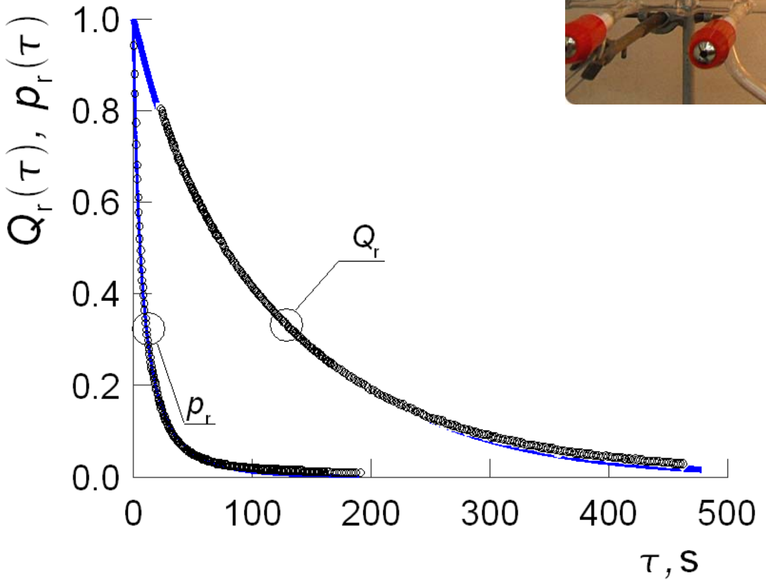
O. Vopi• ka, V. Hynek, et al., Journal of Membrane Science 350 (2010) 217–225

Transient sorption in RTIL-PDMS membranes



- The concept of thermodynamic diffusion coefficient
- Time-dependent boundary conditions
- Gravimetrical closed-volume apparatus, Mc Bain's spiral





Running projects

- *Nanocomposite and Nanostructured Polymeric Membranes for Gas and Vapour Separations*;
  DoubleNanoMem – the project of European Community's Seventh Framework Programme (FP7/2007–2013) , No. NMP3-SL-2009-228631
- *Separation of fluids by supported ionic liquid membranes*;
  Czech Science Foundation, No. 104/08/0600
- *Physico-chemical methods of analysis and characterization of chemical systems and biosystems;*
  Czech Ministry of Education, Youth and Sports, No. MSM 6046137307
- *Preparation and Properties of Hyperbranched Polyimide-Silica Combined Materials Usable as Separation Membranes*;
  Czech Science Foundation, No. 104/08/0600

Recent publications

O. Vopi• ka, V. Hynek, et al., Measuring the transient diffusion of vapor mixtures through dense membranes , J. Membr. Sci. 350 (2010) 217–225

O. Vopi• ka, V. Hynek, et al., A new sorption model with a dynamic correction for the determination of diffusion coefficients, J. Membr. Sci. 330 (2010) 51–56

O. Vopi• ka, V. Hynek, et al., Blended silicone-ionic liquid membranes: Transport properties of butan-1-ol vapor , Eur. Polym. J. 46 (2010) 123-128

O. Vopi• ka, K. Friess, et al., Evaluation of Two Methods for Measuring Vapor Sorption in Polymers, Sep. Sci. Technol. 45(2010) 1260-1264

Equations used

Transient diffusion of mixtures

$$\frac{\partial \phi}{\partial \tau} = (1-\phi)\cdot\frac{\partial}{\partial x}\left\{D^0[\exp(\gamma\phi)]\phi\frac{\partial \ln(a)}{\partial \phi}\frac{\partial \phi}{\partial x}\right\}$$

$$\frac{\partial \phi_1}{\partial \tau} = (1-\phi_1-\phi_2)\cdot\frac{\partial}{\partial x}\left\{D_1^0[\exp(\gamma_{11}\phi_1+\gamma_{12}\phi_2)]\phi_1\frac{\partial \ln(a_1)}{\partial \phi_1}\frac{\partial \phi_1}{\partial x}\right\}$$

$$\frac{\partial \phi_2}{\partial \tau} = (1-\phi_1-\phi_2)\cdot\frac{\partial}{\partial x}\left\{D_2^0[\exp(\gamma_{22}\phi_2+\gamma_{21}\phi_1)]\phi_2\frac{\partial \ln(a_2)}{\partial \phi_2}\frac{\partial \phi_2}{\partial x}\right\}$$

The concept of thermodynamic diffusion coefficient

$$\frac{\partial \phi}{\partial \tau} - \frac{\partial}{\partial x}\left[\underbrace{D_T\phi\frac{\partial \ln a}{\partial \phi}}_{D(\phi)}\cdot\frac{\partial \phi}{\partial x}\right] = 0$$