2D Projective Imaging of Water Concentration Profiles in Adsorption Columns by MRI

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1. Introduction

Magnetic resonance imaging (MRI) that accepted in the medical field widely is recently applied to various industry uses as well. As for the study of the diffusion, the MRI technique was reported to be able to be used to observe chromatographic profiles of water in an adsorption column [1]. But it is more useful to acquire two-dimensional images to observe the profiles precisely because actual columns have some thickness. So we tried to obtain 2D images of the transient profile of water in the adsorption columns filled with zeolite by using a compact MRI device which has 1 T permanent magnet.

2. Experimental

Adsorption columns made of acrylic pipes (2.6 cm inside diam. x 10 cm length) were packed with Li-X zeolite particles. And humidified nitrogen (about 80 %RH) was fed from the bottom end of the columns at the flow rate of 2 L/min or 5 L/min. Each profile was obtained as a projective image to a plane without slicing by spin-echo method [2]. It took 8 min 40 sec to acquire an image in this study, so that the images were obtained while nitrogen feeding was suspended temporarily.

3. Results and Discussion

Figure 1 shows the 2D projection images of water concentration profiles in adsorption columns. Each graph shows area of about 4cm square from the bottom end of adsorbent bed in the columns. As shown in the figure 1, the humid area progressed through the bed, and we can see that the progress speed of the humid area near the wall was faster than that of the humid area near the central axis of the beds like a meniscus shape. The tendency was more obvious at the feed rate of 5 L/min than 2 L/min. Such behaviour was thought to be caused by the lower density of filling of adsorbent near the inner wall of the column, and influenced by the balance of the flow rate, the strength of adsorption, and axial and radial diffusion in the adsorption bed. So we are trying to analyze the detailed

mechanism by several approaches including simulations of adsorption using Stop & Go method [3].

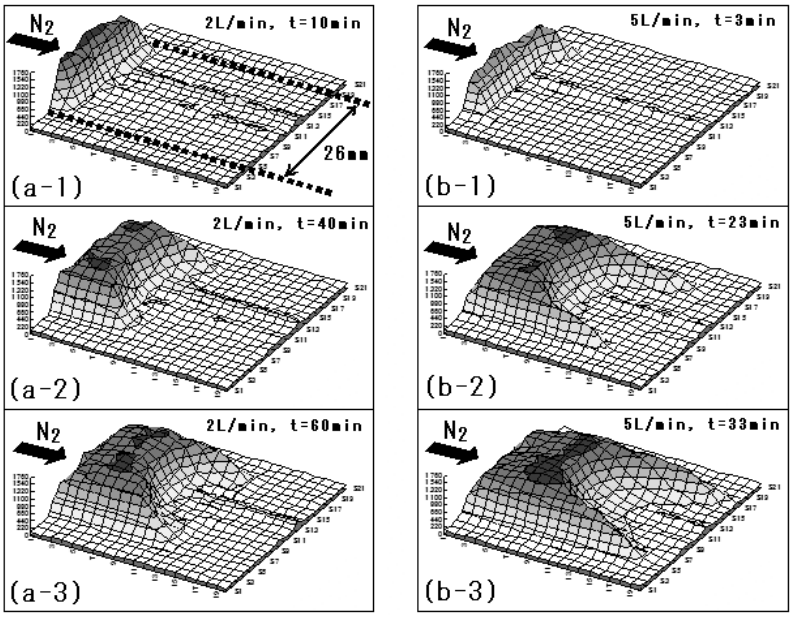

Fig. 1: 2D projection images of water concentration profiles in adsorption columns. (a-1), (a-2), (a-3) show the profiles at 10 min, 40 min, 60 min from start of feeding nitrogen at the flow rate of 2 L/min, and graph (b-1), (b-2), (b-3) shows the profiles at 3 min, 23 min, 33 min at the flow rate of 5 L/min respectively. The adsorbent bed of zeolite extends from the end on the upper left of each graph toward the bottom right (between two dotted lines showed in (a-1)). The third axes of these 3D graphs indicate values in proportion to the MRI signal intensity.

4. Conclusion

2D projection images of the transient profile of water in adsorption columns filled with zeolite were obtained by using a compact MRI. And the differences in the progress speed of the humid areas which were caused by the difference in the condition of flow rate or radial location, were observed from the images. These results suggest that MRI is useful for the detailed analysis of the moisture absorption in adsorption columns.

References

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