SOLVENT RECOVERY BY DR-PSA, A SIMULATION STUDY

Kazuyuki Chihara, Keita Sawada , Tadahiro Aiko,Takashi Kaneko, Takuya Chiyoda*

Meiji University, Japan
1-1-1 Higashi-mita, Tama-ku, Kawasaki, Japan
**Corresponding author, TEL +81-44-934-7197, FAX +81-44-934-7197*
e-mail: chihara@isc.meiji.ac.jp

ABSTRACT

Pressure swing adsorption (PSA) has been applied for various mixed gas separation and purification. And process simulation of PSA has become powerful for PSA process design. These days, solvent recovery became one of attractive PSA applications, not only conventional PSA, but also dual reflux PSA, which has middle point feed to the PSA column.

In this study, we investigated optimization about dual reflux PSA for solvent recovery by process simulation, named Stop & Go method. Dichloromethane adsorption on zeolite was assumed as a case study.

Keywords

PSA, Dual Reflux PSA, simulation

INTRODUCTION

Pressure swing adsorption (PSA) method is a cyclic process useful for the separation of gaseous mixtures. Though there were some problems to be solved, there may be some possibility to apply PSA to solvent recovery.

Dual reflux PSA is a new pressure swing adsorption process proposed for treatment of low-VOC-concentration air streams. Feed gas is supplied to the high pressure column at some intermediate position to divide it into an enriching and a stripping sections. A part of air stream leaving the high pressure column is returned to the low pressure column as enriching reflux. And we can get VOC as a liquid by dual reflux PSA process. [1]

In this study, the solvent recovery by DR-PSA with zeolite was tested by process simulation. As a first step, CH_2Cl_2 was chosen as solvent and the following items were examined.

SIMULATION

Figure 1 shows Dual Reflux PSA unit, respectively. Simulation was tried, based on this unit. The Dual Reflux PSA has feed point to the high pressure column at some middle point of the column, which separates the system into the upper enriching section and the lower stripping section. Operation sequence is shown in Figure 2. It was consist of four sequence, pressurization step, adsorption step, evacuation step and purge step. Pressurization, adsorption, evacuation and purge were set to 20, 200, 20 and 200 seconds. Four type of Purge condition was tried. Column conditions were shown in table.2. Adsorbate conditions were shown table.3.

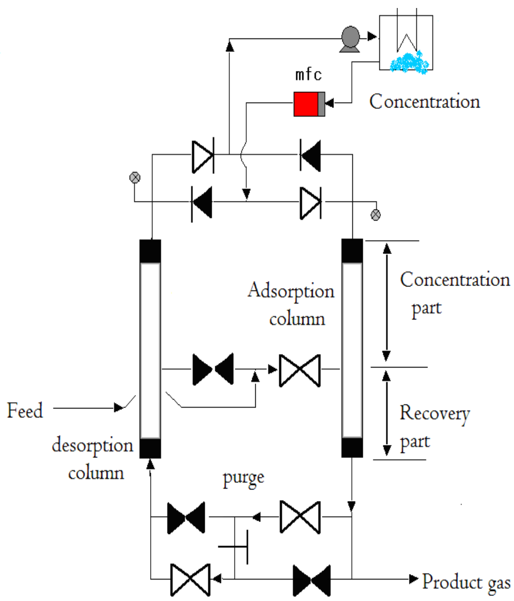

Fig.1 dual reflux PSA unit

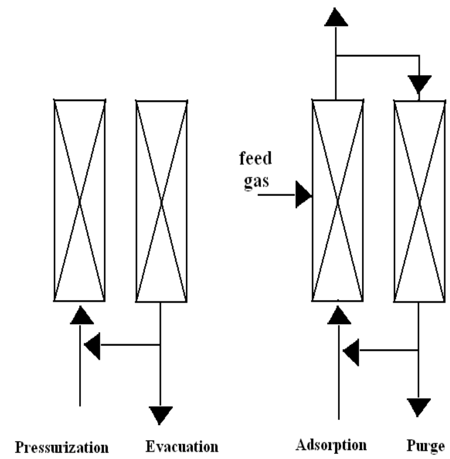

Fig.2 operation seqence

Table.1 operation condision

	feed [m^3/min]	Purge [m^3/min]	product gas [m^3/min]	pressure of saturated vapor [atm@-20deg]	concentration of feed gas [ppm]
A	100	58	99	0.066	10000
B	100	67	99	0.066	10000
C	100	100	99	0.066	10000
D	100	137	99	0.066	10000

Table2. column conditoin

radius[m]	1.02
length[m]	11.34
Amount of adsorbent [kg]	8530
porosity	0.4

Table.3 adsorbent condition

q^{∞}[Nl/g]	0.26
γ/ksav [sec]	150

RESULT AND DISCUSSION

3-1 influence of feed inlet position

Figure 3 shows influence from changing feed inlet position. Changing feed inlet position influence solvent recovery. It means that feed inlet position is very important for dual reflux PSA.

3-2 comparison each optimum feed inlet position

Figure 4 shows influence of amount of purge gas flow. They are each optimum feed inlet position. They are nearly same. It didn't decrease amount of solvent recovery as purge gas flow increasing.

Figure 5 shows concentration solvent in column. About A, CH_2Cl_2 concentration of feed gas equal that in column.

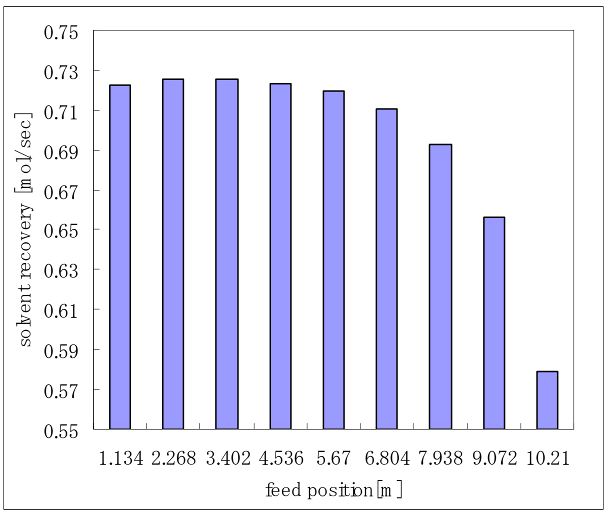

Fig.3 difference of solvent recovery by changing Feed position.

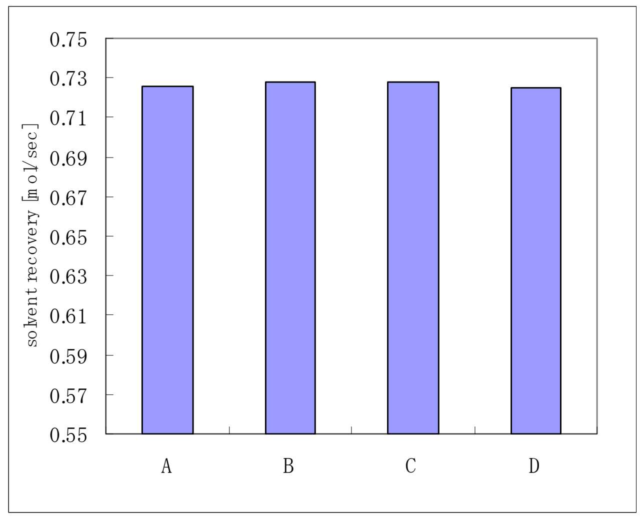

Fig.4 defference of solvent recovery each optimum position

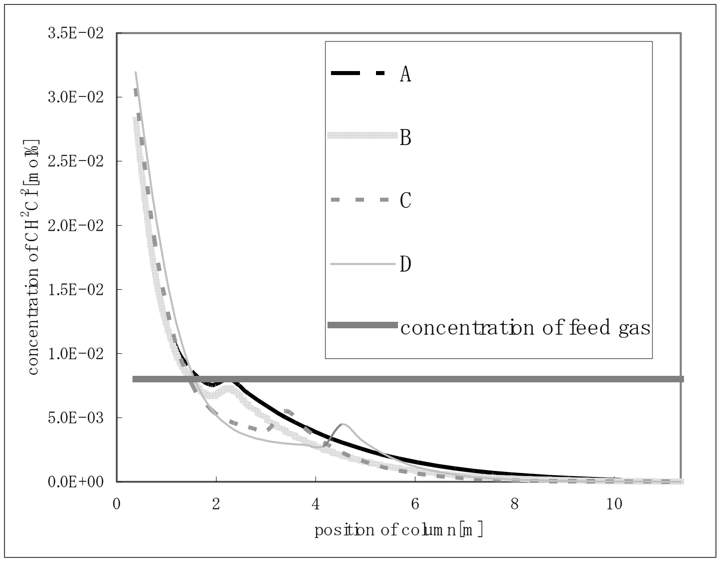

Fig.5 CH_2Cl_2 concentration in column

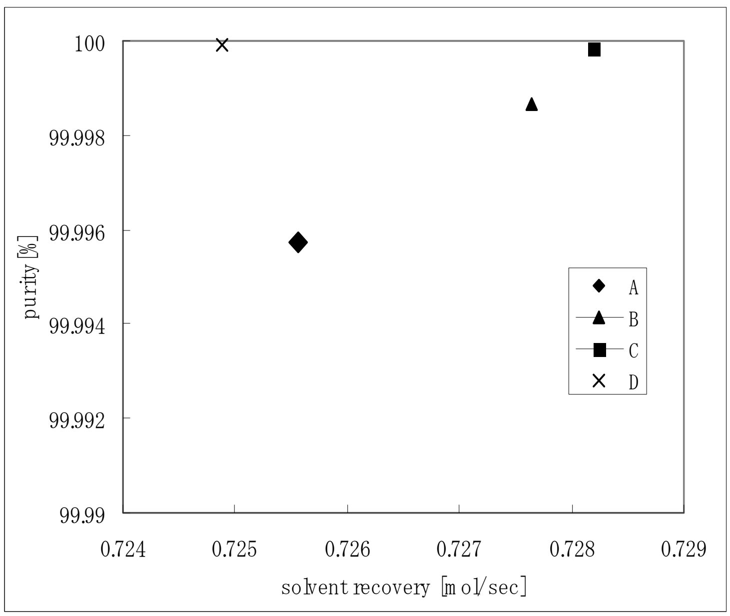

Fig.6 influence of purge gas

CONCLUSION

Numerical calculation for dual reflux PSA were tried using Stop & Go method. Performances were compared as for amount of solvent recovery and purity for different four type of purge gas flow. Running cost will increase as purge gas flow increase. But, amount of solvent recovery isn't change. If purge gas flow was lower than A, it will not be periodic state. So, A is optimum purge gas flow about this unit. When purge gas flow is A, concentration of feed gas equal concentration of gas in column.

REFERENCE

1. Ryoko. Wakasugi et al. (2005), "Dual Reflux PSA Process Applied to VOC Recovery as Liquid Condensate," *Adsorption 11(journal of the international Adsorption Society)*, pp. 561-566
2. Kazuyuki. Chihara et al. (2005), "Solvent Recovery by PSA, an Experimental and a Simulation Study," *Adsorption 11(journal of the international Adsorption Society)*, pp.567-572
3. Kazuyuki. Chihara et al. (2004), "Solvent Recovery by PSA with High Silica Zeolite, an Experimental and a Simulation Study," *14th IZC., Capetown*, pp.2003-2011
4. Diagne D. et al. (1995), "Parametric Studies on CO_2 Separation and Recovery by a Dual Reflux PSA Process Consisting of Both Rectifying and Stripping Sections," *I&EC Research*, 34, pp.3083-3089