

젖산의 반응 증류 회수 공정에 대한 발효액 내의 비휘발성 잔류물과  
휘발성 유기산의 영향

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**Effects of inorganic residual and volatile organic acid on batch reactive  
recovery system of lactic acid**

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**Introduction**

Demand for lactic acid has been increased as monomer of biodegradable polymers. It should be recovered though complex process, especially for one produced from fermentation broth. The enhanced separation methods using specific reactions have been used in purification due to their selectivity [1]. For the case of lactic acid, the process using reversible reaction - esterification and hydrolysis reaction was reported [2]. This process, however, need several steps consisting of reactions and separations. In this study, this previous process was simplified into a single step using the concept of reactive distillation.

To apply this process to the purification of lactic acid from fermentation broth, the selectivity of process for lactic acid against various impurities was investigated.

**Experimental**

The experimental system consisted of following two parts: (1) esterification part and (2) hydrolysis part. The crude lactic acid solution to be purified was fed into

the reboiler of the esterification part and heated. Then methanol and ion exchange resin (DOWEX 50W) as catalysts were added.

Contents of lactic acid and methyl lactate were measured using Waters<sup>TM</sup> HPLC system with SUPELCOGEL<sup>TM</sup> C-610H 59320-U strong cation exchange column. Water content in the reboiler was determined by Karl Fischer titration with coulometric K-F titrimeter model 447. Total ester content of a sample involved the titration of total acid groups present using a standard base, addition of excess base with subsequent saponification of the ester group, and back titration of the remaining base with standard acid (0.1M HCl) to determine the amount of base consumed in saponification.

### **Result and Discussion**

Glucose is one of resource of lactic acid in the fermentation broth and it leaves as residuals in the broth after fermentation process. It is nonvolatile and has no reactivity to esterification part. According to that, it is sure that glucose remains in the reboiler of esterification part. In addition, as shown in **table 1** and **figure 1**, the yield of recovery of lactic acid and the efficiency of system were not affected by the glucose content in the feed mixture.

Acetic acid is by-product in the fermentation of organic acid and most part of impurities in fermentation broth of lactic acid is acetic acid. Both acetic acid and its ester is highly volatile and its esterification is much faster than lactic acid's. Therefore it may affect the reactive distillation of lactic acid.

**Table 2** shows the selectivity and yield of our system's lactic acid recovery for the mixture of lactic acid and acetic acid. Although selectivity decreased as increase of acetic acid concentration, high selectivity was obtained by our system and acetic acid did not affect the yield of lactic acid significantly. **Figure 2** presents the dynamic behavior of system with lactic acid/acetic acid mixture. Due to high volatility of acetic acid, content of acetic acid in the reboilers are much smaller than one of lactic acid.

### **Conclusion**

The nonvolatile impurities such as glucose and salts cannot participate in the esterification and be transported from esterification part to hydrolysis part. Therefore, these species cannot affect the selectivity of process for lactic acid significantly.

Acetic acid is more reactive than lactic acid for esterification and has high volatility. Due to its high volatility, its residual time in the reboiler is much lower than lactic acid's. Therefore, high selectivity can be obtained due to the large difference of volatility between lactic acid and acetic acid.

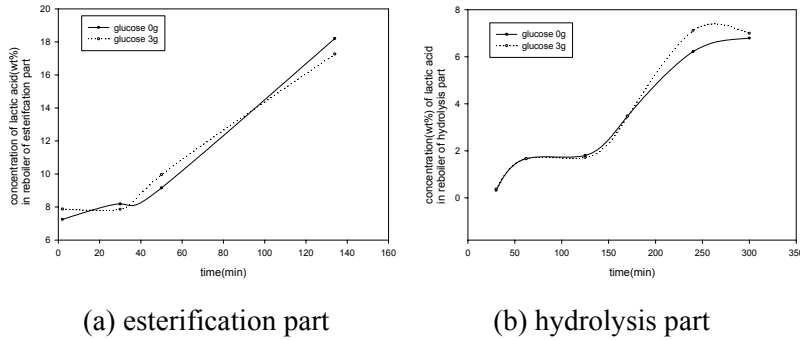
### **References**

1. V. G. Gaikar and M.M. Sharma, *Separation and purification methods*, 18(2), 111-176(1989)
2. Vickroy, T.B, *Comprehensive Biotechnology*, Murray Moo-Young (eds), Pergamon Press, 3, 761-776, (1985)

**Table 1.** Effect of glucose in feed mixture as impurities on the recovery system of lactic acid

Glucose/ lactic acid solution	Yield(%)	Yield(%) /hr	kJ/g of produced lactic acid
0/36	81.7	28.8	48.97
1/36	80.4	27.2	51.91
3/36	83.5	28.4	49.56
5/36	82.1	28.4	49.66

**Figure 1.** Effect of glucose content on the change of lactic acid's concentration of in the reboilers during operation



**Table 2.** Effect of acetic acid in feed mixture as impurities on the recovery system of lactic acid

Lactic acid/acetic acid	2/1	1/1	2/1
Recovery	99.99	99.99	91
Purity	94.84	86.04	68.2
Selectivity	10.56	3.53	1.6

**Figure 3.** Dynamic behavior of reactive batch distillation system of lactic acid/acetic acid(1:1) mixture

