

Comments on the Paper "Simulation of the Aromatic Recovery Process by Extractive Distillation" (Ko, M., Na, S., Cho, J. and Kim, H., Korean J. Chem. Eng., 19(6), (2002), 996-1000)

Zhigang Lei*, Chengyue Li and Biaohua Chen

The Key Laboratory of Science and Technology of Controllable Chemical Reactions, Ministry of Education,
Beijing University of Chemical Technology, Box 35, Beijing, 100029, China
(Received 25 February 2003 • accepted 11 August 2003)

Key words: Extractive Distillation, Aromatics, Non-aromatics, NFM

The purpose of this letter is to offer some comments regarding the article "Simulation of the aromatic recovery process by extractive distillation," 19, pp. 996-1000 (2002) by Min Su Ko, Sangyoun Na, Jungho Cho and Hawayong Kim. We will focus on the limitation of N-methylpyrrolidone (NFM) as the solvent for separating aromatics and non-aromatics by extractive distillation.

The authors think that the NFM process is appropriate for separating aromatics and non-aromatics because NFM has selective affinity with aromatics, and thus increases the relative volatility of non-aromatics (in the case given by the authors methylcyclohexane as the key component of non-aromatics) to aromatics (benzene as the key component of aromatics). However, NFM has a disadvantage, i.e. high boiling point 243 °C, which leads to the following drawbacks:

① If the solvent recovery column (called "subsequent stripper column" by the authors) is operated at normal pressure, a water stream with even higher temperature is needed to heat NFM to reach its boiling point. It means that much energy has to be consumed. In addition, the most important of all is that NFM is easy to decompose at its boiling point temperature. To reduce the bottom temperature, it is often the mixture of NFM and benzene as the extractive distillation solvent, which inevitably decreases the yield ratio of benzene.

② If the solvent recovery column is operated below normal pressure, the degree of vacuum pressure must not be too high due to the restriction for temperature of condensing water at the top of the solvent recovery column. In the end, NFM at the bottom of the solvent recovery column often contains a little benzene in order to decrease reboiler temperature. Accordingly, the yield ratio of benzene is also relatively low. In addition, because benzene is easy to volatilize, some benzene may be drawn into the atmosphere by vacuum pump in the case of operation at vacuum pressure, which does not conform to the requirement of ecological chemical engineering and should be avoided. Therefore, operation at vacuum pressure is not advisable for the solvent recovery column.

So the solvent, NFM, should be improved. A complete extractive distillation process is composed of double columns, i.e., an extractive distillation column and solvent recovery column. However, it is unfortunate that the authors pay more attention to the study of

extractive distillation column and neglect the result of the solvent recovery column. We guess that, in fact, the authors use the mixture of NFM and benzene, not single NFM, as the solvent.

To decrease the solvents boiling point and thus increase the yield ratio of benzene, an effective strategy is to add a little additive to NFM to make it into a mixture. The selected additive should meet these criteria at least:

① have a low boiling point, but the difference of boiling points between additive and methylcyclohexane is great enough to restrict the loss of solvent.

② not apparently influence the separation ability of NFM. It is well-known that for separating hydrocarbon mixtures, the following equation is often used to evaluate the separation ability of different solvents:

$$RT \ln S_{ij} = C \delta^2 (V_i - V_j) \quad (1)$$

where S_{ij} is the selectivity of components to be separated, C is a constant, δ is the polar cohesive density of the solvent and V is molar volume.

It can be seen that if the components to be separated are determined, the selectivity depends on the polarity of the solvent. This indicates that we should select a high-polarity and low-boiling point solvent as additives. At the same time, other factors such as toxicity, chemical stability, hydrolysis and azeotropic judgment must be considered, of course.

By our experience, some kinds of solvents, morpholine (b.p. 128.9 °C), N-methylmorpholine, N-ethylmorpholine (b.p. 138 °C), are potential additives. If the discussion on solvent improvement is incorporated by the authors, their article will be very perfect since just the solvent is the core of extractive distillation process.

RESPONSE FROM AUTHORS

Our paper on "Simulation of the aromatic recovery process by extractive distillation" is to simulate the domestic aromatic recovery process [ARP] of DC chemical Co., Ltd. By using the NFM as a solvent. And there are three ARP designed by Krupp Koppers within the country. These ARP have been operated using only NFM as a solvent. I also simulated the Benzene Extraction Plant of Tabritz Petrochemical Company designed by Krupp Koppers.

1. The domestic ARP were operated under the following pressure

*To whom correspondence should be addressed.

E-mail: leizhg@mail.buct.edu.cn

and temperature conditions. In the ED column case, the temperature is 60-190 °C, and the pressure is 1-2 kg/cm². In the stripper column case, the reboiler temperature is about 180 °C, and the pressure is low pressure. Therefore, your statement "If the solvent recovery column is operated at below normal pressure, ..." is reasonable. But the stripper column installed a cooler before the condenser of partial vapor-liquid type. Therefore, the OVHD component of the stripper column is aromatics, and then the BTMS component is a so-called lean solvent containing NFM, aromatics (a few), and heavy hydrocarbons (few).

2. NFM is easy to decompose at its boiling point. But the real processes were operated at lower temperature than the NFM bp. And NFM is not easy to decompose at the temperature of its boiling point without air (oxygen). Extractive distillation, which had been developed and optimized by Krupp Koppers, uses NFM as solvent. According to the report of Krupp Koppers, for extractive distillation NFM is used without the addition of water in contrast with the sulfolane extractive distillation process. Practically no hy-

drolytic effects of NFM occur. And there is no thermal decomposition. Traces of high molecular polymerization or polycondensation products can be easily removed by vaporizing the solvent in a regeneration unit.

3. According to the engineer at Samsung General Chemicals Co., the NFM as a refresh solvent was not introduced in its process since the NFM process had been installed. There is almost no loss of NFM in the ED column and Stripper column.

4. Since the solvent recovery column is operated at below normal pressure, some benzene may be vented into the atmosphere by vacuum pump. The vacuum unit consists of the pump, cooler and small absorption tower. The bottom product (liquid) of the absorber, which contains most of the benzene, is mixed with the feed line of the lean solvent to the extractive distillation column. The effect of benzene in the lean solvent decreases its boiling point and the mutual solubility for NFM+hydrocarbon systems. In real processes, only a very small amount of benzene is lost through the vent line.