AN OVERVIEW ON SYNTHETIC METHODS OF N-BUTYL ACETATE

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Keywords: overview; synthetic study; n-butyl acetate; catalysts

Nowadays a few synthetic methods of n-butyl acetate using different catalysts such as inorganic salt like ($Ce(S_2O_8)_2$, $FeNH_4(SO_4)_2 \cdot 12H_2O$, $LaSO_4/SiO_2$, $KHSO_4$ and $SnCl_4/C$), HZSM-5, oxide (MoO_3/SiO_2), I_2, heteropolyacid ($H_2(PW_{12}O_{40}) \cdot nH_2O$), quaternary ammonium salt ionic liquid and nanometer ZnO have been reviewed. The yields of n-butyl acetate are improved by the addition of above catalysts. These methods are having the advantages of simple process and low investment costs.

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Introduction

n-Butyl acetate is one of the colourless flammable liquids. It is used as a synthetic flavour agent in food products and/or as a solvent in the production of lacquers, plastic or artificial leather.[1] n-Butyl acetate and other organic solvent such as alcohol, aldehyde, ester, etc. are completely miscible in all proportions. Natural n-butyl acetate exists in apple, banana, cherry and grape fruits, etc. It is easily evaporated and hard to dissolve in water. Furthermore, it can dissolve brain grease, gum and rosin. It has anaesthetic and pungent in character. Its specific gravity d_4^{20}, refractive index n_D^{20} and boiling point are 0.8825, 1.3941 and 126.1 °C, respectively.[2]

In the present paper, different catalysts such as inorganic salt ($Ce(S_2O_8)_2$, $NH_4Fe(SO_4)_2 \cdot 12H_2O$, $LaSO_4/SiO_2$, $KHSO_4$ and $SnCl_4/C$), HZSM-5, oxide (MoO_3/SiO_2), I_2, heteropolyacid ($H_3(PW_{12}O_{40}) \cdot nH_2O$), quaternary ammonium salt ionic liquid and nanometer ZnO have been discussed.

DISCUSSION

$Ce(S_2O_8)_2$ -SBA-15 as a catalyst to produce n-butyl acetate

Yin Yanlei [3] introduced the preparation of n-butyl acetate and the effect of the reaction conditions on its yield. $Ce(S_2O_8)_2$ and SBA-15 as catalysts were ground and roasted to produce n-butyl acetate. The optimum conditions were the reaction time (2 hours) and molar ratio of acetic acid to n-butanol (1.0:1.2), amount of catalyst (0.0375g) respectively. The maximum yield of n-butyl acetate was 95.13%. The experimental results showed that $Ce(S_2O_8)_2$ and SBA-15 had good catalytic performance and were reused several times.

$NH_4Fe(SO_4)_2 \cdot 12H_2O$ as a catalyst to generate n-butyl acetate

Kong Xiangwen [4] explained why $NH_4Fe(SO_4)_2 \cdot 12H_2O$ as a catalyst took the place of concentrated sulfuric acid to generate n-butyl acetate. The effect of the reaction conditions such as the reaction time, molar ratio of acetic acid to n-butanol and amount of catalyst had been discussed. The experimental results represented that the best conditions were that the reaction time, molar ratio of acetic acid to n-butanol and amount of catalyst were 0.75 hours, 1.0:1.2 and 1.1 g, respectively. The maximum yield of n-butyl acetate was 98.5%.

$LaSO_4/SiO_2$ as a catalyst to produce n-butyl acetate

Song Jianguo[5] described the synthetic method of n-butyl acetate by using $LaSO_4/SiO_2$ as catalysts. The effect of the reaction conditions such as the reaction time, molar ratio of acetic acid to n-butanol, amount of catalyst and number of reusable catalyst had been discussed. The best conditions were that the reaction time, molar ratio of acetic acid to n-butanol and amount of catalyst were 2 hours, 1.0:1.3 and 0.06 g, respectively. The maximum yield of n-butyl acetate was 95.2%. After recovery and reuse of $LaSO_4/SiO_2$ as a catalyst it was noticed that its catalytic performance was very poor. For example, when $LaSO_4/SiO_2$ were reused 5 times, the yield of n-butyl acetate only reached 56.3%.

$KHSO_4$ as a catalyst to generate n-butyl acetate

Cai Xin’an[6] used $KHSO_4$ as a catalyst to produce n-butyl acetate. The effect of the reaction conditions such as amount of n-butanol, molar ratio of acetic acid to n-butanol and amount of catalyst had been discussed. The best conditions were that amount of n-butanol, molar ratio of acetic acid to n-butanol and amount of catalyst were 0.25 mol, 1.0:1.3 and 1.15 g, respectively. The maximum yield of n-butyl acetate was 86.83%.

$SnCl_4/C$ as a catalyst to produce n-butyl acetate

Li Jiagui[7] described the synthetic method of n-butyl acetate by using $SnCl_4/C$ as catalysts. The effect of the reaction conditions such as amount of acetic acid, molar ratio of acetic acid to n-butanol, amount of catalyst and number of reusable catalyst had been discussed. The best conditions were that amount of acetic acid, molar ratio of acetic acid to n-butanol and amount of catalyst were 0.1mol, 1.0:2.2 and 0.15 g, respectively. The maximum yield of n-butyl acetate was 94.8%. When $SnCl_4/C$ as catalysts were recovered and reused, their catalytic performance was found to be very good. For example, when $SnCl_4$/C were reused 5 times, the yield of n-butyle acetate still reached 90.1%.

HZSM-5 as a catalyst to generate n-butyl acetate

Li Minghui[8] introduced the preparation of HZSM-5 and the effect of the reaction conditions such as the reaction time, molar ratio of acetic acid to n-butanol and amount of catalyst on the yield of n-butyl acetate. The best conditions were that the reaction time, molar ratio of acetic acid to n-butanol and amount of catalyst were 1 hour, 1.0:1.1 and 0.5 g, respectively. The maximum yield of n-butyl acetate was 94.0%.

MoO_3/SiO_2 as a catalyst to produce n-butyl acetate

Li Shuchang[9] described the preparation of MoO_3/SiO_2 and the effect of the reaction conditions such as the reaction time, molar ratio of acetic acid to n-butanol, amount of catalyst and number of reusable catalyst on the yield of n-butyl acetate. The best conditions were that the reaction time, molar ratio of acetic acid to n-butanol and amount of catalyst were 3 hours, 1.0:4.0 and 1.0 g, respectively. The maximum yield of n-butyl acetate was 95.6%. When MoO_3/SiO_2 as catalysts were recovered and reused, their catalytic performance was perfect. For example, when MoO_3/SiO_2 were reused 5 times, the yield of n-butyle acetate still arrived at 95.2%.

I_2 as a catalyst to generate n-butyl acetate

Jiang Hongbo [10] used I_2 as a catalyst to generate n-butyl acetate. The effect of the reaction conditions such as the reaction time, molar ratio of acetic acid to n-butanol and amount of catalyst had been discussed. The best conditions were that the reaction time, molar ratio of acetic acid to n-butanol and amount of catalyst were 4.0 hours, 1.5:1.0 and 0.6 g, respectively. The maximum yield of n-butyl acetate was 67.52%.

$H_2(PW_{12}O_{40})\cdot nH_2O$ as a catalyst to produce n-butyl acetate

Li Guixian[11] introduced the preparation of $H_3(PW_{12}O_{40})\cdot nH_2O$ with attapulgite and the effect of the reaction conditions such as the reaction time, molar ratio of acetic acid to n-butanol, amount of catalyst and number of usable catalyst on the yield of n-butyl acetate. The best conditions were that the reaction time, molar ratio of acetic acid to n-butanol and amount of catalyst were 2.5 hours, 1.0:2.5 and 0.1580 g, respectively. The maximum yield of n-butyl acetate was 94.0%. When $H_3(PW_{12}O_{40})\cdot nH_2O$ as a catalyst was recovered and reused, its catalytic performance was poor. For example, after used 5 times as catalyst, $H_3(PW_{12}O_{40})\cdot nH_2O$, the yield of n-butyl acetate reached only to 77.98%.

Quaternary ammonium salt ionic liquid as a catalyst to generate n-butyl acetate

Li Wenjun[12] described the preparation of four types of quaternary ammonium salt ionic liquids such as $[Et_2NH_2][HSO_4]$, $[Et_3NH][HSO_4]$, $[n\text{-}Pro_3NH][HSO_4]$ and $[n\text{-}But_3NH][HSO_4]$. He used $[Et_3NH][HSO_4]$ as a catalyst to generate n-butyl acetate. The effect of the reaction conditions such as the reaction time, molar ratio of acetic acid to n-butanol and molar ratio of $[Et_3NH][HSO_4]$ to n-butanol had been discussed. The best conditions were that the reaction time, molar ratio of acetic acid to n-butanol and molar ratio of $[Et_3NH][HSO_4]$ to n-butanol were 8.0 hours, 2.0:1.0 and 1.0:4.0, respectively. The maximum yield of n-butyl acetate was 81.94%.

Nanometer ZnO as a catalyst to produce n-butyl acetate

Lai Wenzhong[13] used nanometer Zno as a catalyst and acetic acid to n-butanol as feedstocks to produce n-butyl acetate. The effect of the reaction conditions such as the reaction time, molar ratio of acetic acid to n-butanol and amount of catalyst on the yield of n-butyl acetate had been discussed. The best conditions were that the reaction time, molar ratio of acetic acid to n-butanol and amount of catalyst were 3.0 hours, 1.0:2.0 and 0.80 g, respectively. The maximum yield of n-butyl acetate was 86.72%.

CONCLUSION

Based on the above discussion and review, $NH_4Fe(SO_4)_2\cdot 12H_2O$ that is one of the best catalysts is used to produce n-butyl acetate because it is very cheap, stable and insoluble in organic acids and organic alcohol. After the reaction is done, $NH_4Fe(SO_4)_2\cdot 12H_2O$ becomes insoluble material and is easily separated from the reaction system. It has high performance catalytic and selectivity and non-corrosive. However, I_2 is one of the worst catalysts and its maximum yield of n-butyl acetate only reaches 67.52%.

REFERENCES

[1]An, J. J. and Wang, B. Y. *Beijing Light Industry Press*, **1989**.

[2]You, H. J. *Sichuang Chem. Ind.*, **2005**, *8*(1), 15.

[3]Yin, Y. L., Tian, Z. M., Deng, Q. G. and Ding, K. P. *J. Qiqihar Univ.*, **2008**, *24*(1), 4.

[4]Kong, X. W., Yu, L., Zhang, J. and Shu, Y. *Res. Exploration Lab.*, **2011**, *30*(2), 21.

[5]Song, J. G. *J. Qiqihar Univ.*, **2008**, *24*(3), 47.

[6]Cai, X. A., Chen, L. X., Zhang, H. F., Wang, L. and Wang, K. K. *J. Jingdezhen College*, **2012**, *27*(3), 37.

[7]Li, J. G., Wei, Q. M. and Zhu. W. R. *J. Yulin Normal Univ.*, **2008**, *29*(5), 47.

[8]Li, M. H., Zhu, M. and Liu, N. *J. Dalian Polytechnic Univ.*, **2009**, *28*(5), 347.

[9]Li, S. C., Sun, D. and Du, C. H. *Chem. Eng.*, **2010**, *10*, 61.

[10]Jiang, H. B. *Chem. Eng.*, **2011**, *6*, 14.

[11]Li, G. X., Wang, X, N., Shi, A. J., Wang, K. Z. and Hu, D. C. *J. Mol. Catal.*, (*Fenzi Cuihua*) **2008**, *22*(2), 137.

[12]Li, W. J., Zhong, L. N., Chen, Y. Q. and Lin, J. Q. *J. Chem. Ind. Eng.*, **2011**, *62*(S2), 74.

[13]Lai, W. Z., Lin, Y. and Xiao, W. C. *Food Sci. Technol.*, **2010**, *35*(2), 210.

Received: 22.10.2012.
Accepted: 24.10.2012.