Organic Process Research & Development **2002**, *6*, 149–151

Homogeneous System for the Synthesis of Benzyl Salicylate

Sri Sivakumar, Vishwas G. Pangarkar, and Sudhir B. Sawant*

Institute of Chemical Technology, University of Mumbai, Matunga, Mumbai - 400 019, India

Abstract:

Synthesis of benzyl salicylate from sodium salicylate and benzyl chloride in the absence of a PTC and with dimethyl formamide as a solvent has been reported. Almost complete conversion of benzyl chloride can be achieved in 1.5 h at 110 °C. The batch time and the reaction temperature are considerably less than that for the commercial process using a PTC. Kinetics of the reaction have been investigated.

1. Introduction

Most of the perfumery and flavour compounds are oxygenated compounds that is, esters, aldehydes, ketones, alcohols, and so forth. Esters of the aromatic carboxylic acids such as benzoic acids, salicylic acid and cinnamic acid have more value in the perfumery and flavour industries. Benzyl salicylate is one such ester. Naturally occuring benzyl salicylate is isolated from an essential oil, for example . that from *Dianthus caryophyllus*.[1] Benzyl salicylate is used as a fixative in perfumes and also in sunscreen preparations. It is frequently used in flavour compositions as well. There are four different routes for the synthesis of benzyl salicylate: (1) By the reaction of benzyl alcohol and salicylic acid,[2−4] (2) by the reaction of benzyl chloride (BnCl) and sodium salicylate using a phase transfer catalyst,[5−8] (3) by the trans-esterification of benzyl alcohol with methyl salicylate using sodium methyl salicylate as catalyst,[9] and (4) by the reaction of benzyl chloride and salicylic acid using a phase-transfer catalyst.[10,11]

The sodium salt of salicylic acid is inexpensive and readily available by Kolbe synthesis. Furthermore, this method of ester preparation would be even more commercially attractive because benzyl chloride gives a less expensive benzyl group than does benzyl alcohol. It may be noted that benzyl salicylate is prepared from sodium salicylate and benzyl chloride using phase-transfer catalysts (PTC). When an aqueous solution of sodium salicylate is used, a number of by-products (benzyl alcohol, benzyl benzoate, salicylic acid, dibenzyl ether, and some high-boiling compounds) are formed. With dry sodium salicylate powder, it takes 8−12 h to get near-complete conversion of benzyl chloride using a PTC. The heterogeneous reaction system necessitates the use of a PTC to enhance the rate of the reaction. In addition a solvent is necessary to provide an easily stirrable reaction mixture. Often the solvent used is benzyl salicylate itself. To avoid the use of a PTC, it was desirable to carry out the reaction in an homogeneous system. Accordingly, a number of solvents were tried. Dimethyl formamide was finally selected because sodium salicylate and benzyl chloride are highly soluble in it. Thus, the reactants are available in an homogeneous liquid phase. The product sodium chloride precipitates as the reaction proceeds due to its poor solubility in dimethyl formamide. The reaction takes place in an homogeneous liquid phase.

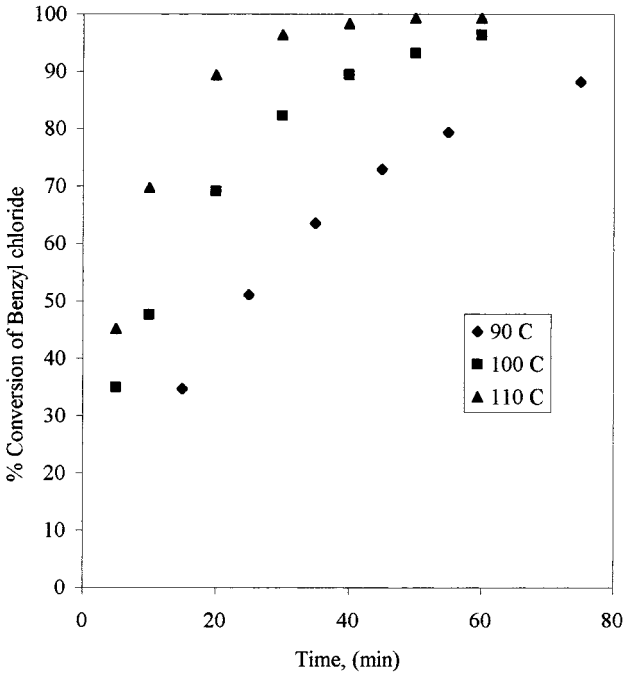

Figure 1. **Effect of temperature on the conversion of benzyl chloride. Moles of benzyl chloride = 0.2. Moles of sodium salicylate = 0.3. Speed of agitation = 2000.**

* To whom correspondence may be addressed. Fax: +91-22-4145614. E-mail: sbs@udct.ernet.in.

(1) Arctander, S. *Perfumer and Flavour Chemicals*; Arctander S.: Montclair, NJ, 1969; Vol. 1.
(2) Ueno, R.; Tsuchiya, H.; Itoh, S.; Yamamoto, I., Eur. Pat. Appl. EP 117,-502, 1984; *Chem. Abstr.* **1985**, *102*, 45629c.
(3) Yamazaki, K.; Yoneyama, T.; Vchama, N.; Matsuoka, T.; Mishima, A.; Nyugaku, H. Jpn. Kokai Tokkyo Koho JP 01,186,846, 1989; *Chem. Abstr.* **1990**, *112*, 20787w.
(4) Yamada, M.; Takahashi, K. Jpn. Kokai Tokkyo Koho JP 02,04,735, 1990; *Chem. Abstr.* **1990**, *113*, 23387x.
(5) Normant, H.; Laurenco, C. *C. R. Hebd. Seances Acad. Sci. Ser. C.* **1976**, *283(11)*, 4836; *Chem. Abstr.* **1977**, *86*, 106129q.
(6) Henry, E. H.; James, P. E., Jr.; Collins L. R.; Leonard R. T. *Ind. Eng. Chem. Prod. Res. Dev.* **1967**, *6(3)*, 193−195.
(7) Barry, J.; Bram, G.; Decodts, G.; Loupy, A.; Orange, C.; Petit, A.; Sansoulet, J. *Synthesis* **1985**, *1*, 40−45.
(8) Crohemore, M. Eur. Pat. Appl. EP 534,817, 1993: *Chem. Abstr.* **1993**, *118*, 254409a.
(9) Ger. Offen DE 3,404,310, 1985; *Chem. Abstr.* **1985**, *103*, 183394u.
(10) Doehler, P.; Reichelt, P. Ger. (East) 91,052, 1972; *Chem. Abstr.* **1973**, *78*, 19464a.
(11) Desmurs, J. R.; Ratton S. Eur. Pat. Appl. EP 467,727, 1992; *Chem. Abstr.* **1992**, *116*, 193922x.

10.1021/op010058d CCC: $22.00
Published on Web 02/14/2002

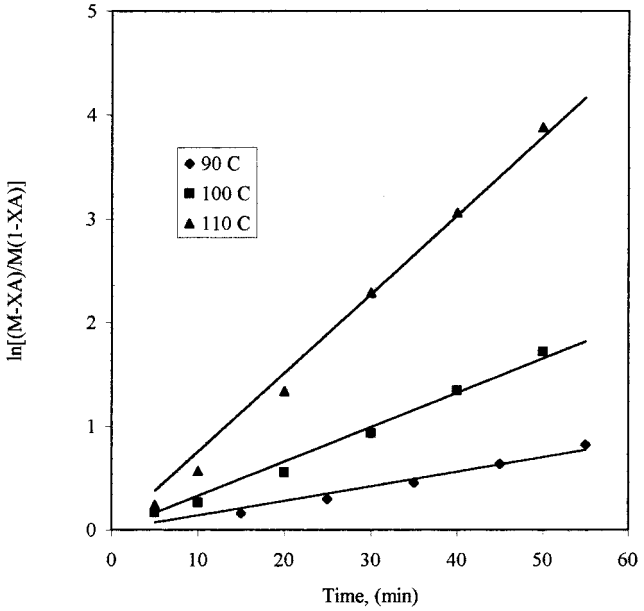

Figure 2. **Kinetics plot, first-order dependence. Moles of benzyl chloride = 0.2. Moles of sodium salicylate = 0.3. Speed of agitation = 2000 rpm.**

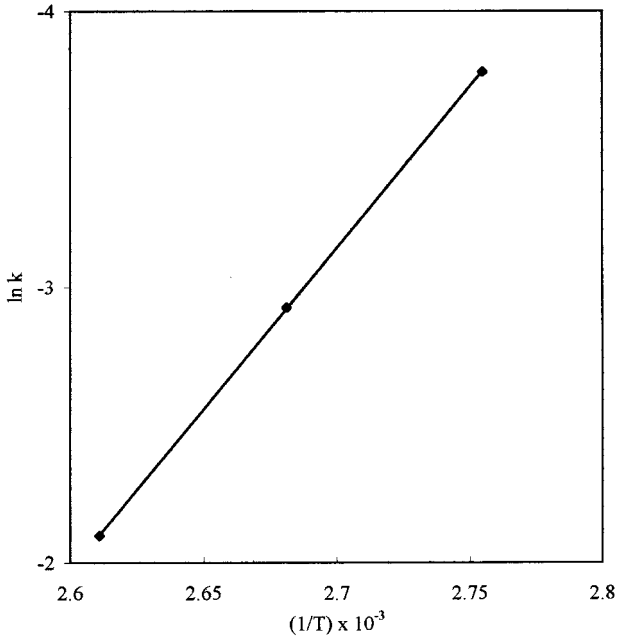

Figure 3. **Arrhenius plot. Moles of benzyl chloride = 0.2. Moles of sodium salicylate = 0.3. Speed of agitation = 2000 rpm.**

2. Experimental Section

2.1. Method. All the experiments were carried out in a batch manner. A 500-mL borosilicate glass reactor with a stirrer and four baffles was used. A constant-temperature oil bath was used for maintaining the desired reaction temperature.

Predetermined quantities of dimethyl formamide and sodium salicylate were added into the reactor. The temperature of the oil bath was raised to the predetermined value and maintained there. The measured quantity of benzyl chloride preheated to the desired temperature was then added, and the experiment was started. Small (1 mL) samples of reaction mixtures were withdrawn at regular intervals, and

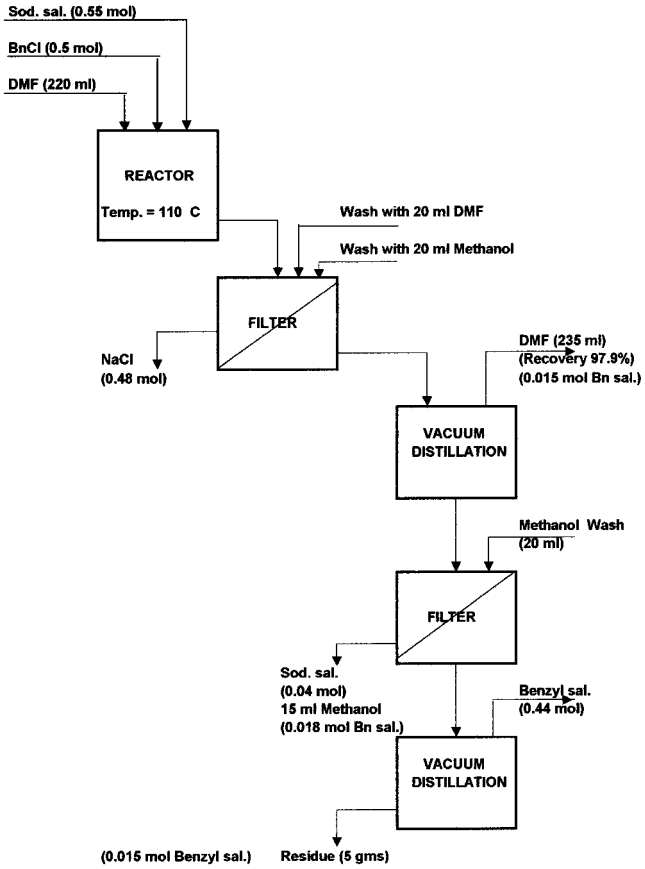

Figure 4. **Flow sheet.**

the samples were analysed by gas chromatography to determine the conversion of benzyl chloride and the yield of benzyl salicylate.

Analysis. To the known quantity (1 mL) of the reaction mixture sample, 20%w/w solution (2 mL) of NaCl was added. The mixture was then extracted with two volumes of ethylene dichloride. The ethylene dichloride layer was analysed by gas chromatography using a 2 m 10% OV-17 column. This method of sample preparation for analysis was first developed and standardized using identical synthetic samples containing known quantities of benzyl salicylate and benzyl chloride. Nitrogen was the carrier, and the detector was FID. Other parameters are given below.

injection temperature	300 °C
detector temperature	325 °C
nitrogen flow rate	30 mL/min
temperature programming	135 °C for 2 min 135−290 °C at 25 °C/min 290 °C maintained for 5 min

3. Results and Discussion

The terms conversion and yield have been defined as follows:

$$\%\ \text{conversion of benzyl chloride} = \frac{\text{mol of benzyl chloride consumed}}{\text{mol of benzyl chloride charged}} \times 100$$

$$\%\ \text{yield of benzyl salicylate} = \frac{\text{mol of benzyl salicylate formed}}{\text{mol of benzyl chloride consumed}} \times 100$$

Figure 1 shows the effect of reaction temperature. The experiments are carried out using 120 mL of dimethyl formamide, 0.3 mol of sodium salicylate and 0.2 mol of benzyl chloride. It can also be seen from Figure 1 that the rate of reaction is increased appreciably when the temperature changes from 90 to 110 °C. The yield of benzyl salicylate is almost 100% in all the experiments.

3.1. Kinetics. For the present reaction, assuming first-order with respect to each reactant, benzyl chloride and sodium salicylate, the rate expression can be written as:

$$-r_A = k(C_A C_B) \tag{1}$$

In the integrated form eq 1 can be written as

$$-\ln\left[\frac{(M - X_A)}{M(1 - X_A)}\right] = kC_{A0}(M - 1)t \tag{2}$$

Thus, validity of the first-order dependence can be checked by plotting $-\ln[(M - X_A)/M \times (1 - X_A)]$ versus time, t. A straight line passing through the origin will confirm the first-order with respect to each reactant and can be used to evaluate the second-order rate constant.

Figure 2 shows that straight-line plots are obtained using the data from Figure 1. This confirms first-order dependence on the concentration of each reactant. From the slopes of these straight-line values of k are calculated for each reaction temperature. Figure 3 shows the Arrhenius plot for these k values. The activation energy is found to 23.4 kcal/mol.

3.2. Material balance. A reaction was performed to establish the material balance. The reaction was carried out by using 0.5 mol of benzyl chloride, 0.55 mol of sodium salicylate, and 220 mL of dimethyl formamide at temperature 110 °C at 2000 rpm. The reaction was carried out for 1.5 h. GC analysis showed 100% conversion of benzyl chloride. The flow sheet shows the material balance (Figure 4).

4. Conclusions

Benzyl salicylate can be prepared in an homogeneous system with dimethyl formamide as a solvent. This process does not need a PTC. The reaction temperature (∼100 °C) is considerably lower than that for the conventional process (∼150 °C). Further complete conversion of benzyl chloride can be achieved in a shorter batch time of about 1.5 h.

NOMENCLATURE

C_A = concentration of benzyl chloride, mol/L
C_B = concentration of sodium salicylate, mol/L
X_A = fractional conversion of benzyl chloride
M = mole ratio of sodium salicylate: benzyl chloride
C_{A^0} = initial concentration of benzyl chloride, mol/L
k = rate constant, L/min·mol

Received for review July 23, 2001.

OP010058D