Research Article

Cyclic Voltammetric Studies on Ethoxylation of Benzyl Alcohol

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Abstract

Benzyl alcohol is an important ingredient in chemical products used in the construction industry. The present work is done on the cyclic voltammetric studies on ethoxylation of benzyl alcohol. Cyclic voltammograms are recorded by varying the P^H, working electrode and scan rate and multiple scan studies have also been done. The system is observed to show variations in the working potentials (anodic peak voltage) with the change in P^H, working electrode and scan rate variation. It is observed that the ethoxylation of benzyl alcohol is diffusion controlled at all aforesaid conditions. It is also found out that benzyl alcohol is not forming polymers with any of the working electrode under investigation.

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1. Introduction

Benzyl alcohol (BA) is a colourless liquid with a sharp burning taste and slight odor. Benzyl alcohol is an aromatic alcohol used in a wide variety of cosmetic formulations as a fragrance component, preservative, solvent and viscosity- decreasing agent.[1] It is used as local anesthetic, pharmaceutical aid, and in perfumery[2]. Many chemical reactions of (BA) have been studied extensively. Many electrochemical studies of BA such as hydroxylation[3], halogenations[4], cyanation[5] and alkoxylation[6] have been reported. Only a few studies on alkoxylation of BA are found in the literature. Recently the electrochemical and analytical studies on ethoxylation[7] of various mono substituted aromatic compounds have been examined and reviewed.[8]

2. Materials and Methods

2.1. Apparatus

Cyclic voltammogramms were recorded with potentiostat CH 10 (Sinsil international) interfaced to 663VA stand (Metrohm) and SyncMaster B 1930 computer. A three electrode configuration was used with platinum /glassy carbon electrode as the working electrode, a silver-silver chloride reference electrode and a platinum wire as the auxiliary electrode. The working electrode was pretreated by polishing it with an alumina-water slurry followed by washing in an ultrasonic path.

2.2. Reagents and solutions

All reagents were of analytical reagent grade and ultra pure water was used throughout the cyclic voltammetric analysis. 0.001M Benzyl alcohol, 1M H_2SO_4/KOH/ KCl, 0.5M Ethanol were prepared freshly. The P^H of the different reaction mixtures measured with pen type P^H meter. The solutions were stored in a light protected cool location.

2.3. Methodology

The three electrode system with platinum or glassy carbon electrode as the working electrode, platinum wire as the auxiliary electrode and Ag-AgCl electrode as the reference electrode was constructed in an divided H-cell. In order to change the P^H of the system 1M solutions of H_2SO_4/KOH/KCl were taken. These solutions were also working as the sources of supporting electrolytes. Then the cyclic voltammogram was recorded with different scan rates, different working electrodes and different P^H conditions. To arrive at an idea about the polymerization of BA on working electrode, multiple scan cyclic voltammogram was also recorded.

3. Results and Discussion

3.1. Substrate and P^H variation studies

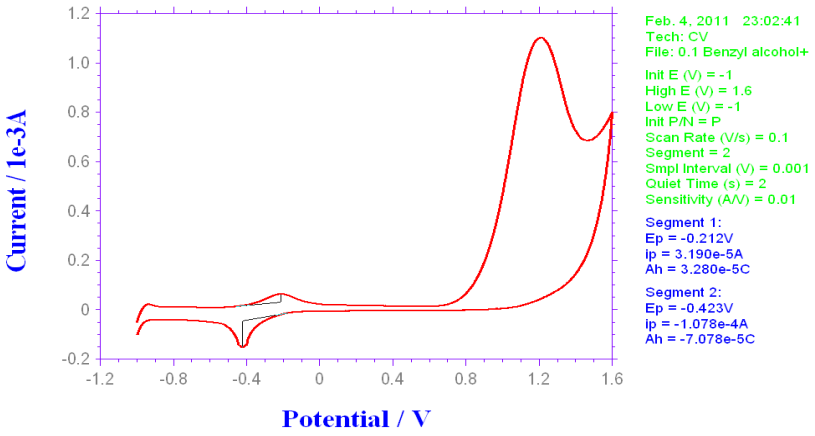

Figure 3.1 (a) Cyclic voltammogram obtained for benzyl alcohol (0.001M) with ethanol (0.1M) in basic medium (KOH, 1M) at Pt anode for 100mVs^{-1}

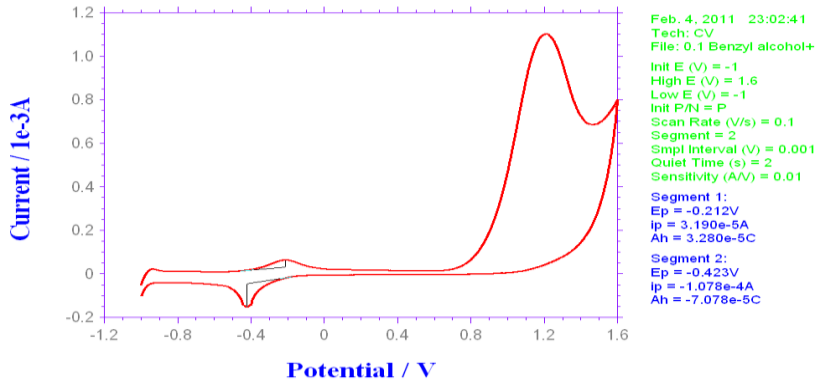

Figure 3.1 (b) Cyclic voltammogram obtained for benzyl alcohol (0.001M) with ethanol (0.1M) in neutral medium (KCl, 1M) at Pt anode for 100mVs^{-1}

The well defined anodic peak potentials seen in the cyclic voltammogram show that the substrate BA is susceptible for electrochemical ethoxylation. The data obtained from the cyclic voltammogram can be used to carry out electrochemical synthesis and for the evaluation of electron transfer kinetics.[9]

3.2. Electrode variation studies

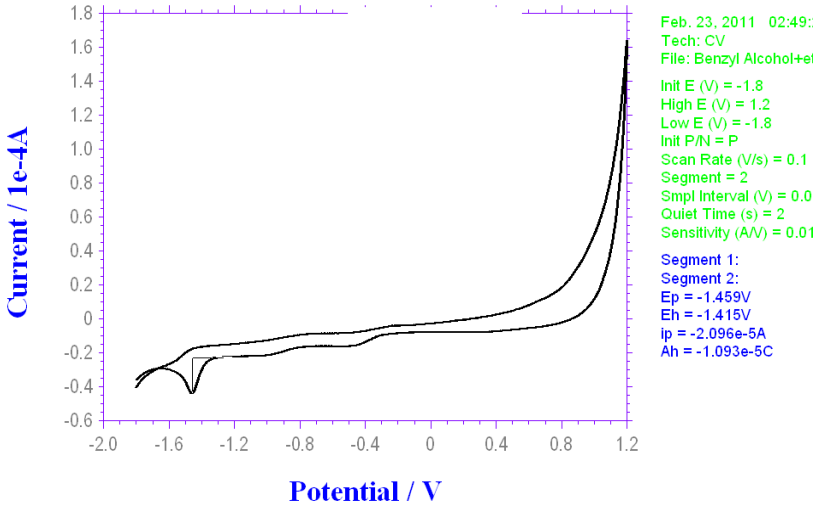

Figure 3.2 (a) Cyclic voltammogram for 10^{-3} M, Benzyl alcohol in pH =12, hydro-alcoholic solution at glassy carbon electrode

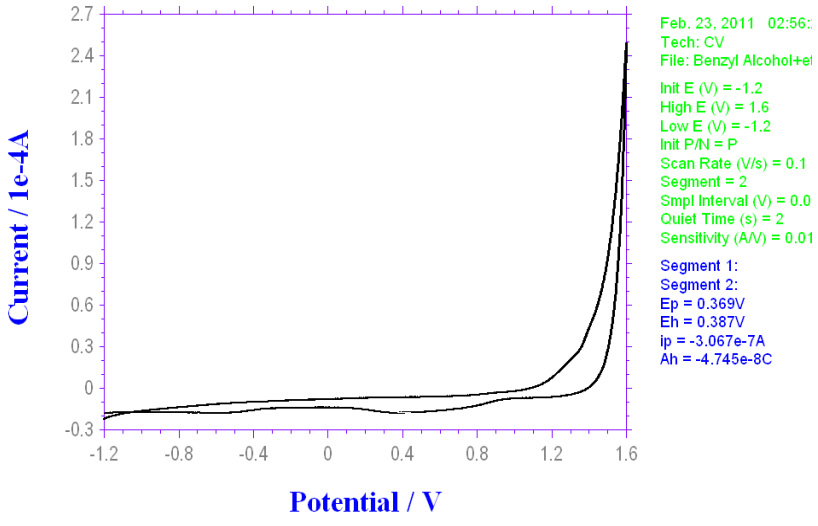

Figure 3.2 (b) Cyclic voltammogram for 10^{-3} M, Benzyl alcohol in pH =7, hydro-alcoholic solution at glassy carbon electrode

Table 1 Comparision of cyclic voltammetric potentials for Benzyl alcohol

Medium	Platinum as working electrode	Glassy carbon as working electrode
Acidic	1.8	1.00
Neutral	1.3	-
Basic	1.2	-

The electrode variation studies are carried out by replacing platinum by glassy carbon electrode. It is found that the anodic peak was observed in acidic medium only on glassy carbon electrode. But on platinum, all three conditions the anodic peaks are observed.

3.3. Scan rate variation studies

Cyclic voltammograms with variable sweep rates in the range of 100 to500mV/second for all the above systems were taken and the results are tabulated below.

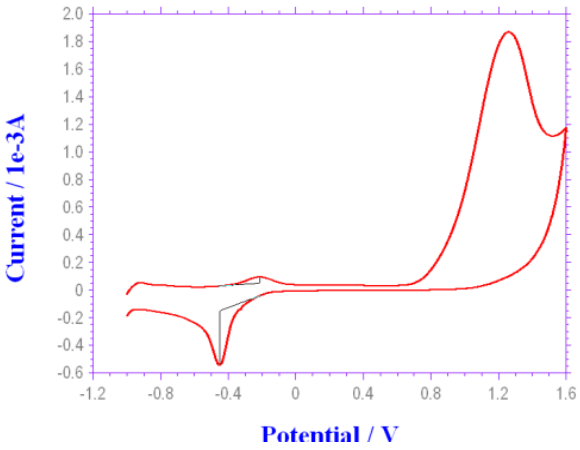

Figure 3.3 (a) 200mV/s

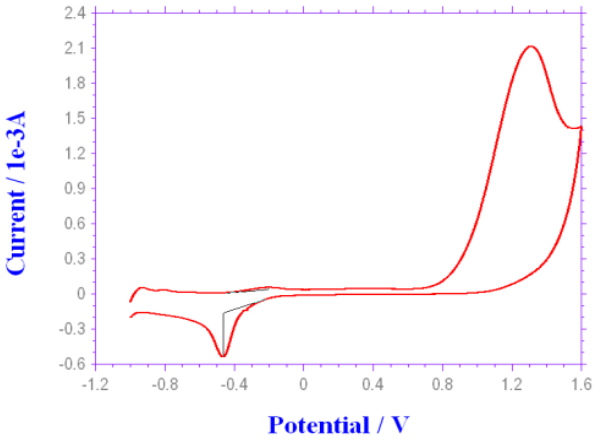

Figure 3.3 (b) 300Mv/s

Table 2 Cyclic voltammograms with variable sweep rates in the range of 100 to500mV/second

Parameters	Scan rate ν (mV/s)				
	100	**200**	**300**	**400**	**500**
$\nu^{1/2}$	10	14.14	17.32	20	22.36
Ip (μA)	135.2	208.3	265.0	298.7	336.3
Ep (v)	-0.856	-0.831	-0.810	-0.802	-0.785

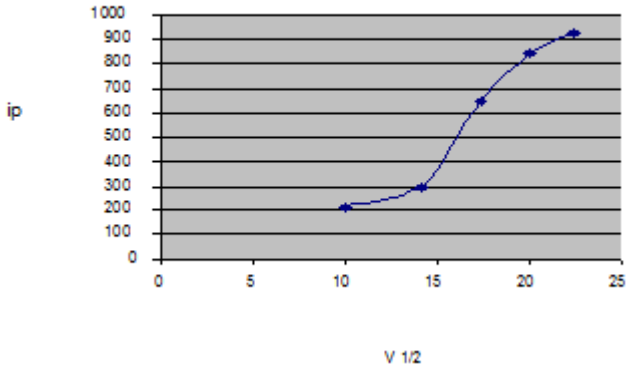

Figure 3.3 (d)

3.3 (a), (b), (c) & (d) Cyclic voltommograms recorded for Benzyl alcohol in basic medium at different scan rates.

The plot drawn between the peak current and the square root of the scan rate produces a line which does not pass through the origin. This shows that the process is irreversible.[10-11]

3.4. Multiple scan studies

The multiple scan rate studies of ethoxylation of benzyl alcohol by varying p^H, working electrode revealed that there is no polymer formation on the working electrode during electrolysis. The monolayer of the multiple cyclic voltammograms confirms the absence of polymer formation.

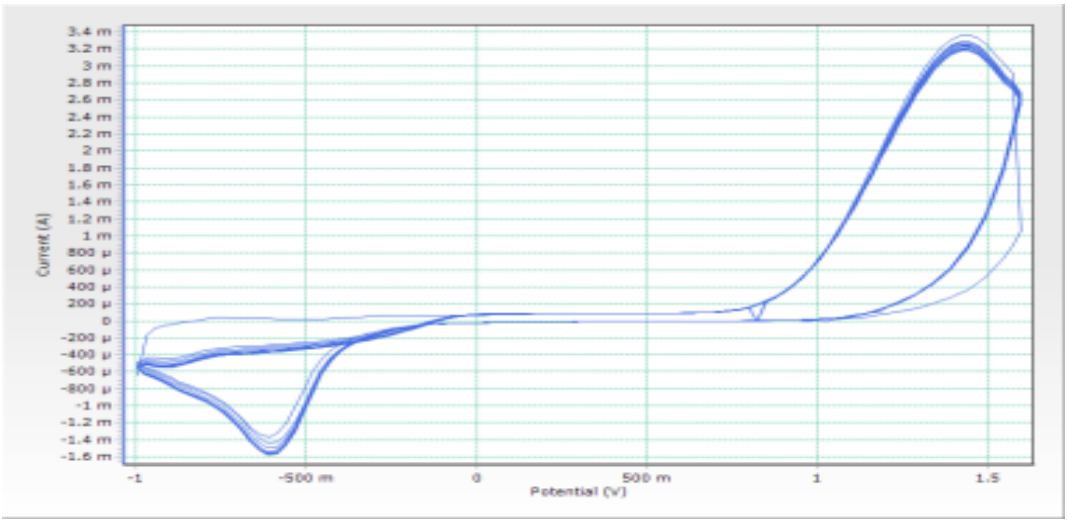

Figure 3.4 Cyclic voltommograms for Benzyl alcohol + Ethanol + KOH mixture at pH=12

Conclusion

In the present study, the electro analytical studies on ethoxylation of benzyl alcohol are carried out. The cyclic voltammograms of benzyl alcohol were recorded by changing the conditions like p^H, working electrode and scan rate. The following conclusions are arrived from the experimental observation.

- Benzyl alcohol is susceptible for anodic ethoxylation.
- Anodic peak potential changes with change in p^H, hence variety of products can be produced by changing the p^H.
- Anodic peak potential changes with change in working electrode. Hence change in electrode changes the reaction mechanism.
- Multiple scan studies indicate that there is no polymer formation on the working electrode.
- Cyclic voltammograms recorded at various scan rate indicate that the process is diffusion controlled, since the current-frequency curve gives a straight line in the desired working potential.

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