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Electro Analytical Studies on Ethoxylation of Benzyl Alcohol

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ABSTRACT

Benzyl alcohol is one of the important compounds that are very much useful in industrial chemistry. It is used as a local anesthetic and antiseptic in the field medicine. The literature on various chemical reactions of benzyl alcohol is scattered. Only a few works have been done on electrochemical studies of benzyl alcohol. This work is concentrated on the cyclic voltammetric studies of benzyl alcohol. Cyclic voltammograms were recorded by varying pH, working electrode and scan rate. Multiple scan studies have also been done. The system showed variations in the working potentials (anodic peak voltage) while the reaction conditions such as pH, working electrode, were changed. These studies also revealed that the ethoxylation of bezyl alcohol is diffusion controlled at all fore said conditions. It is also found out that benzyl alcohol is not forming polymers on the working electrode.

Key words: Cyclic voltammetry, Benzyl alcohol, Working electrode, Ethoxylation, Electro analysis.

INTRODUCTION

Benzyl alcohol (BA) is a primary alcohol of very high industrial importance. For example the esters of benzyl alcohol are used in perfumery. Benzyl acetate is having the fragrance of jasmine. It is a well known solvent for ink, paints, lacquers and epoxy resin coating and a precursor to a variety of esters used in soap and perfume industries[1]. It is also used as an ingredient in ointments for relieving itching[2]. Many chemical reactions of (BA) have been studied extensively. Many electrochemical studies of BA such as hydroxylation[3], halogenations[4], cyanation[5] and acetoxylation[6] have been reported. Only a few studies on ethoxylation[7] of BA are found in the literature. Recently the electrochemical analytical studies on methoxylation[8] of various mono substituted aromatic compounds have been examined and reviewed.

In this present work platinum and glassy carbon electrodes were taken as working electrodes. The electrode potentials of working electrodes were found by taking Ag/AgCl electrode as reference. The ethoxylation of BA was carried out in ethyl alcohol medium. KOH, KCl, H_2SO_4 were used as supporting electrolytes in alkaline, weakly acidic and strongly acidic conditions respectively. The work is carried out to predict the anodic peak

potentials at different pH media, to find out whether the reaction is diffusion or adsorption controlled and to ascertaining the formation of any polymer films on the surface of the working electrode[9].

MATERIAL AND METHODS

Apparatus

Voltammogramms were recorded with potentiostat CH 10 (Sinsil international) interfaced to 663 VA stand (Metrohm) and SyncMaster B1930 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 electrode 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.

Reagents and solutions

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

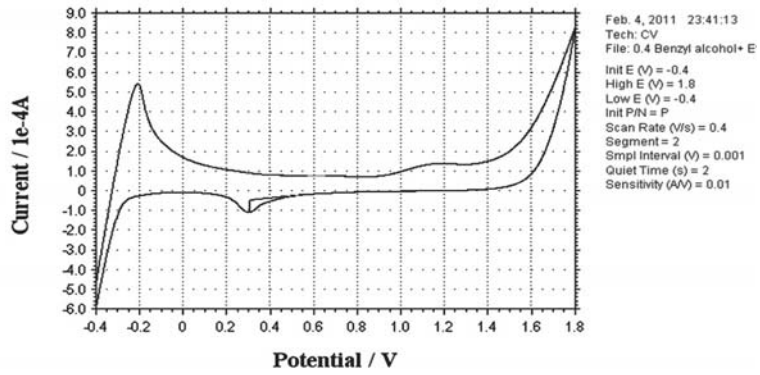
Methodology

The three electrode system with platinum/ 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 undivided cell. In order to change the pH 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 cylclic voltammogram was recorded with different scan rates, different working electrodes and different pH conditions. To arrive at an idea about the polymerization of BA on working electrode, multiple scan cyclic voltammogram was also recorded.

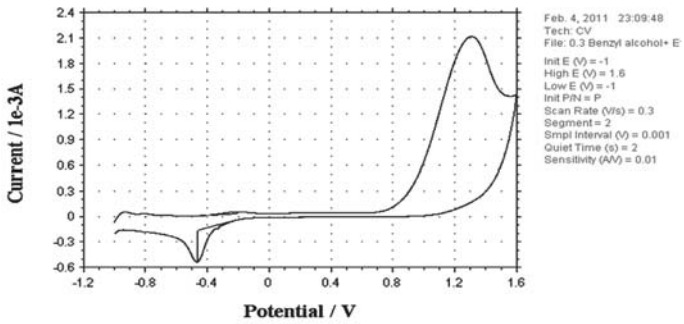
RESULTS AND DISCUSSION

Cyclic voltammograms

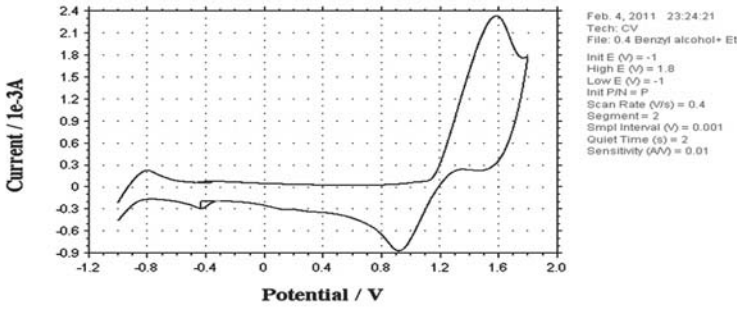
Benzyl alcohol + Ethanol + H_2SO_4 on Pt working electrode



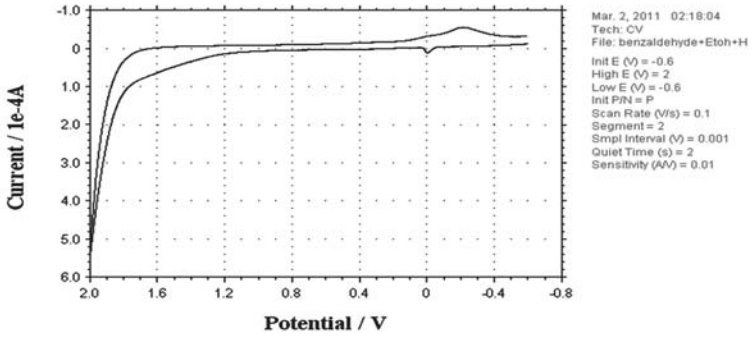
Benzyl alcohol + Ethanol + KOH on Pt working electrode



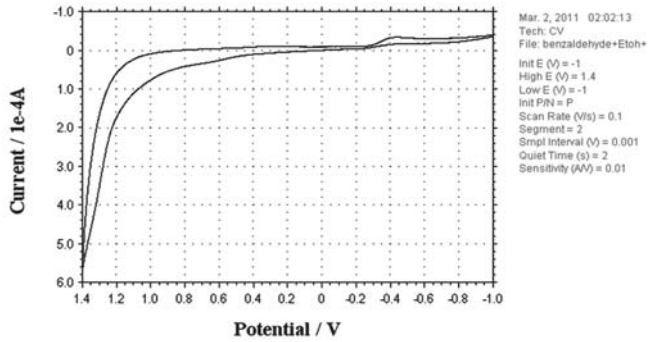
Benzyl alcohol + Ethanol + KCl on Pt working electrode



Benzyl alcohol + Ethanol + H_2SO_4 on Glassy Carbon working electrode



Benzyl alcohol + Ethanol + KOH on Glassy Carbon working electrode



Benzyl alcohol + Ethanol + KCl on Glassy Carbon working electrode

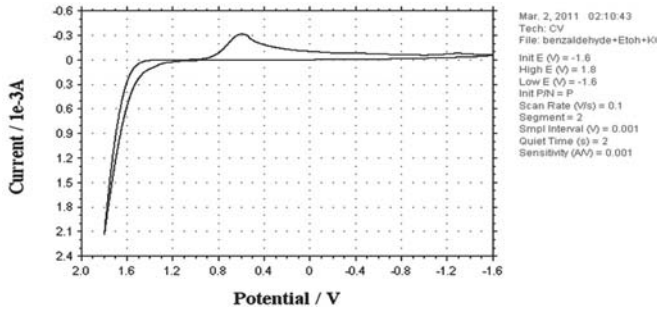


Table 1: From the above cyclic voltammograms, the following anodic potentials and anodic currents were observed

S. No	Substrates	Working Electrode	pH	Anodic potentials (Volts) w.r.t. Ag/AgCl electrode	Anodic current (mA)
1	Benzyl alcohol +Ethanol+H_2SO_4	Platinum	1.0	0.530	3.530
2	Benzyl alcohol +Ethanol + KOH	Platinum	13.0	1.205	1.104
3	Benzyl alcohol + Ethanol + KCl	Platinum	4.5	1.497	1.597
4	Benzyl alcohol +Ethanol+ H_2SO_4	Glassy Carbon Electrode	1.0	1.893	2.323
5	Benzyl alcohol +Ethanol + KOH	Glassy Carbon Electrode	13.0	0.2443	4.512
6	Benzyl alcohol + Ethanol + KCl	Glassy Carbon Electrode	4.5	1.3200	2.376

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[10].

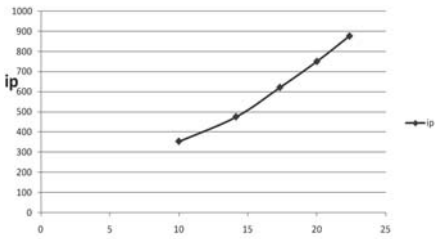
Variations in the anodic peak potential is observed when the pH of the medium is changed, this indicates that pH of the medium changes the mechanism of oxidation process. Hence changes in the pH of the medium will lead to variety of products.

Scan rate variation studies

Cyclic voltammograms with variable sweep rates in the range of 100 to500 mV/second for all the above systems were taken and the results are tabulated below.

Benzyl alcohol+Ethanol + H_2SO_4

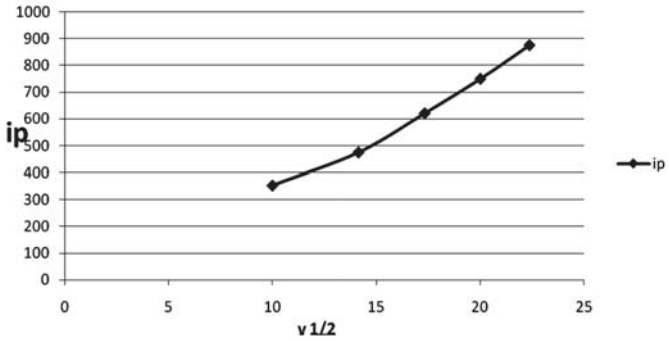
SUBSTRATE : 0.001 M [alcohol] : 0.1M
Anode: Pt Cathode : Pt



Parameters	Scan rate ν (mV/s)				
	100	200	300	400	500
ν ½	10	14.14	17.32	20	22.36
Ip (μA)	353	475	621	750	876
Ep (v)	0.530	0.659	0.655	0.609	0.595

Benzyl alcohol+Ethanol + KOH

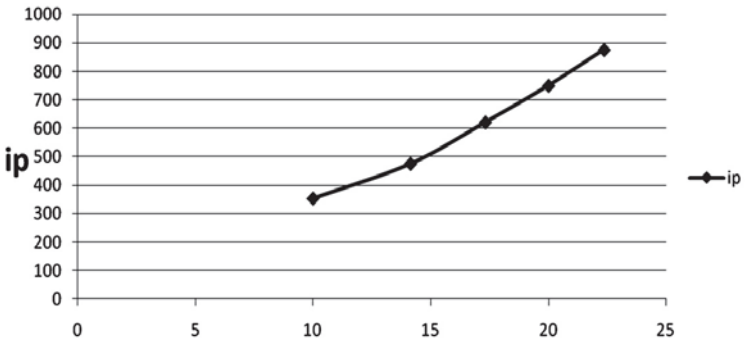
SUBSTRATE : 0.001 M [alcohol] : 0.1M
Anode: Pt Cathode : Pt



Parameters	Scan rate ν (mV/s)				
	100	**200**	**300**	**400**	**500**
ν½	10	14.14	17.32	20	22.36
Ip (µA)	352	483	613	735	845
Ep (v)	-0.212	-0.210	-0.208	-0.199	-0.212

Benzyl alcohol +Ethanol + KCl

SUBSTRATE : 0.001 M [alcohol] : 0.1M
Anode: Pt Cathode : Pt



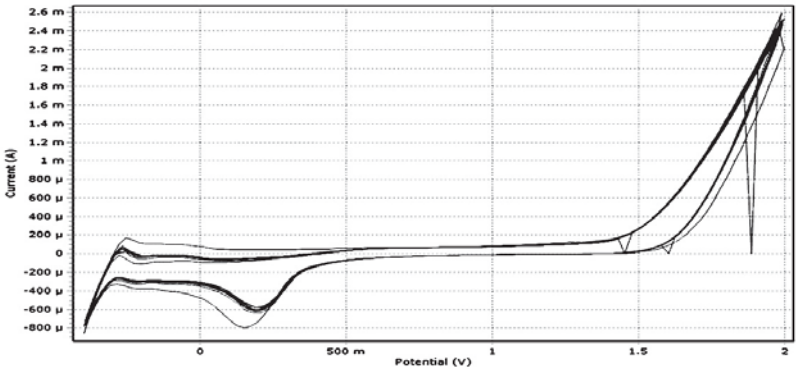
Parameters	Scan rate ν (mV/s)				
	100	**200**	**300**	**400**	**500**
ν½	10	14.14	17.32	20	22.36
Ip (µA)	371	500	627	763	916
Ep (v)	-0.275	-0.374	-0.364	-0.359	-0.364

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[11].

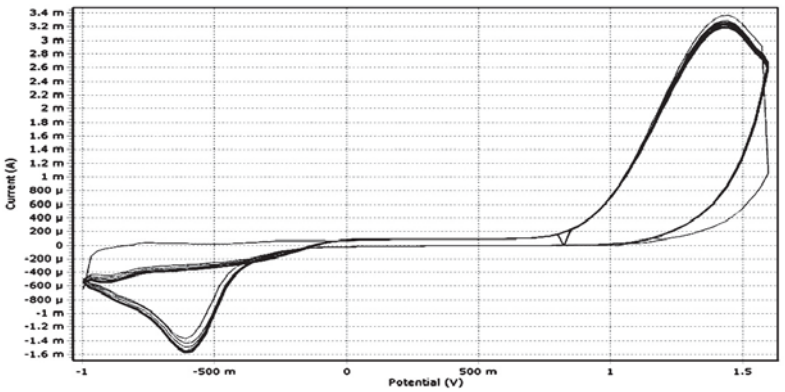
Multiple scan studies

The multiple scan rate studies of ethoxylation different substrates revealed that there is no polymer formation on the electrodes during electrolysis on platinum working electrode.

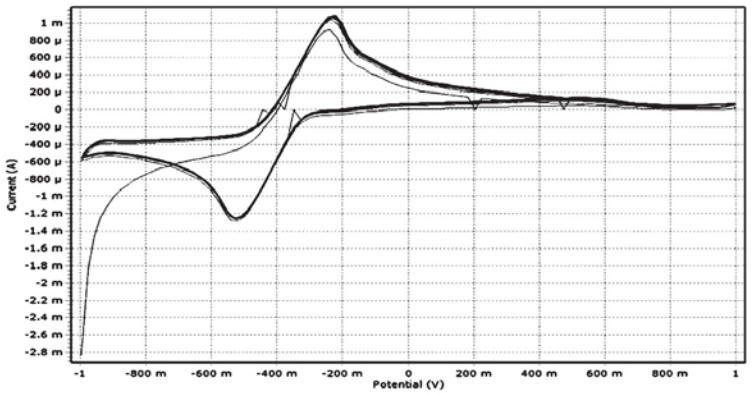
Benzyl alcohol+Ethanol + H_2SO_4



Benzyl alcohol +Ethanol + KOH



Benzyl alcohol +Ethanol + KCl



CONCLUSION

In the present work the cyclic voltammograms of benzyl alcohol were recorded by changing the conditions like pH, working electrode and scan rate. The following are the conclusions arrived at from the work.

- Benzyl alcohol is susceptible for anodic ethoxylation.
- Anodic peak potential changes with change in pH; hence variety of products can be produced by changing the pH.
- Anodic peak potential changes with change in working electrode. Hence change in electrode changes the reaction mechanism.
- Multiple scan indicates that there is no polymer formation on the working electrode.
- Cyclic voltammograms recorded at various scan rates indicate that the process is diffusion controlled.

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