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Influence of Temperature on the Synthesis of the Monovinyl Ether of 1,4 - Dihydroxybenzol (Hydroquinone)

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ABSTRACT: nowadays the synthesis of monomers containing aryl and vinyl groups is very important in several chemical industries. The synthesis of various polymers from them by means of vinyl groups expands the production area. But not always can we have high productivity. Increasing the speed and efficiency of the reaction depends on a number of factors. The reaction yield is greatly influenced by the concentration of the substance, the catalyst, the nature of the solvent, and the temperature. The article examines the effect of different temperatures on the yield of mono-ether synthesis of hydroquinone, which is a representative of diatomic phenols.

KEYWORDS: acetylene, catalyst, vinylacetylene, hydroquinone, KOH-DMSO, dimethylformamide, dimethylsulfoxide.

I. INTRODUCTION

Aromatic vinyl esters differ in their hydrolysis resistance and tendency to radical polymerization compared to aliphatic analogues. The reactivity of such substances as a building block in organic synthesis is very high. Many scientists have created their own directions for the synthesis of vinyl ethers and their derivatives. One of them is the scientific school of F.V. Kalabina. They used acetylene as a vinyl agent in their vinyl ether production technology [1-4]. Their constituents - arylvinyl ethers - are widely used in the synthesis of polymers, in the synthesis of diene and polyene, as well as in the synthesis of biologically active substances. In the chemical industry, the synthesis of arylvinyl esters and their derivatives has developed rapidly over the last few decades. They are used in the synthesis of new composite polymers as well as chemical plant protection products [5-7]. Acetylene is one of the main raw materials in chemical synthesis. This is done due to the triple bond included in it. Due to these properties it is possible to carry out the synthesis of very important substances in the chemical industry as well as in synthetic organics. The work of A.E. Favorsky in the development of the chemistry of acetylene has not lost its relevance today. In a strongly alkaline environment, acetylene can be subjected to a three-bond nucleophilic binding reaction (vinylation) as an electrophile, and as a nucleophile, acetylene can be binded to a carbonyl group (ethinylation) [8-10]. Among super-alkaline environments, KOH / DMSO is one of the most stable, convenient and universal systems. Unlike acetylene, when vinyl acetylene is used as a vinyl agent, the number of double bond increases by one, ie a divinyl product is obtained. KOH / DMSO also had the highest reaction yield when vinyl acetylene was combined with dihydroxy phenols instead of acetylene in a different base medium [11-12]. The essence of the high basicity property of the KOH / DMSO system is related to the weak solvation of cations and strong anions.

II. METHODS

In the experiment, vinylation with vinyl acetylene was studied at different temperatures using high-base systems KOH-DMSO and KOH-DMFA in the presence of hydroquinone. In order to increase the yield of mono position vinyl ether of hydroquinone was studied with the participation of KOH-DMSO-CsF system. The temperature was maintained in the range of 28–75°C. The results obtained are presented in Table 1.

Table 1
Effect of temperature on the yield of mono position vinyl ether of hydroquinone with the KOH-DMSO-CsF system

№	Temperature, °C	The duration of the reaction, hour	Yield of vinyl ether of hydroquinone, %
1.	28-35	1	27,3
2.	28-35	2	28,4
3.	28-35	3	33,4
4.	28-35	4	35,8
5.	28-35	5	37,5
6.	40-45	5	49,2
7.	50-75	5	37,5

(the amount of catalyst KOH relative to the mass of hydroquinone - 14%)

III. RESULT

The results show that when the reaction time is increased from 1 to 5 hours, the yield vinyl ether of hydroquinone passes through the maximum. At a temperature of 28-35 °C and a reaction time of 3 hours, the product yield is 33.4%. A further increase in the reaction time leads to a decrease in the yield vinyl ether of hydroquinone; its yield reaches its maximum value after 5 hours, i.e. 37,5%. An increase in temperature to 40-45 °C led to an increase in product yield by 49,2%. Raising the temperature above 50 °C led to a decrease in product yield. This can be explained by oligomerization of the synthesized vinyl compound and partial oxidation of hydroquinone and the resulting product, or a decrease in the solubility of vinylacetylene at high temperatures and destructive changes in the product. Thus, the study of the reaction of vinylation of hydroquinone showed that its optimal conditions are: solvent - DMSO, content of KOH catalyst - 14% (with respect to the mass of hydroquinone), temperature 40-45 °C, reaction duration 5 hours, yield of monovinyl ether of hydroquinone - 49,2%. Based on the results of studying the effect of temperature on the course the reaction ofvinylation of hydroquinone, a graph was drawn up of the dependence of the yield vinyl ether of hydroquinone at different temperatures on the duration of the reaction (Fig. 1).

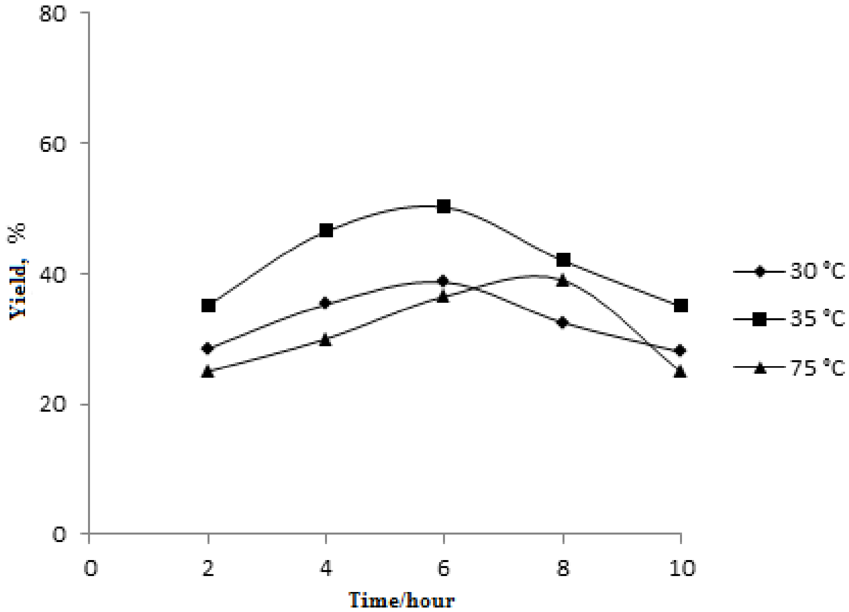

Figure 1. Influence of reaction time on the yield of vinyl ether of resorcinol at different temperatures.

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IV. DISCUSSION

According to the results of the experiments, it was found that temperature has a significant effect on the product yield. In all cases, the product yield increases with time and temperature. When the temperature rises from 35 to 45 °C with a reaction time of 5 hours, the product yield also increases from 37,5 to 49,2% respectively. Increasing the temperature further slows down the reaction relatively slowly, and at 75 ° C the yield is 37,5%. Based on the data obtained, a graph of the temperature dependence of the product yield was built (Figure 2). This law is explained by a decrease in the solubility of vinyl acetylene at high temperatures, which leads to a decrease in its content in the reaction system, the reaction rate, and the yield of vinyl ester in the vinyl ether of hydroquinone.

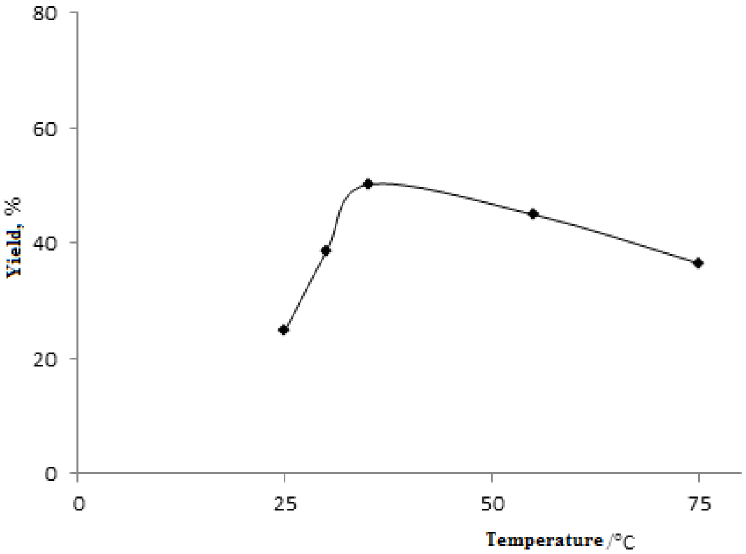

Figure 2. Temperature dependence of the yield of vinyl ether of hydroquinone
(reaction time 5 hours)

V. CONCLUSION

The effect of temperature on the reaction yield during vinylation of diatomic phenols based on vinyl acetylene was studied. At the same time, an increase in temperature to 40-45 °C increased the yield by 49,2%. However, raising temperatures above 50 °C will reduce yields. This is due to oligomerization of the synthesized vinyl compound and partial oxidation of hydroquinone and the resulting product, or a decrease in the solubility of vinylacetylene at high temperatures and destructive changes in the product.

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