

# Selective alkylation of organic compounds

## Abstract

In this paper are presented the results on the selective alkylation of polyfunctional compounds in our research group under conditions of phase transfer catalysis as examples of regioselective alkylation of phenol, aldehyde and ketone, diketone as acetoacetic acid derivatives, malonic ether, acetylacetone (O and C alkylation), ethanolamine (O and N alkylation) and of selectivity for mono- and dialkylation alkylation of primary amid of carbonic acid as acetoamide and acrylamide. The special attention is given to alkylation of very widespread organic molecule-ethanolamine, however on alkylation reaction poorly studied. The conditions for selective and regioselective alkylation are retrieved on the basis of obtained data combination. Depending on a constitution of studied substrate alkylation reaction in basic medium is expedient for conducting or in phase transfer catalysis conditions or at the presence of dipolar solvents. In a number of cases the high selectivity of alkylation reaction is provided a thermal alkylation of organic acid with the quaternary ammonium salt, as a carrier of alkyl group. The formulated scientific conditions open new capabilities for research of alkylation reaction of organic compounds, determine conditions directional and finding of routes for selective and regioselective alkylation.

The offered methods for selective alkylation of organic molecules in comparison with the traditional methods has more advantages: high speed of process, soft condition of reaction allowing lower of a power expenses, the complete exception of application of hazardous and dangerous organic solvents, by virtue of it is sharp reduction of air pollution, much smaller volumes of waste water. This is of all, there are devoted to technological problems of the synthesis of more important organic compounds in the aspect of environmental protection.

**Keywords:** selective alkylation, regioselectivity, phase transfer catalysis, dipolar solvents, thermal alkylation, quaternary ammonium salt, polyfunctional compounds, phenol, aldehyde and ketone, diketone, amid of carbonic acid, alkyl group, ethanolamine, protection of an environment.

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## Introduction

The problem of an effective utilization of initial materials in chemical conversion had, has and will have a principal importance in chemistry and chemical technology. The continuously becoming complicated nature of new synthetic problems awakes the chemists to elaborate the new approaches to implementation already of known conversions and to create in essence new methods of transformation of organic molecules. Such researches set in essentially common vector of development of organic chemistry. High selectivity and speed of a chemical reaction at little energy consumptions, in devices of feasible sizes, become the basic criterion of prospects of chemical process from the practical point of view.

The problem of selectivity is relevant for organic synthesis, that it merits detail discussion as an independent problem. Any organic compound is multifunctional, that makes a problem of selectivity of reactions key for planning of organic synthesis.

In the present paper is given an attention to synthetic methods, which are provide possibility to control of selectivity of conversions on an example of alkylation reactions. We attempt to esteem unique capabilities for design of organic molecules and to tell about how to cause hidden and insensible molecules to react by the manner desirable for us.

Here are presented the examples of an alkylation of phenol, aldehyde and ketone, diketone as acetoacetic acid derivatives, malonic ethers, acetylacetone; <sup>1</sup> ethanolamine and primary amid of carbonic acids with usage of possible methods for improvement of selectivity and regioselectivity. The special attention is given to alkylation of very widespread organic molecule – ethanolamine (colamine), however on alkylation reaction poorly studied.

## Experimental part

### Allyl phenyl ether synthesis

The synthesis of allyl phenyl ether is carried out by interaction of allyl bromide with phenol at the presence of dried powdered potassium hydroxide anhydrous KOH and TEBACH triethylbenzylammonium chloride in anhydrous toluene. The molar ratio of phenol:allyl bromide:KOH:TEBACH = 1:1:1,5:0,1. Toluene for 0,1 mol reagent is 20 ml.

The allyl bromide was brought in flask with phenol, TEBACH, KOH. The temperature of reaction medium is 60°C. The reaction product removes by diethyl-ether and was dried on MgSO<sub>4</sub>. Reaction products were analyzed by chromatograph.

For gaze-liquid chromatography (GLCh) method here are used with the heat conductivity detector; columns from stainless steel

in the size 2m x 3mm; the additional 7 %, silicon elastomer E-301 on chemosorb AW-HMDS (0,26-0,36 mm), 15 % CarboVax 20M on Chromatone N-AW-HMDS (0,126-0,160 mm) and 5 % E-30 on chromatone DMCS (0,400-0,630 mm); gas-carrier-helium (speed of 30-60 ml/min); temperature of columns 40-240.

The products are identified using TLC method as well. Silufol UV-254 plates are used. The eluents for TLC was C<sub>6</sub>H<sub>6</sub>:EtOH (2:1 volume ratio) mixture. The spots are developed by iodine vapors.

The isolated products are identified by IR (specord IR-75) and NMR (Varian "mercury-300" RS) methods. The chemical shifts are expressed by ppm with respect to Si(CH<sub>3</sub>)<sub>4</sub>. The solvent was CDCl<sub>3</sub>.

By distillation in vacuum is next product-allylphenyl ether<sup>1</sup> (88,5%). b.p. 75°/15 mm; n<sub>D</sub><sup>20</sup> 1,5207.<sup>2</sup> IR spectrum: 699,760 (the monoreplaced benzene); 930,997 (CH=CH<sub>2</sub>); 1220 1260 (C-O); 1500; 1600, (C=C). NMR: 4,38 (2H, OCH<sub>2</sub>, 4,8 I 1,4 Hz); 5,18÷5,29 m (2H, =CH<sub>2</sub>); 5,92. (1H, CH, 17,0 and 10,0 Hz); 6,6÷7,3 m (5H, C<sub>5</sub>H<sub>5</sub>).

It has been obtained the residues on traces consists by other allylation products of phenol as C-allylated products of allylphenyl ether –allylether of o-allylphenol and p-allylphenol.<sup>2,4</sup>

### N-allylethanolamine

The mixture of reactants - ethanolamine:allyl bromide 1:1 and cesium hydroxide 10% (in experience 2 – with cesium hydroxide and ТБАБ-5мол of %, in experience 3. - With tetra methyl ammonium hydroxide 10мол of %) introduced to a reaction flask with biunique bulb supplied by a reflux condenser, dropping funnel, intensively hashed dropwise adding allyl bromide. During an adding of allyl bromide the temperature of reaction mixture has mounted up to 60°C. This temperature supported during 3h. Then a reaction mixture chilled till 10-15 °C and triply abstracted by a diethyl ether (or chloroform). The obtained extract is dried above MgSO<sub>4</sub>. The yield of alkylation products is updated outgoing from the data GLCh, with the method of internal normalization, in matching with known samples. N-allylethanolamine b.p. 96-98°C/25mm, n<sub>D</sub><sup>20</sup> 1,4637, d<sub>4</sub><sup>20</sup> 0,8964, IR spectrum: 980,1630, 3020 (CH=CH<sub>2</sub>), 3200-3400 (OH, NH), NMR: 3,62m (2H, CH<sub>2</sub>CH<sub>2</sub>OH); 2,65τ (2H, NCH<sub>2</sub>CH<sub>2</sub>); 3,18 (2H, CH<sub>2</sub>CH=CH<sub>2</sub>); 3,5c (1H, OH); 4,95-6,25m (3H, CH=CH<sub>2</sub>). The analysis - is founded %: C 59,29; H 10,75; N 13,97. C<sub>5</sub>H<sub>11</sub>NO. Is computed of %: C 59,41; H 10,89. N 13,86.

## Results and discussion

Previously was studied the regioselective alkylation of ambident phenol anion. It has been established, that phenol alkylation by allyl bromide in PTC "liquid - liquid" system results at the formation of a number of products with predominance of allylphenyl ether. The exclusive formation last almost from 90 % by the yield takes place in a system "solid phase-liquid" with usage of powdered, dehydrated potassium hydroxide.<sup>1,2</sup>

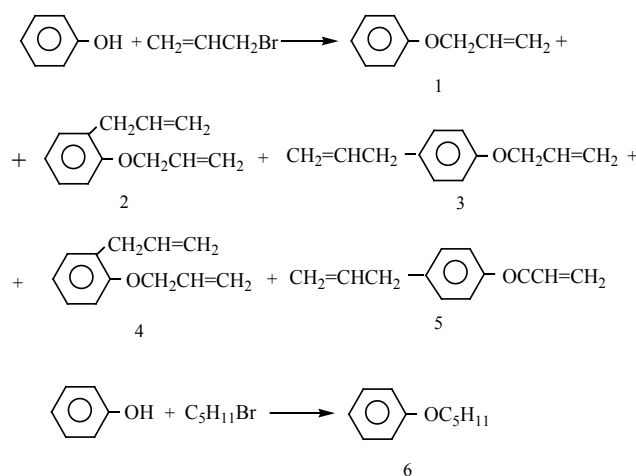
It is known, that PTC alkylation of similar anions takes place in two phase medium at transition of anion from water or solid phase in organic phase. If there is a water environment, even with a powder of customary potassium hydroxide up to 10 % of moisture, the transition of the regenerated anion with a water shell with water molecule takes place. The last more overlaps oxygen, the most hydrated center of ambident anion and reaction particulate flows past on carbon, that is takes place carbon-alkylation with formation of allylphenol and its

derivative.<sup>2,4</sup> With the waterless potassium hydroxide exclusively formed allylphenylether by 90 % yield.

Such weep of reaction is possible during an absence of hydrated shell around. The absence of water around oxygen reacting center of ambident anion does not create alkylation such obstacle in process.

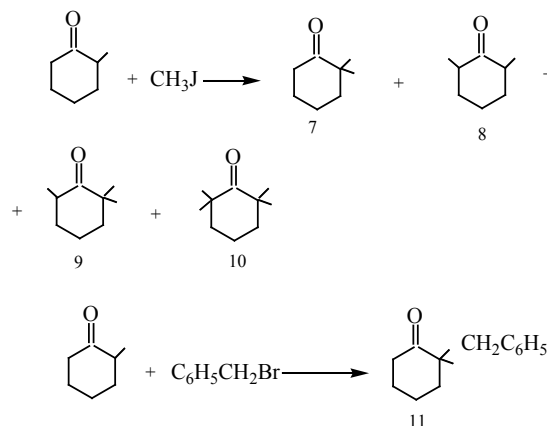
The alkylation reaction results for formation allylphenyl ether an exclusively by 98 % yield during the transition from soft alkylating agent as allyl bromide to hard amyl bromide.

It's known that the value of the O/C-ratio depends on three factors: the polar effect of the alkyl substituents in the alkylating agents, the steric effect of the alkyl groups and the symbiotic effect of the leaving groups.<sup>3</sup>



The relative contribution of the first two effects depends on the leaving group nature. Here is a same leaving group as bromine anion and not the strong steric effect. In this case the important role has here alkyl group and that have fine explanation from HSAB concept.<sup>4</sup>

The powdered waterless potassium hydroxide is fine agent in a selective alkylation of methylcyclohexanone and 2-methylpropanal isobutyraldehyde and 2-ethylhexanal. But in this case the reaction with higher selectivity – the formation of monomethylated products of mentioned substrate - 2,2 dimethylcyclohexanone (7) had a place with powdered waterless potassium hydroxide in the dimethoxyethane DME. The higher selectivity was obtained with benzyl bromide as alkylated agent (11) – the yield 70%.<sup>5</sup>







4. Pearson, Ralph G. Hard and soft acids and bases. *J Am Chem Soc.* 1963;85(22):3533–3539.
5. I.Artaud, G.Torossian, P.Viout, Alkylation directe de cetonas et d'aldehydes en presence de potasse solides en suspension. *Tetrahedron.* 1985;41(21):5031–5037.
6. Torosyan GH, Tahmazyan NK, Babayan AT. Acetamide alkylation. *Journal of Organic chemistry USSR.* 1985;20(3):506–510.
7. Torosyan GH, Tahmazyan NK, Paravyan SL, et al. An alkylation of acetamide and acetoacetic ether in the presence of alkaline agents. *Arm Chim Z Chem J of Armenia.* 1981;34(6):470–473.
8. Torosyan G, Hakobyan H, Galoyan A. Acrylamide alkylation in PTC conditions. *Chem J of Armenia.* 1994;47(1-3):11–15.
9. Torosyan GH, Vardanyan NG, Karapetyan LP, et al. Ethanolamine in theory and practice. *Knowledge and science Publishers.* 1989; 40.