LITERATURE CITED

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BECKMANN REARRANGEMENT OF THE E ISOMER OF CIS-4,6,6-TRIMETHYLBICYCLO[3.1.1]-HEPTAN-2-ONE OXIME

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The individual E isomer of 4,6,6-trimethylbicyclo[3.1.1]heptan-2-one oxime has been obtained, and its transformations under the conditions of acid catalysis have been studied. The action of sulfuric acid on a solution of the oxime in acetonitrile leads to the selective formation of 5,7,7-trimethyl-2-azabicyclo[4.1.1]octan-3-one, while the action of hydrochloric acid with heating gives 4-isopropyl-3-methylaniline.

The interest of research workers in the Beckmann rearrangement is due to the fact that the amides formed as a result of this reaction are used as intermediates for obtaining pharmacologically active azacyclic compounds [1, 2]. However, in the majority of cases the rearrangement of terpene bicyclic oximes forms a mixture of unsaturated nitriles [3, 4]. This circumstance is obviously connected with the high degree of strain of the carbon skeleton of the derivatives of a number of bicyclo[2.2.1]- and -[3.1.1]heptanes, leading to rupture of a carbon-carbon bond and to dehydration. Thus, under the conditions of the Beckmann rearrangement, oximes of ketones of the pinane series are mainly converted into mixtures of unsaturated nitriles, and only in some cases have the corresponding lactams been obtained, in low yield. Only from nopinone oxime by the action of benzenesulfonyl chloride in the presence of sodium hydroxide has 7,7-dimethyl-2-azabicyclo[4.1.1]octan-3-one been obtained, with a yield of 43% [5]. When pinocamphone and isopinocamphone oximes were treated with p-toluenesulfonfyl chloride in the presence of NaOH [6] or with polyphosphoric acid [2] the corresponding lactams were again obtained, but only in trace amounts. The action of sulfuric acid on verbanone oxime (I) formed nitriles exclusively [1], and only under the action of p-toluenesulfonfyl chloride in pyridine on verbanone oxime, in the form of a mixture of the E and Z isomers in a ratio of 3:1 was a multicomponent mixture obtained from which it was possible to isolate a 2-azalactam [7].

The aim of the present work was to study the behavior of the oxime of verbanone (cis-4,6,6-trimethylbicyclo[3.1.1]heptan-2-one) (I) under the conditions of the Beckmann rearrangement.
The oxime (I) was obtained by a known procedure [4] from cis-verbanone. By repeated recrystallization from ethanol of the reaction product we succeeded for the first time in separating and characterizing the individual E isomer of the oxime (I). It is known from the literature [8, 9] that the signal of a proton in the \( \alpha \) position to a hydroxyimino group undergoes a downfield displacement by \(-0.4\) ppm with a change in the orientation of the hydroxy group from anti to syn, and in the Z and E isomers of verbanone oxime the signals of the 1-H protons are found at 3.28 and 2.86 ppm, respectively [7]. In the spectrum of the oxime isomer that we had isolated the shift of the 1-H proton was 2.85 ppm and that of the 3-H\(_e\) proton 3.02 ppm (d, \( ^2J = 12.0\) Hz). The closeness of the values of the chemical shifts in the \(^{13}\)C NMR spectrum of the C-1 and C-5 carbon atoms (33.1 and 33.2 ppm) was also evidence in favor of the E configuration of the oxime (I).

The performance of the Beckmann rearrangement by the procedure of [10] under the action of concentrated hydrochloric acid with the boiling of the reaction mixture unexpectedly led to the selective transformation of the oxime (I) into an aromatic amine. On the basis of an analysis of the results of IR, mass, and \( ^1\)H and \(^{13}\)C NMR spectroscopies (see the Experimental section) the amine (III) was ascribed the structure of 4-isopropyl-3-methyl-aniline.

The "nonclassical" cation (IV) probably gave the intermediate (V) as a consequence of a redistribution of charges leading to the rupture of the C-1-C-6 bond. This intermediate, as the result of a 4,8-hydrogen shift and the ejection of a proton by the cation (VI), was converted into compound (VII) the dehydration of which led to the formation of the aromatic amine (III).

It was considered previously that the action of sulfuric acid on verbanone oxime (I) formed a mixture of unsaturated nitriles exclusively [1]. However, the procedure for obtaining lactams that we have developed, consisting in the slow addition of concentrated sulfuric acid to a solution of the oxime in acetonitrile at room temperature, usually permits bicyclic lactams to be obtained with good yields. In the case of verbanone oxime the yield of 5,7,7-trimethyl-2-azabicyclo[4.1.1]octan-3-one after purification by vacuum distillation amounted to 60%.