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In studying the orientation rules for the electrophilic substitution of 2-aryl-3-hydroxypyridines we found that the electrophilic reactions, in which  $\beta$ -pyridols undergo attack in the cation form (nitration, sulfonation), are directed to the aryl ring [1]. In contrast, substitution reactions, proceeding either in alkaline or slightly acid medium, like aminomethylation or iodination, are directed to the hydroxypyridine ring of the 2-aryl-3-hydroxypyridine molecule [2]. In view of this, it seemed of interest to us to study the orientation of the azo-coupling of 2-aryl-3-hydroxypyridines, which has been studied inadequately. According to the data given in [3], the main azo-coupling product of 3-hydroxypyridine is the 6-isomer. An analogous orientation was also observed for 2-methyl-3-hydroxypyridine [4]. In not a single case could the 4-isomer be isolated.

In the present paper we studied the azo-coupling of the 2-phenyl-, 2-(4'-alkylphenyl)-, 2-(4'-methoxyphenyl)-, and 2-(4'-chlorophenyl)-3-hydroxypyridines. As the diazo components we selected the phenyldiazonium, p-hydroxyphenyldiazonium, p-methoxyphenyldiazonium, p-sulfophenyldiazonium, p-nitrophenyldiazonium and p-bromophenyldiazonium chlorides.

It proved that in all cases, with the exception of the azo-coupling with p-hydroxyphenyldiazonium chloride, the yield of the azo products was 90-95%. The obtained azo compounds were orange crystalline substances, readily soluble in many organic solvents (acetone, chloroform, alcohol), and practically insoluble in water



R1=H, CH3, C2H5, CH (CH3)2, OCH3, Cl; R2=H, SO3H, NO2, CH3O, Br

It is interesting to mention that the azo-coupling of 2-aryl-3-hydroxypyridines, in contrast to aminomethylation, went with equal ease in both alkaline and weakly acid media. The yield of the azo products was practically the same in both cases. This testifies to the greater activity of the diazonium ion when compared with the immonium carbonium cation. However, the phenyldiazonium ion is a weak electrophile and practically does not substitute the benzene molecule, alkylbenzenes and anisole. For this reason, substitution in either the 4 or 6 position of the hydroxypyridine ring of 2-aryl-3-hydroxypyridines could be



Fig. 1. Infrared spectrum of 6-benzeneazo-2-phenyl-3-hydroxypyridine in  $CCl_4$ , concentration =  $3 \cdot 10^{-4}$  mole/liter.

expected. Actually [3], in the azo-coupling of 3-hydroxy-4methyl-5-phenylpyridine the  $\beta$ -pyridol ring undergoes substitution, with the formation of approximately equal amounts of the 2- and 6-isomers. Since in the 2-aryl-3-hydroxypyridines the phenyl ring is deactivated to an even greater degree toward electrophilic substitution, then it can unequivocally be said that the azo-coupling takes place in the  $\beta$ -pyridol ring.

The IR spectra of the obtained azo compounds were characterized by the presence of bands in the  $3558 \text{ cm}^{-1}$  region from the free hydroxyl group. This testified to the entrance of the azo group in the 6 position of the pyridine

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$R_2 - \sqrt{-N} - N$	
TABLE 1. Azo Derivatives of 2-Aryl-3-hydroxypyridines	•

-B1

HO

	Calculated, 7/0	z	15,27	14,53	13,86	13, 24	13,77	11,83	17,5	11,86	13,77	13,59
		Ħ	4,72	5,19	5,61	5,99	4,91	3,66	3,75	3,38	4,91	3,88
		c	74,18	74,74	75, 24	75,70	70,81	57,46	63,75	57,62	70,81	66,01
		Empirical formula	C17H13ON3	$C_{18}H_{15}ON_3$	C <sub>19</sub> H1,ON <sub>3</sub>	C <sub>20</sub> H <sub>19</sub> ON <sub>3</sub>	C <sub>18</sub> H <sub>15</sub> D <sub>2</sub> N <sub>3</sub>	C17H13O4NsS	$C_{17}H_{12}O_{3}N_{4}$	C1,H12ON3Br	Cl <sub>8</sub> H <sub>15</sub> ON <sub>3</sub>	C <sub>17</sub> H <sub>12</sub> ON <sub>8</sub> Cl
	Found, %	N	15,10 15,08	14,36	13,69	13,08	13,93	11,60	17,36	11,51	13,66	13,51
		Н	4,77	5,07 2,07	1 2 9 9 9 9 9	280 280 280 280	4,94,4 49,94	100 200 200 200 200 200 200 200 200 200	3,67		4,84	3,70 3,80
		C	73,94	74,59	75,00	75,60	70,75	57,24	63,55 63,55	57,37	70,71	66,00 65,88
		Mp, °C	194195	149150	144145	169 - 170	225226	300 300 V	243-244	228-229	175176	196197
		Yield, %	95	93	94	95	06	97	93	91	95	96
•		R,	Н	н	н	Н	CH <sub>3</sub> O	SO <sub>3</sub> H	NO2	Br	Н	н
		Ч	Н	CH3	$C_2H_5$	CH(CH <sub>3</sub> )2	Н	Н	Н	Н	0CH3	G

ring, since 4-substitution would be characterized by the formation of an intramolecular hydrogen bond between the azo group and the hydroxy group (Fig. 1). As a result, the 6-azo compounds are formed in the azo-coupling of 2-aryl-3-hydroxypyridines.

## EXPERIMENTAL METHOD

The IR spectra were taken on a UR-20 spectrometer. The samples of the studied compounds represented solutions in  $CCl_4$ , with the concentration of the studied compound being  $3 \cdot 10^{-4}$  mole/liter.

Azo-Coupling Procedure. To a stirred solution of 0.0029 mole of 2-phenyl-3-hydroxypyridine in 50 ml of a 1% aqueous KOH solution, cooled to 5-10°, were gradually added a solution of the diazo component (0.0029 mole) and KOH solution in such a way that the pH of the medium remained in the range 8-9. The reaction mass was kept for 1 h, and the mother liquor was neutralized by the passage of CO<sub>2</sub> gas. The obtained precipitate was separated, washed with water, dried, and recrystallized from alcohol. The azo derivatives of 2-phenyl-3-hydroxypyridines were obtained (the yield and physicochemical constants are given in Table 1).

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## CONCLUSIONS

- 1. The azo-coupling of 2-aryl-3-hydroxypyridines was studied.
- 2. The azo-coupling is directed to the  $\beta$ -pyridol ring, with the formation of the 6-azo compounds.

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