VIII with mp 131-134,C in 93% yield. IR spectrum: 2230, 2220 (C≡N); 1620 (N—C=CH); 1590 cm^{-1} (S—C=CH). The PMR spectrum of mixture VIII contained signals of protons of methyl groups (2.20 and 2.27 ppm) and olefin protons (5.59, 5.73, 5.95, and 6.31 ppm) and multiplets of aromatic protons (6.99 and 7.35 ppm). Found: C 68.1; H 4.2; S 8.6%. $C_{21}H_{15}N_5S$. Calculated: C 68.3; H 4.1; S 8.7%.

Reaction of 5-Imino-7-phenyl-1,2,4-triazolo[3,2-b]-1,3-thiazine (V) with 1-Phenyl-2-cyanoacetylene (IV). A mixture of 1.14 g (5 mmole) of V and 0.1 g of KOH in dioxane was treated with a solution of 0.63 g (5 mmole) of acetylene IV in dioxane. After 6 h, workup gave 1.53 g (86%) of diadduct VII with mp 119°C.

2,4-Bis(1-phenyl-2-cyanovinylene)-1,2,4-triazol-3-one (IX). This compound, with mp 213°C, was obtained similarly from ketone III in 88% yield. Found: C 70.5; H 3.9; N 20.4%. $C_{20}H_{13}N_5O$. Calculated: C 70.8; H 3.9; N 20.6%.

LITERATURE CITED

1. N. D. Abramova, A. G. Mal'kina, Yu. M. Skvortsov, B. V. Trzhtsinskaya, and G. G. Skvortsova, Zh. Org. Khim., 16, 1788 (1980).
2. G. G. Skvortsova, N. D. Abramova, A. G. Mal'kina, Yu. M. Skvortsov, B. V. Trzhtsinskaya, and A. I. Albanov, Khim. Geterotsikl. Soedin., No. 7, 963 (1982).
3. L. I. Vereshchagin, R. L. Bol'shedvorskaya, G. A. Pavlova, and N. V. Alekseeva, Khim. Geterosikl. Soedin., No. 11, 1552 (1979).
4. N. D. Abramova, B. V. Trzhtsinskaya, L. F. Teterina, G. G. Skvortsova, A. G. Mal'kina, and Yu. M. Skvortsov, USSR Inventor's Certificate No. 649719; Byull. Izobret., No. 8, 87 (1979).
5. S. R. Landor, J. Organomet. Chem., 93, 129 (1975).

HETEROGENEOUS-CATALYTIC FISCHER REACTION.

13.* CATALYTIC SYNTHESIS OF 4-, 5-, 6-, AND 7-METHOXYINDOLES

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Methoxy-substituted acetaldehyde phenylhydrazones were cyclized in the vapor phase on a GIPKh-115 catalyst to give 4-, 5-, 6-, and 7-methoxyindoles. 5-Methoxyindole was obtained in 50% yield, 4- and 6-methoxyindoles were obtained in 85% yield, and 7-methoxyindole was obtained in 45% yield.

Methoxy-substituted indoles are finding wide application as starting substances for the synthesis of various sorts of medicinal preparations [2]. The presently known methods for the preparation of methoxyindoles involve many steps and are laborious [3, 4], and the problem of finding a simple and cheap method for the preparation of indoles with a methoxy group in the benzene ring therefore remains an urgent one.

We have previously reported the heterogeneous-catalytic synthesis of 4-, 5-, 6-, and 7-methoxyindoles on aluminum oxide [5], but we were unable to recommend this method as a preparative procedure because of the low yields of the desired products. These results can be explained by the low activity of the catalyst in this reaction at its operating temperature (∿300°C) and also by the low thermal stabilities of acetaldehyde p- and o-methoxyphenylhydrazones. One might have assumed that a catalyst based on GIPKh-115 aluminum oxide [6], which has higher activity at lower temperatures than aluminum oxide itself, would prove to be effective in this case.

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*See [1] for Communication 12.

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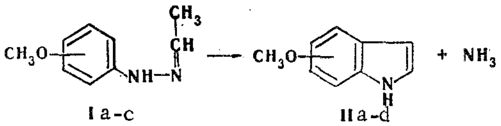
In the present research we accomplished the cyclization of methoxy-substituted acetaldehyde methoxy-substituted phenylhydrazones Ia-c on GIPKh-115 catalyst via the following scheme:



I a *o*-OCH_3, b *m*-OCH_3, c *p*-OCH_3; II a 4-OCH_3, b 5-OCH_3, c 6-OCH_3, d 7-OCH_3

The use of the GIPKh-115 catalyst actually makes it possible to significantly decrease the temperature range of the reaction and to increase the yields of 4-, 5-, 6-, and 7-methoxyphenylhydrazone (Ic) we were able to achieve complete conversion of the hydrazone at 180-200°C and to obtain 5-methoxyindole (IIb) in 50% yield. Acetaldehyde o- and m-methoxyphenylhydrazones (Ia, b) were also subjected to cyclization at 180-200°C, but significant amounts of the hydrazones remained unchanged in this case, and this complicated isolation of the desired products.

Since we set out to develop a preparative method for the synthesis of methoxyindoles, we selected the cyclization conditions in such a way that the starting hydrazone was absent in the catalysate. A temperature range of 260-280°C was optimal for the indolization of hydrazones Ia, b. At these temperatures 7-methoxyindole (IId) was obtained in 40-45% yield, and 4- and 6-methoxyindoles (IIa and IIc, respectively) were obtained in 80-85% yield with slight predominance of 6-methoxyindole (IIc) [the IIa:IIc ratio was 1:(1.5-1.7)]. In all likelihood, the results can be explained, on the one hand, by the lower stability of IId as compared with IIa and IIc [5] and, on the other, by the effect of the steric factor.

We accomplished the isolation of indoles IIb, d by vacuum distillation after removal of the solvent by distillation, and a mixture of indoles IIa, c was obtained after treatment of the catalysate with a dilute solution of sulfuric acid (to remove the amines) and subsequent removal of the solvent by distillation.

EXPERIMENTAL

The catalytic experiments were carried out an GIPKh-115 catalyst (V = 10 cm^3) in a vertical apparatus of the flow type at atmospheric pressure with automatic feeding of a benzene solution of the appropriate hydrazone in a stream of nitrogen. Prior to the experiments, the catalyst was activated in a stream of dry air at 500°C. The purity of the starting hydrazones was verified by chromatography. Benzene solutions (25%) of the hydrazones were fed onto the catalyst layer at a rate of 0.5 ml/min. The nitrogen flow rate was 50 ml/min. The reaction was carried out at 180-280°C.

The isolation and purification of indoles IIb, d were realized (after evaporation of the benzene) by vacuum distillation. Indoles IIa, c were subjected to chromatographic separation with a column filled with silica gel [petroleum ether—ether (3:1)]. This procedure was used to obtain 4-methoxyindole (IIa) with mp 68°C (from petroleum ether) [3], 5-methoxyindole (IIb) with mp 52°C (from pentane) [3], 6-methoxyindole (IIc) with mp 91°C (from hexane) [4], and 7-methoxyindole (IId) with bp 94°C [3 mm (mercury column)] [3].

LITERATURE CITED

1. N. N. Suvorov, V. N. Shkil'kova, and N. Ya. Podkhalyuzina, Zh. Org. Khim., 17, 745 (1981).
2. J. K. Sugden and T. O. Yoloye, Pharm. Acta Helv., 53, 124 (1978).
3. K. G. Blakie and W. H. Perkin, J. Chem. Soc., 125, 296 (1924).
4. D. G. Harvey and W. Robson, J. Chem. Soc., No. 1, 97 (1938).
5. N. N. Suvorov, M. Ya. Bykhovskii, and N. Ya. Podkhalyuzina, Zh. Org. Khim., 13, 424 (1977).
6. V. E. Timofeev, Z. A. Dul'tseva, N. N. Suvorov, Yu. A. Grigor'ev, V. P. Kuznetsova, G. B. Kramerova, S. A. Naumov, N. S. Timofeeva, A. P. Ushakov, and V. N. Shurygin, USSR Inventor's Certificate No. 529604; Byull. Izobret., No. 27, 225 (1979).