*ISSN 1070-4272, Russian Journal of Applied Chemistry, 2006, Vol. 79, No. 12, pp. 2039–2040. © Pleiades Publishing, Inc., 2006.
Original Russian Text © R.I. Yurchenko, T.N. Pilipenko, M.A. Yurchenko, T.I. Krivovyaz, 2006, published in Zhurnal Prikladnoi Khimii, 2006, Vol. 79, No. 12, pp. 2063–2064.*

BRIEF COMMUNICATIONS

Protective Effect of 1-Benzyl-2-R-Pyridinium Halides in Steel Acid Corrosion

R. I. Yurchenko, T. N. Pilipenko, M. A. Yurchenko, and T. I. Krivovyaz

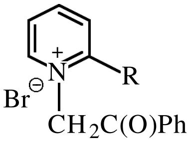
Kievskii Politekhnicheskii Institut National Technical University of Ukraine, Kiev, Ukraine

Received September 4, 2006

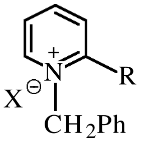
Abstract—The inhibiting effect of 1-benzoyl-2-R-pyridinium halides on the acid corrosion of steel was studied and compared with that of 1-phenacylmethyl-2-R-pyridinium halides.

DOI: 10.1134/S1070427206120299

Previously, using a fairly large data set, we have considered the correlation between the nature of substituent R in 1-phenacylmethyl-2-R-pyridinium bromides (**I**) and their protective properties in steel acid corrosion [1–3]. The coefficients of corrosion inhibition for these compounds range from 10 to 40 at room temperature and may reach almost 900 at 60°C [2]. We assumed that the major factor responsible for the corrosion inhibition may be adsorption of the carbonyl group of the phenacyl fragment and probably of substituents in the pyridinium ring. In order to confirm the decisive role of the carbonyl groups of **I** at elevated temperatures and to clarify the role of R, we studied protective properties of 1-benzyl-2-R-pyridinium halides (**II**, **II'**) in the steel acid corrosion and compared them with the properties of 1-phenacylmethyl-2-R-pyridinium bromides (**I**) with the same R:



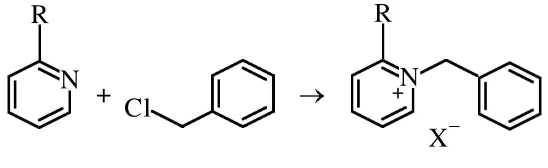
I



II, II'

where X = Cl (**II**), Br (**II'**)

By alkylation of the corresponding pyridine derivatives with benzyl chloride, we synthesized 1-benzyl-R-pyridinium chlorides (**II**, X = Cl). The subsequent treatment with an alcoholic solution of KBr yielded **II'**



where X = Cl (**II**), R = H (**a**), NH_2 (**b**), NHCOCH=CHPh (**c**), NHCO-furyl-2 (**d**), NHCOAd-1 (**e**), NHCSNHPh (**f**); X = Br (**II'**), R = CH_3 (**a**) and NH_2 (**b**).

EXPERIMENTAL

Corrosion tests were performed by the conventional procedure [1] with samples of 08 KP steel with a working surface area of 14×10^{-4} m^2. The samples were kept in 3 M H_2SO_4 at 20°C for 24 h and at 60°C for 2 h. The efficiency of steel protection with substances synthesized at their concentration of 1×10^{-2} M was evaluated by the inhibition coefficient γ and degree of protection Z.

We found that, at 20°C, benzylpyridinium bromides (**II'a**, **II'b**) and the corresponding 1-phenacylmethylpyridinium bromides (**Ia**, **Ib**) differ only slightly in γ, but this difference becomes more substantial with increasing temperature. At 60°C, γ is 209 and 200 for **Ia** and **Ib** and 25.19 and 32.81 for **II'a** and **II'b**, respectively (Table 1).

A comparison of the inhibiting effects of 1-benzyl-2-R-pyridinium chlorides, bromides, and the corresponding phenacylmethylpyridinium bromides **I** showed that, at room temperature, replacement of chloride with bromide, variation of the substituent R in the 2-position of the pyridine ring, and passing from 1-benzyl-2-R-pyridinium bromides to phenacylmethylpyridinium bromides do not substantially change the protective properties of the pyridinium salts (Table 2). For example, the inhibition coefficient γ varies within the range of 6 units for compounds **II** and **II'**,

Table 1. Inhibition coefficient γ and degree of protection *Z* of 08 KP steel corrosion in 3 M H_2SO_4 in the presence of 1×10^{-2} M 1-phenacylmethylpyridinium bromides (**Ia**, **Ib**) and 1-benzylpyridinium bromides (**II'a**, **II'b**)

Compound	20°C		40°C		60°C		80°C	
	γ	*Z*, %	γ	*Z*, %	γ	*Z*, %	γ	*Z*, %
Ia [1]	15.51	93.55	18.73	94.66	209.11	99.52	150.44	99.33
II'a	12.80	92.19	15.23	93.43	25.19	96.03	19.53	94.88
Ib [1]	23.70	95.78	29.02	96.55	200.32	99.50	144.60	99.30
II'b	19.19	95.04	21.40	95.32	32.81	96.95	26.22	96.19

Table 2. Protective properties of 1-benzyl-2-R-pyridinium chlorides and the corresponding 1-phenacylmethyl-2-R-pyridinium bromides (1×10^{-2} M) for 08 KP steel in 3 M H_2SO_4

R	γ at indicated temperature °C		R	γ at indicated temperature °C	
	20	60		20	60
H	10.98* 11.30 [1]	23.00 221.20 [1]	NHCO-Furyl-2	18.36 24.30 [2]	38.33 317.15 [2]
NH_2	17.31 23.70 [1]	28.75 200.32 [1]	NHCOAd-1	17.28 26.60 [2]	51.11 432.45 [2]
NHCOCH=CHPh	23.68 32.10 [2]	33.79 365.90 [2]	NHCSNHPh	19.15 29.17 [3]	49.29 634.30 [3]

* Numerator, data for 1-benzyl-2-R-pyridinium chlorides; denominator, data for 1-phenacylmethyl-2-R-pyridinium bromides.

13 units at variation of substituent R in the series of pyridinium chlorides **IIa**–**IIf**, and 21 units for the corresponding compounds **I**. At 60°C, higher values of γ are observed for **II** and **II'**: 29–33 upon replacement of the anion (with the order of variation on replacing the anion remaining the same) and 23–51 in variation of R in the series of benzylpyridinium chlorides (**IIa**–**IIf**). The difference between the inhibiting effects of phenacylmethyl- and benzylpyridinium halides becomes especially pronounced. For compound **II'b**, i.e., it is a factor of 8 (by 167 units) lower than that for the corresponding 1-phenacylmethyl-2-aminopyridiniun bromide (**Ib**).

Thus, the data obtained confirm that high protecting effect of 1-phenacylmethylpyridinium bromides at 60°C is largely caused by carbonyl-containing groups at the nitrogen atom. Substituents R that can participate in adsorption of pyridinium salt on the steel surface also produce a noticeable, but weaker effect.

CONCLUSIONS

(1) A comparative study of the influence of 1-phenacylmethyl- and 1-benzylpyridinium halides on the steel acid corrosion showed the key role of the carbonyl group of 1-phenacylmethylpyridinium bromides in the inhibiting effect of these compounds at elevated temperatures.

(2) Functional groups of the pyridine ring are directly involved in adsorption on the metal surface and enhance the protective effect of the compounds studied.

REFERENCES

1. Yurchenko, R.I., Pogrebova, I.S., Pilipenko, T.N., and Kras'ko, E.M., *Zh. Prikl. Khim.*, 2003, vol. 76, no. 11, pp. 1814–1818.
2. Yurchenko, R.I., Pogrebova, I.S., Pilipenko, T.N., and Shubina, T.E., *Zh. Prikl. Khim.*, 2004, vol. 77, no. 7, pp. 1132–1135.
3. Yurchenko, R.I., Pogrebova, I.S., Pilipenko, T.N., and Shubina, T.E., *Zh. Prikl. Khim.*, 2006, vol. 79, no. 12, pp. 1969–1972.