the radical and molecular reaction products we also used the methods of ESR and IR spectroscopies. The ESR spectra were recorded at 77 K on a EPR-21 radiospectrometer at a power of the UHF field of $10^{-4}$ W, while the IR spectra were recorded on a UR-20 spectrometer. The concentrations of double bonds were determined with the aid of a ADS-4M double-bond analyzer, the working principle of which is based on the ozonization of isolated double bonds in organic substances.

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**LITERATURE CITED**


**INTERACTION OF LIGNOSULFONATE WITH CERTAIN METAL IONS**

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The reaction of lignosulfonate with the Co$^{2+}$, Ni$^{2+}$, and Cu$^{2+}$ ions has been studied by the methods of gel chromatography, potentiometric titration, and UV spectroscopy. Lignosulfonate forms polymer-metal complexes with the metal ions over a wide pH range. In this process the size of the macromolecule scarcely changes, thanks to the reticular structure of the lignosulfonate. The capacity of lignin with respect to Cu$^{2+}$ ions has been determined.

Interest in the investigation of the binding of metal ions by lignosulfonate is due above all to the availability of this material and the wide occurrence of such processes. An interaction of lignosulfonate with a metal is observed, for example, in the wood digestion process. The formation of metal complexes with lignin interferes with the bleaching of cellulose and increases the depth of color of the effluents. Its complex-forming properties also affect the biological activity of biostimulators from lignin. On the other hand, the products of the binding of metals by the lignin macromolecules may exhibit catalytic activity, a high foam-forming capacity, etc. [1].

We have studied the complex-forming capacity of lignosulfonates with the transition-metal ions Ni$^{2+}$, Co$^{2+}$, and Cu$^{2+}$.

The interaction between the lignosulfonate (LS) macromolecules and metal ions (Me) is accompanied by a shift in the acid-base equilibrium in the system according to the scheme shown below.

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Consequently, the formation (breakdown) of the polymer-metal complex (PMC) can be studied by the method of potentiometric titration. Figures 1 and 2 show curves of the potentiometric titration of the LS-Co$^{2+}$ and LS-Cu$^{2+}$ systems at various ratios of the components. The titration curves for the LS-Ni$^{2+}$ system are similar to those for the LS-Co$^{2+}$ system. It can be seen that the titration curves for the LS-Me mixtures are located below the titration curves for lignosulfonate. This indicates that the reaction between the LS macromolecules and the metal ions takes place by a mechanism of electrostatic interaction with the liberation of protons by the scheme given above.

The results presented also show that the binding of metals into PMCs takes place over a wide pH range.

It can be seen from Fig. 3 that the number of protons liberated when the reactants are mixed is proportional to the amount of metal added.

In the LS-Ni$^{2+}$, Co$^{2+}$ systems, a metal ion displaced one proton over the whole range of Me/LS ratios investigated. The situation was different in the LS-Cu$^{2+}$ system. When the concentration of copper ions in the system was low (initial section of curve 3 in Fig. 3), for each Cu ion bound two protons were liberated. It is obvious that under these conditions either intra- or intermolecular binding of the macromolecules of the lignosulfonate by copper ions took place. With a subsequent increase in the concentration of Cu$^{2+}$ ions in the system the number of H$^+$ ions liberated for each additional metal ion decreased.