

# The Products of Urea Anodic Oxidation.

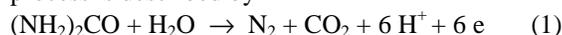
## Effect of the Temperature and Electrolyte Anion Composition.

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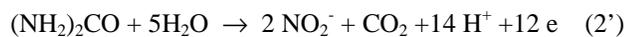
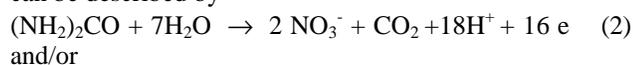
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In spite of considerable practical importance of the process of urea anodic oxidation (*e.g.* in the devices “artificial kidney”) its true mechanism is unclear up to now. Even the composition of products of this process is debatable. Some authors [1-3] ascertained that the main products are nitrogen and carbon dioxide, *i.e.* the anodic process is described by



Meanwhile, in principle the products of urea oxidation at rather high anodic potentials can contain compounds with nitrogen of higher valency. Indeed, nitrogen oxides were observed [4]. In 1994 we also found nitrate (and/or nitrite) as the main products of urea electrooxidation in neutral phosphate solution [5]. Therefore, an alternative route of urea anodic oxidation can be described by



In the present work we studied urea electrooxidation in neutral chloride, fluoride, bromide and sulphate solutions at smooth Pt electrode. Current efficiencies ( $\eta$ ) of parallel processes (1), (2)<sup>\*</sup>, and oxygen evolution



were calculated from data about the rate of total anodic gas evolution, and  $\text{CO}_2$  content in this gas.

It was found that increase of the urea concentration always resulted in increase of current efficiency of the process (1) ( $\eta_1$ ) and decrease of that of the process (3) ( $\eta_3$ ). Concentration dependence of current efficiency of the process (2) ( $\eta_2$ ) as a rule has a maximum. Fig. 1 shows the example of such dependencies for urea solutions in 0.15 M NaF.

An  $\eta_1$  for the electrolysis of chloride solutions of urea was found to be higher than that for fluoride and sulphate solutions. This fact can be explained by a possibility of indirect urea oxidation with hypochlorite. The latter (or hypochloric acid) is the product of chloride oxidation in the cell with undivided electrode compartments.

The most wonderful result is temperature dependencies of  $\eta_1$  and  $\eta_2$ . Such dependencies were obtained in rather concentrated urea solutions, where  $\eta_3$  was negligibly low. The temperature dependencies of  $\eta_1$  and  $\eta_2$  for 1 M NaF is demonstrated in the Fig. 2. The presence of extrema in these plots can be related to complex multistage route of anodic urea oxidation. The temperature effect on  $\eta_1$  and  $\eta_2$  in chloride solutions is much more weak

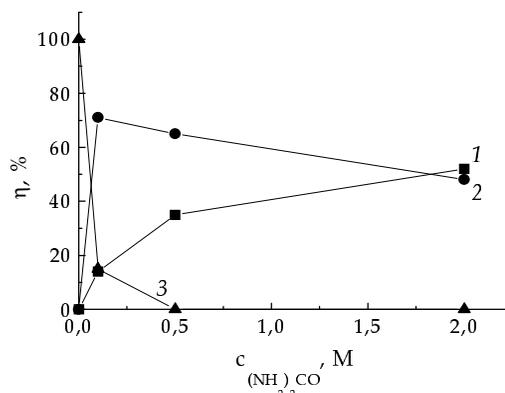


Fig. 1. Current efficiencies of the processes (1), (2), and (3) vs urea concentration in 0.15 M NaF

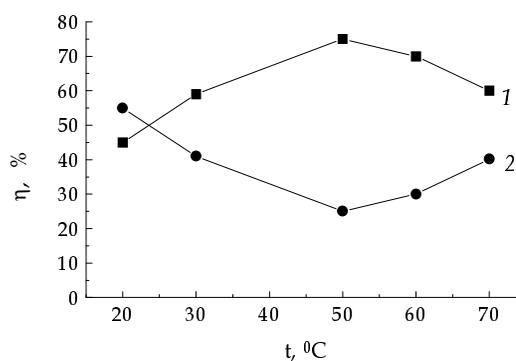


Fig. 2. Temperature dependences of  $\eta_1$  (1) and  $\eta_2$  (2) for 1 M urea + 1 M NaF.

### References

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<sup>\*</sup>) The current efficiency of the process (2') was found to be negligibly low.