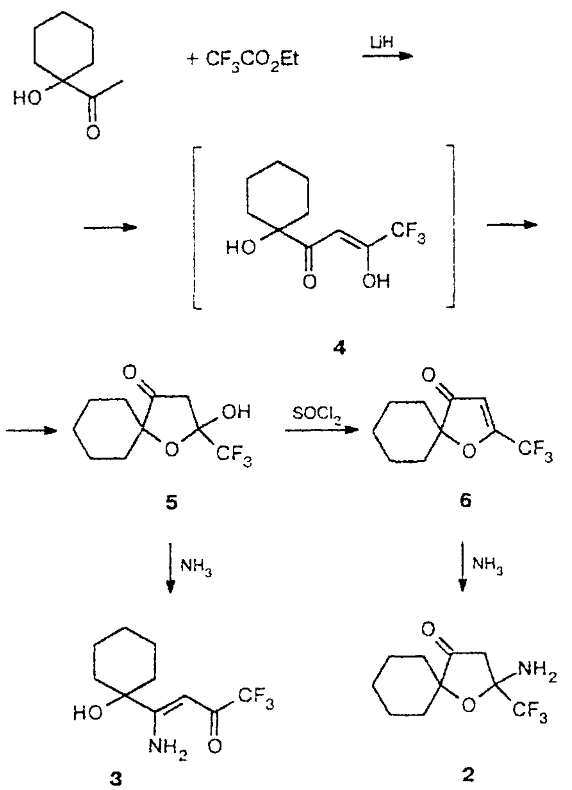
Scheme 1



Compounds 2 and 3 were described previously.[1]

5-Hydroxy-2,2-pentamethylene-5-trifluoromethyltetrahydrofuran-3-one (5). Yield 48%, m.p. 53—54 °C (from hexane). Found (%): C, 50.37; H, 5.35. $C_{10}H_{13}F_3O_3$. Calculated (%): C, 50.42; H, 5.50. IR (Vaseline oil), ν/cm^{-1}: 3380 (OH); 1750 (C=O). ^{1}H NMR ($CDCl_3$), δ: 1.64 (m, 10 H, $(CH_2)_5$); 2.77, 2.97 (dd, 2 H, H_A, H_B, J = 18.7 Hz); 4.22 (s, 1 H, OH).

2,2-Pentamethylene-5-trifluoromethyldihydrofuran-3-one (6). Yield 77%, b.p. 49—51 °C (4 Torr), n_D^{20} 1.4329. Found (%): C, 54.23; H, 5.27. $C_{10}H_{11}F_3O_2$. Calculated (%): C, 54.55; H, 5.04. IR (thin layer), ν/cm^{-1}: 1725 (C=O); 1635 (C=C). ^{1}H NMR ($CDCl_3$), δ: 1.68 (m, 10 H, $(CH_2)_5$); 5.96 (s, 1 H, =C—H).

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Sonolysis of HCl in aqueous solutions: the effect of enrichment of the gaseous phase with a volatile component in sonochemical processes

M. V. Nikonov, Ya. Fujii, and V. P. Shilov*

Institute of Physical Chemistry, Russian Academy of Sciences,
31 Leninsky prosp., 117915 Moscow, Russian Federation.
Fax: 007 (095) 952 0065

In this work, the sonochemical decomposition of HCl in aqueous solutions has been studied. The experiments were carried out over a wide range of HCl concentrations (to 12 mol L^{-1}) with various intensities of ultrasonic vibrations at a frequency of 22 kHz under an argon atmosphere at constant temperature (20 °C).

We have established that the formation and accumulation of molecular chlorine in the solution and in the gaseous phase are major results of sonolysis even in diluted HCl solutions, in which the partial pressure of water is 4—5 orders of magnitude higher than the partial pressure of HCl. Hydrogen is another product of sonolysis

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of the system given; however, we have not performed quantitative measurements of the rate of its formation. At the same time, we failed to detect hydrogen peroxide, the main product of water sonolysis,[1,2] because the dissolved chlorine is consumed in the reaction with H_2O_2:

$$H_2O_2 + Cl_2 \rightarrow 2\ HCl + O_2, \qquad (1)$$

$k = 2.8 \cdot 10^3$ L mol^{-1} s^{-1}.[3]

Therefore, accumulation of Cl_2 in solution is only possible when its yield is higher than that of hydrogen peroxide.

The reaction of the $^{\cdot}$OH radical with Cl^- in solution ($k = 10^{10}$ L mol^{-1} s^{-1})[4] could explain these processes. In this case, the rate of the formation of chlorine is determined by the rate of generation of the $^{\cdot}$OH radicals. However, the calculation performed using the published data[2] showed that the direct participation of $^{\cdot}$OH radicals in the oxidation of Cl^- in solution is insignificant, since the maximum possible rates of formation of $^{\cdot}$OH radicals at certain intensities of ultrasound are more than an order of magnitude lower than the experimental values of the rate of chlorine accumulation. Thus, the products of sonolysis are formed in the cavitation bubble as a result of a "direct action" of ultrasound as a plausible consequence of the electric discharge inside the bubble.

Taking into account the close values of the ionization potentials and the activation energies for thermal decomposition[5,6] of water and HCl molecules, the results obtained indicate that HCl and water are present in comparable amounts inside the cavitation bubble. In the case of diluted solutions, the gaseous mixture inside the cavitation bubble can be enriched with HCl molecules in the course of decreasing acoustic pressure, which results in a decrease in the HCl concentration in the near-bubble layer of the solution and, hence, in an increase in the HCl content in the gaseous phase inside the cavitation bubble.

Since a change in the pressure inside the cavitation bubble is associated with a change in the size of the bubble, which depends on the frequency and intensity of acoustic vibrations,[1] one can conclude that the effect of enrichment of the gaseous phase with the volatile component in the cavitation bubble is also a function of the above-mentioned parameters of the ultrasonic field. Preliminary estimates indicate the possibility of substantial enrichment of gaseous mixture containing HCl in the cavitation bubble, which makes it possible to explain the obtained results.

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