THE POSSIBILITY OF ORGANIC MOLECULE FORMATION IN THE VENUS ATMOSPHERE

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Abstract. Based on the detection of ammonia in the Venus atmosphere, and the suggested presence of hydrogen chloride, a structure for the Venus atmosphere was suggested as having 3 cloud layers, consisting of ammonium chloride (30 to 50 km above the ground), a mixture of ammonium bicarbonate and ammonium carbamate (NH₂COONH₄) from 50-60 km, and water ice crystals above this. There is a strong possibility of electrical discharge in the atmosphere as a result of thermal convective turbulence, which in the case of the slightly reducing atmosphere outlined above could lead to organic compound formation.

The hypothesis was tested experimentally by passing a 60 KV spark from platinum electrodes through a gas mixture of composition: \( \text{N}_2(0.2\%), \text{NH}_3 (2\%), \text{Water (5\%), O}_2 (0.6\%), \text{CO}_2 \) (remainder), for 8 hr. The products were analysed by mass spectrometry and amino acid analysis by ion exchange. Methane and formaldehyde were identified by MS, and glycine and alanine by the amino acid analyzer.

The presence of organic compounds in the Venus atmosphere is therefore a strong possibility.

The presence of complicated compounds, analogous to terrestrial ones, the base of which is carbon, is on planets of the solar system of principal importance from the point of view of the prebiological evolution of the matter.

Results of research in this field must be taken into account when methods of detecting extraterrestrial forms of life are elaborated (Hubbard et al., 1971; Otroshchenko, 1973; Glasston, 1968).

In many model experiments (Hubbard et al., 1971; Ponnamperuma et al., 1969; Chada et al., 1971; Sagan et al., 1971) the possibility of organic molecule formation in the atmospheres of Mars and Jupiter has shown.

According to results of astronomic observations the presence of water and complicated polyatomic organic molecules even outside the solar system has been established (Bune, 1971; Rank et al., 1971).

Based on experimental data, namely results of direct measurements of the chemical composition of the Venus atmosphere out by the automatic stations ‘Venera 4-8’ (Vinogradov et al., 1968, 1970a, b; Surkov et al., 1973b), Table I, an attempt was made to study the possibility of organic molecule formation in the atmosphere of this planet.

From the chemical composition of the atmosphere, as well as from a number of indirect reasons concerning the evolution of the whole planet and the interaction of the lithosphere with the atmosphere (Otroshchenko and Muchin, 1971), it may be considered that the Venus atmosphere must have slightly reducing properties. Under such conditions processes of organic compound synthesis may go on (Hubbard and Hardy,
One of the most interesting results obtained with the aid of the space station 'Venera-8' is the presence of ammonia in the atmosphere of the planet (Surkov et al., 1973b). In the atmosphere it may easily associate with water vapours and carbon dioxide forming various ammonia compounds. There are also data (Lewis, 1968) on the presence of HCl and HF vapours in the atmosphere. Therefore some of the ammonia may form compounds of the NH₄Cl type.

**TABLE 1**

<table>
<thead>
<tr>
<th>Component</th>
<th>Content in weight %</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂</td>
<td>97</td>
</tr>
<tr>
<td>N₂</td>
<td>≤ 2</td>
</tr>
<tr>
<td>H₂O</td>
<td>2.5–3ᵃ</td>
</tr>
<tr>
<td>O₂</td>
<td>≤ 0.1</td>
</tr>
<tr>
<td>NH₃</td>
<td>0.01–0.1ᵇ</td>
</tr>
</tbody>
</table>

ᵃ at a pressure of 2–0.6 atm.
ᵇ at a pressure of 2–10 atm.

The recently proposed model of the Venus cloud layer (Surkov et al., 1973a) mainly calculated on the basis of direct experimental data, assumes the existence of three cloud zones passing one into the other.

From the 30 km height over the average level of the planet surface and to 50 km the existence of clouds consisting of ammonium chloride is assumed. Further, up to 60 km height the main component of the clouds must be ammonium compounds NH₄HCO₃ and NH₂COONH₄ and above 60 km -- fine ice crystals.

According to existing ideas (Ginzburg and Feigelson, 1968; Avduevsky et al., 1971; Kertanovich, 1972) on heights corresponding to the cloud layer (50–60 km) intensive convective displacements of atmospheric currents with speeds up to 50 m s⁻¹ must occur. This process can probably lead to the formation of electric discharges in the depth of the cloud layer.

Based on these reasons an installation was created which allowed simulation of the Venus atmosphere in the region of the cloud layer, both in chemical composition and in the temperature and pressure gradient. Through a mixture of gases the analogue of the Venus atmosphere, a spark discharge of about 60000 V voltage was passed. The distance between the electrodes made of platinium was about 15 mm.

The mass-spectrometric analysis of gas mixtures corresponding to the Venus atmosphere at the level of the cloud layer confirms the possibility of the existence at a 50–60 km height of clouds which consist of ammonium compounds.

In the presence of great amounts of carbon dioxide during ammonium bicarbonate