VENUS IS A SCORCHED WORLD

The surface of Venus is charred black. There, wood, paper or cloth do not burn. Yet, they produce smoke and are instantly scorched black.

Such is the strange world of Venus where everything burns up without flame or fire.

This has been confirmed by experiments which simulate the atmospheric conditions on the surface of Venus carried out by the Asahi Shimbun Publishing Co., one of Japan's major newspaper publishers, in cooperation with the National Institute of Metals of the Government's Science and Technology Agency.

When the results of the survey by the Soviet Union's unmanned probe, Venus 4, were announced, many scientists thought that "on the surface of Venus, everything burns furiously." But this speculation has now been repudiated. There is not enough oxygen on Venus, so nothing burns there. However, it is a veritable inferno of intense heat. If a human being without a protective device against heat should land on Venus, he would instantly become a charred corpse.

22 *Atmospheres,* 270°C, *and* 0.4-0.8% *Oxygen*

The atmospheric conditions on the surface of Venus were minutely observed by the Soviet probe on October 18, 1967. The unmanned surveyor was soft-landed with a parachute and conducted a survey of the Venusian atmosphere as it descended. According to the data thus collected, the surface of the planet has a temperature of 270°C, an atmospheric pressure of 15 to 22, and the atmosphere itself consist primarily of carbon dioxide with an oxygen content of only 0.4 to 0.8 per cent and water vapor of 0.1 to 0.7 per cent.

Compared with the earth's atmosphere which contains 21 per cent oxygen, the Venusian atmosphere contains an extremely small amount. In the light of the fact that Venus has twenty-two atmosphere and a temperature of 270°C, the absolute quantity of oxygen in the atmosphere is not at all small. One liter of Venusian atmosphere contains one-seventh — one-third of the oxygen content contained in one liter of the earth's atmosphere.

Because both the atmospheric pressure and the temperature are high, the oxygen in the Venusian atmosphere is expected to be far more active than that in the earth's atmosphere. This is the reason why it is surmised that combustion there would be far more vigorous than on the earth. But, is this actually the case? At a temperature of 270°C, tin melts but lead does not. Under 22 atmospheres, water boils at 216°C. This much is definitely known. But beyond this, the scientists can only guess.

To simulate conditions of another planet on this earth is one area of experimental astronomy and it was thought that such an experiment would be of great help in producing a realistic picture of the other planet.

Simulation of the Atmosphere

For the simulation experiment, an autoclave of the National Institute of Metals was used. An airtight chamber used in chemical and metallurgical experiments, it is filled with gasses or liquids at high temperatures or pressures in order to test their reactions.

The autoclave used in this particular test had an internal volume of 500 cubic centimeters. It had two windows at the bottom, one admitting light and the other for making observations.

The artificial Venusian atmosphere was created by mixing carbon dioxide, oxygen and water proof. Since the Venus 4 probe failed to detect any nitrogen gas in the Venusian atmosphere, this element was ignored.

The following mixture of gases was used in the experiment:

	Venusian Atmosphere	Simulated Atmosphere
Carbon dioxide	90-95%	98.5-99.5%
Oxygen	0.4-0.8%	0.4-0.8%
Water	0.1-0.7%	0.1-0.7%
Nitrogen	not detected	0%
Atmospheric pressure	15-22	15-22
Temperature	270°C	270°C

This mixture of gases was placed in a 30-liter tank and then transmitted to the autoclave through a preheating tank at the rate of 500 to 1,000 cubic centimeters per minute while the pressure in the chamber was kept at 22. The gas mixture was removed from a second exit. With this arrangement, the autoclave was constantly refilled with a fresh mixture of gases.

No Combustion Because of Lack of Oxygen

A variety of specimens were placed in this chamber to observe any changes that they might have undergone while the temperature in the chamber was increased up to 270°C. The test materials were chosen from among common items readily available in order to facilitate our understanding.

Under the pressure of 22 atmospheres and at room temperature, it was learned that small electric bulbs used in flashlights, pingpong balls and quial eggs were able to withstand this pressure. Under the same pressure, however, killifish in water in a beaker died instantly in the autoclave. When the temperature was raised, the water boiled and evaporated and the killifish was scorched.

A match, the head covered with combustible chemicals, ignited spontaneously at around 150°C, but the fire thus started did not burn the wooden stick which, instead, began to scorch at about 170°C and became charred around 200°C.

This carbonized match stick would burn in ordinary air with a red glow at about

350°C. In the artificial Venusian atmosphere, however, it did not burn even when the temperature was raised to 400°C. After the temperature was raised above 300°C, however, the carbonized match either bent or splintered and gradually became thinner.

With what percentage of oxygen in the Venusian atmosphere, then, would the carbonized match stick began to burn?

In an experiment in which the oxygen content in the carbon dioxide was raised gradually from 3 per cent to 5, 10, 20 and 30 per cent, the match stick did not burn at 10 per cent. With an oxygen content greater than 20 per cent, however, it began to burn at 230°C.

That is to say, even when the atmospheric pressure is as high as 22 and the temperature as much as 270°C, a match stick does not burn if the oxygen content is only from 0.4 to 0.8 per cent.

The same may be said of sulphur which readily burns in the air.

Sulphur burns spontaneously in the earth's atmosphere at 230°C. In the man-made Venusian atmosphere, however, it merely melts and turns into an amber-colored fluid.

It furiously emits smoke but does not create the whitish blue flame which is characteristic of the combustion of sulphur in the air. Even when the oxygen content was increased to 10 per cent in the autoclave, sulphur did not burn, but it did when the oxygen content was increased to 20 per cent.

In the Venusian atmosphere of 270°C, even absorbent cotton, gauze and handkerchiefs simply became carbonized. But these carbonized materials proved surprisingly sturdy. They could be, with some care, folded or unfolded, without crumbling to pieces or turning into ashes.

Does all this mean that nothing ever burns in Venus' atmosphere?

The head of a match burned, to be sure. But this was because the tip was covered with chemicals containing potassium chlorate, an oxidizer. It would burn even in an atmosphere containing carbon dioxide alone or even in vacuum because of the effect of the oxidizer it contains. This would be true with celluloid which consists primarily of nitrocellulose, such as a pingpong ball.

There are some things, however, which do burn in the Venusian atmosphere because of the slight amount of oxygen contained in it.

The fine particles of magnesium is one example. Magnesium powder which used to be used for flash-light in photography, does not burn spontaneously even when heated up to 360°C in the air. But if mixed with an oxidizing agent, such as used in a match, it can be made to burn instantly with a flash when the agent is ignited at temperatures around 150°C. When the same substances are placed in a container with carbon dioxide with 22 atmospheres and heated, the oxidizing agent of the match alone burns at temperatures around 150°C while the magnesium powder does not. When the same experiment is conducted in the simulated Venusian atmosphere, however, magnesium, too, is ignited and burns instantly.

In the Venusian atmosphere which contains a very small amount of oxygen, only a small of substances including magnesium burn. Even benzene does not burn there.

When a cigarette is lighted in the earth's atmosphere and placed in a test tube, which in turn is placed in the Venusian atmosphere, the cigarette is instantly extinguished, producing a large quantity of smoke and tar while the cigarette itself becomes charred. Water under 15 atmospheres boils at 197°C and under 22 atmospheres at 216°C. In the Venusian atmosphere, heavy oil evaporates instantly leaving only a dark brown residue.

As said before, the oxygen content in one liter of the atmosphere on the surface of Venus is from one-seventh to one-third that in the same amount of the earth's atmosphere. Yet, despite this relative abundance of oxygen in the earth's atmosphere, things do not burn as readily as they might be expected.

This, reasons Dr. Tsuyoshi Hikita of Tokyo University, is because "in the earth's atmosphere, carbon dioxide, too, is equally compressed and this, among other things, impedes combustion because it deprives the heat necessary for burning."

"If we took a substance whose temperature is several thousand degrees," says Professor Hikita, however, "to the surface of Venus, the high temperature itself would dissociate oxygen from carbon dioxide, and then that oxygen would cause the substance to burn."

Apart from the combustion experiments, a test was also conducted for checking changes that occur in metals in the Venusian atmosphere. This was done with stainless steel, magnesium, pure iron and aluminum, whose specimen pieces were left alone for one week in the simulated atmosphere. The result showed that the iron became covered with a black coat of rust which in turn prevented the iron from further rusting. Stainless steel, magnesium, and aluminum, also, rusted.

Specialists have said that "metal pieces rust rapidly in the Venusian atmosphere, which has less oxygen than the earth's because of the high temperature." Another factor in causing the metals to rust may be that oxidization takes place because of the oxygen created by the dissociation of carbon dioxide, besides the 0.4 to 0.8 per cent oxygen in the atmosphere.

Further Approach to Real Atmosphere

The data obtained through the above experiments seem to repudiate almost all the hypotheses hitherto advanced by many scientists concerning Venus.

The theory advanced by Svante Arrhenius (1859-1927), the Nobel Prize-winning Swedish scientist, and Dr. Graviil A. Thikhoff, the late Soviet space biologist that "Venus is covered with vegetation" is now totally inconceivable. The theory of Dr. Fred L. Whipple (1906-), director of the Smithsonian Astrophysical Observatory, and Dr. Fred Hoyle (1915-), a British astronomer, who both advanced the theory that there would be "sea of petroleum" on the surface of Venus, too, would be impossible. For water and petroleum would evaporate and any plant would instantly turn into charcoal.

The only remaining hypotheses yet to be repudiated is that the surface of Venus is an intensely hot, barren desert. Yet, there is no way of knowing as yet whether the entire surface is desert or if there are high mountain ranges as on the earth and if plant life and microbes might be found at places on the high mountains where the temperature is low. On these questions, there is now only speculation.

The experiments jointly conducted by the Asahi Shimbun Publishing Company and the National Institue of Metals have made a major contribution in changing much of the speculation about Venus into reality. In order to learn more of the realistic facts of life on Venus, however, it will be necessary to send more sophisticated surveying instruments to its surface.

It is no mere dream to expect that someday such nations as the United States and the Soviet Union, countries which are capable of launching rockets, will launch Venus probes one after another and establish a cooperative relationship in space science, and conduct experiments by reproducing on the earth conditions similar to those on Venus with the further data obtained from such Venusian probes. These recent experiments in Japan will undoubtedly contribute to stimulating further efforts to reveal the secrets of Venus and other planets of our solar system in the interests of greater international cooperation and understanding.
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