ductivity increases only slowly with a further temperature increase. For this reason the electrical gradient must increase if the current is to grow. It is interesting to observe that all current-voltage characteristics of the water-stabilized arc[5] have a minimum of the electrical gradient in the neighborhood of 15,000°K.

Suggestions for Further Work

The ablation-type plasma generator has the potential for reaching temperatures of the order of 50,000°K,[5] and it is believed that high pressures can be attained simultaneously. Such flows may, despite a limited test time of the order of 1 sec, be of considerable value for planetary re-entry studies. One obvious application is the measurement of ablation rates in a somewhat modified pipe test,[2] another might be the determination of the influence of the extreme radiation intensities on ablation rate and boundary-layer characteristics.

The ablation-type plasma generator might also be used as a light source for spectral analysis. An attractive feature for this application seems to be the possibility of regulating the jet temperature by changing the diameter of the duct. At relatively moderate currents but high current densities, high temperatures can be reached for the excitation of higher energy levels.

Plasma composition can be changed via wall materials; metals can be used if the metal wall is interrupted sufficiently often along the arc path (similar to Maecker's cascade arc), and even frozen liquids or gases (e.g., dry ice) can be used.

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Thermal Vaporization for Recovery of Water from Urine

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The present demands in the space program have brought into sharp focus the necessity of recovering from human urine water that is fit for consumption by personnel occupying a closed space vehicle. The ability to achieve this objective alleviates to some degree the large power requirements presently imposed on missiles intended for lunar and planetary travel. The possibility of recovering water from human urine has been frequently suggested as a scheme that would enable the sustenance of astronauts with a minimum of initial water supply.[1,2] For the successful operation of such a program, schemes capable of recovering 85–95% of the water present in urine are needed.

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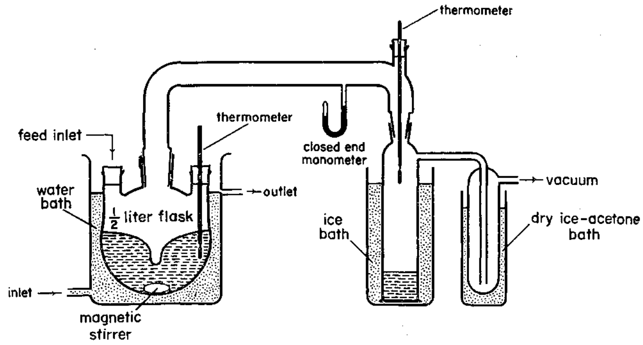

Fig. 1 Schematic diagram of experimental unit.

Several methods are currently being investigated to reach this objective[3]: 1) atmospheric distillation after pretreatment with sulfuric acid; 2) simple vacuum distillation after sulfuric acid pretreatment, the vapors being passed through activated charcoal before condensation; 3) vacuum distillation from sponges saturated with urine, the vapors being passed through a filter screen and condensed on cooled sterilized sponges; 4) catalysis of vapors from vacuum distillation, which are then passed, together with air, over a platinum gauze, heated, and then condensed; 5) vapor compression in which the vapors are adiabatically compressed and are used to supply heat to the boiler; and 6) air evaporation of water vapor from soaked sponges followed by condensation on a cold panel. Each of these methods has certain disadvantages with respect to optimum recovery of water for a space-vehicle system. Unless special mechanical features are incorporated in a distillation process conducted in a zero gravity field, the inability of the vapor and liquid to separate out in the boiling step limits the possible use of direct boiling as a means of water recovery. However, the continuous vaporization of water without boiling and the direct condensation of the vapors produced offers a means of eliminating the problems that arise from direct boiling. Such a system is described herein.

Development of Recovery Method

In this investigation the central neck of a three-necked flask (½ liter) was connected through a glass tube (i.d. = 1

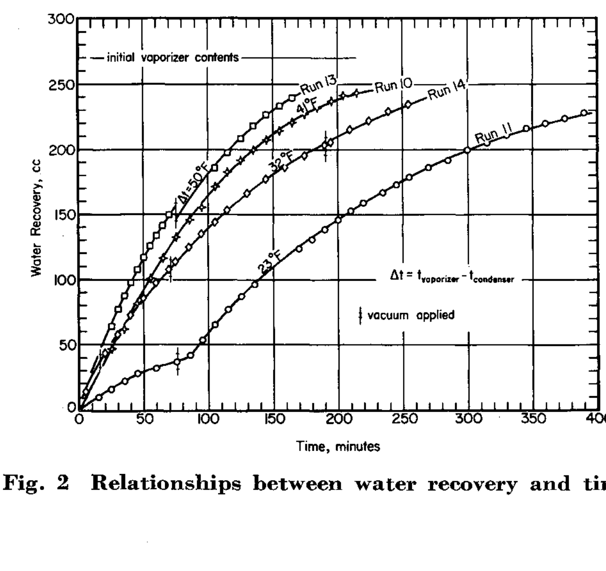

Fig. 2 Relationships between water recovery and time.

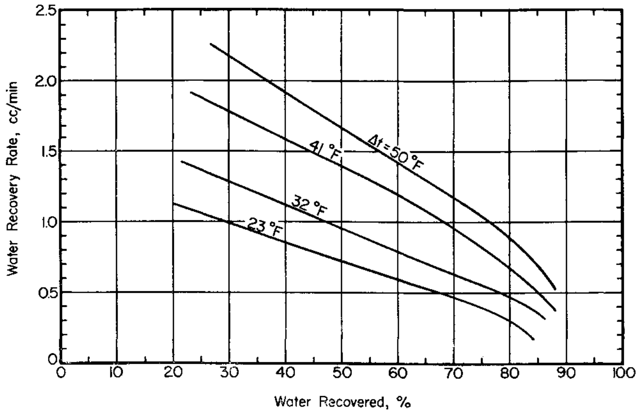

Fig. 3 Relationships between water recovery rate and percent water recovered for various temperature differences.

in., length = 18 in.) to an ice-cooled (32°F) receiver (Fig. 1). Urine was charged into the vaporizer through the feed inlet. The evacuating facilities consisted of a mechanical forepump and a dry ice-acetone vapor trap. The system was evacuated to remove the noncondensable gases. A magnetic stirrer was used in the liquid. The temperature of the vaporizer bath was adjusted to maintain the vaporizer contents at a constant temperature. This arrangement permitted water vapor to escape continuously, without boiling, from the surface of the liquid in the vaporizer to the receiver, where it was liquefied. The temperature difference (Δt) between the vaporizer and condenser dictated the initial rate of water transport to the receiver. However, when these two temperature levels were held constant, the rate of water vapor transport to the condenser gradually decreased while the urine constituents were being concentrated in the vaporizer.

A batch run was conducted at each of four Δt's with 270 cm^3 each of human urine. During the initial evacuating procedure and for the entire duration of the run, no more than 2 cm^3 of water escaped into the dry ice-acetone trap. Once proper vacuum condition was established, the evacuating facility was disconnected from the system. At times, vacuum was applied very briefly to insure the removal of any noncondensables that may have found their way into the system through leaks or through the decomposition of the urine constituents. Considerable difficulty was encountered with runs in which the vaporizer temperature was higher than ambient temperature, because the vapors tended to condense immediately after leaving the liquid surface within the vaporizer and thus decreased the over-all efficiency. This difficulty was eliminated by operating the vaporizer at temperatures somewhat lower than the temperature of the surroundings. The data for the four runs are presented in Fig. 2. Also included in this figure are the recovery relationships of the other three runs. With the exception of run 11, which exhibits an initial unsteady state condition, the recovery vs time relationships are essentially continuous, despite the fact that vacuum was applied in runs 11, 13, and 14 at times indicated by the vertical bars. For run 13, considerable adjustment was required after 75 min of operation to re-establish steady-state conditions. For run 10, no vacuum adjustment was applied over its entire duration of 215 min. With the exclusion of the initial unsteady-state period, the slopes of the curves give the instantaneous rates of water recovery, which are related to percent water recovery in Fig. 3. Because the data are specific to the experimental unit used in this study, no attempt has been made to obtain quantitative projections for the establishment of basic heat-transfer factors and design procedures.

The recovered water was clear but possessed an odor that was still characteristic of urine. A small quantity of carbon black was capable of eliminating the odor. The pH of the untreated water recovered varied with each run from 7.95 to 9.65. After treatment with activated charcoal, the pH approached 9.65 in all cases. Better removal of contaminants probably would follow if an ion-exchange resin were employed in conjunction with the activated charcoal. This mode of treatment was not attempted, but it should produce better potable water.[4]

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Signal Loss vs Antenna Pointing Error

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The design curves presented here relate coverage, beamwidth, antenna pointing accuracy, and signal loss. The geometry from which the analysis proceeds is shown in Fig. 1 for cases where the antenna beamwidth is greater than and equal to the desired coverage. Here, C is the required coverage, measured in degrees. Typical cases would be the angle subtended by the earth from a synchronous satellite (16.4° to 10° elevation ground antennas) or from the lunar surface

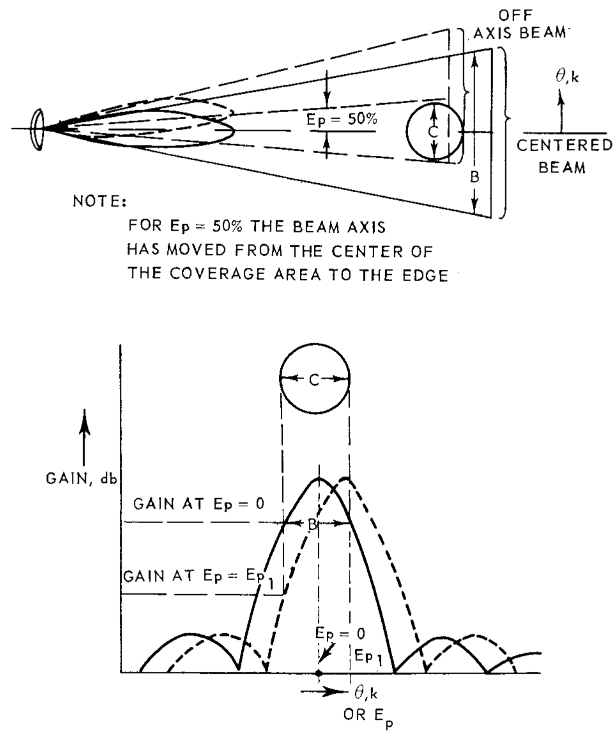

Fig. 1 Geometry for B ≥ C.

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