like profile of Eq. (11) than a parabola. It is for this reason that the present analysis would seem to be appropriate for those cases where magnetic effects are important over a significant portion of the channel length.

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Equilibrium Electron Density on Mars

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In order to investigate the possibility of communication blackout during entry into the Martian atmosphere, it is necessary to make estimates of the expected electron concentration. The following contains thermochemical equilibrium values of electron concentration corresponding to five models[1, 2] of the Martian atmosphere as a function of temperature and density. The results show that at a given temperature and density the electron concentration on Mars will be less than that on Earth, and that this is most evident at low temperatures and high densities.

The five atmospheric models considered are shown in Table 1. Figures 1–5 show equilibrium electron concentration for the various atmospheric models as a function of temperature and density. Figures 6 and 7 show electron concentration for all 5 models and for the Earth's atmosphere[3] as a function of density at 2000° and 5000°K, respectively.

In all of the atmospheres in which both nitrogen and oxygen are assumed present, the principle source of electrons is due to ionized NO at 2000° and 3500°K and to both NO and C at 5000°K. For the atmospheric model in which nitrogen is assumed absent, the electron density is essentially due to ionized O_2 at the lower temperatures and to O_2, O, C, and CO at 5000°.

Table 1 Mars atmospheric models

Atmospheric model	Percent composition CO_2	A	N_2
Kaplan[1]			
1	65	35	0
2	43	32	25
3	11	13	76
Spiegel[2]			
4	7.2	6.0	86.8
5	0.7	0.6	98.7

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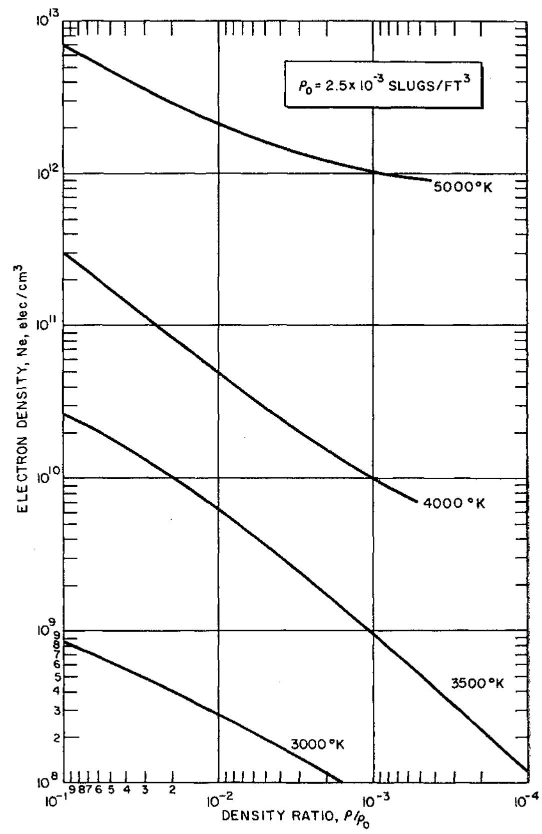

Fig. 1 Equilibrium electron density, 65% CO_2, 35% A.

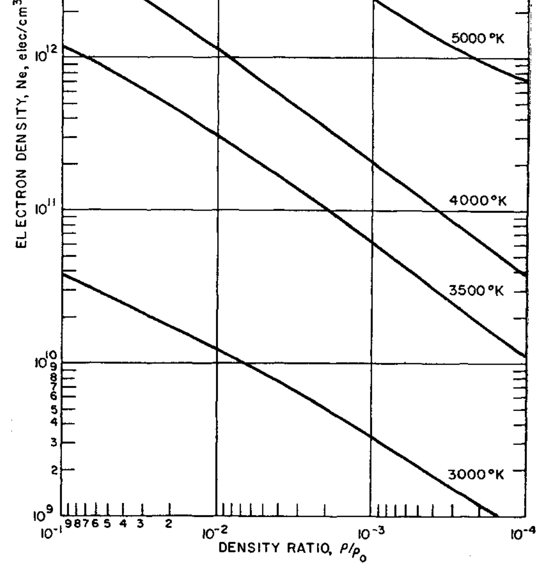

Fig. 2 Equilibrium electron density, 43% CO_2, 32% A, 25% N_2.

It is interesting to compare electron concentration obtained here with results given previously by Davies.[4] Davies considered an atmospheric model composed of 98% N_2, 0.66% CO_2, and 1.2% A,[5] and made the assumption that, for determining electron concentration, the atmosphere could be replaced by a model that is 100% nitrogen. Equilibrium electron concentrations for nitrogen[6] along with calculated values for an atmosphere (98.7% N_2, 0.7% CO_2, 0.6% A) similar to

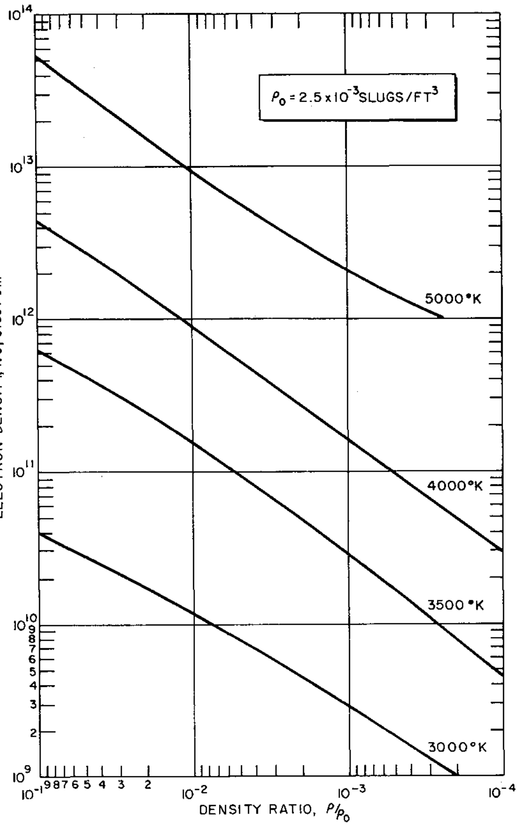

Fig. 3 Equilibrium electron density, 11% CO_2, 13% A, 76% N_2.

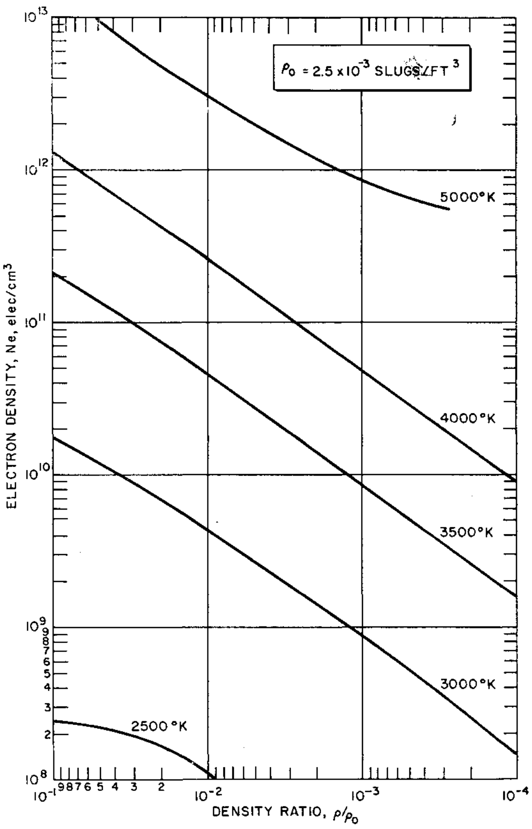

Fig. 5 Equilibrium electron density, 98.7% N_2, 0.7% CO_2, 0.6% A.

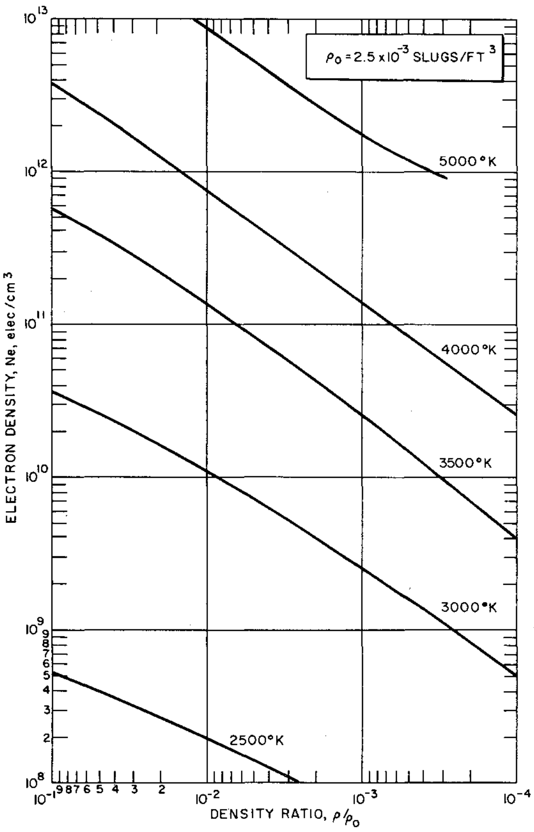

Fig. 4 Equilibrium electron density, 7.2% CO_2, 6.0% A, 86.8% N_2.

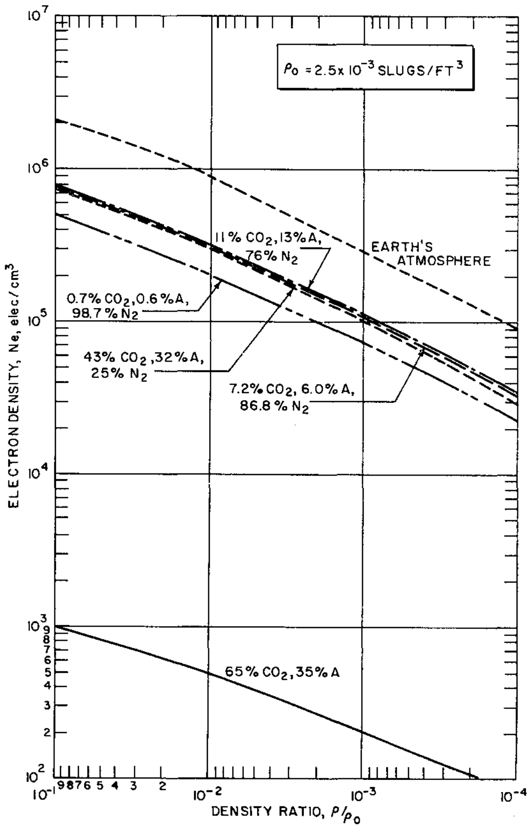

Fig. 6 Equilibrium electron density on Mars and Earth, temperature = 2000°K.

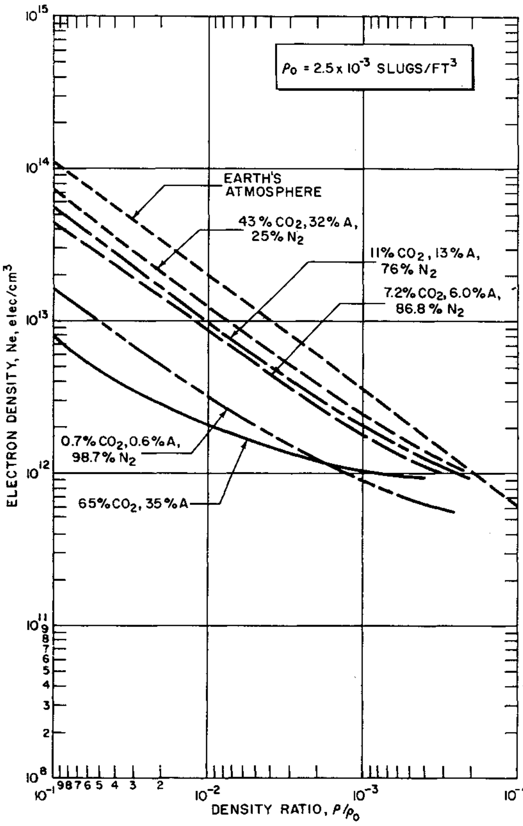

Fig. 7 Equilibrium electron density on Mars and Earth, temperature = 5000°K.

Table 2 Equilibrium electron density for 100% N_2 and 98.7% N_2, 0.6% CO_2, 0.7% A atmospheres

Temperature, °K	Density, slugs/ft³	N_e, elec/cm³ 100% N_2	N_e, elec/cm³ 98.7% N_2, 0.6% CO_2, 0.7% A
2000	2.3×10^{-6}	1.17×10^{-1}	7.1×10^4
2000	2.3×10^{-4}	1.17	4.8×10^5
3500	2.3×10^{-6}	4.82×10^7	8.1×10^9
3500	2.3×10^{-4}	4.72×10^8	2.1×10^{11}
5000	2.3×10^{-6}	2.37×10^{11}	8.3×10^{11}
5000	2.3×10^{-4}	1.64×10^{12}	1.55×10^{13}

that assumed by Davies are shown in Table 2. As can be seen, the electron concentrations predicted by a 100% nitrogen atmosphere are too small by several orders of magnitude at low temperatures. The preceding discrepancy brings out an important point in determining the properties of any reentry plasma, namely, that relatively small amounts of an easily ionizable species (e.g., NO) may be the dominant source of electrons.

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Measurement of Uniform Flow Duration in a Chambered, Buffered Shock Tube

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THIS report shows results obtained in the investigation of uniform flow duration in a chambered, buffered tube. This testing has been done at lower density and higher Mach number than has been reported previously.

The investigation is being conducted in the Martin-Denver shock tube,[1] which uses a buffer section, cold driver gas, and an area contraction to give high shock Mach numbers. The tube has a 3-ft-long driver with a 10⅛-in. i.d., a 10-ft-long buffer with the same i.d. as the driver, a 16½-ft-long test section with a 4-in. i.d., and a dump tank 15 ft long with a 19¼-in. i.d. Air at pressures of 0.015 to 1.0 mm Hg at shock Mach numbers 12 and 15 was the test gas. Argon was used as the buffer gas, and hydrogen as the driver.

Uniform flow duration was measured by detecting the passage of the shock front and contact surface using a monochromator and an attached 1P21 photomultiplier mounted at a quartz window in the test section. Photomultiplier output was monitored by a Tektronix 545A oscilloscope and an attached Polaroid camera. The monochromator was aligned so the optical axis was perpendicular to the axis of the test section, and light was collimated with a slit system. This arrangement eliminated scattered light and insured a narrow, sharp view of the shock front. The monochromator was set at 4500 Å with a 60 Å bandpass.

Figure 1 shows a typical oscilloscope intensity/time trace from this test configuration. The first peak is the nonequilibrium overshoot caused by the shock front passing through the air. The second rise has been attributed to the contact surface, containing highly radiative impurities from the tube wall, buffer-test section diaphragm, etc.

To verify the assumption that the second rise represents passage of the contact surface, chromium carbonyl [$Cr(CO)_6$] vapor was introduced into the buffer section before admitting the argon. This vapor readily decomposes into chromium and carbon monoxide, and, when shock heated, the neutral chromium atom emits a number of intense spectral lines in the 4500 Å region.[2] This radiation is readily distinguishable and thus validates the position of the contact surface. This, in turn, would define the maximum uniform flow time.

In Fig. 2, the chromium radiation appears as a spike between the two original rises (the gain setting of this trace is only ⅖ that of Fig. 1). Its shape is similar to the nonequilibrium radiation overshoot produced by initial shock passage in

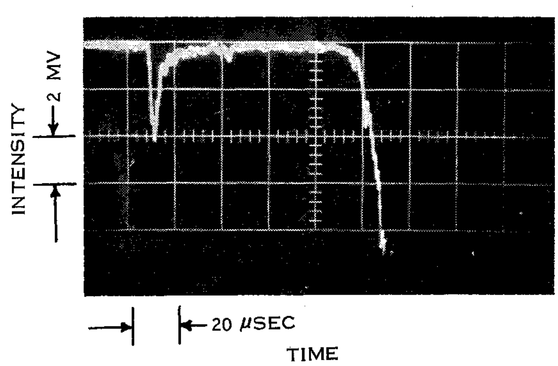

Fig. 1 Typical radiation profile; initial test pressure 0.2 mm Hg, M_s = 13.2.

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