MEASUREMENTS OF THE DIELECTRIC CONSTANTS FOR PLANETARY VOLATILES.

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The model of Titan at present has the surface temperature, pressure, and composition such that there is a possibility of a binary ethane–methane ocean (ref. 1). Proposed experiments for future Titan flybys include microwave mappers. Very little has been measured of the dielectric properties of the small hydrocarbons at these radar frequencies. Nor, is there much known about the loss tangent (imaginary component of the dielectric constant) which relates to the penetration distance of the microwaves into the liquids.

We have set up a laboratory experiment, utilizing a slotted line, to measure the dielectric properties of the hydrocarbons, methane to heptane, from room temperature to −180 C. Temperatures below 25 C are maintained using various ice baths. A large dry box is used to eliminate the condensation of water vapor at these lower temperatures.

The literature reveals very little data on these systems. A substantial study was made into the real part of the dielectric constants of these hydrocarbons using a 1 kHz frequency (refs. 2–6). Besides being so far away from 1.2 GHz, the proposed frequency of the mappers, the measurements were made at both reduced and elevated pressures. The change in pressure has a marked effect on the magnitude of the dielectric constants and therefore these earlier results must be evaluated.

Figure 1 is a graphical summary of our results thus far. We have thus determined that our experimental measurements of the real part of the dielectric constants are accurate to ±0.006 and the imaginary part of the dielectric constants, the loss tangent, of the liquids studied is ≤.001. In order to verify this low of a loss tangent we studied the real part of the dielectric constant of hexane at 25 C as a function of the frequency range of the slotted line system that we have. Figure 2 show these results. The dielectric constant of hexane at room temperature, between 500 MHz and 3 GHz, is constant within our experimental error. The real parts of the dielectric constants measured here are consistent with the those that can be compared to the previous literature after pressure extrapolations.

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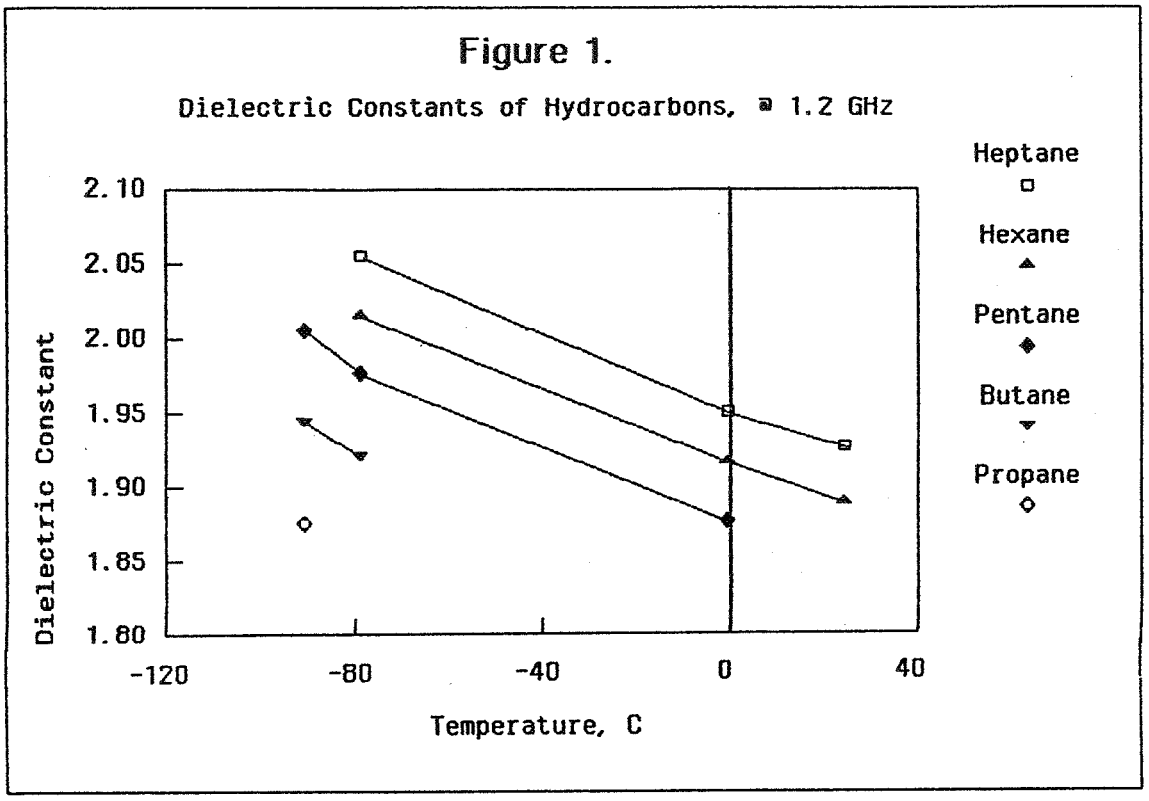
Figure 1.
Dielectric Constants of Hydrocarbons, @ 1.2 GHz
Heptane
Hexane
Pentane
Butane
Propane
2.10
2.05
2.00
1.95
1.90
1.85
1.80
Dielectric Constant
-120
-80
-40
0
40
Temperature, C

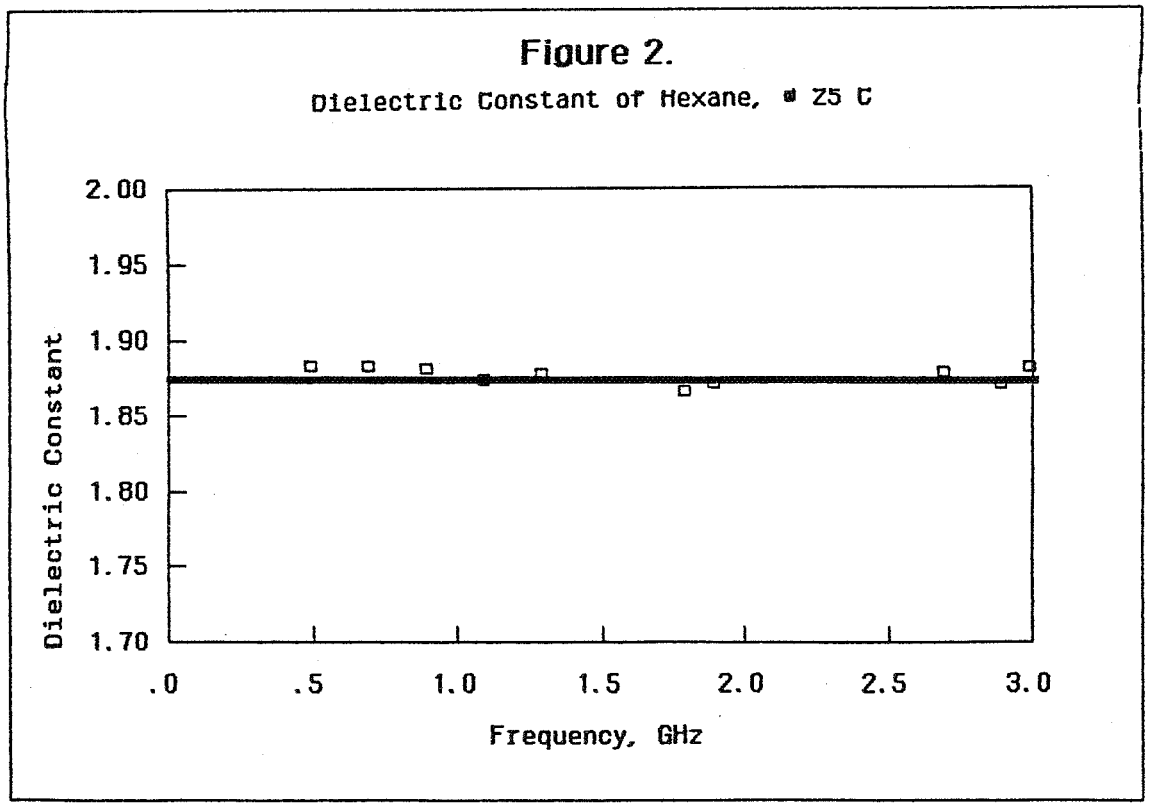
Figure 2.
Dielectric Constant of Hexane, @ 25 C
2.00
1.95
1.90
1.85
1.80
1.75
1.70
Dielectric Constant
.0
.5
1.0
1.5
2.0
2.5
3.0
Frequency, GHz