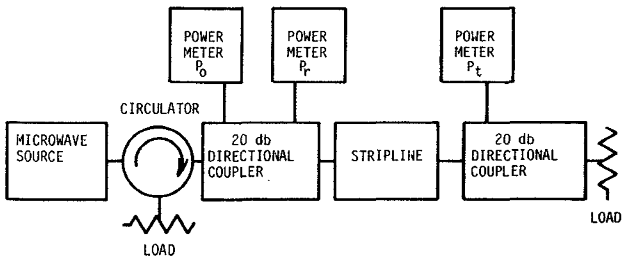

Fig. 2. Equipment arrangement used for measuring power absorbed by a sample in the stripline.

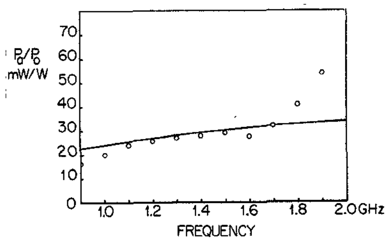

Fig. 3. The measured (circles) and calculated (solid curve) values of power absorbed for a seawater sample with the dimensions: $L = 1.7$ cm, $b = 2.65$ cm, $w/b = 1.22$, $t/b = 0.03$, $s/b = 0.28$, $w_s/b = 0.4$, $h/b = 0.29$.

in the sample (P_a) as

$$P_0 = P_r + P_t + P_{as} + P_a. \tag{20}$$

With the empty Plexiglas container in the stripline, P_0 is set to the value in (20) and P_{as} should remain about the same, so that

$$P_0 = P_r' + P_t' + P_{as} + 0. \tag{21}$$

Subtracting (21) from (20) yields the power absorbed in the seawater sample as

$$P_a = (P_r' - P_r) + (P_t' - P_t). \tag{22}$$

V. Discussion of Results and Conclusions

For the seawater sample of length $L = 1.7$ cm, the measured and calculated results are shown together in Fig. 3. The total power absorbed by the rectangular sample in the stripline was calculated using (11), and close agreement with measurement is noted over most of the 1–2-GHz range. The difference below 1 GHz could be due to measurement errors, since at these lower frequencies the absorbed power is such a small fraction of the incident power.

The equivalent dielectric constant of the stripline cross section is increased by the presence of the seawater sample. Calculations based upon the dimensions given in Fig. 3 and the permittivity of seawater ($\varepsilon = 63\varepsilon_0$) show that higher order modes can exist within the section of stripline occupied by the seawater sample at frequencies above about 1.8 GHz. These higher order modes probably account for the measurement errors above 1.8 GHz in Fig. 3.

The directional couplers used in the testing arrangement were not 20 dB at all frequencies, but the measured values shown in Fig. 3 were corrected for coupling errors. Also, the walls of the Plexiglas container were thin enough (1 mm) to have a negligible effect upon the experimental results [12].

As a further indication that (11) correctly accounts for the absorption cross section of the rectangular sample, if Δw_s is neglected in (11), P_a/P_0 decreases to 0.73 times the values represented by the solid curve in Fig. 3. Hence Δw_s, as expressed by (4), cannot be neglected in accurate calculations of the power absorbed.

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Additional Information on the Noise-Temperature Behavior of F8T5 Lamps

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***Abstract*—Noise temperature versus bulb temperature is given for an F8T5 lamp operating at 160-mA dc at bulb temperatures from 0 to 70°C. The new values supplement and correct previously published values. The behavior of the noise temperature is explained in terms of an Ar discharge at low bulb temperatures and the normal Hg–Ar discharge at high temperatures.**

Introduction

A few years ago, a study was made of the noise temperature as a function of bulb temperature for normal and for cataphoretically pumped fluorescent lamps [1]. A second study was made to determine the lower limit on the noise temperature as the mercury-vapor pressure was lowered by "freezing out" the mercury [2]. Finally, the results were compared with those obtained from pure-argon discharges at various pressures [3].

The purposes of this letter are: 1) to show the noise-temperature behavior of a normal F8T5 lamp over the entire range from 0 to 70°C, thus filling in the gaps between the results given in [1] and [2]; 2) to correct some of the values given in [1]; and 3) to indicate the existence of a sharp boundary between the Ar and the Hg–Ar discharge as the bulb temperature is varied.

Bulb-Temperature Control

In the original study, the bulb temperature was controlled by the lamp dissipation and the ambient temperature; the bulb temperature was measured by means of a thermocouple. Recently,

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these techniques for bulb-temperature control and measurement were found to be responsible for the scatter shown in the lower curve of [1, fig. 3].

Therefore, a water-cooling system was devised which consisted of a small water jacket surrounding the lamp for about a 5-cm length in the vicinity of each cathode. The water was circulated through the jackets and an 8-l reservoir at a rate of 600 ml/min. The remainder of the bulb was kept warmer than the water-cooled portions by thermally insulating it; thus, the water temperature controlled the mercury vapor pressure within the lamp.[1]

Measuring Techniques

The noise-temperature measuring technique was basically the same as in the original study. The lamp was inserted into three gold-plated copper tubes [1, fig. 2]; the outer two tubes were grounded and the noise was extracted from the center one via a double-stub tuner. The tuner was adjusted to give 50 Ω for each value of discharge current or bulb temperature by connecting it to an impedance bridge. After the impedance was adjusted, the noise output was measured by comparison with a corrected 5722 temperature-limited diode noise source. All measurements were made at 147 MHz.[2]

Results

Fig. 1 shows the data obtained from one F8T5 lamp operated at 160-mA dc as the bulb temperature was varied from 70 to 0°C. One hundred and eight readings were taken in two separate runs several days apart. The standard deviation of the data is 0.02 dB (0.5 percent).

When compared with the data originally given for normal lamps [1, fig. 3], [2, fig. 1], the end points given here agree with the original values, but those for intermediate temperatures disagree, with the present values being higher. The slope for the portion from 40 to 70°C is -0.069 dB/°C instead of -0.058 dB/°C as originally reported.

In the original study, F8T5 and F13T5 lamps appeared to give the same noise temperature in spite of the different argon fill pressures so long as the lamps were operating with the normal amount of mercury. The present study shows a significant difference between lamp types which was previously hidden in the scatter. Curves similar to that given in Fig. 1 were obtained from two other lamps. One of the curves is about 0.1 dB higher at all temperatures; the other is about 0.05 dB higher. The variation from lamp to lamp agrees with known variations in the argon filling pressure.

During the tuning procedure with bulb temperatures between 28 and 70°C, the impedance bridge-detector output was about the same as with medium-pressure (20–50-mmHg) pure-argon discharges; i.e., very small impedance fluctuations existed. Below about 26°C, the detector "nulls" were similar to those from low-pressure (1–4-mmHg) pure-argon plasmas; i.e., there were large, random-impedance fluctuations having an average value equivalent to about a 4-Ω static-impedance error. The transition occurred over a small range in bulb temperature, typically from 26 to 28°C for the full change from a low- to a medium-pressure characteristic. This transition is slightly below the peak in the curve in Fig. 1, and optimum efficiency as a lamp occurs just beyond the peak.

[1] Although the coldest spot on the bulb is supposed to control the mercury-vapor pressure, cataphoretic pumping, or some other effect, makes it necessary to control the bulb temperature at both ends of the lamp. Also, the noise temperature was somewhat erratic and low for up to 2 h after starting; this is believed to be caused by the liberation of adsorbed mercury from the phosphor in the hotter regions of the lamp.

[2] 147 MHz was used for the measurements because it is about the highest frequency at which temperature-limited diodes can be used without large corrections and the lowest frequency at which plasma sources can be used; i.e., traditional high-frequency noise sources and microwave noise sources can be compared in the upper VHF region.

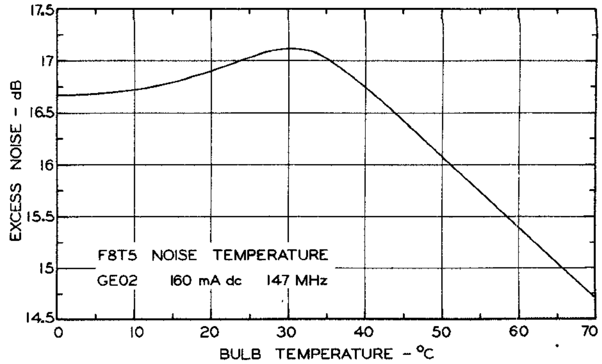

Fig. 1. Excess noise in decibels as a function of bulb temperature for a normal F8T5 lamp operating at 160-mA dc. $EN_{dB} = 10 \log_{10}(T_N - 290)/290$, where T_N is the noise (electron) temperature in kelvins.

Conclusion

The noise temperatures obtained from fluorescent lamps are quite reproducible when the bulb temperature, and thus the mercury-vapor pressure, is accurately controlled. Above 30°C, the characteristics are those of a medium-pressure discharge; the noise temperature is quite sensitive to bulb temperature and has a linear characteristic with a slope of -0.069 dB/°C. Below a bulb temperature of 26°C the characteristics are those of a low-pressure argon discharge, and the noise temperature asymptotically approaches that of the rare-gas filling pressure.

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Comments on "Scattering of Surface Waves at a Dielectric Discontinuity on a Planar Waveguide"

BENJAMIN RULF

An analysis of the problem of scattering of surface waves at a dielectric discontinuity on a planar waveguide has recently appeared in this Transactions.[1]

This writer has worked on some very similar problems and has reached somewhat different conclusions [1], [2]. The object

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