Magnetron life time

Our advanced cathode design has extended the magnetron's life time to sometimes beyond the life of the radar equipment. Our X band 2, 4 and 6 kW patented ESAC magnetrons are operating in many shipboard and airborne radar in excess of 15,000 hours, hence very little replacements are required for these low power types. Our higher power magnetrons also contain long life cathodes and improved with our thermal control techniques. They also obtain an extremely long lifetime. This includes our 25 kW X and 30 kW S band shipboard radar magnetrons and our high power line of coaxial, vane and strap, and hole and slot type magnetrons used in airport surveillance radar, vessel traffic control radar, meteorological radar and medical and industrial linear accelerators.

1. Life end mechanism

Each magnetron's cathode has a special coating to enhance performance. Over time this material is consumed during normal operation. However, under improper operating conditions this consumption is expedited. The consumption ratio is the function of the anode current density and the cathode's temperature. As these increase beyond specification the lifetime of the magnetron decreases. Reduced emitter material causes low emission ability and unstable oscillation. This reduction in performance can be detected by the radar operator by recognizing loss of long range targets and difficulty in tuning the radar due to unstable oscillation. The consumption of material is dependent on current density and temperature, hence conditions of; average output power, heater voltage, load VSWR, anode temperature, and rrv (rate of rising of voltage) will affect the life time of the magnetron.

2. Operating condition effect

1) Average output power

Basically a magnetron's life time is extended by operating at low average output power at low duty cycle as compared to high output power at long pulse and high duty cycle. All of New JRC's life test data is measured at the most severe operating conditions; high average output power, maximum pulse length and a high duty cycle. Under normal operating conditions our customers can expect from 1.5 to 5 times longer life time than our life test data shows, if the magnetron is mainly operated under the middle or short pulse conditions.

2) Heater voltage

Cathode temperature is depended on heater voltage, electron back bombardment, ambient temperature, and cathode's heat conductive design. Some of our high power magnetrons required heater voltage reduction at normal operation because electron back bombardment increases the cathode temperature on high power magnetrons. A heater voltage reduction schedule is listed in our

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specification sheet and should be adhered to in order to avoid short life. This reduced heater voltage keeps the cathode temperature within its limit. Please accurately adjust the heater voltage to the center of the specified voltage value both during preheat and during the operation period.

3) Load VSWR

A low VSWR of the transmission waveguide line extends the life time. A good matched circulator and waveguide line, including the antenna are important to maintain good lifetime of the magnetron. Please ensure a low VSWR at least under the specified level in each specification.

4) Environmental temperature

The magnetron's lifetime is affected by the environmental temperature. High environmental temperature beyond specification increases the cathode temperature thereby reducing the life of the magnetron. So it is important that the magnetron's specified anode temperature be kept under the absolute maximum rating in any operating condition. Environmental temperature effects on a magnetron can be reduced by thick waveguide flange connecting to chassis, using heat sinks, fans, or other methods or cooling devices.

5) rrv (rate of rising of voltage)

Mismatched rrv from the modulator to the magnetron causes mode shift oscillation. The less efficiency of this mode shifted oscillation degrades the cathode. A degraded cathode causes unstable oscillation. The rrv should be kept within the limits of the specification sheet of each magnetron.

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