



APPLICATION NOTES

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CLEANING AND FLUSHING WATER- AND VAPOR-COOLING SYSTEMS

In addition to this document, the following three related technical publications are available from CPI to provide guidance in the design and maintenance of liquid-cooling systems for high-power microwave vacuum electron devices (VEDs):

- AEB-17 Recommendations for Cooling High-Power Microwave Devices
- AEB-26 "Foaming Test" for Water Purity
- AEB-31 Water Purity Requirements in Water- and Vapor-Cooling Systems

Each document addresses a different aspect of the concern about proper design and care of cooling systems; together, they should answer the most common questions concerning liquid cooling. If additional information is needed, please contact the CPI Engineering Department.

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INTRODUCTION

Klystron amplifiers are well known as reliable, long-life microwave devices that provide the user with many thousands of hours of trouble-free operation. Inadequate or improper cooling due to scale or corrosion may curtail the life of the device. AEB-31 specifically delineates the recommendations for cooling-system maintenance.

As mentioned in AEB-31, one of the major problems encountered in klystron cooling systems operating in the field is the formation of corrosion products. The klystron body and electromagnet cooling channels frequently become corroded, as does the surface of the water/vapor-cooled collector. This is due to the chemical reaction between free oxygen-laden coolant and the hot copper channel wall.

Scale formation, which differs from corrosion, can result from the use of other than very pure water or may be the byproduct of electrolysis between dissimilar metals in the heat-exchange system. As noted in AEB-31, this can be controlled by the usage of in-line purification loops.

The practices that follow are suggested for cleaning the cooling passages of water/vapor-cooled klystrons and associated transmitter equipment. These procedures should be performed before installing a klystron and repeated as part of a periodic maintenance schedule while the klystron is in service.

THE KLYSTRON/ELECTROMAGNET—

Flushing the Transmitter Water Lines

Contaminants such as solder, soldering or brazing flux, oils, metal chips or burrs, and possibly Teflon sealing tape, can frequently be found in new transmitter waterlines. When the water lines are first installed, these

contaminants must be flushed and cleaned from the system before the device and magnet are connected. The cleaning procedures in the transmitter manual should also be followed.

Before cleaning the transmitter closed circulating water system, disconnect the device and magnet, then:

1. Add jumper hoses between the input and output of the klystron and electromagnet water lines.
2. Disconnect or bypass the pump motor.
3. Fill the system with hot tap water. Open drain in transmitter cabinet, and flush for 15 minutes or until clean.
4. Separately flush water lines between tank and pump with hot tap water until clean.
5. Connect all water lines, and fill system with hot tap water and non-sudsing detergent. Trisodium phosphate is recommended; follow product directions.
6. Operate water system with hot tap water for 30 minutes. An immersion heater may be used to maintain hot water.
7. Drain and flush system with hot tap water for 30 minutes.
8. Remove and clean filter element.
9. Refill water system with tap water (ambient temperature).
10. Operate water system. Maintain water level while draining and flushing system until no detergent, foam, or foreign objects or particles are visible in drained or filter element. To test for detergents in water, use small glass test tube, drain sample of water into test tube, and allow to sit for 5 minutes. To generate foam, vigorously shake test tube for 15 seconds and allow to stand 15 seconds. A completely foam-free surface indicates no foam-producing impurities. Refer to the foaming test instructions in AEB-26.
11. Repeat steps 9 and 10 if detergent foam is still present. Drain and refill system with very pure water when the VED and transmitter water lines are both clean.
12. Remove, clean, and replace filter before using.

Flushing the Klystron Water Lines

CPI VEDs are shipped with their water passages clean and dry. It is good engineering practice to flush all cooling passages before installing the device. VEDs that have been in service for some time will develop scale on the collector. Contaminated water also contributes to dirty water lines. The following backflushing procedure is suggested for units having contaminated water lines, corrosion, scale, or blocked passages:

1. Remove Hansen-type input water fitting and add a straight pipe extension, approximately 1 or 2 inches long, to the VED.
2. Attach a hose to this fitting, securing with a hose clamp. This is the drain line, which should be emptied into a convenient outlet.
3. On some VED models, the normal body-cooling output line is fed to the base of the Vapotron[®] boiler. Remove hose at base of Vapotron boiler without damaging this fitting, as it must remain usable and capable of being tightly sealed.
4. Attach an extension pipe 2 or 3 inches long that will fit the small hose at one end and a garden hose at the other end. Secure with hose clamps.
5. Connect garden hose to a tap-water faucet; hot tap water is preferable.
6. Backflush the klystron body cooling passages for 10 or 15 minutes at full pressure until clean.
7. Reconnect input and output water lines to klystron.

8. If scale is present on the Vapotron collector, a solution of trisodium phosphate should be used for the first cleaning. This should be performed on a clean transmitter water system.
9. Connect klystron to transmitter water lines and fill system with hot tap water and non-sudsing detergent, as indicated on the directions.
10. Operate the water system for 15 minutes. Make sure water level completely covers the collector core.
11. Drain and flush system for 30 minutes or until no detergent foam is present.
12. Remove and clean filter element.
13. Fill system with very pure water.
14. Drain system water, and refill with very pure water.

Cleaning Water Lines

If there is heavy scaling on the Vapotron collector and/or blocked water passages, consult CPI for cleaning recommendations.

Chlorine present in tap water is harmful to the klystron water passages. Thorough flushing with deionized water will remove all traces of chlorine. *Never* use tap water for final refill or for makeup water.

Flushing and Cleaning Magnet Water Lines

The magnet water lines may be flushed and cleaned in the same manner as described for the VED.

OTHER CLEANLINESS ISSUES

The sight glass and float of the water-flow indicators must also be kept clean to achieve efficient system operation. The water-flow indicators usually become contaminated during use, and this contamination collects on the sight glass and float, making the readouts difficult to see. If too much contamination is present on the glass and float, they may stick and produce an erroneous reading. The detergent and cleaning solutions may not remove all of this contamination. If this is the case, the flow meter must be removed and cleaned and the glass surface brushed.

CAUTION

This cleaning and flushing procedure is meant to provide an additional method for cleaning coolant passages of VEDs and transmitters, whether new or already in use, and *NOT* to supersede any transmitter manufacturer's procedure. Merely adhering to this procedure does not guarantee that the liquid coolant in the refilled system is sufficiently pure. More information can be obtained from CPI publication AEB-31.