



INTRODUCTION

Klystron amplifiers are well known as reliable, long-life microwave devices, which provide the user many thousands of hours of trouble-free operation. Inadequate or improper cooling, due to scale or corrosion, may curtail tube life.

Specific recommendations for maintenance of water/vapor cooling systems are delineated in Varian Application Engineering Bulletin AEB-31.

As mentioned in the above reference, one of the major problems encountered in field operation of klystron cooling systems is the formation of corrosion products. Corrosion frequently occurs in the cooling channels of the klystron body on the surface of the water/vapor-cooled collector, and in the cooling channels of the electromagnet. It is caused by chemical reaction between free oxygen-laden coolant and the hot copper channel wall.

Corrosion, as described above, is different from scale formation, which can be caused by the use of other than clean distilled water, or as the by-product of electrolysis between dissimilar metals in the heat-exchange system. The latter can be controlled, as noted in Application Engineering Bulletin AEB-31, by the use of on-line purification loops.

The following procedures are suggested for cleaning the cooling passages of water/vapor-cooled klystrons and associated transmitter equipment. The procedures should be performed before installing a klystron and repeated on a scheduled periodic maintenance program while the tube is in service.

THE KLYSTRON/ELECTROMAGNET

New transmitter water lines frequently have contaminants, such as solder, soldering or brazing flux, oils, metal chips or burrs, and possibly teflon sealing tape. When the water lines are first installed, these contaminants must be flushed and cleaned from the system before the klystron and magnet are connected. In addition, the cleaning procedures in the transmitter manufacturer's manual should be followed.

TRANSMITTER FLUSHING

Before cleaning the transmitter closed circulating water system, disconnect tube and magnet.

1. Add jumper hoses between input and output of klystron and electromagnet water lines.
2. Disconnect or bypass pump motor.
3. Fill system with hot tap water, if available. Open drain in transmitter cabinet and flush for 15 minutes or until clean.
4. Flush water lines between tank and pump separately with hot tap water, if available, until clean.
5. Connect all water lines and fill system with hot tap water, if available, and one (1) cup of non-sudsing detergent. Trisodium phosphate is recommended.
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).
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 filtered element. To test for detergents in water, use small glass test tube, drain sample of water into test tube and allow to set for 5 minutes. To generate foam, shake test tube vigorously for 15 seconds and allow to stand 15 seconds. A complete foam-free surface indicates no foam-producing impurities. (Refer to Application Engineering Bulletin AEB-26, which describes a foaming test for water purity.)
11. Repeat Steps 9 and 10 if detergent foam is still present. Drain and refill system with distilled water when tube and transmitter water lines are both clean.
12. Remove, clean, and replace filter before using.

FLUSHING KLYSTRON WATER LINES

Varian klystrons are shipped with water passages clean and dry. However, it is good engineering

practice to flush all cooling passages before installing the tube, but this is not mandatory. The following flushing procedure is suggested for tubes having contaminated water lines, corrosion, scale, or blocked passages. Occasionally, tubes that have been in service for some time will develop scale on the collector. Contaminated water also contributes to dirty water lines.

Back flush klystron body water lines.

1. Remove input water fitting (Hansen type) and add a straight pipe extension, approximately 1 or 2 inches long, to tube.
2. Attach hose to this fitting, using "hose-clamp" to secure hose. This is the drain line and should be drained into a convenient outlet.
3. On some model tubes, the normal body-cooling output line is fed to the base of the Vapotron® boiler. Remove hose at base of Vapotron boiler. Do not damage this fitting as it must be reused and must seal tightly.
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 tap water faucet. (Hot tap water is preferable.)
6. Back flush 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 tri-sodium phosphate should be used for first cleaning. This should be done with a clean transmitter water system.
9. Connect klystron to transmitter water lines and fill system with tap water (hot, if available) and 1 cup of non-sudsing detergent.
10. Operate water system for 15 minutes. Make sure water level covers collector core completely.
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 distilled water.

14. Drain system water and refill with distilled water.

CLEANING KLYSTRON WATER LINES

If there is heavy scaling on the Vapotron collector and/or blocked water passages, they may be cleaned by using a stronger cleaning agent. A solution of SAN* is recommended to remove scale and corrosion.

1. The transmitter water system should be cleaned prior to this procedure.
2. Connect tube to transmitter water system.
3. Fill system with hot tap water (if available) and add 2 gallons of cleaning solution for every 50 gallons of water. (Do not exceed 5 gallons of cleaner for every 50 gallons of water.)
4. Operate water system for 15 minutes or until scale has been removed and collector has a clean copper color.
5. Make sure water level covers top of collector during cleaning. Evidence of cleaning action may be observed in flow meters.
6. Drain and flush system with tap water.
7. Remove and clean filter element and replace.
8. Refill system with distilled water and flush for 30 minutes to one hour.
9. Check for detergent foam at end of flushing period; also check pH factor. Continue flushing with distilled water if foam is present or if pH factor is not within the specified range.
10. Refill system with clean distilled water.

Chlorine present in tap water is harmful to the water passages of the klystron. Thorough flushing with distilled water will remove all chlorine traces. 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 klystron.

* SAN - Product of:
Mobile Chemical Company
407 East Main
Richmond, Virginia

GENERAL CLEANING

Two remaining items must be clean to achieve efficient operation. They are the sight glass and float of the water-flow indicators. The water-flow indicators usually become contaminated during use. This contamination collects on the sight glass and on the float, making flow-reading difficult. If too much contamination is present on the glass and float, sticking or erroneous readings may result. The detergent and SAN cleaning solution may not remove all of this contamination. If this is the case, the flow meter will have to be removed and cleaned, using a brush to clean the glass surface.

CAUTION

This cleaning and flushing procedure is not meant to supersede any transmitter manufacturer's procedure but it provides an additional method for cleaning coolant passages of new klystrons and transmitters, or ones that have been in operation for some time. Just adhering to this procedure does not guarantee that the refilled system has "good water." Refer to Varian Application Engineering Bulletin AEB-31 for this determination.

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