Communications & Power Industries
microwave power products division

APPLICATION NOTES

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WATER PURITY REQUIREMENTS IN 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-32	Cleaning and Flushing 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.

INTRODUCTION

The high power levels of present-day microwave electron devices require careful attention to the maintenance of water purity to ensure the best possible heat dissipation. Any water with a contaminant level that exceeds the limits specified in this publication will cause corrosion and scaling, and this includes *plain tap water*. However, deionized water meets these requirements and is the recommended fluid to be used in cooling systems. Periodic monitoring of water purity is necessary, because the water can become contaminated by impurities from the cooling-system components and from the surrounding environment. When combined with the effects of high surface temperatures, these impurities induce a chemical reaction that results in corrosion and the formation of solids or scaling. Unchecked corrosion will attack the metals in the VED and thereby reduce its operating life. Scaling prevents efficient heat transfer and obstructs cooling passages, which greatly increases the possibility of premature product failure.

The recommendations given herein are based on a study of liquid-cooling systems conducted for Varian Associates (CPI) by Stanford Research Institute and the subsequent analysis and correction of the problems in various field-operating situations.

WATER PURITY SPECIFICATION

1. The resistivity of the water shall be maintained at a level of 100 kΩ-cm or higher at 30°C.
2. Dissolved oxygen should not exceed 0.5 parts per million.
3. The pH factor shall be within the range of 6 to 8.
4. The particulate-matter size shall not be greater than 50 microns (325 mesh).
5. The inlet water temperature should not exceed 60°C, and it is recommended that this temperature be regulated to ±5°C.

When the water fails to satisfy any one of these requirements, prompt action is necessary to correct these deficiencies. If the water temperature exceeds 70°C, the heat-exchanger system should be checked or adjusted. If the water is contaminated, the system must be flushed and replaced with clean water. Specific recommendations are described in CPI Publication AEB-32.

PURITY TESTS

The recommended approach for measuring resistivity, pH, and particulate matter utilizes laboratory instruments. However, the following simple tests should provide enough information to determine purity:

1. *Appearance* of the water is a good general indicator. If the water looks turbid or smells brackish, it is good practice to change the water and flush the system.
2. *pH factor* is easily checked by using pH paper or litmus paper. Sold under a variety of trade names, pH paper is available at aquarium or swimming-pool-equipment supply stores. Directions for use are usually printed on the packages.
3. *Particulate* matter and impurities can be checked with the foaming test described in AEB-26.
4. *Resistivity accuracy* should always be measured with a resistance bridge. As a general rule, if the water does not pass the foaming test, the resistivity is too low.

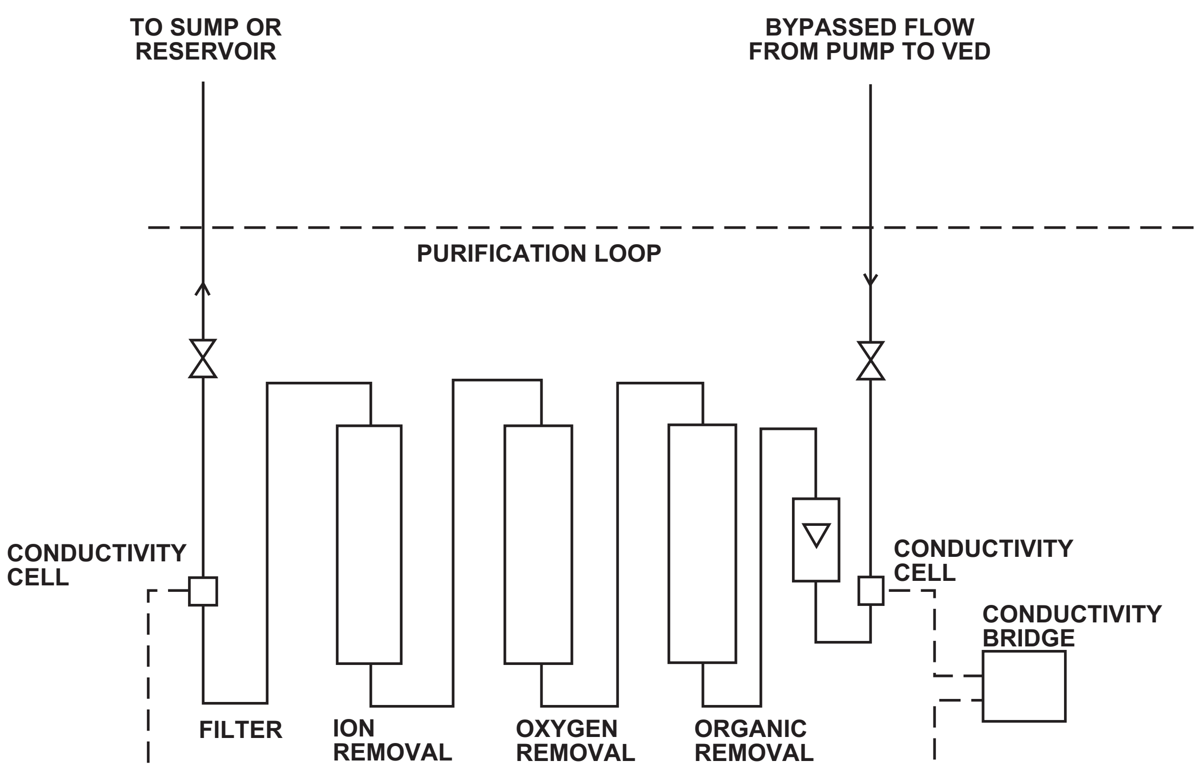

Figure 1. TYPICAL PURIFICATION-LOOP ARRANGEMENT

MAINTAINING WATER PURITY

Continuous purification is the recommended method for maintaining high purity-water. Figure 1 shows a typical purification-loop arrangement. Packaged systems such as this are available from a number of manufacturers. These systems generally consist of replaceable cartridges that provide the filtering, ion-exchange, and organic-solid-removal functions. The system should include flow and pressure gauges with interlocks, valves, and conductivity cells to continuously evaluate the condition of the water and filters. The size of the purification system should correspond to the VED manufacturer's recommendations.