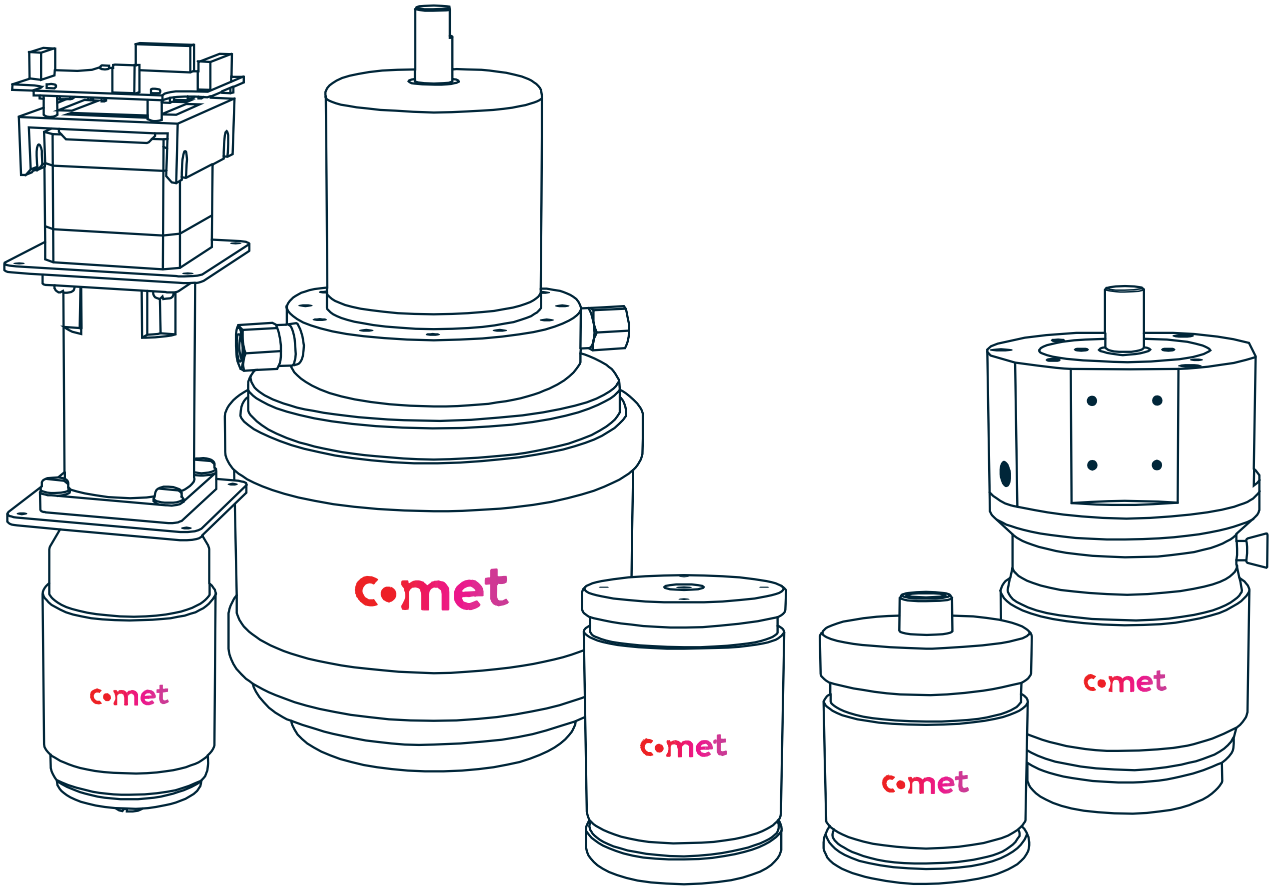
Service Bulletin-26 | Vacuum Capacitors

Liquid Cooling System and Water Purity Requirements



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1. Introduction

The high-power density experienced in RF transmitters and generators using water cooled vacuum capacitors and electron tubes, requires careful attention to maintenance of adequate coolant flow and purity, to assure proper operation and long life of the components. Ordinary tap water will not meet these requirements. Distilled or de-ionized water should be used to fill such a cooling system. The water purity and flow protection should be periodically checked to insure against excessive degradation. Water flow requirements and absolute maximum inlet pressure must be maintained at all time when the system is operating. For details see Service Bulletin SB-52.

Water purity can be seriously degraded by contaminants from the various cooling system components. For example, free oxygen and carbon dioxide in the coolant will form copper oxide on the surfaces of the coolant courses, particularly the inside of the water-cooled capacitors itself, thereby reducing the cooling efficiency. The formation of these oxides is greatly accelerated by elevated temperatures within the system.

Electrolysis may also take place due to the presence of ions in the liquid and the electric potential across the coolant courses. Electrolysis may reduce the heat transfer to the liquid coolant. In extreme cases, heavy oxide deposits can plug up coolant passages and reduce flow. Either of these may result in premature failure of components as for instance a vacuum capacitor. Special cooling designs within a capacitor reduce these effects to a minimum but they are still present.

2. Basic System Design

The liquid cooling system consists of a source of coolant, reservoir, circulation pump, heat exchanger, coolant purification loop and the external connection pipes, valves, gauges and flow interlocking devices required to ensure coolant flow anytime the equipment is energized.

Most of the time the coolant will be water. In some instances, if there is danger of freezing, it will be necessary to use an anti-freeze solution, such as ethylene glycol. In these cases, coolant flow must be increased if possible or the dissipation reduced accordingly to allow for the poorer heat capacity of the ethylene glycol solution. A mixture of 60 % ethylene glycol to 40 % water by weight will be approximately 75 % as efficient as pure water as coolant at 25° C. Regardless of the choice of liquid, the system volume should be kept to the minimum required to insure proper cooling of the capacitor.

An air space above the liquid in the reservoir should be avoided. It is suggested that the user verifies the properties of the ethylene glycol and the media used to assure good cooling liquid conditions in regard to possible negative influence these elements may have on the lubricants found in variable capacitors. In general no difficulties have been experienced.

The cooling or heat exchanger system must be designed to maintain its outlet temperature such that the outlet water from the capacitor does always not exceed 80°C . It is suggested that as good engineering practice the maximum be kept at 70°C.

The lines connecting the plumbing system to the inlet and outlet parts of the capacitor should be of an insulating material flexible enough and arranged so as to avoid excessive strain on the water connections. Polypropylene tubing is a good choice for this service, but chlorinated polyvinyl chlorid (CPVC) pipe is also acceptable and is stronger. Reinforced polypropylene, such as Nylobraid is expensive, but is excellent in this application.

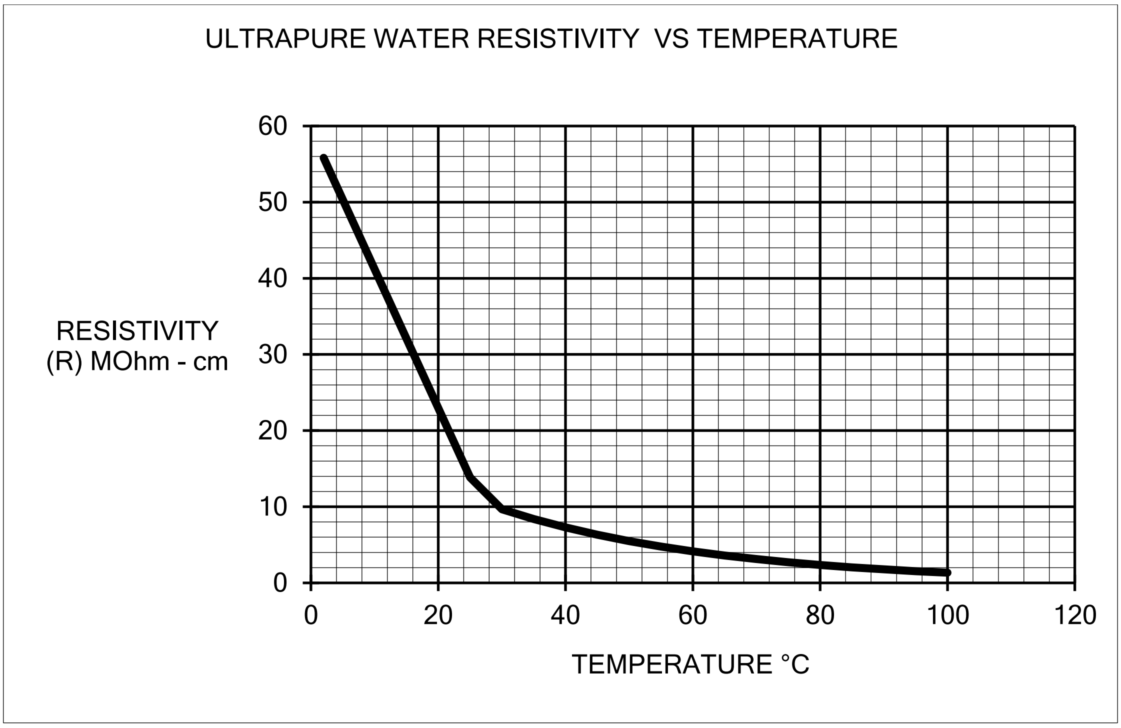
The lines must be of sufficient length such that at operating voltages of up to 55 kV, at least 4 MOhm resistance at maximum water temperature is provided in the water column between the high voltage ends and ground for every 1000 Volts.

All metallic components within the water system, including the pump, must be of copper, stainless steel, or unleaded brass or bronze with copper or stainless steel preferred. If brass or bronze is used, some zinc may be leached out of the metal into the system. Any other material, such as iron or cold rolled steel will grossly contaminate the water. Even if the system is constructed using the recommended materials, and is filled with distilled or de-ionized water, oxygen and carbon dioxide in coolant will form copper oxide reducing cooling efficiency and electrolysis may destroy the coolant passages. Therefore, water flow and plumbing fittings must be inspected on a regular basis. The connections on the positive potential end of an insulating section are particularly subject to corrosion or electrolysis unless they have protective targets (sacrificial anodes). These targets should be checked periodically and replaced when they have disintegrated.

The regeneration loop should be capable of maintaining the cooling systems such that the following maximum contaminates levels are not exceeded.

Copper	0.05 ppm by weight
Oxygen	0.5 ppm by weight
CO_2	0.5 ppm by weight
Total Solids	3.0 ppm by weight

The levels above are meant to be maximum allowables, but if the precautions outlined herein are taken, actual levels will be considerably lower.



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