Communications & Power Industries

APPLICATION NOTE

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EIK WATER COOLING REQUIREMENTS

INTRODUCTION

Water cooled EIK's operate at high power densities and requires careful attention to the maintenance of adequate water flow and purity to ensure proper operation and long life. Water with contaminant levels that exceed the purity requirements will cause corrosion and scaling, this includes *ordinary tap water*. Unchecked corrosion of the metals in the EIK coolant passages reduces operating life. Scaling obstructs cooling passages preventing efficient heat transfer resulting in overheating and permanent damage. Continuous filtering, deionizing and oxygen removal is necessary for maintaining high water purity.

WATER PURITY REQUIREMENTS

1. Deionized or distilled water
2. Water resistivity shall be maintained at 1 Megohm-cm or higher at 25 °C.
3. Dissolved oxygen should not exceed 0.5 parts per million
4. The particulate matter sized shall not be greater than 50 microns (325 mesh)

Water purity and flow protection must be periodically checked to ensure against excessive degradation. Water can become contaminated by the cooling system components and from the environment. For example, free oxygen in the coolant will form copper oxide on the surfaces of the coolant passages, particularly the collector. The oxide compounds can drastically reduce heat transfer to the water. In extreme cases, heavy oxide deposits can plug up coolant passages reducing flow. The formation of these oxides is greatly accelerated by elevated temperature within the system.

Corrosion via electrolysis between dissimilar metals may also take place when ions are present in the water and there is an electric potential across the coolant passages (i.e. as in depressed collector operation). Electrolysis will destroy the coolant passages.

The presence of either oxidation of electrolysis will result in premature EIK failure.

BASIC SYSTEM DESIGN

Figure 1 shows a typical arrangement of a recirculating cooling system with a purification loop. The main cooling loop consists of a heat exchanger, water reservoir, particulate filter (10-50 micron), circulation pump, the connection tubing, valves, pressure gauges, temperature and flow sensing interlocks required to ensure sufficient coolant flow and temperature whenever the equipment is energized. A nitrogen gas pressurized system as shown is recommended to reduce oxidation.

The purification loop taps off approximately 10% of the total cooling system flow rate. The purification loop consists of a purity meter, oxygen, ion and particulate removal cartridges.

Flow and pressure regulating valves should be installed on the inlet lines to the EIK for adjustment of flow rate and pressure drop. A thermometer interlock should be placed in the inlet line to the EIK and a flow meter interlock should be placed in the outlet coolant line from the EIK. These interlocks must be wired into the electrical controls, such that the EIK is completely de-energized in the event of loss of coolant flow or an over temperature condition.

The main circulation pump must be of sufficient size to ensure the flow and pressure throughout the operating range as specified on the Test Data Sheet. Care must be taken when connecting the coolant lines to the EIK. Be certain that the flow is in the direction specified. Reversed flow may result in inadequate cooling.

The coolant lines to the EIK inlet and outlet ports should of an insulating flexible material arranged so as to avoid excessive strain on the coolant ports of the EIK. Many EIK's are shipped with the collector and body-cooling lines partially assembled using nylon tubing. Nylon, polypropylene and chlorinated polyvinyl chloride (CPVC) tubing with adequate wall thickness are acceptable choices for this service.

All metallic components within the water system, including other tubing, fittings, pumps and other material that will be in direct contact with the coolant should be made from copper, nickel, bronze, Monel, Inconel, 304L stainless steel and 347 stainless steel for weld parts to minimize galvanic action. ***Metals that should not be used in direct contact with the coolant include steel, cast iron, galvanized iron, aluminum and magnesium. Brass should be used as sparingly as possible and should be low zinc brass.***

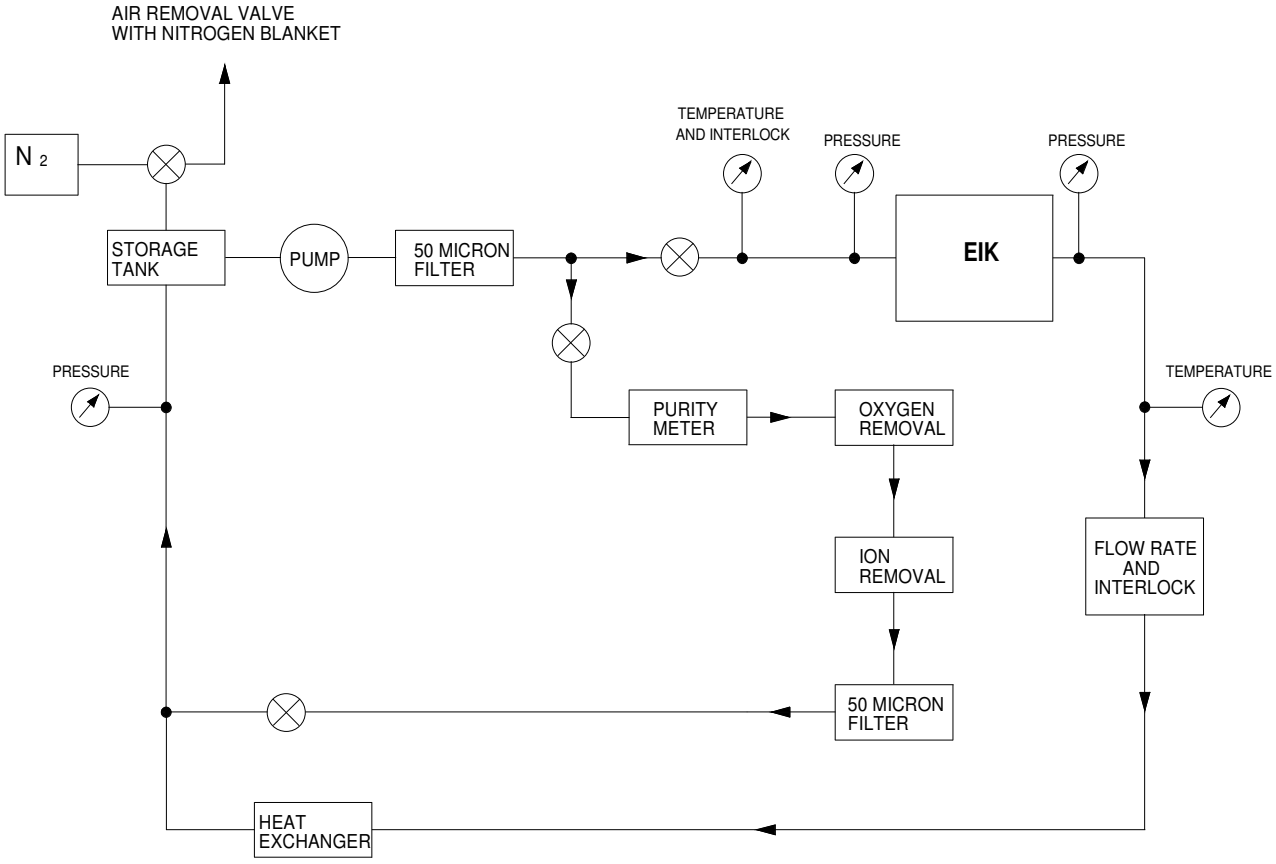

Figure 1

TYPICAL COOLING SYSTEM WITH PURIFICATION LOOP

Packaged purification systems suitable for this purpose are available from many suppliers; including Barnstead International (www.barnsteadthermolyne.com) Advice in setting up a cooling system should be obtained from the water processing manufacturers.

COOLANTS

Deionized water (which is chemically stable with a high heat-transfer capability) is the recommended coolant for EIK's.

For protection against freezing temperatures, use water heaters or drain the system during non-operating periods.

If a freezing point depressant is necessary, an *uninhibited* solution of 60% ethylene glycol and 40% water by weight can be used. Although inhibited ethylene glycols are more stable than uninhibited ethylene glycols, field experience has shown that present operating methods using uninhibited glycols are adequate. Also, inhibited ethylene glycol cannot be used with coolant purification systems, because the inhibitor will saturate the ion-exchange resin and render it useless.

Where an ethylene glycol solution is used, the coolant flow must be increased to compensate for the poorer heat capacity and higher viscosity of the ethylene glycol solution. For example, a mixture of 60 % ethylene glycol to 40% distilled or deionized water by weight at 25 °C will be about 75% as efficient as pure water and will require a 2.5 times increase in the flow rate.

COOLING SYSTEM OPERATION

Before connecting the resin beds and filling with deionized water, all contaminants such as oils, greases, pipe compound and particulate matter such as solder must be cleansed from the system prior to use. They may deposit on the heat exchange surfaces inside the EIK and reduce the heat transfer capability and reduce the life of the resin beds in the purification loop. All coolant lines should be flushed with a non-sudsing detergent and a citric acid solution. It is also good practice to sterilize the coolant lines with a chlorine solution before filling then rinsed repeatedly with deionized water to prevent algae and bacteria growth. Also, do not add oil inhibitors or stop leak compounds to the water. These additives may cause foaming and will clog up the filters rendering them useless.

The purification loop can theoretically process water to 18 megohm –cm resistivity at 25 °C. In practice it will be somewhat below this value.

After normal operation for an extended period, the system should be capable of holding 3-4 megohm-cm until the deionizer beds become consumed and need to be replaced. Although the resistivity measurement is not a test for free oxygen in the water, the oxygen filter should always be replaced when replacing the deionizing bed.

If corrosion effects are indicated, by an increase (by 20% to 25%) in pressure differential across the EIK, corrosion products must be removed from the system. After removing the EIK, these contaminants (mainly copper oxide, CuO) can be flushed out or dissolved out of the cooling channels be means of dilute hydrochloric acid, followed be a neutralizing flush and then deionized water flushing. It is especially important that flushing procedures be instituted before any of the cooling channels inside the EIK become completely blocked. To prevent this, it is necessary that the EIK flow and pressure instrumentation be a permanent part of the coolant system installation. Contact CPI for specific flushing-solution recommendations and procedures.

EIK WATER COOLING REQUIREMENTS

SUMMARY
Generally speaking, the cooling system component manufacturer's recommendations should be followed for overall cooling system maintenance; however, to obtain the longest possible life of the EIK, the following points must be considered:

1. Keep the water temperature constant and as close to 20 °C as ambient weather conditions and other total system requirements will allow.

2. Use clean deionized water for original flushing, final filling and make-up.

3. Use uninhibited ethylene glycol and deionized water only (do ***not*** use automobile radiator antifreeze).

4. Monitor the condition of the ion exchange cartridge, recognizing that this will not provide any knowledge of the condition of the oxygen removal section.

5. Maintain the cleanliness of the main loop and branch loop filters through routine inspections.

6. Ensure the system remains free of dissolved oxygen. Flush the EIK if the differential pressure increases by 25 percent above the original value at the specified flow rate.

7. Follow the cooling system manufacturers instructions for replacement of filter membranes and cartridges.

8. Contact CPI Canada should you require further assistance in the cooling of CPI Canada EIK's.

Footnotes:

1. Citric acid solution – 375 g. citric acid, 220 ml household ammonia, 4 liter H_2O.
2. Chlorine Solution – Sodium hypochlorite bleach added in an amount sufficient to give the odor of chlorine in the circulating water.