Specification of cooling water for converters and induction systems by EMA Indutec GmbH

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1. Introduction

This specification applies to the **cooling of converters and of induction systems**. It comprises **regulations and requirements** as for the quality of the cooling water with regard to specific elements (e.g. **MF-systems, rectifier, electronic parts** etc.) Should any service instruction concerning these elements be available, it must be adhered to.

In case there is no specialist at hand for the preparation of the necessary cooling water, it is recommended to consult a specialized company that offers qualified services.

Any non-observation of the instructions given may result in : corrosion within very short terms, destruction of the tubes, resp., deposits that may heavily reduce the cooling capacity which all may lead in the end to considerable malfunctions or breakdowns in the system.

On all its systems, EMA Indutec GmbH only applies clearly defined material of well-known brands. Therefore, hardly any case of occuring rust or lime deposit has been due to the material provided by EMA Indutec so far.

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2. Cooling water limiting values

The limiting values indicated form, altogether, a system of balance. Therefore, they must **all be kept to.** In case of any divergence, an efficient and consistent adjustment must be effected.

Any divergence from the limiting values indicated may cause damage to the machine!

In order to keep to the specified limiting values, different measures may be necessary with respect to the system in question. The quality of the cooling water must be regularly checked. As for conditioning and controlling the cooling water, we recommend to cooperate with a company specializing in water treatment.

All local regulations and limitations concerning drains and environmental protection as well as the specific safety instructions given as for the use of chemical substances must be followed!

The limiting values indicated refer, among other things, to the recommendations given in the VDI 3803 for recooling units – circulating water.

In order to minimize the risk of, e. g., microbiological germination, the system must be operated in a closed cycle. Any contact with the outside atmosphere must be avoided and is only allowed if the necessary measures to compensate the pressure or to deaerate the system must be taken.

The water within the system is subject to regular control according to VDI 6022 concerning microbiological impact.

The system should preferably be filled or refilled with fully demineralized water, resp., with water processed by means of reversible osmosis. In any case, the **appropriate protective product to avoid corrosion** must be provided. (Please consult an expert)

Quality	Limiting values	Comments
appearance	Preferably limpid, clean, no deposits	
Size of particles	< 150 µm	**Important**: Install dirt pans prior to water inflow.
pH-value	7.5 – 8.5	The use of chemical substances to condition the water may cause divergences. **Attention**: Consult an expert.
Overall salt content	< 250 mg/l	
Conductivity	< 30 mS/m = < 300 µS/cm	**Attention!** see item 2 – protection against corrosion
Total hardness*	1 bis 2 mmol/l = 1 bis 2 mol/m^3 = 5.6 bis 11.2 °dH	If the water has been softened, efficient inhibitors must be used to work against corrosion. **Attention**: consult an expert.
Chloride [Cl^-]	< 50 mg/l	
Sulfate [SO_4^{2-}]	< 50 mg/l	
Nitrit [NO_2^-]	< 0.04 mg/l	
Metal content (Fe, Mn, Cu, Al)	< 0.2 mg/l	
$KMnO_4$- consumption	< 100 mg/l	
Germination index	< 1,000 ml^{-1}	

*) According to the SI-measuring system the content of alkaline earth ions (calcium and magnesium), i.e. the total hardness, is stated in Mol per liter respectively regarding the low concentration in Millimol per liter (mmol/l).

In former times, the water hardness has been stated in degree of German hardness (°dH). Therefore, 1 °dH was formally defined as 10 mg CaO per one liter. The other hardness profiles such as magnesium were defined as equivalent quantity (7,19 mg MgO per liter). Regardless the practical requirements, the mentioned above molar values are nowadays required by law.

If the values for magnesium (Mg) and calcium (Ca) are known, the water hardness can be calculated as follows:

Water hardness in mmol/l = [Ca-value in mg/l] ÷ 40 + [Mg-value in mg/l] ÷ 24,3

Conversion table:

Unit	alkaline earth ions [mmol/l]	German degree [°d]	ppm $CaCO_3$ (USA)	English degree [°e]	French degree [°fH]	Russian degree [°rH]
mmol/l alkaline earth ions	1.00	5,63	100.00	7.02	10.05	40.08
German degree [°d]	0.178	1.00	17.80	1.253	1.78	7.118
ppm $CaCO_3$ (USA)	0.01	0.056	1.00	0.07	0.10	6.834
English degree [°e]	0.142	0.798	14.30	1.00	1.43	5.695
French degree [°fH]	0.10	0.56	10.00	0.702	1.00	3.986
Russian degree [°rH]	0.025	0.14	0.146	0.176	0.251	1.00

3. Troubleshooting and elimination

Malfunctions or failures are reflected in different ways such as described in the following:

- divergence from the admissible limiting values,
- rusty or muddy cooling water,
- sediments or deposits (e.g. furring),
- selective corrosion,
- destruction of the naturally built protective layers,
- destruction of the naturally built protective layers, bio-fouling.

The causes for these occurences are often hard to recognize. The different reactions may arise from the cooling system, water-logged material, the temperature of the cooling water, the pH-value as well as from the concentration of substances.

In order to securely eliminate any malfunction or failure that cannot be quickly repaired, resp., removed, we recommend to consult a company specialized in water treatment.
You may contact your EMA Indutec GmbH personal project manager who is responsible for your system.

4. Cooling systems and their effect on the cooling water

The system must be connected to the cooling system available on the respective premises at the inlet/outlet devices (system delimitation). It is designed for pressureless outlet.

In case of an expected **back pressure** or if the **connection to a closed cooling cycle system**, the **seller's consent**, resp., approval **must be obtained** prior to the quotation being made.

Particular annotation:

Between converter and recooling unit, there must in no way be any galvanized tubes. All tubes must be made of stainless material.

The individual cooling circuits of the system and the controlling devices provided are represented in the cooling water scheme where you will also find details on the inlet temperature, pressure and quantities.

4.1 Quasi-closed-cycle cooling system

The cooling water releases the heat that has been taken up by the refrigeration consumer to a heat exchanger and then flows back into the system via a slightly opened capacity or storage tank. There are only little evaporation and only a few hardening deposits (sediments) which develop in proportion to the water quantity that is being refilled. Via the equalizing tank, oxygen can permanently diffuse into the water. Thus, the oxygen content is saturated. Organic pollution may occur thus provoking the formation of sediments within the system. Furthermore, a high concentration of salt as well as an unpredictable occurrence of different metals in combination with unfavourable pH-values of the water may also contribute to the formation of internal corrosion.

The system must be protected against corrosion by means of efficient inhibitors.

4.2 Closed-cycle cooling system

This cooling system is hermetically sealed. It releases the stored heat to a heat exchanger. Thermal extensions are intercepted by a membraned pressure vessel. There is no loss of water.

The formation of sediments or deposits is largely excluded on this system. A yearly, preventive control of the system by means of a water analysis is recommended.

5. Pressure of cooling water

water pressure at inlet:	4.0 bar minimum	8,0 (6.0) bar maximum
differential pressure:	4.0 bar minimum	

6. Temperature of cooling water

Maximum inlet temperature 30°C (higher cooling water inlet temperature available on request)

Minimum inlet temperature, depending on the ambient temperature and humidity. The minimal inlet temperature must be selected so as to avoid a condensation formation in general

7. Information about de-mineralized water

De-ionized or de-mineralized or fully desalinated water (VE-water) is water without minerals (salt, ions) in normal well, spring or tap water. It is basically found in technical applications as operating material but is also used as cleaning agent or solution.

The conductivity is measured with conductivity measuring devices to determine the purity level of de-mineralized water. This conductivity is stated in S/m (Siemens per meter).

De-mineralized water can be obtained with help of different methods:

1. **Water softening (cation exchanger):** During this procedure, only the hardeners calcium and magnesium are removed. The total salt load and the conductivity are only changed slightly. This procedure cannot be used in case of a high salt level as the obtained water stays corrosive.

2. **Complete desalination (cation and anion exchanger):** This procedure is recommendable in case of high salt contents and high quantities of hardeners. the obtained water (without salt and hardeners but still contaminated with germs) should be blended with untreated water in the most cases. The hardness for quench medium or cooling water should than be between one and two Millimol per liter (mmol/l) = approx. 5 °dH to 11 °dH. As the quality of untreated water can change, the obtained water is also not of constant quality.

3. **Reverse Osmosis (RO):** In case of a high water demand and for reaching a constant water quality, this procedure is recommendable. The obtained water still contains approx. 5% of all salts and minerals. A change of the untreated water quality has no essential influence on the quality of the obtained water. In case the untreated water has a high total hardness, a softening system will be installed upstream.