 <p>Voltea B.V. Wasbeekerlaan 24 2171 AE Sassenheim The Netherlands Tel: +31(0)252200100 E:mail: info@voltea.com</p>	Voltea's Technical Bulletin Feedwater Guidelines		REV	BY	APV	REVISION	DATE	
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This technical bulletin outlines the feedwater characteristics and Voltea guidelines for number of CapDI applications. Its purpose to help customers and engineers identify the needed pre-treatment process components/stages prior processing water through the CapDI system.

Feedwater quality guidelines

Most parameters are defined by the module requirements. The CapDI® modules are comprised of a stack of cells, which in turn are formed of membrane-electrode pairs separated by a flow channel (technical bulletin 402D019 - principle of CapDI®). The flow channel is relatively narrow to enable high ion removal efficiency which is a reason that the water must meet certain criteria to prevent fouling and loss of performance. Parameters related to scaling and organic fouling are important for the correct operation of the whole system. Although fixed limits are given, many parameters are inter-dependent and full water analysis needs to be verified by Voltea engineers.

Table 1: Water parameters for industrial and commercial applications.

The following guidelines listed in Table 1 are relevant for applications such as cooling towers make-up treatment, commercial laundry, wastewater effluent and customer appliance. The following will not remove the need to clean the modules but should be sufficient to minimize the need for cleanings.

Laundry reuse water has higher temperature and it is typically very low in TSS but high in TDS and dissolved organics.

Parameter	Unit	Range	Intermittent
Removal limit	[Δppm]	0 - 2000	
TDS (Total Dissolved Solids)	[ppm]	0 - 4000	
TOC (Total Organic Carbon)	[ppm]	<15	
COD (Chemical Oxygen Demand)	[ppm]	<50	<100
Turbidity	[NTU]	<4	<100
FOGs (Fats-Oils-Greases)	[ppm]	<0.5	
SDI₅ (Silt Density Index)	[-]	N/A	
TSS (Total Suspended Solids)	[ppm]	<4	<20
Free chlorine	[ppm]	<1	<25
pH	[-]	2 - 10	1 - 12
Fe total (Iron)	[ppm]	<0.5	
Total Hardness (as CaCO ₃)	[ppm]	<1000*	
M Alkalinity (as CaCO ₃)	[ppm]	<1000*	
Silica	[ppm]	N/A	
Pre-filtration (Nominal)	[µm]	5	
Temperature	[°C]	5-60	
Chemicals		None	

*These limits depends on set ion removal and water recovery

Controlling fouling

Voltea's CapDI module is less sensitive to fouling due to fact that feedwater is not transported through the membrane. It flows along the membrane surface and only ions are transported through the membrane due to the electric field and they are stored in the carbon electrodes. Total length of the CapDI flow path is ca. 10cm (4") which is very short compared with other technologies (e.g. EDR). The short flow path as well as only ion transport through the membrane results in low fouling and scaling potential.

Voltea's CapDI technology operates in cycles and that means that the purification phase is followed by an electrode regeneration phase. The cycle length is short and it takes approximately 2-3 minutes. During the regeneration phase the polarity of the electrodes is reversed and a concentrated stream of ions is pushed back into the flow channel which aids in cleaning the membrane of any deposition.

Controlling scale formation

In consumer appliance applications TDS levels can vary between 1000ppm to 3000ppm and very often water is hard. Therefore, it is crucial to reduce risk of scaling and there are many ways in which the rate and probability of scale formation is assessed. The Langelier Saturation Index (LSI) is one of the most common. The required parameters are pH, temperature, calcium (or total hardness), alkalinity (carbonates) and TDS.

High levels of alkalinity and calcium at high temperatures and pH will increase the rate of scale formation. Nevertheless, just one of these parameters alone will not cause scale formation and as a consequence the following are guide values only. For pH, temperature and TDS please refer to Table 1.

Depending on the application requirements there are different ways to control scale formation. If there is higher risk of scaling the operational settings can be adapted in order to reduce risk of scale formation during the concentrate (LSI<1.5) and to avoid chemical addition. However, if changing settings is not possible, chemical addition (frequent cleanings with acid, continuous pH modification of the feed or use of anti-scalants) should be considered.

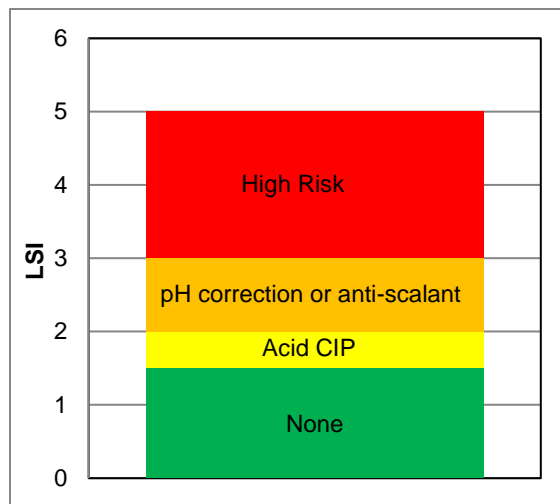


Figure 1: LSI during CapDI® regeneration with corresponding scale control.

Figure 1 shows scale control methods corresponding to LSI values during a CapDI® regeneration phase, where all ions are released from the electrode to the flow channel. If LSI value is higher than 1.5 a preventive acid CIP should be implemented. However, if LSI is above 2 then continuous pH modification of the feedwater or anti-scalant addition should be implemented. If the concentrate LSI is higher than 3 then this water type and settings are potentially not suitable for the CapDI® system.

Summary

Voltea guidelines for feedwater characteristics can vary depending on the intended use and the application. Precise water data allows us to optimize the performance of the CapDI® system. Voltea's CapDI® module and operational cycles are designed to minimized fouling. The CapDI® system has built-in automatic acid CIP to minimize risk of scaling in addition to an automatic cleaning system which minimize risk of biofouling/fouling.

For more information, contact Voltea by telephone: +31(0)252200100, e-mail: info@voltea.com, or visit www.voltea.com.