


6 Chemically Enhanced Backwash (CEB)

6.1 General Overview


A chemically enhanced backwash (CEB) is used to boost the effectiveness of a backwash. It is performed after a defined number of operating cycles

NOTE	
	<p>ATTENTION!</p> <p>Observe the following guidelines!</p>

- The guidelines stipulated in the section on "Using Chemicals for CEB/CIP" must be observed. For most applications, acidic and caustic (with or without the addition of oxidants) CEBs have generally proved to be the best choice. Before using any other chemicals, it is necessary to contact DuPont™ to obtain written approval and information on permissible concentrations.
- If a CEB is executed with a reduced flux (less than 230 L/(m²h)), a backwash should be performed first. This enhances the effectiveness of the cleaning solution in the subsequent CEB.
- A CEB may only be performed using water of at least PES-UF filtrate quality or reverse osmosis permeate. The water used must be free of abrasive and membrane-blocking particles. When drawing water from the tank for a CEB, the same rule applies as for normal backwashes, e.g. ensure that no corrosion or erosion products that may have formed in the tank or in the pipes are washed into the module.
- CEB frequency depends on feed water quality and other operating conditions such as flux rate and recovery rate. The CEB is usually carried out several times a week.
- It is important to ensure that the CEB chemicals are injected into the system for a sufficiently long period of time to ensure that they are distributed evenly and homogeneously throughout the entire rack.
- The effectiveness of a CEB depends not only on the chemicals used, but also on the soaking time and the operating cycles and time intervals between CEBs. The sequence of the various CEBs should therefore be programmed as flexibly as possible.
- For the vast majority of applications, alkaline CEBs have proved to be the best choice for removing organic build-up and acid CEBs have been proven as the best solution for removing inorganic fouling.
- Since there is always the possibility of precipitation in an alkaline CEB, this must always be followed by an acid CEB. It is advised to operate the membrane system for one filtration cycle between a caustic CEB and an acid CEB to refill the backwash tank and neutralize the water in the membrane fibers.
- An alkaline CEB should always be performed in combination with acid as a caustic/acid CEB. Acid CEBs may be performed as a standalone procedure or in combination with caustic as a caustic/acid CEB.
- If iron-based coagulants are used in the pretreatment stage, the residue can only be removed by an acid CEB. If aluminum-based coagulants are used, then either acid or alkaline CEBs may be performed.
- Chlorine containing CEB solution rinsed out of the system should under no circumstances be mixed with acid CEB solutions (e.g. in a neutralization tank), since this could lead to the formation of toxic chlorine gas.

The CEB's mentioned in Table 6.2-1 or their combination - with defined frequencies - are used depending on the application and feed water quality. The following points must be considered during the programming or organization of the CEB sequences.

6.2 Types of CEB

NOTE	
	<p>ATTENTION!</p> <p>Observe the following guidelines!</p>

- A caustic/acid CEB sequence is treated as a single CEB. In Table 6.2-1, this is designated as CEB 1 and is divided into an alkaline CEB 1.1 and an acid CEB 1.2. If an oxidant is added to the alkaline CEB 1.1, it is referred to as CEB 1.1 (B); if no oxidants are added, it is designated as CEB 1.1 (A).
- The acid CEB is designated as CEB 2 (Table 6.2-1). The acid CEB 2 is considered stand-alone, which means it is used independently from other CEB's to enable the effective removal of foulant build-up caused by inorganic water constituents or coagulants (e.g. FeCl₃, PACl).
- The oxidant CEB is designated as CEB 3 (Table 6.2-1). CEB 3 is considered stand-alone, which means it is used independently from other CEB's. It is only required in applications involving the treatment of water discharged from a wastewater treatment plant.

Table 6.2-1 - Organization of the CEB's

	CEB 1			CEB 2	CEB 3
Note	Sequence of two chemical cleaning stages (CEB 1.1 and CEB 1.2): caustic followed by acid			Single stage, Performed separately from other CEBs	Single stage, Performed separately from other CEBs
Purpose	To clean off organic deposits and then to clean off inorganic deposits and/or remove precipitation			To remove inorganic deposits (including coagulant residue)	Disinfection
Subprogram	CEB 1.1(A)	CEB 1.1(B)	CEB 1.2	-	-
Characteristics	Purely alkaline	Alkaline + oxidative	Acid	Acid	Disinfection
Chemicals	NaOH	NaOH und NaOCl	HCl or H ₂ SO ₄	HCl or H ₂ SO ₄	NaOCl

Further advice for the programming of the control logic can be requested at DuPont™.

6.3 How a CEB is Performed

The CEB is essentially performed in a similar way to a backwash, i.e. filtrate flows from the filtrate side to the feed side.

In addition, a cleaning chemical is added to the filtrate to boost the effectiveness of the process. Figure 6.3-1 shows the basic sequence of steps generally used to perform a CEB based on typical values for the respective parameter settings. The chemicals are introduced into the system using a defined flux rate (referred to here as the injection flux rate) of approx. 120 L/(m²h) (71 GFD), which is lower than the backwash flux rate. To improve the distribution of the CEB solution within the rack, the injection of the solution must be divided into a "chemical injection to drain bottom" and a "chemical injection to drain top". The duration of the injection to drain bottom and injection to drain top must be at least 20% of the total duration of the chemical injection time in each case.

Once the rack has been completely filled with cleaning solution (controlled by the chemical injection time setting) the injection process is stopped and the UF rack is isolated by closing all inlet and outlet valves.

This marks the beginning of the soak period. Once the soaking time has elapsed, the chemical solution and the substances removed from the membrane must be washed out of the module(s)/rack with filtrate. This is achieved by means of a Backwash Drain Bottom (with a duration of approximately 30 seconds) followed by a Backwash Drain Top (also with a duration of approximately 30 seconds). The flux rate for rinsing out the solution should be 230 L/(m²h) (135 GFD) just like a normal backwash. Higher flux rates for rinsing are applicable under consideration of the limits as described in the respective product data sheets.

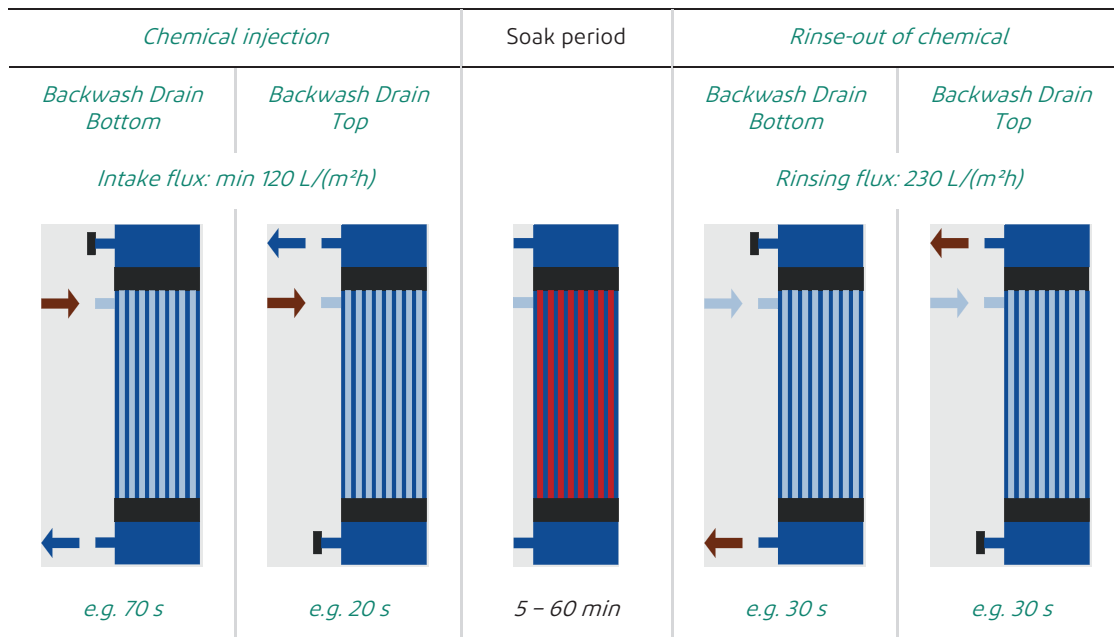


Figure 6.3-1 - Chemically enhanced backwash (CEB) process with typical parameters for an injection flux rate of 120 L/(m²h) (71 GFD)

Chemically Enhanced Backwash (CEB)

The time required to wash the chemicals into the module(s)/rack in a CEB depends on the position of the chemical dosing points (referred to here as t_{ex} (= “**external time**”, which is defined as the time required for the CEB solution to make its way from the chemical dosing point to the rack), installed mixing devices, and on the respective flow velocities in the backwash piping and in the piping systems built into the rack. At an injection flux rate of 120 L/(m²h) (71 GFD), the chemical injection time (measured from the moment the CEB solution enters the rack[®] until the entire rack[®] is completely filled) is approximately 60 - 90 seconds. This time period is referred to here as t_{int} (= “**internal time**” inside the rack).

The total chemical injection time total is the sum of t_{int} and the time period t_{ex} (see Figure 6.3-2). The precise figures for these two time periods should be calculated as part of the system commissioning process.

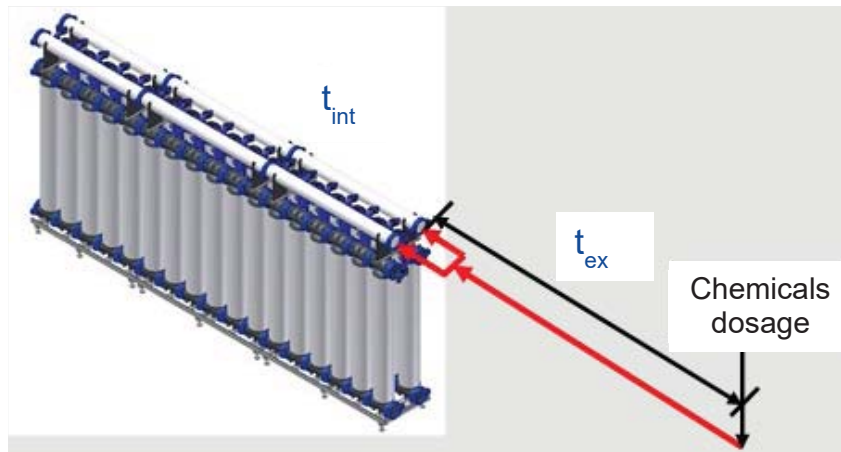


Figure 6.3-2 - Total chemical injection time during CEB