Hardness Removal Using Cuf

The Cuf (Ceramic Ultra-Filtration) process will remove high levels of hardness to the desired 80 ppm range in a cost effective and simple method.

Conventional Hardness Removal

Chemical precipitation is used in conventional hardness removal by the addition of lime ($Ca(OH)_2$) or soda ash (Na_2CO_3) prior to a rapid mix tank, which is then followed by flocculation, sedimentation, recarbonation (acidification) and filtration[1,2]. This type of hardness removal (Lime Softening) operates at elevated pH in the 10.5 range followed by Neutralization using acid.

Cuf Harness Removal

The Cuf process, utilises simple sodium hydroxide to promote precipitation of Magnesium (Mg) and Calcium (Ca). A novel component of the Cuf process is that the precipitation of the Ca and Mg occurs at a much lower pH of 8.6. This reduces chemical requirements for softening and eliminates the need for post acid addition for neutralization.

Depending on the initial characteristics of the source water, sometimes stoichiometric amounts of bicarbonate ion must be added to maintain appropriate water chemistry (i.e. if there is insufficient alkalinity in the water for precipitation).

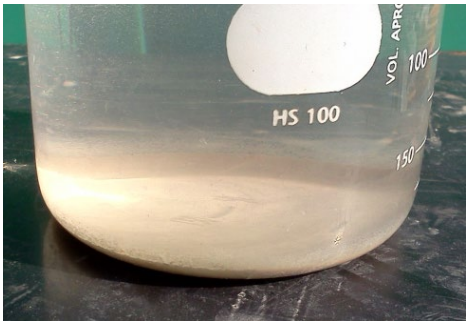
Hardness removal has the added environmental benefit of eliminating the customer practice of water softeners and salt addition to municipal waste water.

The Cuf process offers hardness removal “in one step”, reducing process complexity and footprint. This hardness removal can be in combination with other contaminate removal such as metals, bacteria, DOC removal in the same Cuf process as illustrated in the case study below.

Case Study: Hardness Removal

Cuf was successfully piloted for drinking water purification from a GUDI well with contaminants of concern consisting of Hardness and Manganese (Mn). These contaminates are not removed in the existing treatment plant. The Cuf process removed Hardness, Mn and exceeded all potable water treatment requirements offered by the existing treatment plant. The Cuf produces **better water** at **lower cost**.

Parameter	Well Water Influent	Cuf Filtrate
Manganese	70 – 200 ppb	< 1 ppb
Hardness (as $CaCO_3$)	350 – 390 ppm	85 ppm
pH	7.14 – 8.04	8.6



Filtered Mn and Ca Precipitation

Cuf Advantages with NO Additional CAPEX

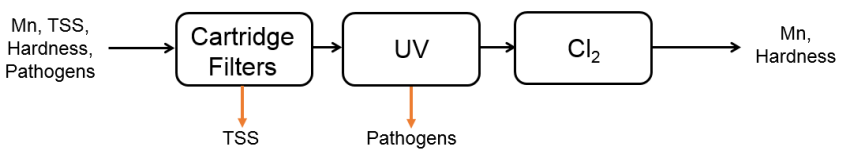
The critical advantage is that the Cuf process purifies the water of

- Hardness & Manganese (existing plant & cost structure does not)
- Provides primary & secondary disinfection and eliminates the need for UV
- Provides LT2ESWTR Compliance (> 5 log removal)[4]
- Significantly Reduces Chlorine demand and allows conversion from Chloramines to Free Chlorine
- Can simultaneously remove
    - Other metals such as Iron chemical free
    - Remove TSS
    - Remove DOC (with coagulant addition) which removes THM and HAA precursors

System Configurations & Costs

The existing treatment plant consists of cartridge filters (2 parallel trains, each train with a 5 um and 1 um filter), followed by UV for primary disinfection, and chlorination for secondary disinfection. The plant generally runs at a flow rate of approximately 6.5 - 7 L/s (600 m^3/day). The primary operating cost for the existing plant consists of bi-monthly cartridge filter replacement, power & maintenance for the UV system (1.9 kW)[3] and Chlorine addition.

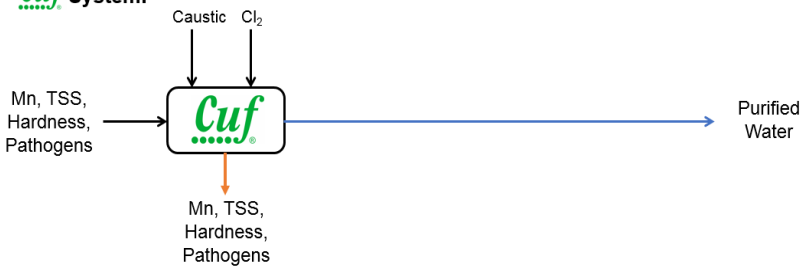
Existing System:



The Cuf process reduces operating costs by:

- Eliminating filter consumables & unit operations
- Reduced labor as Cuf is fully automated
- Eliminates frequent line flushing for metals

Cuf System:



Summary of Cost Comparison:

CASE: 13 L/s	OPEX	Annual Cost	OPEX Ratio	CAPEX Ratio
Existing System	\$ 0.130/m^3	\$ 26,644	1.0	1.0
Cuf	\$ 0.066/m^3	\$ 13,570	0.51	0.48

References:

1. US EPA. Drinking Water Treatability Database: Precipitative Softening. https://iaspub.epa.gov/tdb/pages/treatment/treatmentOverview.do
2. Minnesota Water Works Operations Manual. 2009. https://www.mrwa.com/mnwaterworksmnl.html
3. Operating cost structure information obtained by existing plant operators.
4. 3rd Party Verification "Direct Integrity Challenge Study – A Field Verification Testing for LT2ESWTR Compliance" conducted by NEWT (Nanotechnology-Enabled Water Treatment)
5. Refer to document DOC3074 for CUF® sizing estimate.

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