BoMet

Boron selective adsorbent resin from Hungary

Boron Fluorine Iodine Arsenic Mitigation Technology

S-Metalltech '98 Ltd

EDITION 2015-4

BoMet is a highly effective regenerable granular absorbent resin that removes boric acid from aqueous sources.

The main component of the **BoMet** product is the cerium-oxide as absorbent. In addition to this material this product contains only polymer substrate, thus they can be safely used for treatment of drinking water.

ADSORPTION MECHANISM

Boron dissolved in water at pH 7 and above occurs as $B(OH)_4^-$. The borate anion reacts with the OH- group of the filter media and adsorbs. The type of reaction is replacement and the adsorption can be treated as ion exchange.

Adsorption:

$$Ce - OH + B(OH)_4^- \rightarrow Ce - B(OH)_4 + OH^-$$

Desorption / Regeneration:

$$Ce - B(OH)_4 + NaOH \rightarrow Ce - OH + B(OH)_4^- + Na^+$$

The different methods for the removal of boron from water can be classified in these categories: adsorption method, ion exchange method, membrane process method (reverse osmosis).

BoMet is a specially developed filter resin that offers cost-effective, sustainable and low–power solution in water treatment.

PROPERTIES

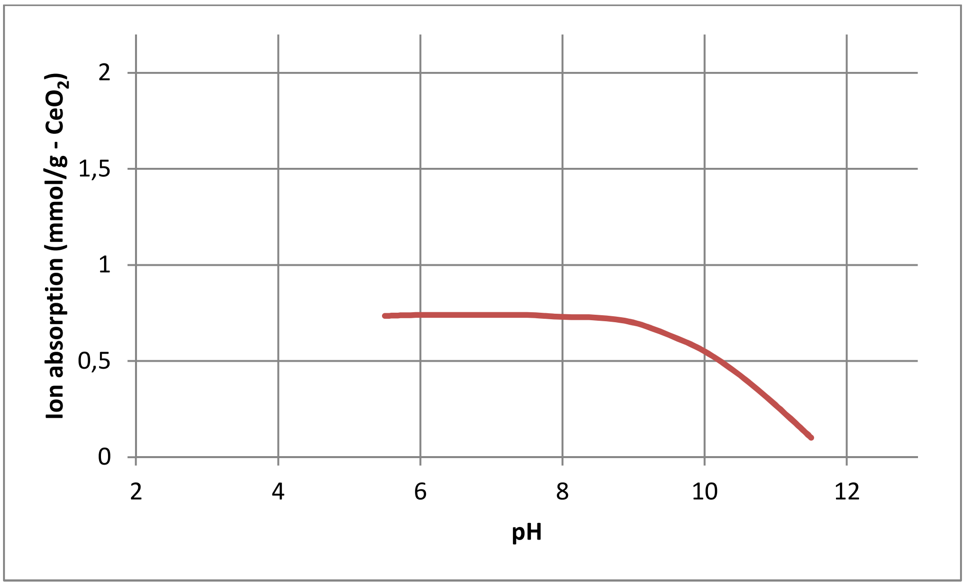


Figure 1 **Effect of pH on $B(OH)_4$ ion absorption of hydrous cerium oxide**

		BoMet
Product		Boron
Composition		Hydrated cerium-oxide embedded in polymer substrate
Properties	Total boron adsorption [g/l-Ad]	10
	Specific gravity	1.8
	Average bead size [mm]	0.7
Use conditions	Pretreatment	Not necessary
	pH	7 – 9
	Max. operating temperature [°C]	50
	Contaminants that have influence on adsorption efficiency	High concentrations of oxidizing or reducing agents, PO_4^{3-}, F^-, HCO_3^-, SiO_2
Condition of regeneration		NaOH, HCl

Table 1 **Physical properties of BoMet**

SUPPORT

Expert engineers from S-Metalltech 98 Ltd. can participate in adaption of BoMet-based boron mitigation technology. Involving partner companies S-Metalltech 98 Ltd. is able to design and construct full waterworks.

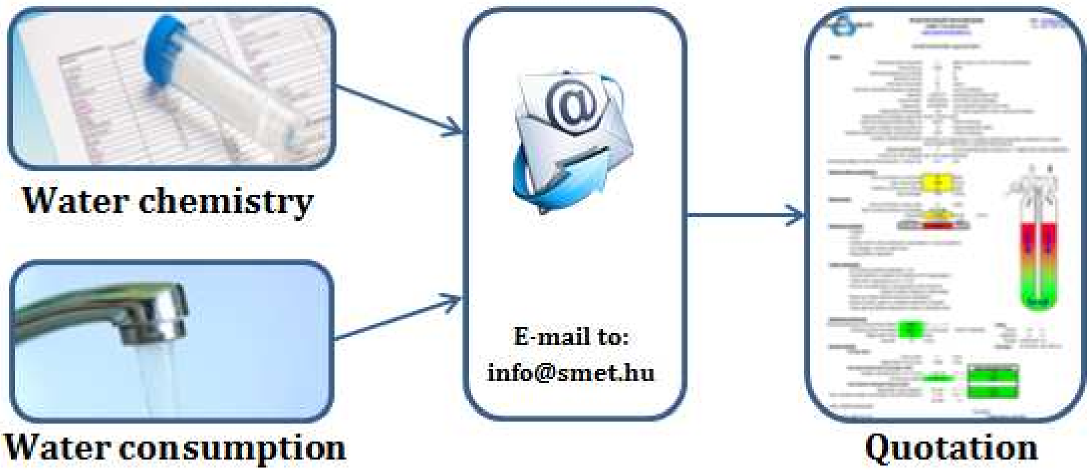
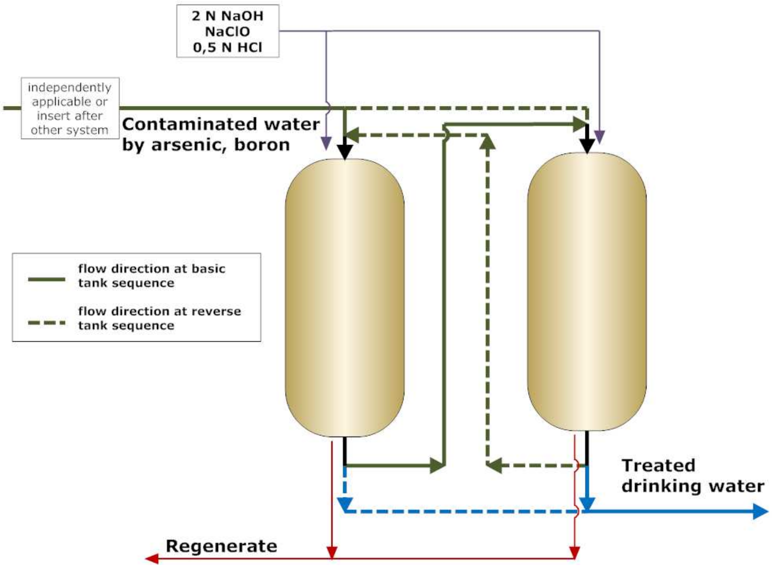


Figure 2 **The block diagram shows how simple to acquire quotation for BoMet technology**

PLANT DESIGN

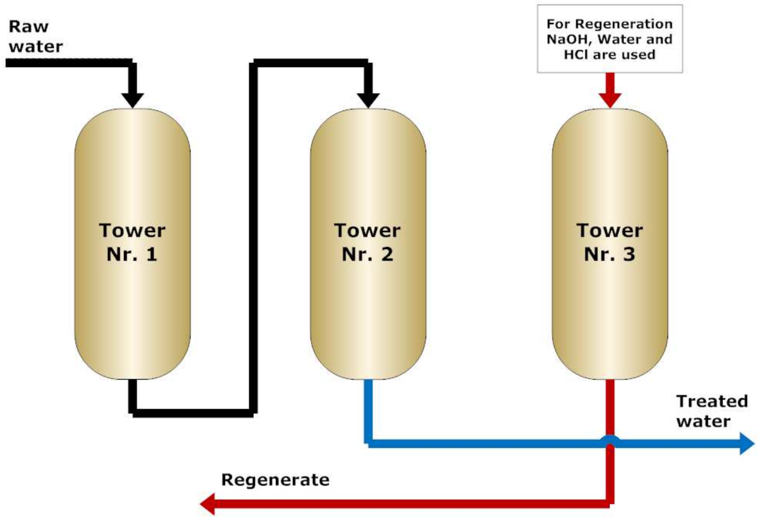


CASE 1:

Very simple (lead-lag) design flow-through unit with a few minutes contact time. For boron contaminated raw water it is preferable to pass through a filter (two containers in series), which are filled with absorbent material **BoMet**. Two towers are connected in series and the feed water is passed through them. When concentration of boron at the outlet of the first tower exceeds the specified value, only the second tower should be operated and the first tower should be regenerated. When regeneration is finished, the water has to flow through the second and the first in this sequence.

- The equipment filled with filter material operates without human supervision, constant supply of energy and chemical addition.
- Regeneration of the first adsorption tower in the chain becomes necessary if the harmful components of the treated water exceed the limit.
- Because of the mechanical contaminants the equipment requires the backwash of the containers weekly, this takes 10 – 15 minutes. The water used for backwash is sewage and does not contain hazardous material.
- In case of significant load 10% of resin replacement proposed annually. The backwash brings the end of life beads to the surface, hence they can be removed and replaced. These cartridges are not classified as hazardous waste after the final regeneration. There is 7 years warranty for the absorbent.

Depending on the amount of the adsorbent material this solution is adaptable in various sizes (domestic, industrial) with the appropriate sized tanks.



CASE 2:

The process consists of three absorbent towers. Two connected in series and the third is on standby. When the concentration at the outlet of the first tower exceeds the specified value, operation of the second and the third should take place and the first should put in regeneration process thus continuous operation can be realized.

REGENERATION

The sodium hydroxide solution used for the regeneration is in a container next to the filter towers. During the regeneration the water from the filter media is drained. After the NaOH solution pumped into the filter tower the regeneration process is going on as circle flow penetration. At the end of the cycle the high boron-containing alkaline solution is returned to the storage tank where the boron will precipitate by addition of calcium hydrate. After removing the precipitation and checking the concentration of regeneration agent it is reusable. The process is well automatable.

BORON IN WATER

Chemical composition of boron compounds are:

- H_3BO_3 : at lower pH than 7 and at lower concentration
- $B(OH)_4^-$: at higher pH than 7 and at lower concentration
- $B_5O_6(OH)_4^-$ and/or $B_4O_5(OH)_5^{2-}$ etc. : at higher concentration

Boron is essential element for the cultivation of fruits and vegetables. However, if it is present in amounts larger than required, it becomes toxic (Nadav, 1999).

Some surface waters contain boron as boric acid. For instance, boron more than 10 mg/L frequently occurs in hot spring waters In addition, industrial wastewaters also contain boron at unacceptable concentrations (Jyo et al., 2001).

WHO GUIDELINES FOR DRINKING-WATER QUALITY - 4TH ED.:

Boron compounds are used in the manufacture of glass, soaps and detergents and as flame retardants. Naturally occurring boron is present in groundwater primarily as a result of leaching from rocks and soils containing borates and borosilicates. The borate content of surface water can be increased as a result of wastewater discharges, but this use has decreased significantly, and levels of boron in wastewater discharges continue to fall.

Guideline value: 2.4 mg/l (2400 μg/l)

Occurrence: Concentrations vary widely and depend on the surrounding geology and wastewater discharges; for most of the world, the concentration of boron in drinking-water is judged to be below 0.5 mg/l

Treatment performance: Conventional water treatment (coagulation, sedimentation, filtration) does not significantly remove boron, and special methods need to be used in order to remove boron from waters with high boron concentrations. Ion exchange and reverse osmosis processes may enable substantial reduction but are likely to be prohibitively expensive. Blending with low-boron supplies may be the only economical method to reduce boron concentrations in waters where these concentrations are high (WRc, 1997).

Additional comments: Because it will be difficult to achieve the guideline value of 2.4 mg/l in some desalinated supplies and in areas with high natural boron levels, local regulatory and health authorities should consider a value in excess of 2.4 mg/l by assessing exposure from other sources.

Assessment date: 2009

Component	Unit	WHO 2011	83/EU 1998	201/2001 Hungarian Government Regulation
Boron	mg/l	2.4	1.0	1.0

Table 2 Guideline limit value of boron in drinking water prescribed by various organizations

Against the directive drafted by the WHO in 1997 the continuously improved **BoMet**-based boron mitigation technology is now competitive with the blending with low boron supplies method.

Cost factors

The following items determine the price of the system:

- **Investment**:
    - Resin (7-10 years product life)
    - Equipment (containers, piping, fittings) capacity dependent value (for 20 years)
- **Running cost:**
    - *Regeneration*:
        - Chemicals
        - Hazardous waste destruction (with different sedimentation techniques the amount of regenerate can be reduced by 60 – 70 %)
    - Energy consumption:
        - Continuous operation: 0 EUR (does not require energy)
        - Pumps at regeneration process
    - Maintenance:
        - Requires backwash weekly
        - Requires a few hours of labor and hazardous waste (regenerate) removal at every regeneration cycles

Fields of applications

BoMet can be used for:

- removal of boron from drinking water,
- treatment of wastewater from electronic parts manufacturing plants,
- decrease the boric acid concentration of reactor coolant of PWR type nuclear reactors,
- removal of boron from seawater.

References

Town of Fábiánsebestyén – Care Centre and the Pankota-Kórogy Kft.

Factory

Location

Industrial Park Jászfényszaru
2532/3 Jászfényszaru
Hungary

Contact

S-Metalltech 98 Materials Research and Development Ltd.
H-1037 Budapest Zay utca 3.
Hungary
www.smet.hu / www.arzenmentesites.hu
E-mail: info@smet.hu
Phone: +36-1-367-92-91

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