Test Canvas

Add, modify, and remove questions. Select a question type from the Add Question drop-down list and click **Go** to add questions. Use Creation Settings to establish which default options, such as feedback and images, are available for question creation.

Add Calculated Formula GO | Creation Settings

Name Softening

Description Questions about softening of CT4471 Drinking Water Treatment 1

Instructions Answer the questions in small groups (2 persons). Think well and you are allowed to consult your lecture notes or other sources.

Modify

Add Question Here

Question 1 **True/False** **10 points** Modify Remove

Question Softening is amongst others applied to decrease the release of heavy metals from the distribution network and to reduce scaling of household equipment.

Answer

- ✓ True
- False

Add Question Here

Question 2 **Multiple Choice** **10 points** Modify Remove

Question A water hardness of 6 oD (German Degrees) is equivalent to ..

Answer

- 6 mmol/l
- 1.6 mmol/l
- ✓ 1 mmol/l
- 0.6 mmol/l

Correct Feedback See table 5.2 in lecture notes

Incorrect Feedback See table 5.2 in lecture notes

Add Question Here

Question 3 **Multiple Answer** **10 points** Modify Remove

Question Which of the following chemicals can be used for softening of drinking water

Answer

- ✓ Caustic soda (NaOH)
- Iron chloride (FeCl3)
- Aluminium sulphate (Al2(SO4)3)
- ✓ Sodium carbonate (Na2CO3)
- ✓ Lime water (Ca(OH)2)
- Gipsum (CaSO4)

Correct Feedback Depending on the situation NaOH, Na2CO3 or Ca(OH)2 is dosed.

Incorrect Feedback Depending on the situation NaOH, Na2CO3 or Ca(OH)2 is dosed.

Add Question Here

Question 4 **True/False** **10 points** Modify Remove

Question

One of the disadvantages of softening in the storage lakes compared to softening in pellet softeners are the high investment costs.

Answer
True
✓ False

Correct Feedback One of the advantages of softening in the storage lakes compared to softening in pellet softeners are the low investment costs. Disadvantages are short circuiting, removal of produced sludge and flexibility related to location in the treatment train.

Incorrect Feedback One of the advantages of softening in the storage lakes compared to softening in pellet softeners are the low investment costs. Disadvantages are short circuiting, removal of produced sludge and flexibility related to location in the treatment train.

Add Question Here

Question 5 **True/False** **10 points** Modify Remove

Question Water with a concentration Na of 63 mg/l, K of 5 mg/l, Ca of 45 mg/l, Mg of 9 mg/l and Fe of 4 mg/l has a hardness of 1.5 mmol/l.

Answer
✓ True
False

Correct Feedback 1.13 mmol/l Ca and 0.37 mmol/l Mg.

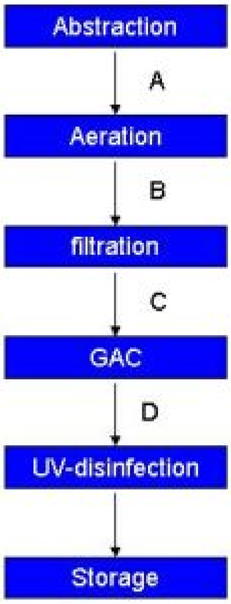
Incorrect Feedback 1.13 mmol/l Ca and 0.37 mmol/l Mg.

Add Question Here

Question 6 **Multiple Answer** **10 points** Modify Remove

Question

Indicate possible locations for softening in the following ground water treatment train



Answer
✓ A
✓ B
✓ C
D

Correct Feedback Softening is possible on raw water, after aeration and after filtration. However, carry over filtration should always be present.

Incorrect Softening is possible on raw water, after aeration and after filtration. However, carry

Feedback over filtration should always be present.

Add Question Here

Question 7 **True/False** **10 points** Modify Remove

Question The disadvantage of softening aerated groundwater is that is has a high carbondioxide concentration.

Answer

True

✓ False

Correct Feedback Raw groundwater can have a high carbondioxide concentration. Carbon dioxide is stripped during aeration.

Incorrect Feedback Raw groundwater can have a high carbondioxide concentration. Carbon dioxide is stripped during aeration.

Add Question Here

Question 8 **Multiple Choice** **10 points** Modify Remove

Question

Assume a water with the following characteristics: ca2+ = 3 mmol/l; Mg2+ = 0.5 mmol/l; HCO3- = 6 mmol/l; CO2 = 2 mmol/l.

Determine the lime dosing and the effluent HCO3- at an effluent total hardness of 1.5 mmol/l

Answer

✓ Ca(OH)2 = 4 mmol/l; HCO3- = 2 mmol/l.

Ca(OH)2 = 2 mmol/l; HCO3- = 2 mmol/l.

Ca(OH)2 = 4 mmol/l; HCO3- = 4 mmol/l.

Ca(OH)2 = 2 mmol/l; HCO3- = 4 mmol/l.

Correct Feedback

Deacidification: 2CO2 + Ca(OH)2 => 2HCO3- + Ca2+

result: dosing of 1 mmol/l; HCO3- = 8 mmol/l; Ca2+ = 4 mmol/l

Softening: Ca(OH)2 + Ca2+ + 2HCO3- => 2CaCO3 + 2h2O

result: dosing of 3 mmol/l; HCO3- = 2 mmol/l; Ca2+ = 1 mmol/l

Total lime dosing: 4 mmol/l

Incorrect Feedback

Deacidification: 2CO2 + Ca(OH)2 => 2HCO3- + Ca2+

result: dosing of 1 mmol/l; HCO3- = 8 mmol/l; Ca2+ = 4 mmol/l

Softening: Ca(OH)2 + Ca2+ + 2HCO3- => 2CaCO3 + 2h2O

result: dosing of 3 mmol/l; HCO3- = 2 mmol/l; Ca2+ = 1 mmol/l

Total lime dosing: 4 mmol/l

Add Question Here

Question 9 **Multiple Choice** **10 points** Modify Remove

Question

The softening of water for the ¿Berenplaat¿ is performed by dosing $Ca(OH)_2$ to the storage pond of the ¿Brabantse Biesbosch¿. The water quality of the river Meuse is (the river Meuse is the feed of the storage lakes): Ca^{2+} = 53 mg/l; Mg^{2+} = 17,5 mg/l; Na^{+} = 37 mg/l; HCO_3^- = 154 mg/l; PH = 7,9; Temperature = 10°C.

What is the hardness of the raw water in mmol/l and the amount of $Ca(OH)_2$ needed to lower the hardness to the regulated value of 1.5 mmol/l

Answer

Hardness is 1.33 mmol/l

Dosing of Ca(OH)2 is 0.6 mmol/l

Hardness is 2.04 mmol/l

Dosing of Ca(OH)2 is 0.6 mmol/l

Hardness is 1.33 mmol/l

Dosing of Ca(OH)2 is 0.65 mmol/l

✓ Hardness is 2.04 mmol/l

Dosing of Ca(OH)2 is 0.65 mmol/l

Correct Feedback

The hardness is 53/40+17.5/24.3=2.04 mmol/l

pH = pK1-log([CO2]/[HCO3-]) --> 7.9 = 6.46-log([CO2]/[2.52]) → CO2 = 0.1 mmol/l

Dosering Ca(OH)2 first removes CO2

$CO_2 + Ca(OH)_2 \rightarrow Ca^{2+} + 2 \cdot HCO_3$

0.1		1.33	2.52
-0.1	-0.05	+0.05	+0.1
0		1.38	2.62

Afterwards the softening reaction till a calcium hardness of 0.78 mmol/l takes place

$Ca(OH)_2 + Ca^{2+} + 2 \cdot HCO_3 \rightarrow 2 \cdot CaCO_3 + 2 \cdot H_2O$

	1.38	2.62
-0.6	- 0.6	- 1.2
	0.78	1.42

In total 0.05 +0.6 = 0.65 mmol Ca(OH)2 is dosed.

Incorrect Feedback

The hardness is 53/40+17.5/24.3=2.04 mmol/l

pH = pK1-log([CO2]/[HCO3-]) --> 7.9 = 6.46-log([CO2]/[2.52]) → CO2 = 0.1 mmol/l

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-0.1	-0.05	+0.05	+0.1

--- +

0 1.38 2.62

Afterwards the softening reaction till a calcium hardness of 0.78 mmol/l takes place

$Ca(OH)2 + Ca^{2+} + 2\cdot HCO3 \rightarrow 2\cdot CaCO3 + 2\cdot H2O$

	1.38	2.62	
-0.6	- 0.6	- 1.2	
	0.78	1.42	

-- +

In total 0.05 +0.6 = 0.65 mmol Ca(OH)2 is dosed.

Add Question Here

Question 10 **True/False** **10 points** Modify Remove

Question

One of the advantages of using $Ca(OH)_2$ for softening is that no Na^+-increase takes place. One of the disadvantages of using $Ca(OH)_2$ is that the buffering capacity of the water decreases more than by using NaOH

Answer

✓ True

False

Correct Feedback No comment

Incorrect Feedback No comment

Add Question Here

Question 11 **True/False** **10 points** Modify Remove

Question

Of a water type the water composition is known: Ca^{2+} = 100 mg/l; Mg^{2+} = 6.1 mg/l; HCO_3^- = 347.7 mg/l; CO_2 = 11.44 mg/l; Na^+ = 10.8 mg/l;

The legislation for the water composition is: total hardness = 1.5 mmol/l; concentration HCO_3^- > 2 mmol/l; concentration Na^+ < 5.2 mmol/l

NaOH is the chemical for softening that is most suited for this water.

Answer

✓ True

False

Correct Feedback

dosing NaOH: 1.51 mmol/l

Ca^{2+}: 1.25 mmol/l
Mg^{2+}: 0.25 mmol/l
Na^+: 1.98 mmol/l
HCO_3^-: 4.71 mmol/l
CO_2: 0 mmol/l

dosing Ca(OH)2: 1.51 mmol/l

Ca^{2+}: 1.25 mmol/l
Mg^{2+}: 0.25 mmol/l
Na^+: 0.47 mmol/l
HCO_3^-: 3.22 mmol/l
CO_2: 0 mmol/l

Ca(OH)2 is the most appropriate chemical for softening

Add Question Here

Question 12 **Multiple Choice** **10 points** Modify Remove

Question The most important reason that split treatment during softening is not applied, is:

Answer

Supersaturation of calcium carbonate in the mixed effluent.

Low temperatures during winter and thus slow crystallisation.

Costs of construction of the softening reactors.

✓ High magnesium concentrations in the raw water.

Correct Feedback Calcium reduction in a pellet reactor is limited to aproximately 0.5 mmol/l. When high magnesium concentrations occur in the raw water (up to 1 mmol/l), it is not possible to apply split treatment for softening until a total hardness of 1.5 mmol/l.

Incorrect Feedback Calcium reduction in a pellet reactor is limited to aproximately 0.5 mmol/l. When high magnesium concentrations occur in the raw water (up to 1 mmol/l), it is not possible to apply split treatment for softening until a total hardness of 1.5 mmol/l.

Add Question Here

Question 13 **Multiple Answer** **10 points** Modify Remove

Question

The most important reason(s) why split treatment is applied, is/are:

(more answers can be right)

Answer

✓ Supersaturation of calcium carbonate in the mixed effluent.

Low temperatures during winter, thus kinetics of crystallisation are slow.

✓ Construction costs of the pellet reactors.

High magnesium concentrations in the raw water.

Correct Feedback Applying split treatment less reactors can be build and the mixed effluent has a lower level of supersaturated calcium carbonate.

Incorrect Feedback Applying split treatment less reactors can be build and the mixed effluent has a lower level of supersaturated calcium carbonate.

Add Question Here

Question 14 **Multiple Choice** **10 points** Modify Remove

Question

Of a water type the water composition is known: Ca^{2+} = 100 mg/l; Mg^{2+} = 6.1 mg/l; HCO_3^- = 347.7 mg/l; CO_2 = 11.44 mg/l; Na^+ = 10.8 mg/l;

The legislation for the water composition is: total hardness = 1.5 mmol/l; concentration HCO_3^- > 2 mmol/l; concentration Na^+ < 5.2 mmol/l

There is a possibility to soften in a split stream. How large should the split stream be if this spilt stream can be softened to 0.7 mmol/l?

Answer

✓ 0.61 times total flow

0.39 times total flow

0.77 times total flow

0.23 times total flow

Correct Feedback Q*1.5 = (Q-R)*2.75 + R*0.7 --> 1.25*Q = 2.05*R --> R = 0.61*Q

Incorrect Feedback Q*1.5 = (Q-R)*2.75 + R*0.7 --> 1.25*Q = 2.05*R --> R = 0.61*Q

Add Question Here

Question 15 **True/False** **10 points** Modify Remove

Question The kinetics of crystallisation of calcium carbonate on the pellets, depends amongst others on temperature, grain size and flow velocity

Answer ✓ True
False

Correct Feedback The kinetic constant (and the porosity) is dependent on temperature.

The grain size influences the specific crystallisation surface area.

The flow influences the porosity and thus the specific crystallisation surface area.

Incorrect Feedback The kinetic constant (and the porosity) is dependent on temperature.

The grain size influences the specific crystallisation surface area.

The flow influences the porosity and thus the specific crystallisation surface area.

Add Question Here

Question 16 **True/False** **10 points** Modify Remove

Question With an increase of temperature the specific surface area in a fluidised bed increases, because of a decrease in porosity

Answer ✓ True
False

Correct Feedback S = 6*(1-pe)/d

$pe^3/(1-pe)^{0.8}=130v^{0.3}/g*\rho_w/(\rho_p-\rho_w)*v^{1.2}/d^{1.8}$ d

Increase of temperature => decrease of viscosity => decrease of porosity => increase of specific surface area.

Incorrect Feedback S = 6*(1-pe)/d

$pe^3/(1-pe)^{0.8}=130v^{0.3}/g*\rho_w/(\rho_p-\rho_w)*v^{1.2}/d^{1.8}$ d

Increase of temperature => decrease of viscosity => decrease of porosity => increase of specific surface area.

Add Question Here

Question 17 **True/False** **10 points** Modify Remove

Question The head loss in a fluidised bed is amongst others dependent on the filterbed height, the density of the pellets and the flow velocity.

Answer True
✓ False

Correct Feedback The head loss in a fluidised bed is amongst others dependent on the fixed filter bed height, the fixed filter bed porosity and the density of the pellets. Not on flow velocity.

Incorrect Feedback The head loss in a fluidised bed is amongst others dependent on the fixed filter bed height, the fixed filter bed porosity and the density of the pellets. Not on flow velocity.

Add Question Here

Question 18 **Multiple Choice** **10 points** Modify Remove

Question

What is the head loss in a fluidised bed, assuming the following data:

Fixed bed height = 2 m; maximum pellet grain size 1 mm; fixed bed porosity = 0.4; minimum fluidised bed porosity = 0.5; density pellets = 2700 kg/m3; flow velocity = 80 m/h; temperature = 10 oC.

Answer 2 m

✓ 2.04 m
1 m
1.02

Correct Feedback H = (1-p)*L*(rhop-rhow)/rhow = 2.04 m

Incorrect Feedback H = (1-p)*L*(rhop-rhow)/rhow = 2.04 m

Add Question Here

Question 19 **Multiple Choice** **10 points** Modify Remove

Question

What is the bed height of a fluidised bed, assuming the following data:

Fixed bed height = 2 m; pellet grain size 1 mm; fixed bed porosity = 0.4; density pellets = 2700 kg/m3; flow velocity = 80 m/h; temperature = 10 oC.

Answer

✓ 2.68 m
3.27 m
4.13 m
5.39 m

Correct Feedback Le = (1-pe)/(1-po)L;

$$pe^3/(1-pe)^{0.8}=130v^{0.3}/g*\rho_w/(\rho_p-\rho_w)*v^{1.2}/d^{1.8} \Rightarrow pe = 0.55$$

=> Le = 2.68 m

Incorrect Feedback Le = (1-pe)/(1-po)L;

$$pe^3/(1-pe)^{0.8}=130v^{0.3}/g*\rho_w/(\rho_p-\rho_w)*v^{1.2}/d^{1.8} \Rightarrow pe = 0.55$$

=> Le = 2.68 m

Add Question Here

Question 20 **Multiple Choice** **10 points** Modify Remove

Question

Normally, several softening reactors are placed in parallel. What is the main reason for that?

Answer

The limited size of the steel reactors.
✓ Flexibility in operation.
Equal distribution of chemicals over the bottom.
Construction costs of softening reactors

Correct Feedback The softening reactors can handle a flow velocity between 60 and 100 m/h. Variations in flow can heve that magnitude that one reactor is not sufficient. For flexibility in operation it is therefore necessary to install more than one reactor (apart from maintenance purposes).

Incorrect Feedback The softening reactors can handle a flow velocity between 60 and 100 m/h. Variations in flow can heve that magnitude that one reactor is not sufficient. For flexibility in operation it is therefore necessary to install more than one reactor (apart from maintenance purposes).

Add Question Here

Question 21 **Multiple Choice** **10 points** Modify Remove

Question What type of reactor you see on the photograph

Answer		Spiractor
		Blackpool reactor
	✓	Amsterdam reactor
		Woerden reactor
Correct Feedback	You see a Amsterdam reactor. The reactor is placed at Amsterdam Water Supply and is characterised by its flat bottom.	
Incorrect Feedback	You see a Amsterdam reactor. The reactor is placed at Amsterdam Water Supply and is characterised by its flat bottom.	

Add Question Here

OK