This problem corresponds to FEENP page P1-29, problem number 51.

Return to Questions (/admin/questions/4?sfield=magento_id&stext=89591&sdka=&stype=&sdiff=)

Test Bank Question preview

Question

Assume a first-order reaction for destruction of chloroform. For chloroform, the frequency factor is 2.90×10^{12}/s and the activation energy is 49 kcal/mol. The temperature needed to achieve 99.99% destruction of chloroform in an incinerator treating contaminated soil that has a 1.2 s residence time is most nearly

Answers

(A) 800K

(B) 900K

(C) 1000K

(D) 2000K

The answer is (B).

Solution

Content in blue refers to the NCEES Handbook.

For a first-order reaction,

First-Order Irreversible Reaction

$$-dC_A/dt = kC_A$$
$$\frac{dC_A}{dt} = -kC_A$$

Integrate to get

$$\int_{C_{A,0}}^{C_A} \frac{1}{C_A} dC_A = -k \int_0^t dt$$
$$\ln \frac{C_A}{C_{A,0}} = -kt$$

Solve for *k*.

$$k = \frac{1}{t} \ln \frac{C_{A,0}}{C_A}$$

Solve the Arrhenius equation for *T*.

Chemical Reaction Engineering — Nomenclature

$$k = Ae^{-Ea/\bar{R}T}$$
$$\ln \frac{k}{A} = -\frac{E_a}{\bar{R}T}$$
$$T = -\frac{E_a}{\bar{R} \ln \frac{k}{A}}$$

Substitute for *k*.

$$T = -\frac{E_a}{\bar{R} \ln \frac{\frac{1}{t} \ln \frac{C_{A,0}}{C_A}}{A}}$$
$$= \frac{-49 \times 10^3 \frac{\text{cal}}{\text{mol}}}{\left(1.987 \frac{\text{cal}}{\text{mol·K}}\right) \ln \frac{\frac{1}{2} \ln \frac{1}{1 \times 10^{-4}}}{2.90 \times 10^{12} \frac{1}{\text{s}}}}$$
$$= 9$$

QUESTION DATA

Vendor
0000089591
Solving Time
2-4
Difficulty
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Quantitative?
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Status
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OTHER VERSIONS

12/05/2017 09:17:55 PM (/admin/questions/preview/14685)

11/15/2018 12:07:42 AM (/admin/questions/preview/17266)

DISCIPLINES

FE Chemical (/admin/questions/index?sfield=discipline&stext=FE Chemical)

FE Environmental (/admin/questions/index?sfield=discipline&stext=FE Environmental)

KNOWLEDGE AREAS

Chemical Reaction Engineering (/admin/questions/index?sfield=area&stext=Chemical Reaction Engineering)

Environmental Science and Chemistry (/admin/questions/index?sfield=area&stext=Environmental Science and Chemistry)

PRODUCTS USED IN DSENW

This problem corresponds to FEENP page E1-42, problem number 107.

Return to Questions (/admin/questions/0?sfield=magento_id&stext=162145&sdka=&stype=&sdiff=)

Test Bank Question preview

Question

A sample of water contains ionic components at the concentrations shown. The alkalinity of the sample is 82 as $CaCO_3$, and the pH of the sample is 7.01.

Ca^{2+}	90 mg/L
Mg^{2+}	92 mg/L
Na^{+}	18 mg/L

The non-carbonate hardness of the sample is most nearly

Answers

(A) ~~210~~ meq/L

(B) ~~310~~ meq/L

(C) ~~520~~ meq/L

(D) ~~625~~ meq/L

The answer is (C).

Solution

Content in blue refers to the NCEES Handbook.

Non-carbonate hardness is equal to the total hardness minus the carbonate hardness.

First, find the total hardness. From a table of equivalent weights, the equivalent weight of Ca2+ is 20.0. [Lime-Soda Softening Equations]

The equivalent concentration is

$$\frac{90\ \frac{\text{mg}}{\text{L}}}{20.0} = 4.5\ \text{meq/L}$$

From a table of common radicals in water, the equivalent weight of Mg^{2+} is 12.2. The equivalent concentration is

$$\frac{92\ \frac{\text{mg}}{\text{L}}}{12.2} = 7.541\ \text{meq/L}$$

The Na^{+} does not add to the total hardness. The total hardness of the water sample is

$$4.5\ \frac{\text{meq}}{\text{L}} + 7.541\ \frac{\text{meq}}{\text{L}} = 12.041\ \text{meq/L}$$

The carbonate hardness in terms of $CaCO_3$ is the same as the alkalinity as $CaCO_3$, 82 mg/L. From a table of common radicals in water, the equivalent weight of $CaCO_3$ is 50.0.

The equivalent concentration is

$$\frac{82\ \frac{\text{mg}}{\text{L}}}{50.0} = 1.64\ \text{meq/L}$$

~~The total hardness in terms of $CaCO_3$ is~~

$$\cancel{\left(12.041\ \frac{\text{meq}}{\cancel{\text{L}}}\right)(50.0) = 602.05\ \text{meq/L}}$$

The non-carbonate hardness is

QUESTION DATA

Vendor
0000162145
Solving Time

Difficulty

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No
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OTHER VERSIONS

DISCIPLINES

FE Civil (/admin/questions/index?sfield=discipline&stext=FE Civil)

FE Environmental (/admin/questions/index?sfield=discipline&stext=FE Environmental)

KNOWLEDGE AREAS

Water Resources and Environmental Engineering (/admin/questions/index?sfield=area&stext=Water Resources and Environmental Engineering)

Water and Wastewater (/admin/questions/index?sfield=area&stext=Water and Wastewater)

PRODUCTS USED IN FEEN3EX

$$
\begin{aligned}
\text{non-carbonate hardness} &= \text{total hardness} - \text{carbonate hardness} \\
&= 602.05\ \frac{\text{meq}}{\text{L}} - 82\ \frac{\text{meq}}{\text{L}} \\
&= 520.05\ \text{meq/L} \quad (520\ \text{meq/L})
\end{aligned}
$$