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*.

$$T = -\frac{E_a}{\bar{R} \ln \frac{\frac{1}{t} \ln \frac{C_{A,0}}{C_A}}{A}}$$

$$= \frac{-49 \times 10^3 \ \frac{\text{cal}}{\text{mol}}}{\left(1.987 \ \frac{\text{cal}}{\text{mol·K}}\right) \ln \frac{\frac{1}{1.2 \ \text{s}} \ln \frac{1}{1 \times 10^{-4}}}{2.90 \times 10^{12} \ \frac{1}{\text{s}}}}$$

$$= 900\text{K}$$

QUESTION DATA

Vendor
0000089591

Solving Time
2-4

Difficulty
medium

Quantitative?
Yes

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OTHER VERSIONS

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

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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.

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~~ meg/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~~

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

The non-carbonate hardness is

QUESTION DATA

Vendor

0000162145

Solving Time

Difficulty

Quantitative?

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

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

This problem corresponds to FEENP page E2-11, problem number 78.

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Test Bank

Question preview

Question

A rounded venturi meter with a throat diameter of 1.5 in is placed in a 3.0 in horizontal pipe. The pressure drop is 3 mm Hg. The volumetric flow rate is most nearly

Answers

(A) ~~0.0011~~ m^3/s

(B) 0.0022 m^3/s

(C) 0.0033 m^3/s

(D) 0.0044 m^3/s

The answer is (A).

Solution

Content in blue refers to the NCEES Handbook.

The equation for the volumetric flow rate is

Venturi Meters

$$Q = \frac{C_v A_2}{\sqrt{1-(A_2/A_1)^2}}\sqrt{2g\left(\frac{P_1}{\gamma}+z_1-\frac{P_2}{\gamma}-z_2\right)}$$

This can be simplified to

$$Q = \frac{C_v A_2}{\sqrt{1-(A_2/A_1)^2}}\sqrt{\frac{2(P_1-P_2)}{\rho}}$$

The ratio of the areas is

$$\frac{A_2}{A_1} = \left(\frac{D_2}{D_1}\right)^2 = \left(\frac{1.5\text{ in}}{3.0\text{ in}}\right)^2 = 0.25$$

The area of the throat in units of square meters is

$$\begin{aligned} A_2 &= \frac{\pi D_2^2}{4} \\ &= \left(\frac{\pi}{4}\right)\left(\frac{1.5\text{ in}}{12\ \frac{\text{in}}{\text{ft}}}\right)^2\left(30\ \frac{\text{cm}}{\text{ft}}\right)^2\left(\frac{1\text{ m}}{100\text{ cm}}\right)^2 \\ &= 0.0011\text{ m}^2 \end{aligned}$$

The coefficient C_v = 0.98 for a rounded venturi meter.

QUESTION DATA

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Solving Time

Difficulty

Quantitative?

No

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OTHER VERSIONS

DISCIPLINES

FE Industrial and Sys (/admin/questions/inc sfield=discipline&ste Industrial and Systen

FE Chemical (/admin/questions/inc sfield=discipline&ste Chemical)

FE Other Disciplines (/admin/questions/inc sfield=discipline&ste Other Disciplines)

FE Civil (/admin/questions/inc sfield=discipline&ste Civil)

Convert the pressure drop to units of N/m^2.

$$(3\ \text{mm Hg})\left(760\ \frac{\text{atm}}{\text{mm Hg}}\right)\times\left(9.689\times 10^{-6}\ \frac{\text{atm}\cdot\text{m}^2}{\text{N}}\right) = 399\ \text{N/m}^2$$

The volumetric flow rate is

$$Q = \left(\frac{(0.98)(0.0011\ \text{m}^2)}{\sqrt{1-(0.25)^2}}\right)\sqrt{\frac{(2)\left(399\ \frac{\text{N}}{\text{m}^2}\right)}{\left(1\ \frac{\text{g}}{\text{cm}^3}\right)\left(10^3\ \frac{\text{kg}}{\text{m}^3}\right)}}$$

$$= 0.0011\ \text{m}^3/\text{s}$$

FE Environmental (/admin/questions/inc sfield=discipline&stex Environmental)

PE Chemical (/admin/questions/inc sfield=discipline&stex Chemical)

KNOWLEDGE AREAS

Facilities and Supply (/admin/questions/inc sfield=area&stext=Fa and Supply Chain)

Fluid Mechanics/Dynamics (/admin/questions/inc sfield=area&stext=Flu Mechanics/Dynamics

Fluid Mechanics (/admin/questions/inc sfield=area&stext=Flu Mechanics)

Fluid Mechanics (/admin/questions/inc sfield=area&stext=Flu Mechanics)

Fluid Mechanics and Hydraulics (/admin/questions/inc sfield=area&stext=Flu Mechanics and Hydraulics)

Flow and Pressure Measurement Techniques (/admin/questions/inc sfield=area&stext=Flo and Pressure Measurement Techniques)

PRODUCTS USED IN

FEEN4EX