Chapter 2 Diffusion in dilute solutions

1. Water evaporation

To find the rate of evaporation, we need to find the flux of water across the air film:

$$\dot{f_1} = \frac{DH}{\ell} \Delta c_1$$

Since the film is made up of air, H = 1. We are given D and ℓ , so we need to find de_{ℓ} . We first calculate the difference in the partial pressure of water across the film. From a steam table we find that at 20 °C, $p_{tot} = 2.3388$ kPa. Since the air immediately above the water is saturated we have:

$$\Delta p_i = p_{im} - 0.5 p_{im} = 0.5 p_{im} = 0.5(2.3388 kPa) = 1.1694 kPa = 1169.4 Pa$$

Assuming an ideal gas, we can find the concentration difference:

$$\Delta c_1 = \frac{\Delta p_1}{RT} = \frac{1169.4 \, Pa}{\left(8.3145 \, \frac{J}{K \cdot mol}\right) (293 \, K)} = 0.48 \, \frac{mol}{m^3} = 4.8 \cdot 10^{-7} \, \frac{mol}{cm^3}$$

We can now calculate the flux:

$$J_1 = \frac{0.25 \frac{cm^2}{s}}{0.15 cm} \left(4.8 \cdot 10^{-7} \frac{mol}{cm^3} \right) = 8.0 \cdot 10^{-7} \frac{mol}{cm^2 s}$$

To find the height change, we divide by the molar density of water:

$$\frac{8.0 \cdot 10^{-3} \frac{mol}{cm^2 s}}{1 \frac{g}{cm^3} \cdot \frac{1 mol}{18.015 g}} = 1.44 \cdot 10^{-3} \frac{cm}{s} = 1.25 \frac{cm}{day}$$

2. Diffusion across a monolayer

Recalling that the resistance is the inverse of the permeance, we have:

$$\frac{1}{P} = 2 \frac{s}{cm} \Rightarrow P = 0.5 \frac{cm}{s}$$

We know that the permeance is given by:

$$P = \frac{DH}{\ell} \Rightarrow D = \frac{P\ell}{H} = \frac{\left(0.5 \frac{cm}{s}\right) \left(2.5 \cdot 10^{-7} cm\right)}{0.018} = 7 \cdot 10^{-6} \frac{cm^2}{s}$$

3. Diffusion coefficient of NO; in water

We treat the water as a semiinfinite slab. From Eq. (2.3-18) we know that the flux at the surface is given by:

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Huw Golledge, Claire Richardson

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Chemical Product Design E. L. Cussler, G. D. Moggridge, 2011-05-12 The chemical industry is changing going beyond commodity chemicals to a palette of higher value added products This groundbreaking book now revised and expanded documents this change and shows how to meet the challenges implied Presenting a four step design process needs ideas selection manufacture the authors supply readers with a simple design template that can be applied to a wide variety of products Four new chapters on commodities devices molecules drugs and microstructures show how this template can be applied to products including oxygen for emphysema patients pharmaceuticals like taxol dietary supplements like lutein and beverages which are more satisfying For different groups of products the authors supply both strategies for design and summaries of relevant science Economic analysis is expanded emphasizing the importance of speed to market selling ideas to investors and an expectation of limited time in the market Extra examples homework problems and a solutions manual are available Solution Behavior of Surfactants K.L. Mittal, E.J. Fendler, 2012-12-06 This and its companion Volume 2 comprise the proceedings of the International Symposium on Solution Behavior of Surfactants Theoretical and Applied Aspects organized under the auspices of the 11th Northeast Regional Meeting of the American Chemical Soci ety held in Potsdam N Y June 30 July 3 1980 This Symposium re presented the third event in the series of symposia dealing with the topic of surfactants in solution The first Symposium was held in Albany N Y in 1976 under the title Micellization Solubili zation and Microemulsions 1 the proceedings of which have been doc umented in a two volume set The second was held under the title olution Chemistry of Surfactants in 1978 in Knoxville TN and the proceedings of this event have also been properly chronicled Apropos the fourth biennial Symposium in this series is entitled International Symposium on Surfactants in Solution K L Mittal and B Lindman Cochairmen and is scheduled to be held from June 27 to July 2 1982 in Lund Sweden Since these biennial events have been very successful and important in bringing researchers with varied interests together and in stimulating interdisciplinary communication so the plans are to continue these on a regular basis with a change in venue for Clive Cussler's The Devil's Sea Dirk Cussler, 2021-11-11 DIRK PITT IS BACK AND ON HIS SHOULDERS each meeting RESTS THE FATE OF THE ENTIRE PLANET JOIN THE LATEST THRILL RIDE FROM THE GRAND MASTER OF ADVENTURE CLIVE CUSSLER In 1959 a Skytrain plane flees Tibet carrying a precious artefact but after crossing the Himalayas it is never seen again Sixty years later Dirk Pitt and NUMA are surveying near the Philippines when a rogue wave nearly sinks their ship Diverting to rescue washed away islanders Pitt discovers the wave has raised a sunken relic an ancient cargo plane But before he can get to the bottom of one mystery Pitt is hit with another beat the Chinese military to find a lost hypersonic missile Yet what should be a simple search and retrieve reveals evidence of a far more dangerous weapon Because the rogue wave that almost sank Pitt and devastated the islands was no natural phenomenon And the weapon that caused it is to be turned on a much bigger target

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appendices include conversion of units selected thermophysical properties plant utilities and an extensive list of manufacturers and suppliers of food equipment Handbook of Fat Replacers Sibel Roller, Sylvia A. Jones, 1996-06-20 Technology is only beginning to catch up with the public demand for foods that are low in fat and taste good An extensive number of ingredients are under development for the sole purpose of fat replacement using a variety of approaches and base materials The Handbook of Fat Replacers describes in detail for the first time in a single volume the science and application of fat replacers in food products including the multiplicity of technological legislative sensory nutritional and marketing issues involved Part I of the Handbook is an overview of fundamental issues including historical analyses and critical assessments of technological strategies in the development of low fat foods and the ingredients used as fat replacers Part II discusses individual fat replacers and their properties in detail The compounds are organized by their composition starch derived fiber based protein based gums emulsifiers bulking agents combination systems comprised of interactive blends low calorie fats and synthetic fat substitutes are all examined in detail Forthcoming Books Rose Arny, 2004 **Process Engineering** Phillip C. Wankat, 2022-10-24 The Definitive Learner Friendly Guide to Chemical Engineering Separations Extensively Updated Including a New Chapter on Melt Crystallization Efficient separation processes are crucial to addressing many societal problems from developing new medicines to improving energy efficiency and reducing emissions Separation Process Engineering Fifth Edition is the most comprehensive accessible guide to modern separation processes and the fundamentals of mass transfer In this completely updated edition Phillip C Wankat teaches each key concept through detailed realistic examples using actual data with up to date simulation practice spreadsheet based exercises and references Wankat thoroughly covers each separation process including flash column and batch distillation exact calculations and shortcut methods for multicomponent distillation staged and packed column design absorption stripping and more His extensive discussions of mass transfer and diffusion enable faculty to teach separations and mass transfer in a single course And detailed material on liquid liquid extraction adsorption chromatography and ion exchange prepares students for advanced work New and updated content includes melt crystallization steam distillation residue curve analysis batch washing the Shanks system for percolation leaching eutectic systems forward osmosis microfiltration and hybrid separations A full chapter discusses economics and energy conservation including updated equipment costs Over 300 new and updated homework problems are presented all extensively tested in undergraduate courses at Purdue University New chapter on melt crystallization solid liquid phase equilibrium suspension static and falling film layer approaches and 34 questions and problems New binary VLE equations and updated content on simultaneous solutions New coverage of safety and fire hazards New material on steam distillation simple multi component batch distillation and residue curve analysis Expanded discussion of tray efficiencies packed column design and energy reduction in distillation New coverage of two hybrid extraction with distillation and the Kremser equation in fractional extraction Added sections on deicing with eutectic systems eutectic freeze

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