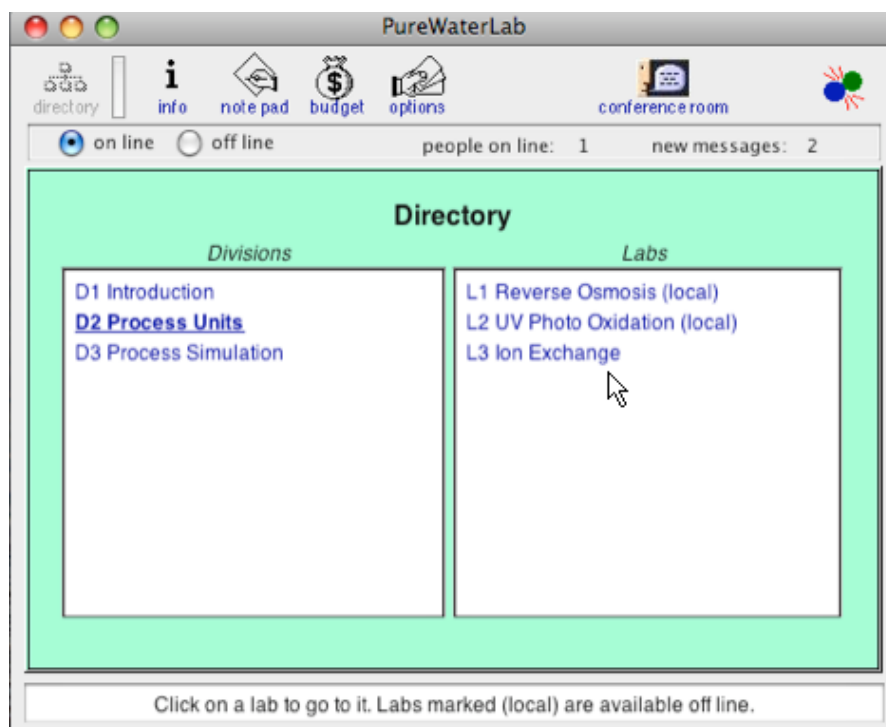


PureWaterLab - Conservation Education and Research Through Interactive Simulation

This attachment to the annual report discusses progress and plans for the PureWaterLab project.

PureWaterLab is a desktop application that is integrated with the Internet and associated software on web servers. In the current web jargon, the Lab is a "rich Internet application." When on-line, a student can access new modules and communicate in the Conference Room with other students. Updates to software are automatically downloaded and installed. When off-line, the student can continue to work on the modules they previously accessed while on-line.



This project is a collaboration. The University of California, San Diego (UCSD) part of the team is working on the software programming and the interactive simulations. The University of Arizona (UA) part of the team is working on the main module content, including text, graphics, math equations, and assessment components.

A work process was developed such that the UA group can develop and add new and revised content easily without having to involve the software group at UCSD. The UA group develops content as standard web pages and uploads them to the PureWaterLab (PWL) server. Whenever a student is using PWL on-line, the software automatically detects new and updated modules and downloads them for on- or off-line use.

UV Photo Oxidation

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Div 2 Lab 2

Sections:

- Introduction
- Applications
- Design**
- Operation
- Sample
- Problems
- Solutions
- Vocabulary
- References

Simulations

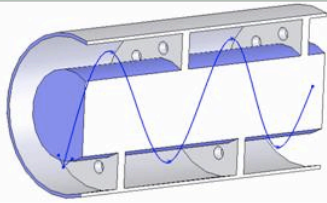


Figure 5. Annulus Reactor with baffles showing water flow

Source Radiant Power

The **source radiant power** (Φ) is the radiant power emitted by any radiant power source in all directions, such as a UV lamp. As stated above, power ratings typically fall between 40-100W for **low-pressure** lamps and 1-5kW for **medium-pressure** lamps (Bolton, 2002). Through a non-absorbing medium, the radiant intensity (I) of UV light will not diminish. In this case, for a **point source**:

$$\Phi = 4\pi I \quad (11)$$

Most UV lamps for UPW application are cylindrical tubes that can be modeled as multiple point sources lined next to each other. This technique is known as **Multiple Point Source Summation (MPSS)** and can be integrated using a technique called **line source integration (LSI)** to find the fluence rate (E') through water as a function of height from the center of the lamp (H) and distance from the lamp (r), neglecting absorption and **reflection** (Bolton, 2000):

$$E'(r, H) = \frac{\Phi}{4\pi Lr} \left[\arctan\left(\frac{L/2 + H}{r}\right) + \arctan\left(\frac{L/2 - H}{r}\right) \right]$$

Source radiant power ~ The total amount of electromagnetic power emitted from a source. The SI unit is watt (W)

Text can contain links to web sites external to PWL. These links are opened in the users web browser.

Drinking Water Contaminants | Safewater | Water | US EPA

http://www.epa.gov/safewater/contaminants/index.html

U.S. ENVIRONMENTAL PROTECTION AGENCY

Drinking Water Contaminants

Recent Additions | Contact Us Search: ☐ All EPA ☒ This Area Go

You are here: [EPA Home](#) » [Water](#) » [Safewater](#) Drinking Water Contaminants

On this page

- [National Primary Drinking Water Regulations](#)
 - [List of Drinking Water Contaminants & their MCLs](#)
- [National Secondary Drinking Water Regulations](#)
 - [List of Secondary Drinking Water Regulations](#)
- [Unregulated Contaminants](#)

Overview

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Div 1 Lab 1

Sections:

- Objectives
- Water Use
- Water Purity
- Ultrapure Water
- Dimensional Analysis
- Quizzes
- References**

Simulations

References

Miller, G.T. Living in the Environment. 13th ed. Brooks/Cole-Thomson, 2004.

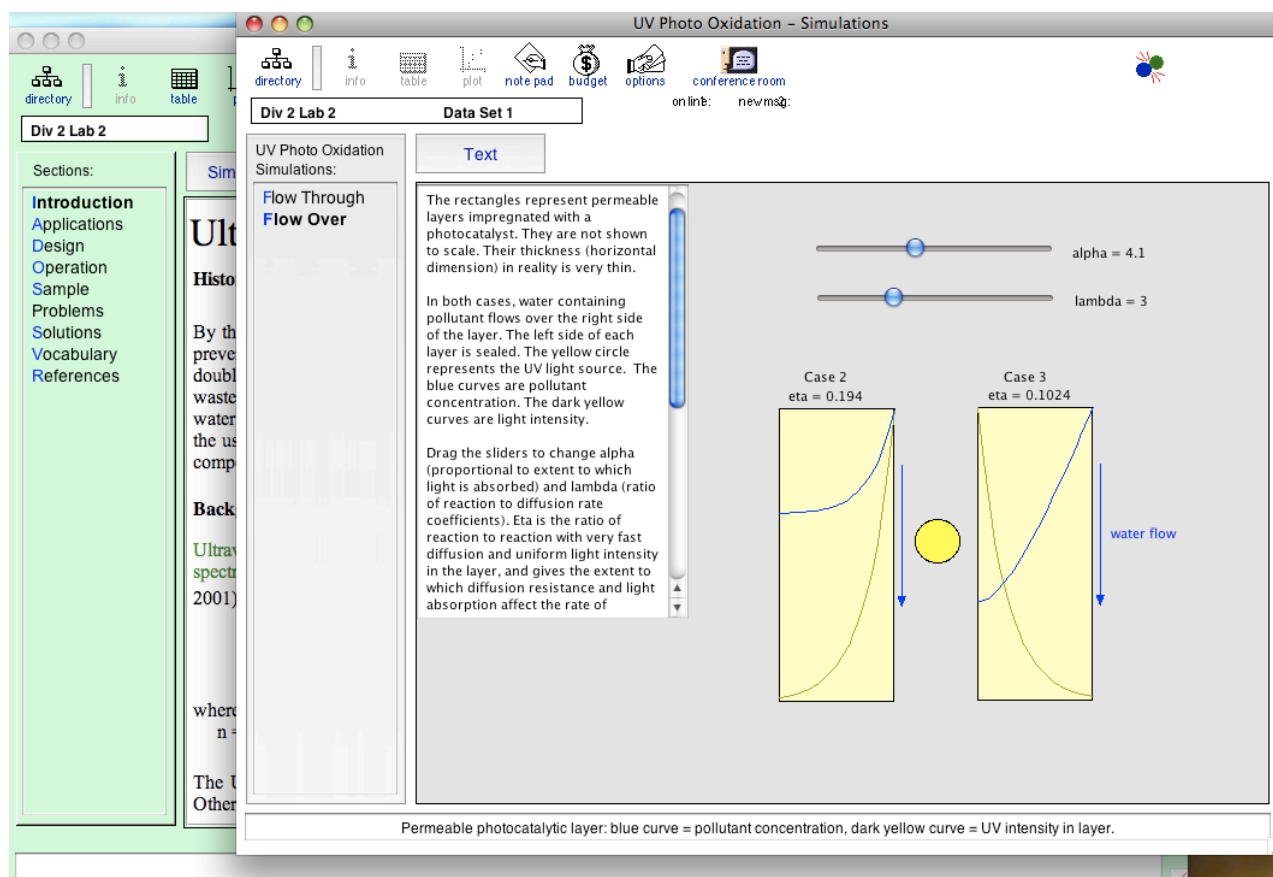
Timberlake, K.C. Basic Chemistry. 1st ed. Pearson Benjamin Cummings, 2005.

Tomcak, M. "Oceanogr. Notes Chapter 1." 12 Nov 1999. Jun 2006
<http://www.es.flinders.edu.au/~mattom/IntroOc/notes/lecture01.html>.

U.S. Environmental Protection Agency. "Drinking Water Contaminants." July 2002. EPA. 20 June 2006
<http://www.epa.gov/safewater/mcl.html>.

"USGS Estimated Use of Water in the United States in 2000", Fact Sheet 2005—3051, Sep 2005.

The advantage of using these web pages in PWL, as compared with a standard web browser, is that many other features are additionally available in PWL, such as the interactive simulations. A simulation in the UV Photo Oxidation module is shown here.



Several ways were developed to help students search text and understand vocabulary. A result of a search for a word is shown here.

One special feature provided by the PWL software is automatic scanning of text for words listed in the vocabulary section. Other than preparing the vocabulary section, the content authors do not have to do anything else. The PWL software highlights vocabulary words automatically, and the definition is shown at the bottom of the window when the student passes the cursor over a highlighted word, as shown below.

Applications

There are several functions of UV radiation in UPW disinfection systems. Wavelengths 254 nm and 185 nm are primarily responsible for different treatments, as summarized by DeGenova (2001):

Primary Wavelength (nm)	Function
254	Bacterial Disinfection
254	Ozone Decomposition
185	TOC Oxidation

Bacterial Disinfection

Every known living organism contains genetic material (DNA and/or RNA). DNA will absorb energy when exposed to UV-C range UV, as shown on Figure 3. This causes photochemical alterations to nucleic acids and damages the cell's ability to reproduce. This mode of inactivation follows first-order disinfection kinetics presented by the AWWA (1990) from Chick and Watson;

$$r = -kN$$

where:
 r = rate of inactivation [(organisms killed)/volume/time]
 N = concentration of viable organisms

Inactivation ~ The sufficient cellular death of microorganisms to prevent reproduction

Another new feature being added are quizzes to assess student learning. Several different types of questions are available, and the software automatically scores the answers and provides feedback, as shown here.

Quizzes

Links on this page open quizzes.

[Practice Problems](#)

Question:
 If it takes 2,000 gallons of Ultrapure Water (UPW) to clean one wafer, how many can you clean with 32,000 gallons?

Enter your answer here (number only, no commas, no units):

16

Check Your Answer Show Correct Answer

Response:
 That's correct!

32,000 gallons ÷ 2,000 gallons = 16 wafers

If a student enters incorrect answers several times, they are allowed to view the correct answer.

Overview

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Div 1 Lab 1

Sections:

- Objectives
- Water Use
- Water Purity
- Ultrapure Water
- Dimensional Analysis
- Quizzes**
- References

Simulations

Quizzes

Links on this page open quizzes.

[Practice Problems](#)

Question:

If in 1990 the amount of water used in the U.S. was 339 billion gallons per day and in 2000 the number rose to 408 gallons per day, how big of an increase is this in liters per week?

Enter your answer here in billions of liters per week (number only, no commas, no units):

900

Check Your Answer 3 attempts Show Correct Answer

Response:

The correct answer is 1828.16

$$408 \text{ billion } \frac{\text{gal}}{\text{day}} - 339 \text{ billion } \frac{\text{gal}}{\text{day}} = 69 \text{ billion } \frac{\text{gal}}{\text{day}}$$

$$69 \text{ billion } \frac{\text{gal}}{\text{day}} \times 7 \frac{\text{days}}{\text{week}} \times 3.785 \frac{\text{L}}{\text{gal}} = 1828.16 \text{ billion } \frac{\text{L}}{\text{week}}$$

Back Next

Quiz development will continue to provide for instructor and student registration and reporting of student progress through the modules and quiz score reporting.

Progress is continuing to be made on the plant simulator to allow for inter-campus collaboration on simulations of water purification plants.

The software is being used in classes by the developers, and is distributed on the web to other instructors.

We are requesting a no-cost extension of the project. This is a complex project and work still needs to be done to ensure smooth content creation, distribution, and use by students. The PI will take a sabbatical in Fall 2008 in order to devote full time to completion of this phase of the project development.