

VIRTUAL EXPERIMENTS FOR FOOD SCIENCE-TECHNOLOGY- ENGINEERING EDUCATION

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Significance

- Hands-on lab experiments are **the most effective tools** in teaching new concepts and testing novel hypothesis in engineering education.
- They are
- typically organized around groups of students
- follow the paradigm of students spending **a long time** clustered around workbenches.

Significance

- Due to the limited time
 - students receive an **uneven exposure time**,
 - it is **difficult to design** an experiment to examine the effects of various variables on the outcome, and
 - this leads to demonstrate only one set of processing condition for a given process.

Significance

- With this approach we **might not achieve** a functional understanding of process performance.
- Personal observations indicate **that only a few active learners** actually perform the required tasks in a typical lab exercise, leaving many of the remaining students to only **observe or daydream**.
- In addition, many universities **cannot afford** to maintain up-to-date labs with the latest instrumentation.

Objectives

- to develop virtual labs for various food processing operations,
- to improve understanding of food processing principles, and
- to reduce the cost and time required for lab experiments.

Implementation

- Virtual labs were created using a computer programming language (*Microsoft VB6.0*) to write the numerical simulation codes.
- The numerical codes were accompanied by
 - **Active-X programs** for extended graph abilities, visualization and spreadsheet abilities, and
 - **Animated picture technologies** to give the taste of an actual hands-on lab experiment.

Implementation

- **The use of virtual labs involved the users to interact by setting operation parameters, observing changes and recording data for further analysis.**

Implementation

- In a lab, students run an actual process using a limited number of operating conditions.
- Using the virtual labs, this might be followed by each student generating a set of additional data.
- The output from the simulation is analyzed as if it were actual data (*obtained from a hands-on lab experiment*) so that students can determine the effects of operating conditions on the results.

Virtual experiments in food processing – 27 experiments

Virtual Laboratory - Mozilla Firefox

File Edit View History Bookmarks Tools Help

file:///C:/MyFiles/RarelyUsed/Virtual%20Lab%20Final%20do%20not%20trash/VirtualLabCD_1/Enter_Lab.htm

Getting Started Latest Headlines jfe KCRA Yahoo! Geckomail Met UC enterprise BBC3 MY pure IFT SA IUFOST

Virtual Experiments in Food Processing

Note: To view files in each laboratory experiment, you must have a Flash player installed in the browser. The player is available free of charge from [Macromedia](#).

To view pdf file in "Getting Started," you will require an Adobe® Reader® available free of charge from Acrobat .

- [Getting Started \(pdf\)](#)
- [Energy Requirements of Pumping Apple Juice](#)
- [Rheological Properties of Foods -- Determining Flow Properties of Vanilla Pudding](#)
- [Temperature sensors -- Response Time of Thermocouples](#)
- [Convective Heat transfer -- Determining Heat Transfer Coefficient in Air and Water](#)
- [Heat exchangers - Heating Milk in a Tubular Heat Exchanger](#)
- [Heating liquid foods -- Heating Tomato Juice in a Steam-Jacketed Kettle](#)
- [Canning Foods -- Determining Heating Rate Parameters Conduction-Heating Foods in a Can](#)
- [Lethality of a Thermal Process -- Determining Lethality During Heating of a Canned Food](#)
- [Hydrocooling - Cooling Melons and Cherries in a Hydrocooler](#)
- [Kinetics of Nutrient Degradation -- Determining Kinetics of Ascorbic Acid Loss in Heating Orange Juice](#)
- [Food Frying - Determining Frying Time of French Fries](#)
- [Grilling of Foods - Determining Cooking Time of a Hamburger Patty](#)
- [Refrigeration -- Designing a Refrigeration System](#)

Done

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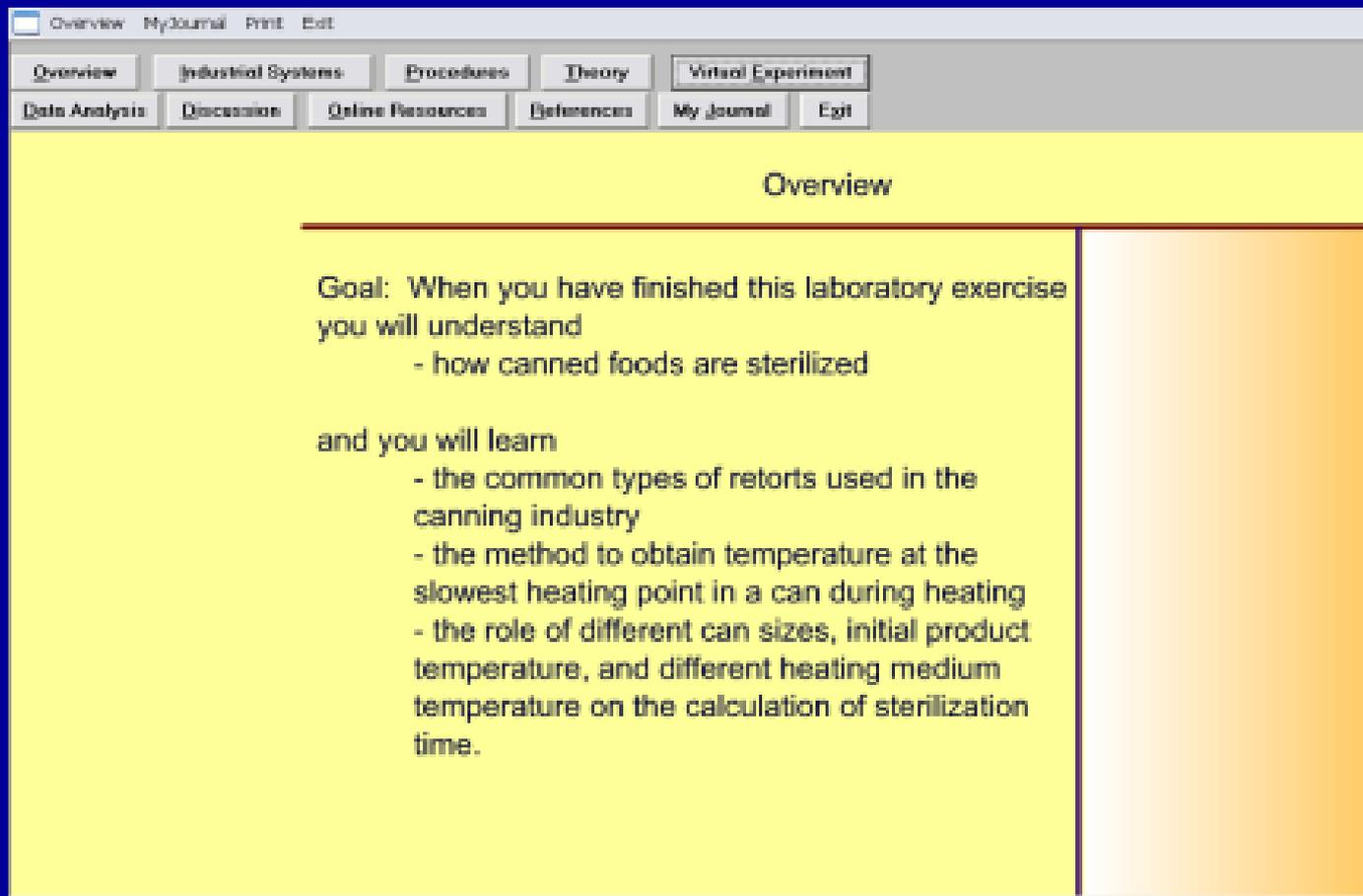
Virtual experiments in food processing – 27 experiments

- Fluid flow,
- Heat transfer fundamentals,
- Food processing operations,
- Mass transfer operations,
- Food storage and distribution.

Navigation bar used in each experiment



Overview of a virtual lab exercise



The screenshot shows a web application interface for a virtual lab exercise. At the top, there is a menu bar with the following options: Overview, Industrial Systems, Procedures, Theory, Virtual Experiment, Data Analysis, Discussion, Online Resources, References, My Journal, and Exit. The 'Overview' page is currently selected and highlighted in yellow. The main content area is also yellow and contains the following text:

Overview

Goal: When you have finished this laboratory exercise you will understand

- how canned foods are sterilized

and you will learn

- the common types of retorts used in the canning industry
- the method to obtain temperature at the slowest heating point in a can during heating
- the role of different can sizes, initial product temperature, and different heating medium temperature on the calculation of sterilization time.

Industrial applications relevant to each exercise

Overview MyJournal Print Exit

Overview Industrial Systems Procedures Theory Virtual Experiment

Data Analysis Discussion Online Resources References My Journal Exit

Industrial Systems

In the food canning industry, both batch and continuous retorts are used. Retorts operate under atmospheric or higher pressures depending upon the process requirements.

Batch Retort



In a batch retort, carts loaded with canned food are pushed into the retort. The retort lid is closed and steam is turned on. After a desired heating period, the steam is turned off, cooling water is introduced to cool the cans. The retort lid is opened and carts are pulled out of the retort.



Photographs and diagrams how an exercise is conducted in a lab

Overview MyJournal Print Exit

Overview Industrial Systems Procedures Theory Virtual Experiment
Data Analysis Discussion Online Resources Exercises My Journal Exit

Procedures

1) To install a thermocouple in the center of a can, a hole is punched in the lid of the can, and special fittings are used to prevent leakage of food during the heating process. The fittings are shown below.



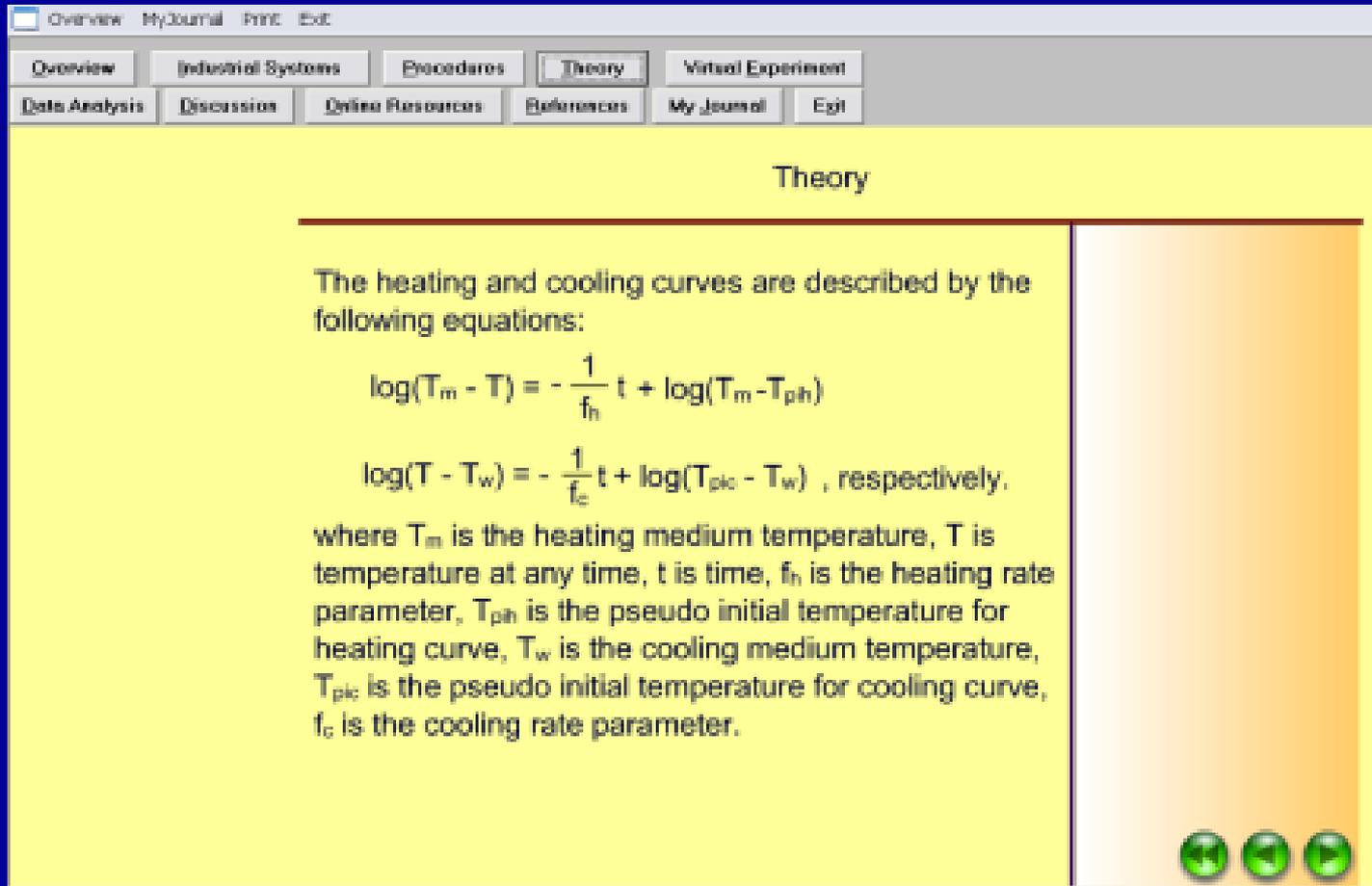
Lid with a hole drilled in its center

Thermocouple

Nut and bolt

Three green circular icons are visible in the bottom right corner of the interface.

Theoretical considerations



The screenshot shows a software window titled "Theory" with a menu bar containing "Overview", "Industrial Systems", "Procedures", "Theory", and "Virtual Experiment". Below the menu bar, there are sub-menus for "Data Analysis", "Discussion", "Online Resources", "References", "My Journal", and "Exit". The main content area is yellow and contains the following text:

The heating and cooling curves are described by the following equations:

$$\log(T_m - T) = -\frac{1}{f_h} t + \log(T_m - T_{ph})$$
$$\log(T - T_w) = -\frac{1}{f_c} t + \log(T_{pic} - T_w) , \text{ respectively.}$$

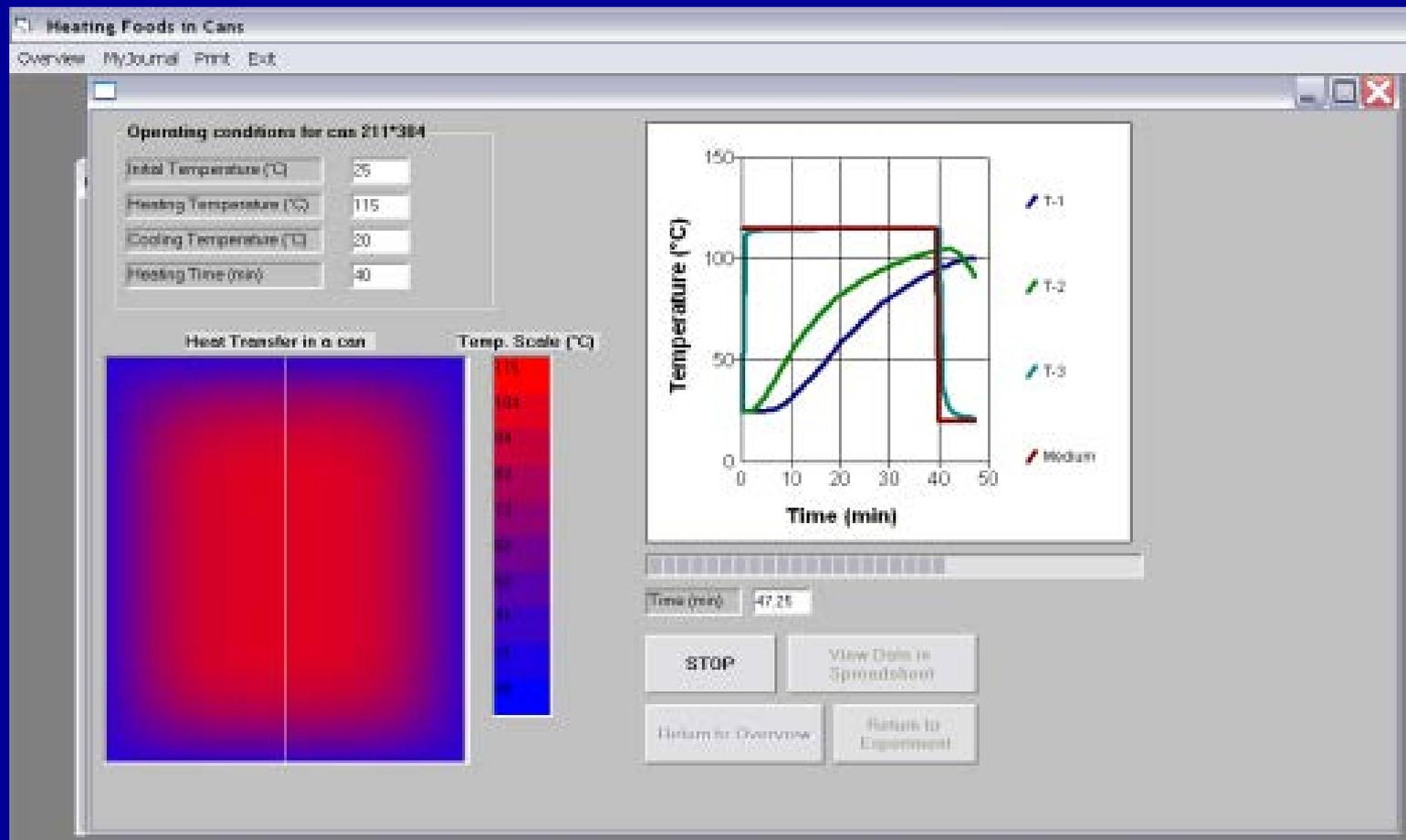
where T_m is the heating medium temperature, T is temperature at any time, t is time, f_h is the heating rate parameter, T_{ph} is the pseudo initial temperature for heating curve, T_w is the cooling medium temperature, T_{pic} is the pseudo initial temperature for cooling curve, f_c is the cooling rate parameter.

At the bottom right of the window, there are three green circular icons.

Operator`s panel for users to select operating conditions



Results of a virtual experiment



Description of how to analyze data

Heating Foods in Cans - [Data Analysis]

Overview MyJournal Print Exit

Overview Industrial Systems Procedures Theory Virtual Experiment

Data Analysis Discussion Online Resources References My Journal Exit

Analysis

To Calculate f_h :

- Prepare a new column on your spreadsheet for $\log(T_m - T)$ where T_m is the retort temperature, and T is the variable temperature at a given location.

	A	B	C
1	211*304		
2	Retort Temperature (°C)	115	
3	Heating Time (min)	40	
4	Cooling Temperature (°C)	20	
5	Initial Temperature (°C)	25	
6		$-\log(115-25)$	
7			
8		Time(s) T	$\log(T_m - T)$
9		0	1.95424
10		47.48	1.95424
11		95.494	1.95424



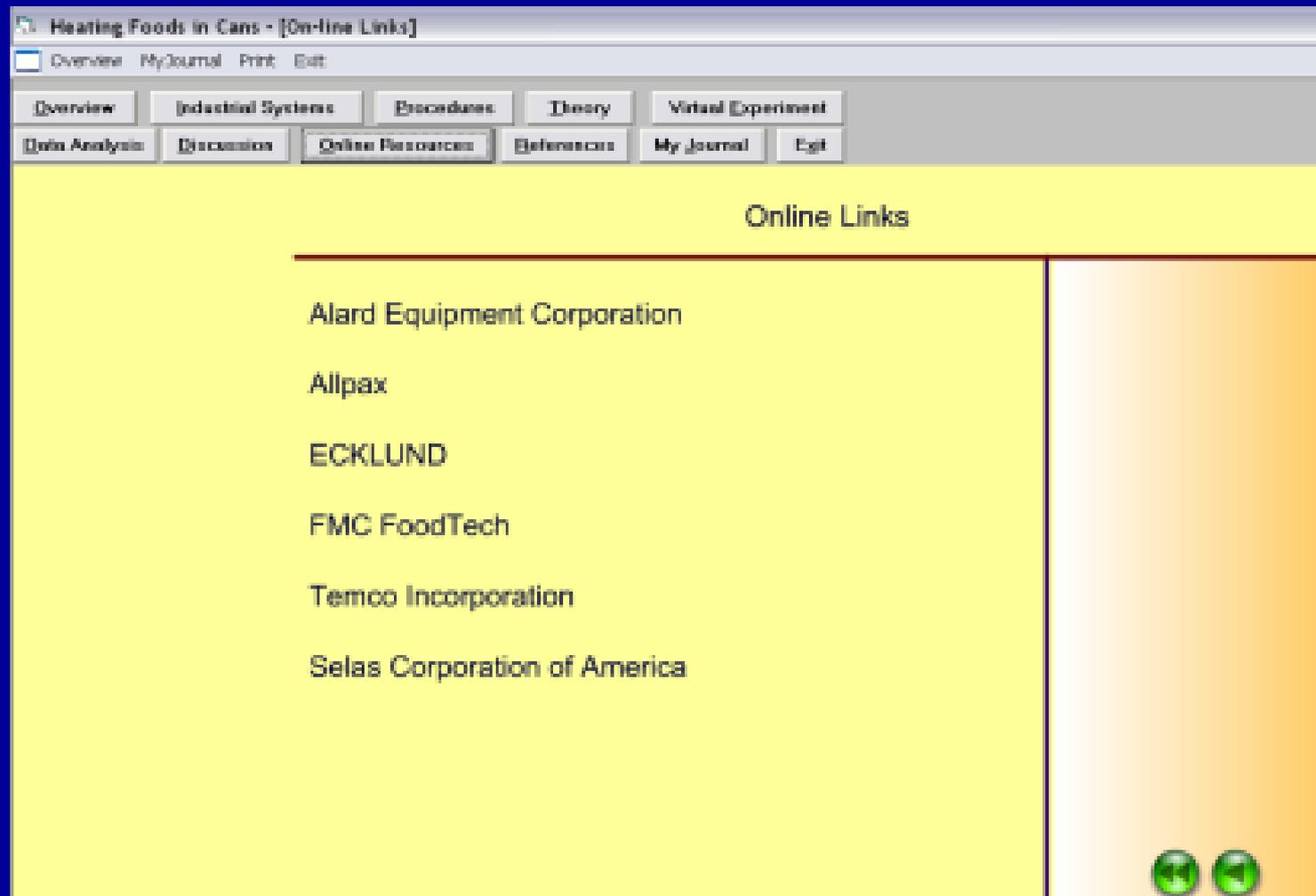
Discussion questions

The screenshot shows a software window titled "Heating Foods in Cans - [Discussion]". The window has a menu bar with "Overview", "My Journal", "Print", and "Exit". Below the menu bar is a navigation pane with buttons for "Overview", "Industrial Systems", "Procedures", "Theory", "Virtual Experiment", "Data Analysis", "Discussion" (which is highlighted), "Online Resources", "References", "My Journal", and "Exit". The main content area is titled "Discussion" and contains three numbered questions.

Discussion

1. In conduction heated foods, you determined the slowest heating point to be the geometric center of the can. Where do you expect this point to be located for a convection heating food such as canned tomato juice?
2. Discuss the effect of changing retort temperature on t_h at the geometric center of a can.
3. Does t_h vary by location in the can? Discuss.

Links to industrial sites for more information



The screenshot shows a web browser window titled "Heating Foods in Cans - [On-line Links]". The browser's address bar and menu bar are visible. The main content area has a yellow background and is titled "Online Links". A list of industrial companies is displayed on the left side of the page, with a vertical gradient bar on the right. At the bottom right of the page, there are two small green circular icons.

Heating Foods in Cans - [On-line Links]

Overview MyJournal Print Exit

Overview Industrial Systems Procedures Theory Virtual Experiment

Data Analysis Discussion Online Resources References My Journal Exit

Online Links

- Alard Equipment Corporation
- Allpax
- ECKLUND
- FMC FoodTech
- Temco Incorporation
- Selas Corporation of America



References to consult for writing a report

The screenshot shows a web application window titled "Heating Foods in Cans - [References]". The interface includes a menu bar with "Overview", "MyJournal", "Print", and "Exit". Below the menu bar is a navigation bar with buttons for "Overview", "Industrial Systems", "Procedures", "Theory", "Virtual Experiment", "Data Analysis", "Discussion", "Online Resources", "References", "My Journal", and "Exit". The "References" button is highlighted. The main content area is titled "References" and contains three entries:

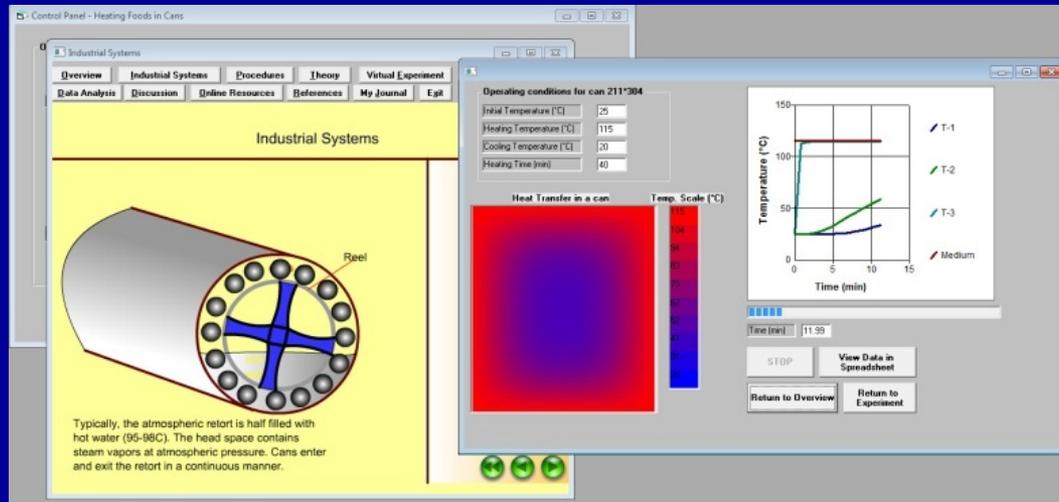
Karel, M., and Lund, D.B. (2003). "Physical Principles of Food Preservation," 2nd ed., Marcel Dekker, Inc., New York.

Singh, R. P. and Heldman, D.R. (2001). "Introduction to Food Engineering" 3rd ed., Academic Press, London.

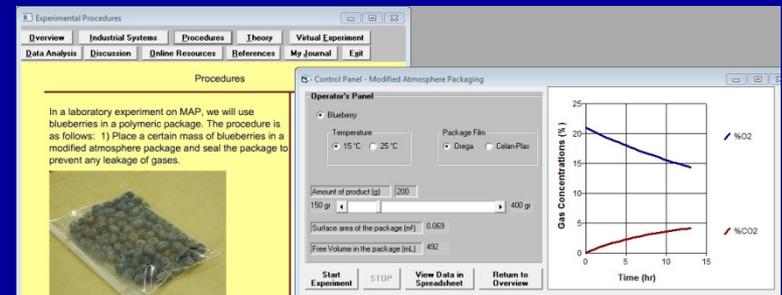
Toledo, R.T. (1994). "Fundamentals of Food Process Engineering," 2nd ed., Chapman and Hall, New York.

Examples

- Canning



- MAP
(modified atmosphere packaging)



Use in various universities

- **Virtual experiments of individual food processing operations have been routinely used in different universities for the past ten years.**
- **The following universities have introduced new courses/ laboratory exercises using Virtual Experiments described in this webinar:**

Use in various universities

- **University of California, Davis**
- **University of Mersin**
- **Ohio State University**
- **University of Illinois**
- **Oregon State University**

Use in various universities

- **Purdue University**
- **California State University, Pomona**
- **University of Newfoundland, Canada**
- **Iowa State University**

In addition, instructors from 31 countries have acquired the computer software from us to enhance their teaching.

Conclusions in summary

- **Personal observations revealed that the virtual labs**
 - **led students get engaged more in the hands-on lab experiments,**
 - **encouraged the students to explore what-If scenarios in the process,**
 - **eliminated the obstructive effect of not having the appropriate equipment to conduct various hands-on lab experiments,**
 - **allowed the students to develop higher level cognitive skills to analyze and evaluate processing parameters,**

Conclusions in summary

- It was also demonstrated that the integration of advanced technology tools (*interactive visualization and simulations*)
 - enhanced student learning, and
 - improved the quality of education changing the learning environment to student-centered case.
- Virtual labs are also expected to improve the quality of instruction in distance learning courses.