Sprinkle & Trickle Irrigation

Lecture Notes

BIE 5110/6110
Fall Semester 2004

Biological and Irrigation Engineering Department
Utah State University, Logan, Utah

Preface

These lecture notes were prepared by Gary P. Merkley of the Biological and Irrigation Engineering (BIE) Department at USU, and Richard G. Allen of the University of Idaho, for use in the BIE 5110/6110 courses. The notes are intended to supplement and build upon the material contained in the textbook *Sprinkle and Trickle Irrigation* by Jack Keller and Ron D. Bliesner (Chapman-Hall Publishers 1990). Due to the close relationship between the lecture notes and the textbook, some equations and other material presented herein is taken directly from Keller and Bliesner (1990) – in these instances the material is the intellectual property of the textbook authors and should be attributed to them. In all other cases, the material contained in these lecture notes is the intellectual property right of G.P. Merkley and R.G. Allen.

Copyright Notice

This material has been duplicated by special permission of the copyright holders. It is not to be duplicated or used for purposes other than learning resource support for Utah State University. Any violation of this agreement is punishable under existing copyright laws and may include severe fines and or imprisonment.

© Copyright 1990 to 2004

These lecture notes are formatting for printing on both sides of the page, with odd-numbered pages on the front. Each lecture begins on an odd-numbered page, so some even-numbered pages are blank.

Contents

Note: Equations are numbered consecutively in these lecture notes as (xxx). Equations with the (xxx.xx) format refer to those found in the textbook by Keller & Bliesner.

Units, Constants and Conversions

28.35 g/oz
15.85 gpm/lps (= 60/3.785)
7.481 gallons/ft^3
448.86 gpm/cfs (= 7.481*60)
3.7854 litre/gallon

6.89 kPa/psi
1 cb = 1 kPa
10 mb/kPa, or 100 kPa/bar
2.308 ft/psi, or 9.81 kPa/m (head of water)
14.7 psi = 101.3 kPa = 10.34 m (head of water) = 1,013 mbar = 1 atm
62.4 lbs/ft^3, or 1000 kg/m^3 (max density of pure water at 4°C)
0.1333 kPa/mmHg

1 ppm ≈ 1 mg/liter (usually)
1 mmho/cm = 1 dS/m = 550 to 800 mg/liter

0.7457 kW/HP
1 langley = 1 cal/cm^2
0.0419 MJ/m^2 per cal/cm^2

0.3048 m/ft
1.609 km/mile
2.471 acre/ha
43,560 ft^2/acre
1,233 m^3/acre-ft

57.2958 degrees/radian
$\pi \approx 3.14159265358979323846$
$e \approx 2.71828182845904523536$

$^oC = (^oF - 32)/1.8$
$^oF = 1.8(^oC) + 32$

Ratio of weight to mass at sea level and 45° latitude: g = 9.80665 m/s^2

PVC = Polyvinyl chloride
PE = Polyethylene
ABS = Acrylonitrile-Butadiene-Styrene

Equation Chapter 1 Section 1**Lecture 1**

Course Introduction

I. Course Overview

- Design of sprinkle and trickle systems – perhaps the most comprehensive course on the subject anywhere
- Previously, this was two separate courses at USU
- Everyone must be registered at least for audit
- Prerequisites: BIE 5010/6010; computer programming; hydraulics
- There will be two laboratory/field exercises
- Review of lecture schedules for sprinkle and trickle

II. Textbook and Other Materials

- Textbook by Keller and Bliesner
- Two textbooks are on reserve in the Merrill Library
- Lecture notes by Merkley and Allen are required
- We will also use other reference materials during the semester

III. Homework and Design Project

- Work must be organized and neat
- Working in groups is all right, but turn in your own work
- Computer programming and spreadsheet exercises
- Submitting work late (10% per day, starting after class)
- Sprinkle or trickle system design project

IV. Tests, Quizzes, and Grading Policy

- Maybe some quizzes (these will not be announced)
- Two mid-term exams
- Final exam is comprehensive

V. Units

- It is often necessary to convert units in design calculations
- Make it a habit to perform dimensional analysis when using equations; only in some of the empirical equations will the units not work out correctly

VI. Irrigation Systems

- On-farm level (field)
- Project level (storage, conveyance, tertiary)

VII. General Types of On-Farm Irrigation Systems

Type	U.S. Area	World Area
Surface	65%	95%
Sprinkler	30%	3%
Micro Irrigation	3%	1%
Sub-Irrigation	2%	1%

These are approximate percent areas

VIII. Sprinkler Systems

Important Advantages

1. effective use of small continuous streams of water
2. greater application uniformity on non-homogeneous soils (provided there is no appreciable surface runoff)
3. ability to adequately irrigate steep or undulating topographies w/o erosion
4. good for light and frequent irrigation where surface irrigation may be used later in the growing season
5. labor is only needed for a short time each day (unless there are many fields)
6. labor can be relatively unskilled (pipe moving)
7. automation is readily available for many sprinkler systems
8. can be effective for weather (micro-climate) modification

Important Disadvantages

1. initial cost can be high (compared to surface irrigation systems) at $500 to $3500 per ha
2. operating cost (energy) can be high compared to non-pressurized systems, unless sufficient head is available from a gravity-fed supply
3. water quality can be a problem with overhead sprinklers if water is saline, and in terms of clogging and nozzle wear. Also, some types of water are corrosive to sprinkler pipes and other hardware
4. some fruit crops cannot tolerate wet conditions during maturation (unless fungicides, etc., are used)
5. fluctuating flow rates at the water source can be very problematic
6. irregular field shapes can be difficult to accommodate
7. very windy and very dry conditions can cause high losses
8. low intake rate soils (< 3 mm/hr) cannot be irrigated by sprinkler w/o runoff

IX. Slides of Sprinkler Systems

[these will be shown in class]