CE 3372 WATER SYSTEMS DESIGN

PIPELINE HYDRAULICS EXAMPLES : PART 1

EXAMPLE 1: USING ON-LINE TOOLS

- Repeat the flow between two reserviors, but change materials, include entrance and exit losses

$K_{in} = ?$

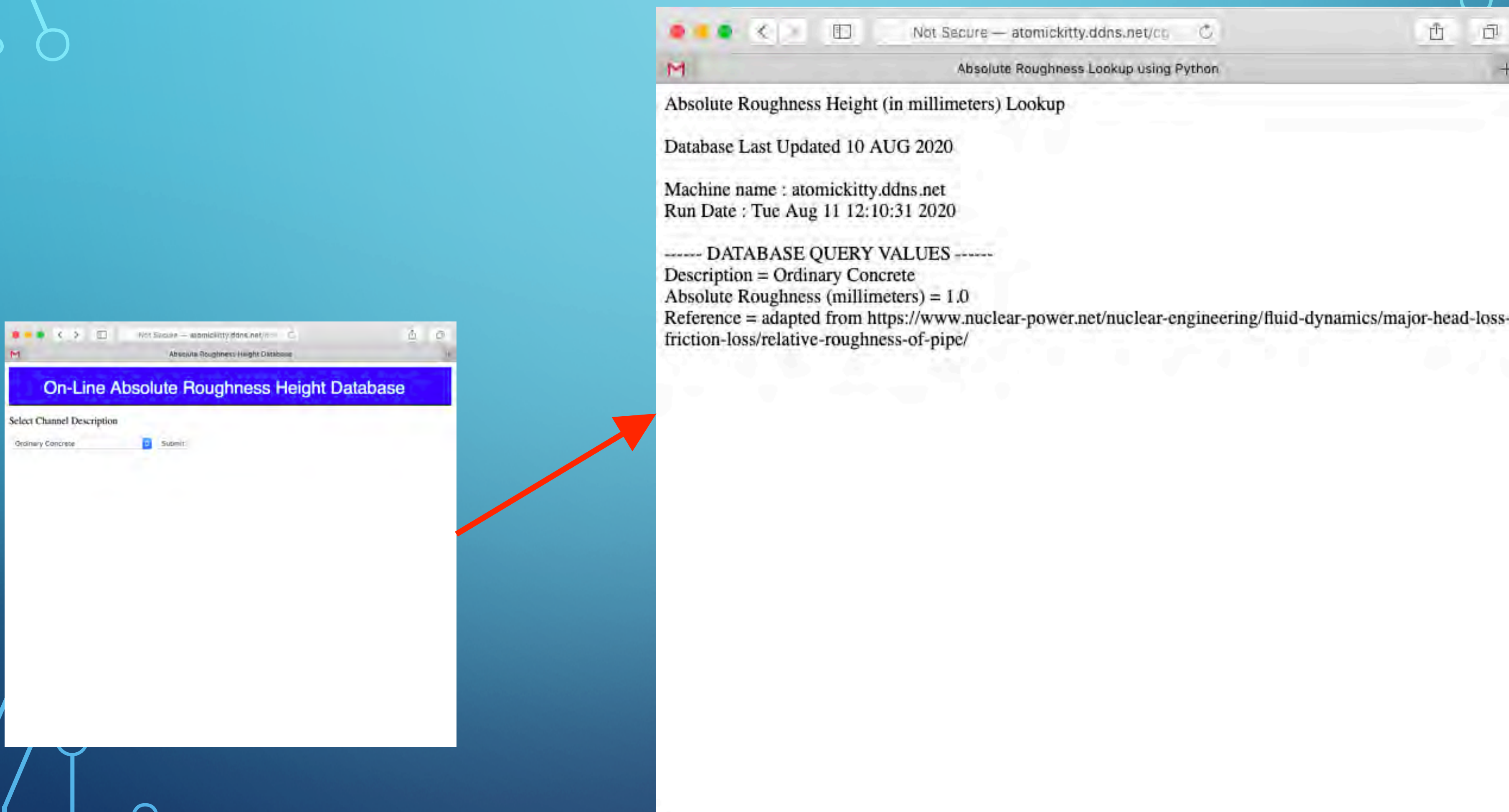
Figure 1: Two reservoirs connected by a ~~cast-iron~~ pipe

concrete

$K_{exit} = ?$

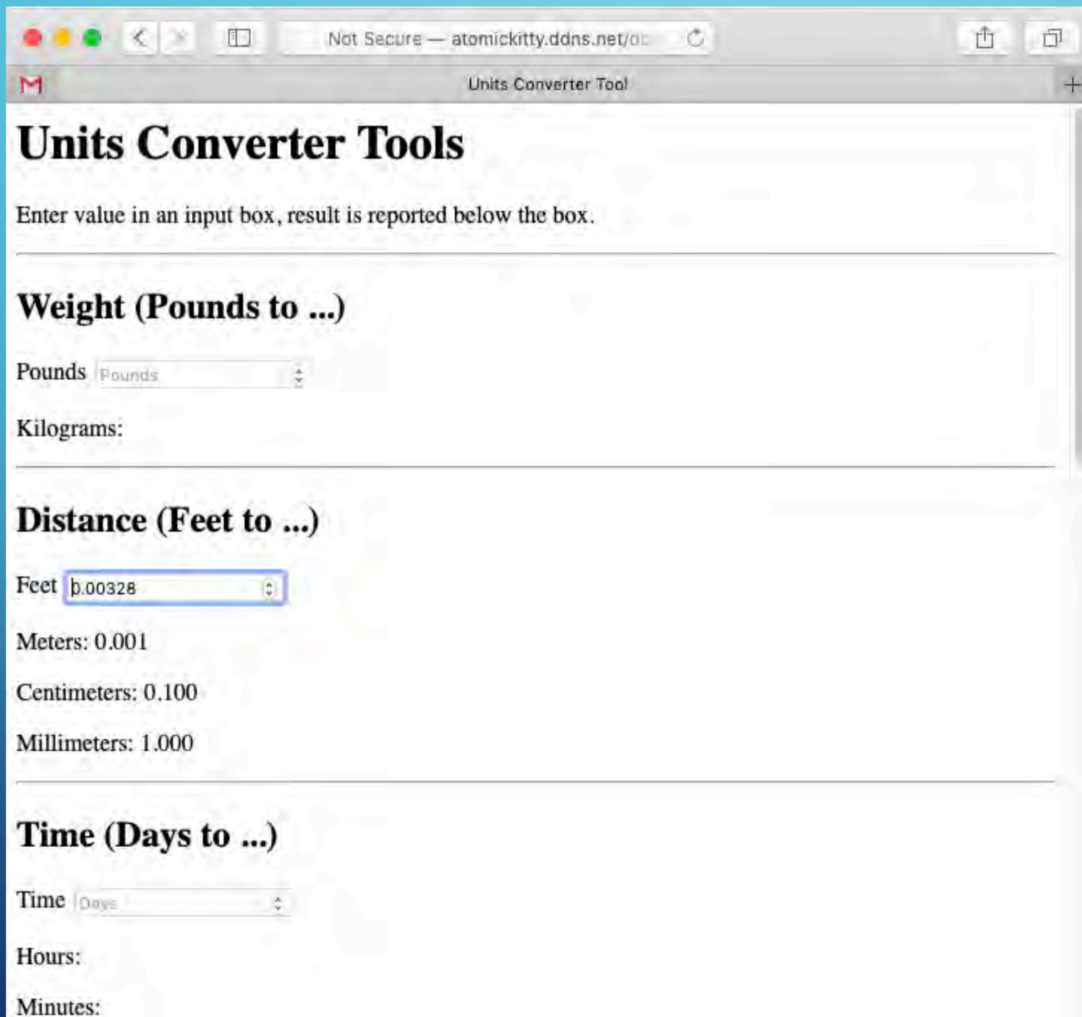
EXAMPLE:

- Determine roughness height for pipeline; $k_s = 1.0$mm



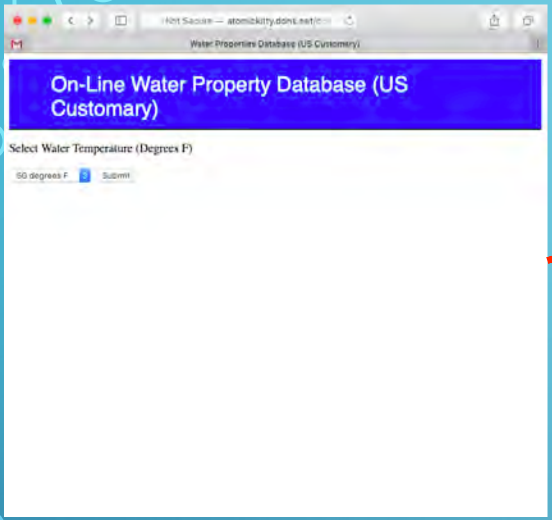
EXAMPLE:

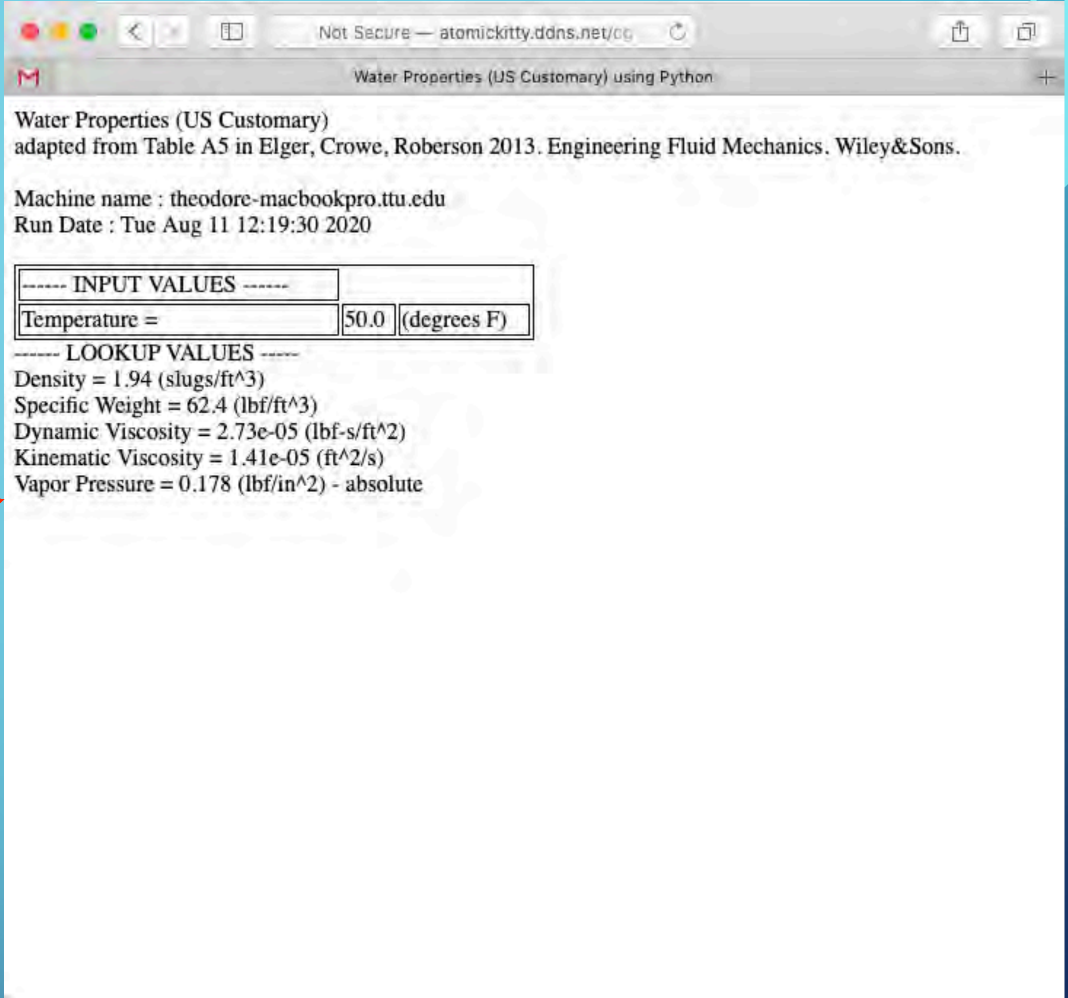
- Convert millimeters to feet, $k_s = 0.00328$ ft



EXAMPLE:

- Water Properties





Water Properties (US Customary)
adapted from Table A5 in Elger, Crowe, Roberson 2013. Engineering Fluid Mechanics. Wiley&Sons.

Machine name : theodore-macbookpro.ttu.edu
Run Date : Tue Aug 11 12:19:30 2020

------ INPUT VALUES ------		
Temperature =	50.0	(degrees F)

------- LOOKUP VALUES -----
Density = 1.94 (slugs/ft^3)
Specific Weight = 62.4 (lbf/ft^3)
Dynamic Viscosity = 2.73e-05 (lbf-s/ft^2)
Kinematic Viscosity = 1.41e-05 (ft^2/s)
Vapor Pressure = 0.178 (lbf/in^2) - absolute

EXAMPLE:

- Minor Loss Coefficients

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municipal water distribution, stormwater collection, and wastewater collection systems. Oral and written presentations. (Communication Intensive)

Estimation of Water Demand

Lesson Description +

Notes -

Lesson Notes Instructor notes used in face-to-face presentation.

Estimating Water Demand R. S. Gupta 20XX. Chapter 2 in Hydrologic and Hydraulics Systems.

USGS Circular 1200 Solley, W. B., Pierce, R. R., and Perlman, H. A. (1998). Estimated Use of Water in the United States in 1995. U.S. Geological Survey Circular 1200.

Hydraulics of Pipelines and Pipe Networks Wurbs, R.A., and James, W. P. (2002) Water Resources Engineering, Prentice Hall; pp.130-156; and 156-198.

TAC-290d Texas Administrative Code. Chapter 290, Subchapter D. Rules and Regulations for Public Water Systems

Water Distribution Systems "Water Distribution Systems" in Land Development Handbook, Ed. S.O. Dewberry, Dewberry Inc., McGraw-Hill

Video Links +

Data Links +

TABLE 25.13 Table of Local Loss Coefficients

Use the equation $h_v = kv^2/2g$ unless otherwise indicated. Energy loss E_L equals h_v head loss in feet.

Perpendicular square entrance:

$k = 0.50$ if edge is sharp

Perpendicular rounded entrance:

$R/d =$	0.05	0.1	0.2	0.3	0.4
$k =$	0.25	0.17	0.08	0.05	0.04

Additional loss due to skewed entrance:

$k = 0.505 + 0.303 \sin \alpha + 0.226 \sin^2 \alpha$

Strainer bucket:

$k = 10$ with foot valve
$k = 5.5$ without foot valve

Standard tee, entrance to minor line:

$k = 1.8$

Confusor outlet:

$d/D =$	0.5	0.6	0.8	0.9
$k =$	5.5	4	2.55	1.1

Exit from pipe into reservoir:

$k = 1.0$

Check valves:

Swing type	$k = 2.5$	when fully open
Ball type	$k = 70.0$	
Lift type	$k = 12.0$	

Angle valve:

$k = 5.0$ if fully open

Segment gate in rectangular conduit:

$k = 0.3 + 1.3\,[(1/n)]^2$
where $n = \phi/\phi_0$ = the rate of opening with respect to the central angle

Sluice gate in rectangular conduit:

$k = 0.3 + 1.9\,[(1/n) - n]^2$
where $n = h/H$.

Sudden expansion:

$E_L = \left(1 - \frac{v_2}{v_1}\right)^2 \frac{v_1^2}{2g}$ or $E_L = \left(\frac{v_1}{v_2} - 1\right)^2 \frac{v_2^2}{2g}$

Sudden contraction:

$(d/D)^2 =$	0.01	0.1	0.2	0.4	0.6	0.8
$k =$	0.5	0.5	0.42	0.33	0.25	0.15

use v_2 in Equation 13.13

Diffusor:

$E_L = k(v_1^2 - v_2^2)/2g$

$\alpha° =$	20	40	60	80
$k =$	0.20	.028	0.32	0.35

$K_{in} = 0.5$

$K_{exit} = 1.0$

EXAMPLE:

- Collect the various pieces of information:

$K_{in} = 0.5$

Figure 1: Two reservoirs connected by a ~~cast iron~~ pipe

$K_{exit} = 1.0$

Concrete: $k_s = 0.00328$ ft

Kinematic Viscosity = 1.41e-05 (ft^2/s)

- Apply the JupyterLab tool, or online tool.

EXAMPLE:

- Online tool:

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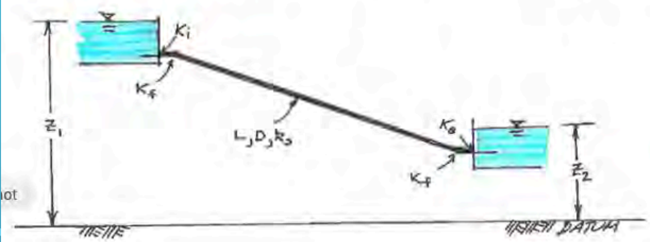
NewANTS

Discharge Between Two Reservoirs (US Customary Units)



Pipeline connecting two reservoirs. Pool elevations are Z1 and Z2.
Pipeline length is L, diameter is D, sand roughness height is ks.
Pipeline can be analyzed with entrance and exit loss coefficients (Ki and Ke).
Pipline can be analyzed with 2 fitting (Kf) loss coefficients.
Calculator solves for flow rate in the pipeline.

Uses Jain equation to make initial flow estimate,then Newton's method to refine the estimate.

Detailed Explaination (Under Construction)

Pipeline Parameters
Pool Elevation (Z1): 20
Pool Elevation (Z2): 0
Pipeline Length (L) : 10560
Pipeline Diameter (D) : 2
Sand Roughness Height (ks) : 0.00328
Kinematic Viscosity (nu) : 1.41e-5
Gravitational Acceleration (g) : 32.2

Fittings Parameters
Inlet Loss (Ki): 0.5
Exit Loss (Ke) : 1.0
Fitting Loss (Kf) : 0
Fitting Loss (Kf) : 0

Use zero fitting values to ignore minor losses

Submit

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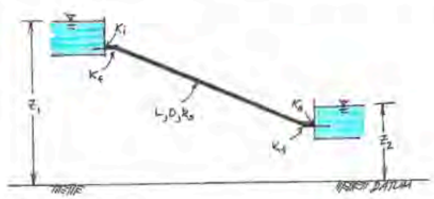
Discharge Between Two Reservoirs

Machine Name : theodore-macbookpro.ttu.edu
Run Date : Tue Aug 11 12:37:16 2020
COMMAND TO RUN : /usr/bin/Rscript 2QReservoir.R

Return Code : 0

INPUT VALUES		
Pool Elevation 1 (Z1) =	20.0	feet
Pool Elevation 2 (Z2) =	0.0	feet
Pipeline Length (L) =	10560.0	feet
Pipeline Diameter (D) =	2.0	feet
nd Roughness Height (ks) =	0.00328	feet
Kinematic Viscosity (nu) =	1.41e-05	feet^2/second
Gravitational Acceleration (g) =	32.2	feet/second^2
Inlet Loss Coefficient (Ki) =	0.5	
Outlet Loss Coefficient (Ke) =	1.0	
Fitting Loss Coefficient (Kf) =	0.0	
Fitting Loss Coefficient (Kf) =	0.0	



COMPUTED RESULT		
Discharge =	10.21029	ft^3/sec
Friction Factor =	0.02281027	
EGL Slope =	0.001893939	ft/ft

EXAMPLE:

- JupyterLab Notebook:
  - Nearly same result, Notebook did not account for entrance and exit losses