

Design Problem
CE 6628 - Pipeline Hydraulics
SALINAS DAM PIPELINE INFORMATION

Water is supplied from Salinas dam to the city of San Luis Obispo through a 24-inch pipeline (23.25-inch I.D.). Sufficient pressure is available to supply the required flows only at the higher reservoir elevations. For low reservoir conditions, two pumps, located at the dam can be used. Water is transmitted to a 2-million gallon reservoir at a booster pump station. Three pumps are available at the booster station to lift the water over a mountain into the city. We will analyze this system.

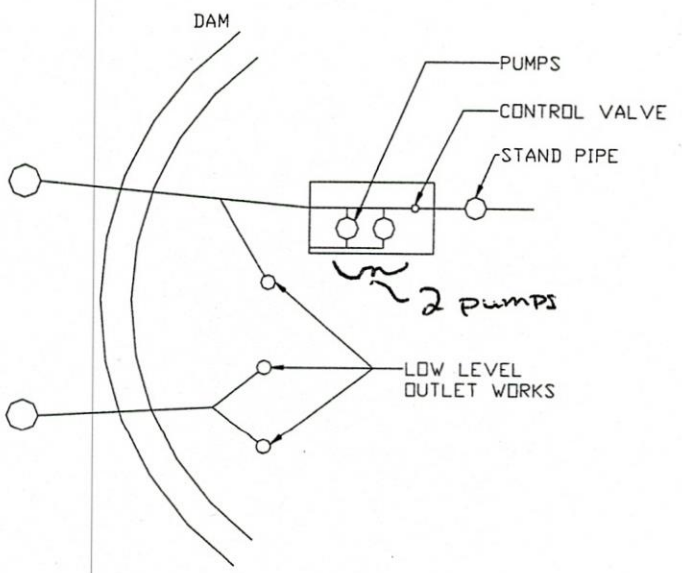
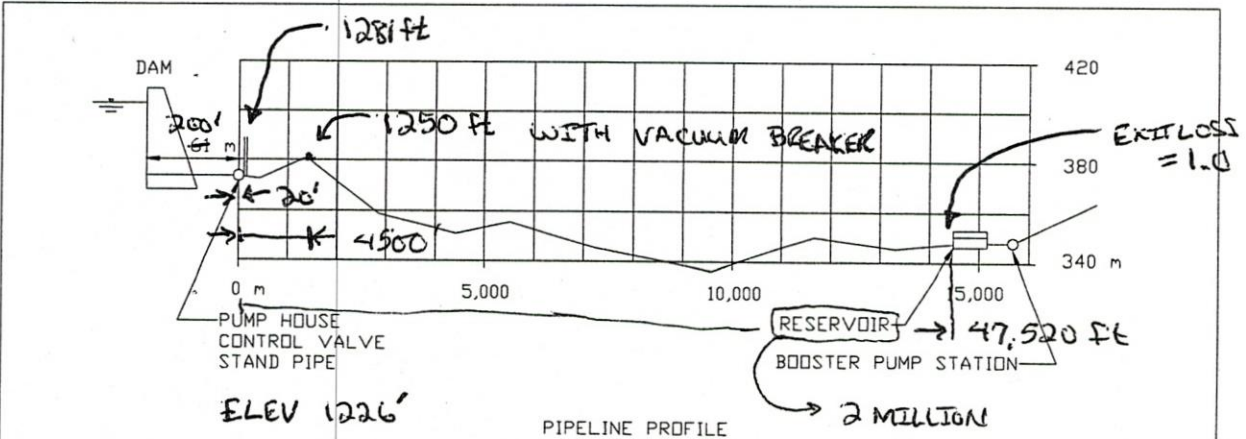
1. There are three pumps at the booster station (BS),
capacity =
9.2 mgd (3 pumps),
6.3 mgd (2 pumps)
3.6 mgd (1 pump).
2. Maximum Reservoir = 1320 ft
3. Reservoir Elevation at the downstream booster station = 1150 ft
4. The nominal pump capacity at the reservoir pump station (PS) is = 3000 gpm per pump @ about 40-foot head (There are two pumps.). Assume the following data define the pump curve for each PS pump.

<u>Qgpm</u>	<u>H-ft</u>
0	55
1500	50
3000	40

5. Ignore Losses at PS when Pumps are not operating.
6. Pipe elevation at PS = 1226 ft, L = 200-feet from dam to PS and CV
7. The surge tank is located 20 ft downstream of the CV and has a top elevation = 1281 ft.
8. The pipe length is 47,520 ft between the CV and the BS reservoir, D = 23.25 inches (ID), e = 0.004 inches (roughness)
9. Elevation of high point of pipe = 1250 ft, located 4500 feet downstream from the control valve. There is a vacuum breaker valve at that location.
10. The water temperature is 60 degrees F and the barometric pressure should be calculated at the valve elevations.
11. The control valve (CV) is a butterfly valve.
12. Minor loss coefficients:
inlet = 0.9
between reservoir and CV = 1.0
exit = 1.0

Additional Comments

- a) Hand calculations must be provided to get a score
- b) Identify method used to calculate friction factor
- c) Add a column in spreadsheet for "f"
- d) Print out functions
- e) Use reference cells for program rather than inserting constants into program.
- f) Use appropriate fluid property values based on temperature and elevation
- g) Assume a value of 32.2 ft/sec² for gravity.



PLAN VIEW OF INTAKES, OUTLETS, AND CONTROL STRUCTURE

Figure 1 Salinas Dam Project Overview

Pipeline Project

Part A

1. Set up a spreadsheet to calculate the flow at valve opening increments of every **5 degrees**. Determine the maximum flow rate that can be supplied to the downstream storage reservoir via the pipeline with the upstream reservoir at maximum reservoir elevation (El 1320ft). What controls the maximum allowable flow rate and what is the corresponding valve opening?

- a) Use the Swamee-Jain equation to calculate f . Use the appropriate friction factor for each flow condition.

$$f = \frac{1.325}{\left(\log_e \left[\frac{5.74}{\text{Re}^{0.9}} + \frac{e}{3.7D} \right] \right)^2}$$

- b) Use minor loss coefficients as given in the system data.
- c) Use the following Valve C_d equation with the following coefficients:

$$a = -0.01566$$

$$b = 0.889$$

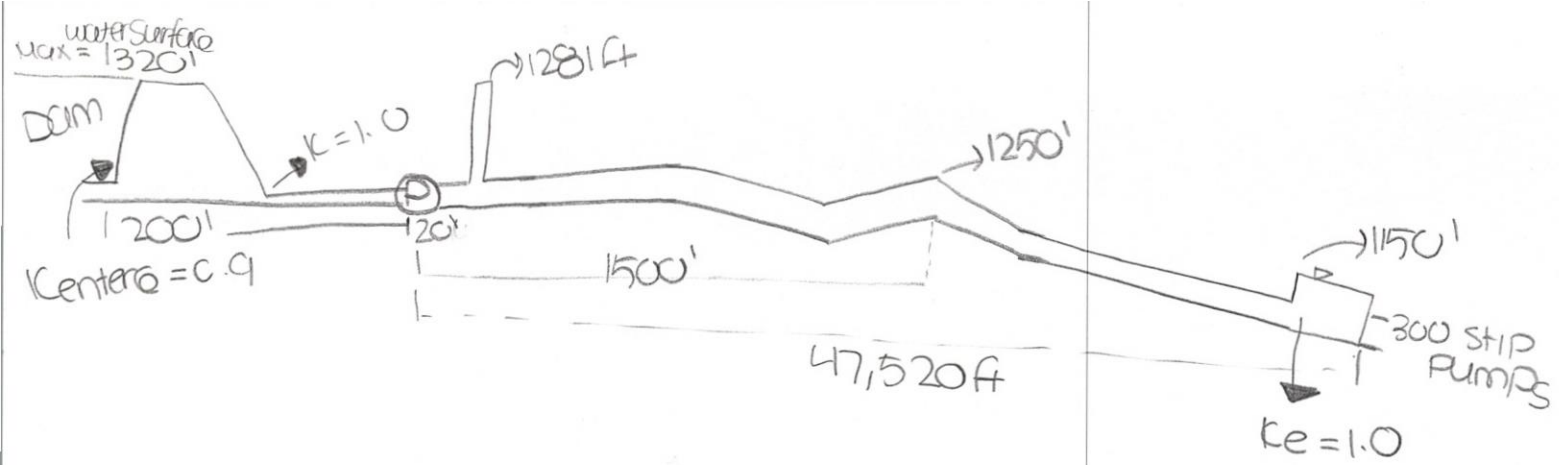
$$c = 55.61$$

$$d = 14.77$$

$$C_d = a + \frac{b}{1 + e^{-(x-c)/d}}$$

Note: "x" is the valve opening in **degrees**

- d) Calculate C_d using the above equation, along with C_v , and K_l
- e) Use spreadsheet program format like that given on the handout.
- f) Start calculations with the valve full open then close the valve until you identify the maximum system flow rate that does not result in a spilling surge tank condition. Identify the corresponding valve opening. Calculate the actual valve opening, rather than just the closest 5-degree incremental opening.
- g) What is the required ΔH across the control valve (CV) at the maximum flow rate?
- h) List the equations and assumptions and provide hand calculations for one complete row of data.
- i) Provide a brief write-up (grad students).



Prob. 1 Part A, (Swamee Jain Equation)

System Data:

DS Pipe Length (L) = 47520 ft
 US pipe length = 200 ft
 Pipe Diameter (D) = 23.25 in
 Elevation of top surge tank = 1281 ft
 Pipe Roughness (e) = 0.004 in
 e/D = 1.72E-04 in
 Kinematic Viscosity = 1.217E-05 sq-ft/sec
 g = 32.2 deg F
 water temperature = 60 ft²/sec
 US. Reservoir Elevation (RH1) = 1320 ft
 DS. Reservoir Elevation (RH2) = 1150 ft
 Elevation of pipe at valve = 1226 ft
 Barometric Pressure @ Valve (Elev. 1226 ft) = 14.087 psi
 Absolute vapor pressure (@ 60 deg F) = 0.2556 psi
 Entrance Loss Coef. = 0.9
 Minor Loss Coef. = 1
 Exit Loss Coef. = 1

$$Cd = a + \frac{b}{1 + e^{-(x-c)/d}}$$

Cd eqn coef:
 a = -0.01566
 b = 0.889
 c = 55.61
 d = 14.77

$$f = \frac{1.325}{\left[\log e \left(\frac{K_s}{3.7D} + \frac{5.74}{Re^{0.9}} \right) \right]^2}$$

Swamee Jain
 Log=LOGe in VB
 Pipe Area(A) = 2.95 sf
 X = degrees Open

Valve Open. deg.	Cv	Cd	Kl loss coef	f friction factor	Calc. Flow gpm	6	Calc. Flow mgd	7	Pipe Vel fps	8	Calc. Valve Dp psi	9	HGL at S-tank feet	10	Pu valve psi	11	Pd valve psi	12	Cond at s-tank	13
90.0	21091	0.794	0.5846	0.01457	7273.0	10.48	5.50	0.12	1317.6	39.82	39.70	Spill								
85.0	19241	0.766	0.70	0.01457	7271.8	10.47	5.50	0.14	1317.5	39.82	39.68	Spill								