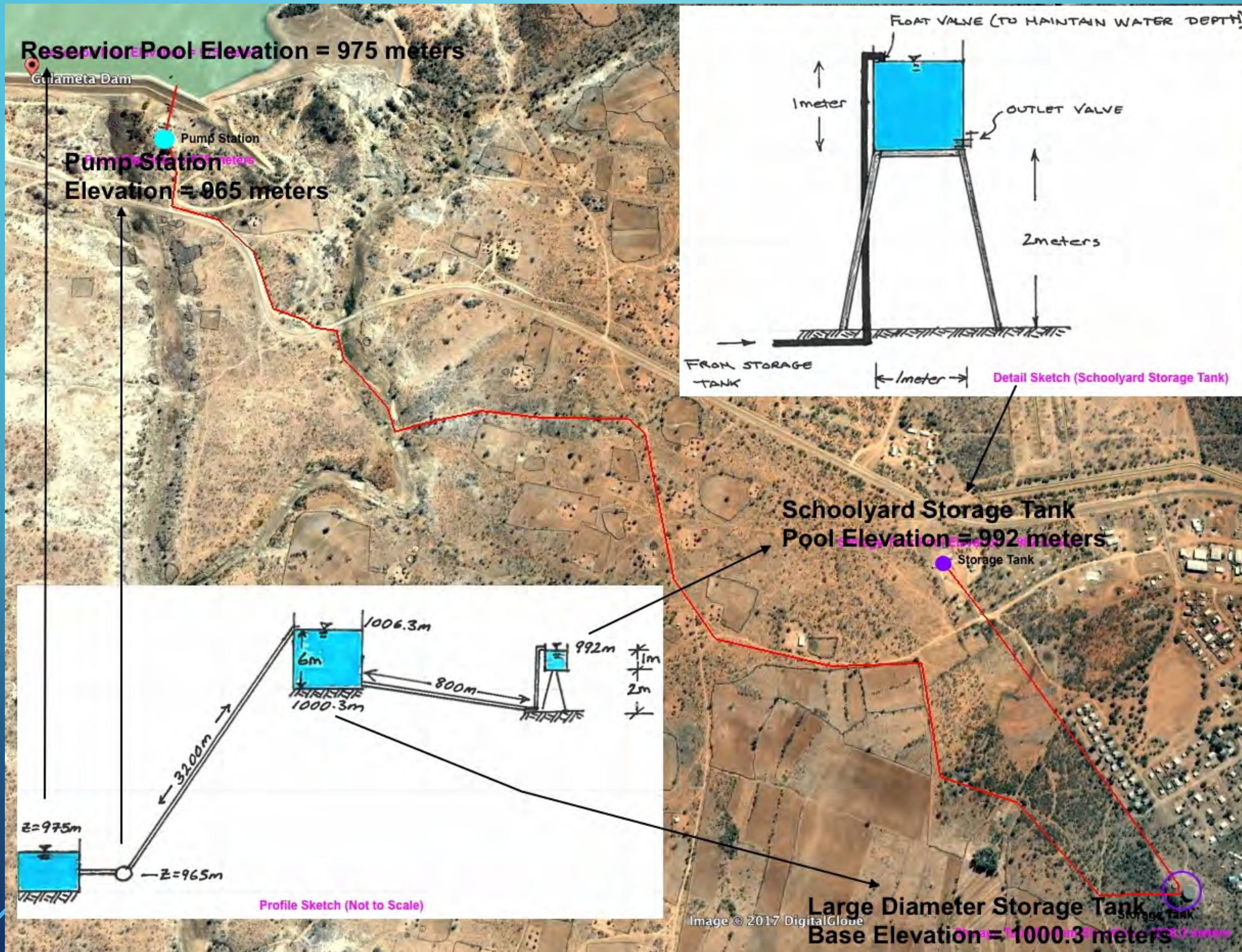
CE 3372 WATER SYSTEMS DESIGN

PIPELINE HYDRAULICS EXAMPLES : PART 3

LINKING SYSTEMS

- A hydraulic system can be analysed as a set of linked components to make an otherwise complicated system easier to analyze.
- Idea is to break system into independent parts, analyze the parts then reassemble to answer questions about the whole system
- Continued example

LINKING SYSTEMS

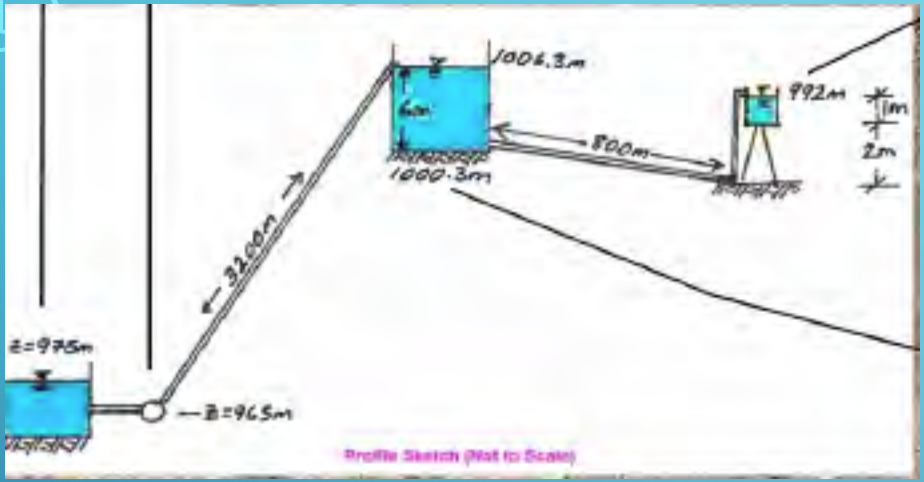


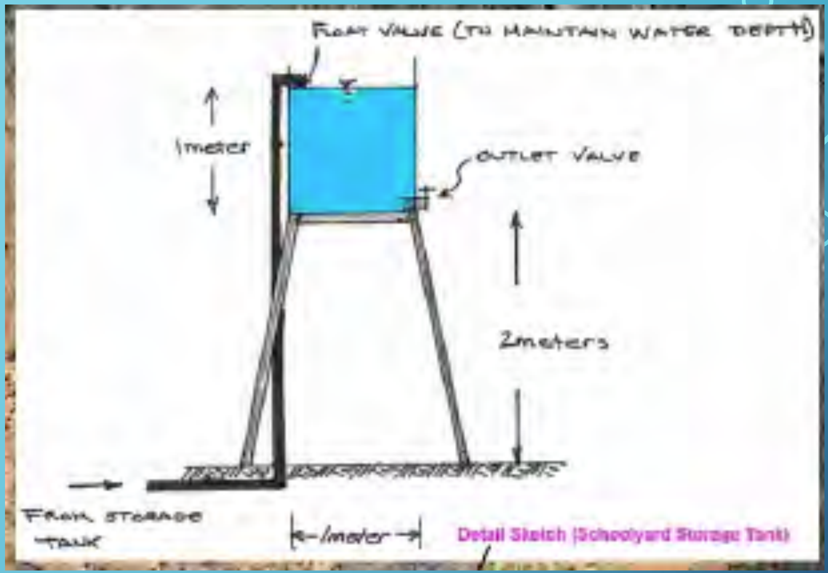
LINKING SYSTEMS

- Analyze proposed system to determine anticipated behavior
  - Float valve fails at school
  - Outlet valve accidently left open
  - Pump operation under worst failure mode
  - Pump fails, time until system fails
    - Float valve limited
    - Oultet valve limited

LINKING SYSTEMS

- Float valve fails at school



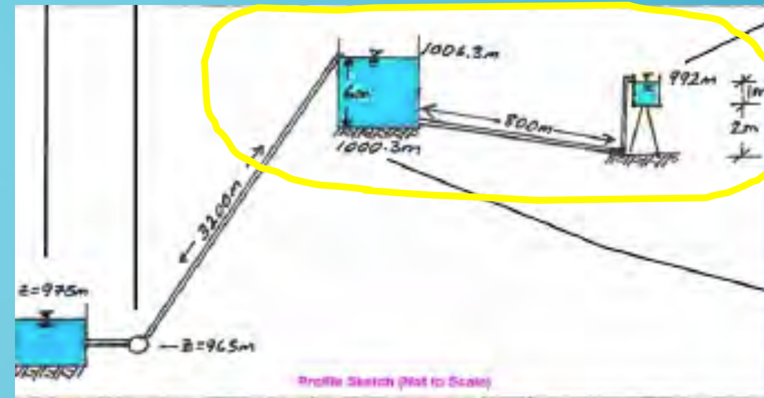


- Upstream head = 1006.3 m
  (pump working, supply tank stays full)
- Downstream head = 992 m
  (pool elevation at schoolyard tank overflow)

LINKING SYSTEMS

- Float valve fails at school
- Z_1= 1006.3 m ; Z_2 = 992 m
- 2 bends, K =1.5 each
- 1 inlet K =0.5
- Upstream valve K =0.15
- Float valve K = 70
- Viscosity = 1.0 E-06sq.m/s
- Ks (HDPE) = 0.007mm

  0.000007m



Not Secure — atomickitty.ddns

Water Properties (SI) using Python

Water Properties (SI)
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 14:54:11 2020

------ INPUT VALUES ------
Temperature = 20.0 (degrees C)
------ LOOKUP VALUES -----
Density = 998 (kg/m^3)
Specific Weight = 9790 (N/m^3)
Dynamic Viscosity = 0.001 (N-s/m^2)
Kinematic Viscosity = 1e-06 (m^2/s)
Vapor Pressure = 2340 (N/m^2) - absolute

Not Secure — atomickitty.ddns

Absolute Roughness Lookup using Python

Absolute Roughness Height (in millimeters) Lookup

Database Last Updated 10 AUG 2020

Machine name : atomickitty.ddns.net
Run Date : Tue Aug 11 14:48:16 2020

------ DATABASE QUERY VALUES ------
Description = PVC and plastic pipe
Absolute Roughness (millimeters) = 0.007
Reference = adapted from https://www.nuclear-power.net/nuclear-engineering/fluid-dynamics/major-head-loss-friction-loss/relative-roughness-of-pipe/

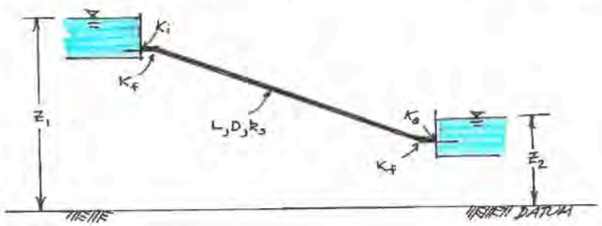
LINKING SYSTEMS

- Hydraulic Model

Not Secure — atomickitty.ddns.net/documents/mytooli

NewANTS

Discharge Between Two Reservoirs (SI 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): 1006.3

Pool Elevation (Z2): 992

Pipeline Length (L) : 800

Pipeline Diameter (D) : 0.127

Sand Roughness Height (ks) : 0.000007

Kinematic Viscosity (nu) : 1e-6

Gravitational Acceleration (g) : 9.8

9.8

Fittings Parameters

Inlet Loss (Ki): 0.5

Exit Loss (Ke) : 70

Fitting Loss (Kf) : 0.15

Fitting Loss (Kf) : 3

Use zero fitting values to ignore minor losses

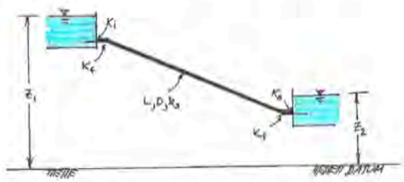
Not Secure — atomickitty.ddns.net/cgi-bin/Hydraulics

Discharge Between Two Reservoirs (SI units)(Update: 2020-0811)

Machine Name : atomickitty.ddns.net
Run Date : Tue Aug 11 15:45:32 2020
COMMAND TO RUN : /usr/bin/Rscript 2QReservoir.R

Return Code : 0

INPUT VALUES		
Pool Elevation 1 (Z1) =	1006.3	meters
Pool Elevation 2 (Z2) =	992.0	meters
Pipeline Length (L) =	800.0	meters
Pipeline Diameter (D) =	0.127	meters
Sand Roughness Height (ks) =	7e-06	meethers
Kinematic Viscosity (nu) =	1e-06	meters^2/second
Gravitational Acceleration (g) =	9.8	meters/second^2
Inlet Loss Coefficient (Ki) =	0.5	
Outlet Loss Coefficient (Ke) =	70.0	
Fitting Loss Coefficient (Kf) =	0.15	
Fitting Loss Coefficient (Kf) =	3.0	



COMPUTED RESULT		
Discharge =	0.01586378	m^3/sec
Friction Factor =	0.01667988	
EGL Slope =	0.017875	m/m

~ 16 liters/second

LINKING SYSTEMS

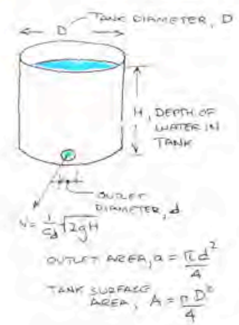
- Outlet valve left open
- Treat as hole in tank

Lesson Collection – Fall 2020 | Discharge from Circular Tank | JupyterLab

atomickitty.ddns.net/documents/mytoolbox-

Flow-Rate Circular Tank

Compute Flow From a Tank



d = Outlet pipe diameter
D = Tank diameter
H = Depth of water above outlet centerline
Cd = Discharge coefficient

Client-Side Javascript

----- INPUT VALUES -----

Outlet diameter (d in feet or meters)	0.05	
Tank Diameter (D in feet or meters)	1.00	
Depth (H in feet or meters)	1.00	
Discharge coefficient (Cd)	1	Use Cd=1 for Bernoulli Analysis
Gravitational acceleration (g)	9.8	SI=9.8, US=32.2
Submit Input Values		

----- COMPUTED RESULTS -----

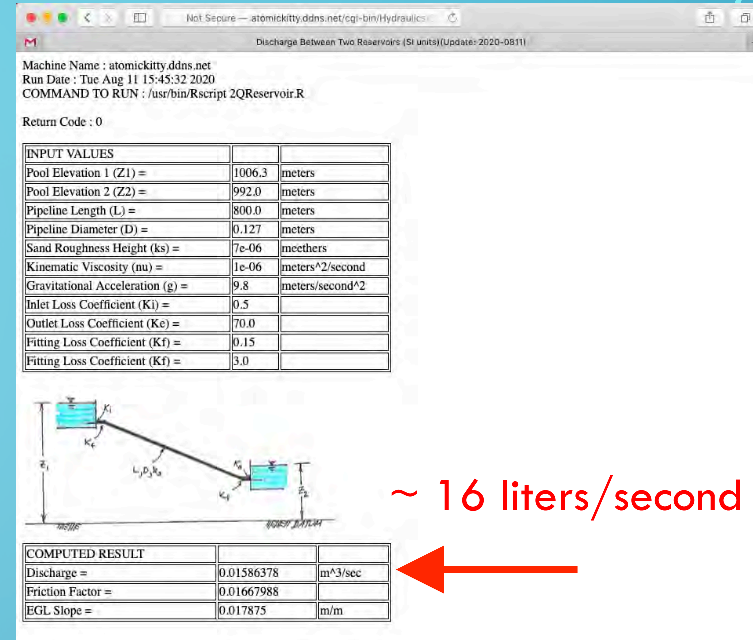
Tank Pool Surface Area	0.7854	L^2 (sq.ft. or sq.m.)
Outlet Area	0.0020	L^2 (sq.ft. or sq.m.)
Discharge Rate	0.0087	L^3/T (cfs or cms)

~ 8 liters/second

LINKING SYSTEMS

- Pump Requirements
  - Float Valve Fails: Q = 16 LPS
  - Outlet Valve Left Open: Q = 8 LPS
  - Pipe Fails: Q = 24 LPS
- Thus a pump that produces
  - 1006.3 – 975 = 29.3 meters of head
  - 24 LPS discharge should be suitable

  - Example catalog listing next slide



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Sand Roughness Height (ks) =	7e-06	meethers
Kinematic Viscosity (nu) =	1e-06	meters^2/second
Gravitational Acceleration (g) =	9.8	meters/second^2
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COMPUTED RESULT		
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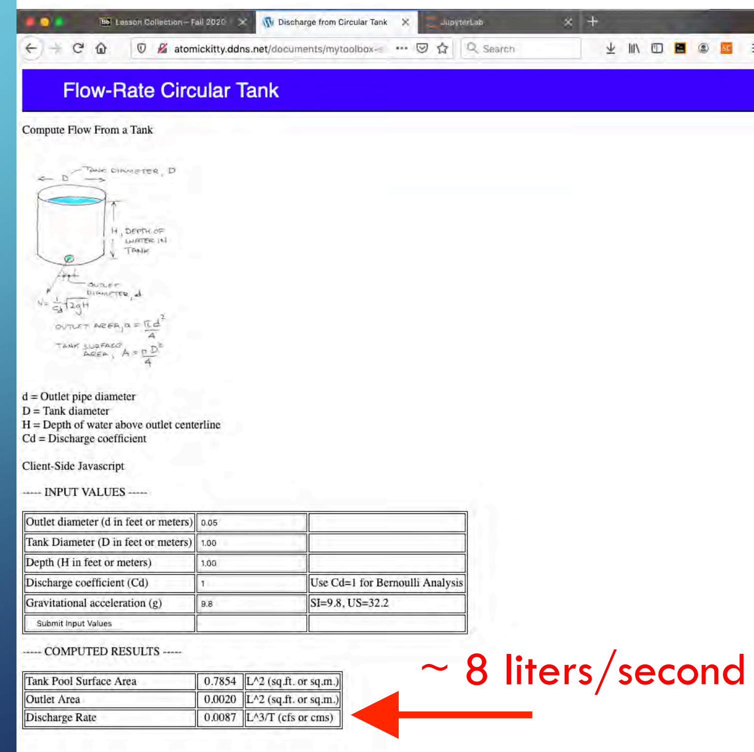
Friction Factor =	0.01667988	
EGL Slope =	0.017875	m/m

~ 16 liters/second



Flow-Rate Circular Tank

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Tank Diameter (D in feet or meters)	1.00	
Depth (H in feet or meters)	1.00	
Discharge coefficient (Cd)	1	Use Cd=1 for Bernoulli Analysis
Gravitational acceleration (g)	9.8	SI=9.8, US=32.2
Submit Input Values		

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  - E.g. Kirloskar KLS 1537 specified for 100mm pipe, so will need reducer/ expander

Product Catalogue

KIRLOSKAR
KOS

Features

- Designed for underwater applications. No need of priming and foot valve
- Easy installation-Foundation and installation platform or pump house not required
- Can withstand wide voltage fluctuations from 200-440 Volts
- Water shower arrangement for out of water applications
- Designed to prevent overloading and motor burning
- Dynamically balanced rotating parts to ensure minimum vibrations during running
- Replaceable wearing parts and hence longer life
- Easy maintenance and spares availability
- **CED coating cast iron components long life & rust free**
- More hygienic & potable for drinking water.

Material of Construction

Standard Supply

Impeller : Cast Iron Delivery
Delivery Casing : Cast Iron
Motor Body : Cast Iron
Shaft : Stainless Steel

Applications

- Submerged pump in Wells, Sumps and Water tanks
- Gardening and sprinklers / conventional irrigation

Range

Head : 6-64 metres
Capacity : 32-2.1 LPS
Power Rating : 2.2 kW-7.5 kW (3.0 HP-10.0 HP)

Approximate performance

PUMP MODEL	POWER RATING		PIPE SIZE (mm)		FULL LOAD CURRENT (in AMPS)	RATED VOLTAGE (VOLTS)	TOTAL HEADS IN METRES															
	kW	HP	SUC	DEL			6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
							DISCHARGE IN LITRES PER SECOND															
KOS-314+	2.2	3.0	80	80	5.5	415	19.0	17.5	15.5	13.2	9.0											
KOS-318+	2.2	3.0	80	65	5.5	415		13.2	12.3	11.4	10.4	9.1	7.4									
KOS-325+	2.2	3.0	65	50	5.5	415				8.8	8.4	7.9	7.5	6.9	6.3	5.6	4.7	3.2				
KOS-335+	2.2	3.0	50	40	5.5	415							4.7	4.5	4.4	4.2	4.0	3.8	3.5	3.1	2.7	2.1
KOS-520+	3.7	5.0	80	80	8.85	415		22.7	21.6	20.4	19.0	17.3	15.4	13.2	10.0							
KOS-527+	3.7	5.0	80	65	8.85	415					14.9	14.2	13.5	12.6	11.6	10.3	8.8	6.4				
KOS-822+	5.5	7.5	100	100	14.5	380				27.0	25.5	23.8	21.7	19.7	17.1	13.8						
KOS-830+	5.5	7.5	80	65	14.5	380						18.9	18.0	17.2	16.2	15.2	14.0	12.4	10.1			
KOS-1030+	7.5	10.0	100	100	19.5	380				32.0	31.0	29.8	28.5	27.0	25.2	23.4	20.9	17.9	13.2			
KOS-1040+	7.5	10.0	80	65	19.5	380				21.0	20.6	20.4	20.0	19.5	19.0	18.6	18.0	[illegible]	[illegible]	[illegible]	14.5	13.4
KOS-1637	11.19	15.0	100	100	29.0	415					36.0	35.5	35.0	35.0	34.0	33.0	32.0	31.0	28.0	24.0	[illegible]	6.0
							24	28	32	36	40	44	48	52	56	60	64	[illegible]	[illegible]	[illegible]		
KOS-538+	3.7	5.0	65	50	9.0	415		7.8	7.0	5.8	4.0											
KOS-550+	3.7	5.0	50	40	9.0	415				4.3	3.8	3.2	2.1									
KOS-844	5.5	7.5	65	65	14.5	380	10.7	10.2	9.3	8.2	6.5											
KOS-852+	5.5	7.5	65	50	14.5	380			8.4	7.9	7.2	6.5	5.6	4.2								
KOS-1050+	7.5	10.0	65	65	19.5	380	12.8	12.4	11.9	11.3	10.5	9.4	8.0	5.8								
KOS-1065+	7.5	10.0	65	50	19.5	380					7.3	7.1	6.7	6.3	5.8	5.2	4.3					
KOS-1555	11.19	15.0	80	65	29.0	415	19.5	19.2	18.5	18.0	17.0	15.5	13.8	9.0								
KOS-1575	11.19	15.0	65	50	29.0	415								7.8	7.5	7.0	6.5	6.0	5.0	[illegible]		

Note: Performance applicable to liquid of specific gravity 1 and viscosity as of water.
All Models are available in Metro Series with Rated Voltage as 415V.

4

LINKING SYSTEMS

- Thus a pump that produces
  - 1006.3 – 975 = 29.3 meters of head
  - 24 LPS discharge should be suitable
  - E.g. Kirloskar KLS 1537 specified for 100mm pipe, so will need reducer/ expander

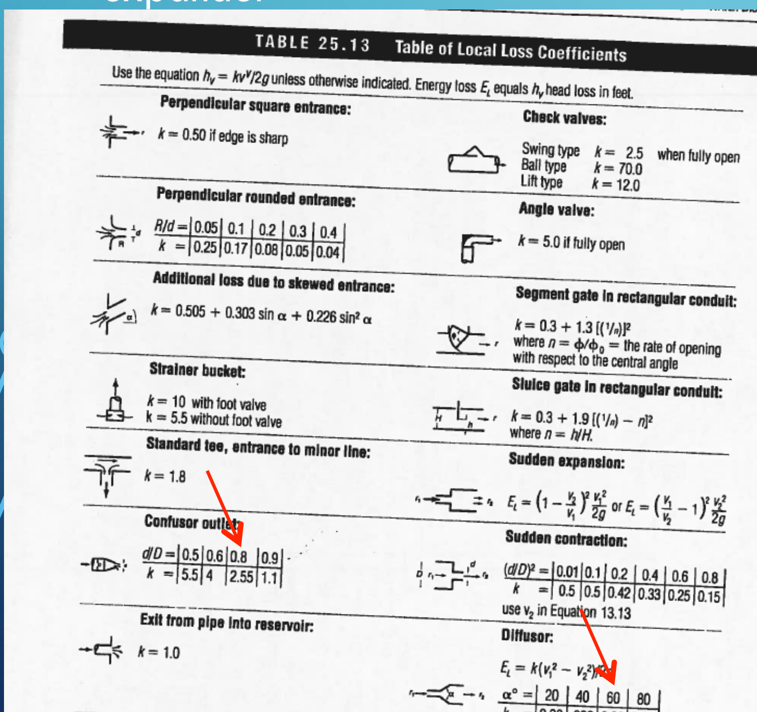

TABLE 25.13 Table of Local Loss Coefficients

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

Perpendicular square entrance:

$k = 0.50$ if edge is sharp

Check valves:

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

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

Angle valve:

$k = 5.0$ if fully open

Additional loss due to skewed entrance:

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

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

Strainer bucket:

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

Sluice gate in rectangular conduit:

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

Standard tee, entrance to minor line:

$k = 1.8$

Sudden expansion:

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

Confusor outlet:

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

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

Exit from pipe into reservoir:

$k = 1.0$

Diffusor:

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

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

www.kirloskarpumps.com/download/prod_cat...
4 of 36 80%

Product Catalogue

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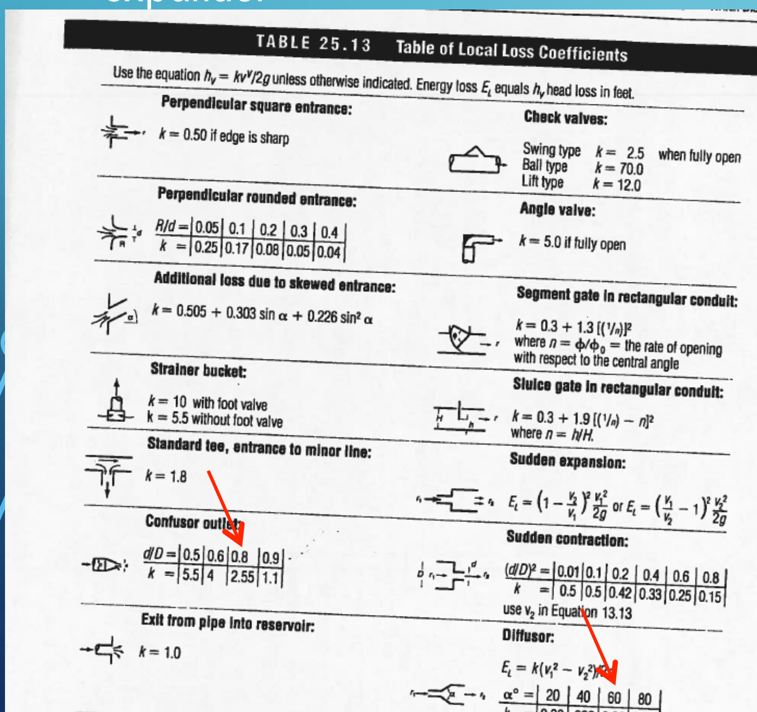

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Strainer bucket:

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Sluice gate in rectangular conduit:

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

Standard tee, entrance to minor line:

$k = 1.8$

Sudden expansion:

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

Confusor outlet:

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

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

Exit from pipe into reservoir:

$k = 1.0$

Diffusor:

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

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

Product Catalogue

KIRLOSKAR
KOS

Features

- Designed for underwater applications. No need of priming and foot valve
- Easy installation-Foundation and installation platform or pump house not required
- Can withstand wide voltage fluctuations from 200-440 Volts
- Water shower arrangement for out of water applications
- Designed to prevent overloading and motor burning
- Dynamically balanced rotating parts to ensure minimum vibrations during running
- Replaceable wearing parts and hence longer life
- Easy maintenance and spares availability
- **CED coating cast iron components long life & rust free**
- More hygienic & potable for drinking water.

Material of Construction

Standard Supply
Impeller : Cast Iron Delivery
Delivery Casing : Cast Iron
Motor Body : Cast Iron
Shaft : Stainless Steel

Applications

- Submerged pump in Wells, Sumps and Water tanks
- Gardening and sprinklers / conventional irrigation

Range

Head : 6-64 metres
Capacity : 32-2.1 LPS
Power Rating : 2.2 kW-7.5 kW (3.0 HP-10.0 HP)

Approximate performance

PUMP MODEL	POWER RATING		PIPE SIZE (mm)		FULL LOAD CURRENT (in AMPS)	RATED VOLTAGE (VOLTS)	TOTAL HEADS IN METRES															
	kW	HP	SUC	DEL			6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
							DISCHARGE IN LITRES PER SECOND															
KOS-314+	2.2	3.0	80	80	5.5	415	19.0	17.5	15.5	13.2	9.0											
KOS-318+	2.2	3.0	80	65	5.5	415		13.2	12.3	11.4	10.4	9.1	7.4									
KOS-325+	2.2	3.0	65	50	5.5	415				8.8	8.4	7.9	7.5	6.9	6.3	5.6	4.7	3.2				
KOS-335+	2.2	3.0	50	40	5.5	415							4.7	4.5	4.4	4.2	4.0	3.8	3.5	3.1	2.7	2.1
KOS-520+	3.7	5.0	80	80	8.85	415		22.7	21.6	20.4	19.0	17.3	15.4	13.2	10.0							
KOS-527+	3.7	5.0	80	65	8.85	415					14.9	14.2	13.5	12.6	11.6	10.3	8.8	6.4				
KOS-822+	5.5	7.5	100	100	14.5	380				27.0	25.5	23.8	21.7	19.7	17.1	13.8						
KOS-830+	5.5	7.5	80	65	14.5	380						18.9	18.0	17.2	16.2	15.2	14.0	12.4	10.1			
KOS-1030+	7.5	10.0	100	100	19.5	380				32.0	31.0	29.8	28.5	27.0	25.2	23.4	20.9	17.9	13.2			
KOS-1040+	7.5	10.0	80	65	19.5	380				21.0	20.6	20.4	20.0	19.5	19.0	18.6	18.0	[illegible]	[illegible]	15.5	14.5	13.4
KOS-1637	11.19	15.0	100	100	29.0	415					36.0	35.5	35.0	35.0	34.0	33.0	32.0	31.0	28.0	24.0	[illegible]	6.0
							24	28	32	36	40	44	48	52	56	60	64	[illegible]	[illegible]	[illegible]		
KOS-538+	3.7	5.0	65	50	9.0	415		7.8	7.0	5.8	4.0											
KOS-550+	3.7	5.0	50	40	9.0	415				4.3	3.8	3.2	2.1									
KOS-844	5.5	7.5	65	65	14.5	380	10.7	10.2	9.3	8.2	6.5											
KOS-852+	5.5	7.5	65	50	14.5	380			8.4	7.9	7.2	6.5	5.6	4.2								
KOS-1050+	7.5	10.0	65	65	19.5	380	12.8	12.4	11.9	11.3	10.5	9.4	8.0	5.8								
KOS-1065+	7.5	10.0	65	50	19.5	380					7.3	7.1	6.7	6.3	5.8	5.2	4.3					
KOS-1555	11.19	15.0	80	65	29.0	415	19.5	19.2	18.5	18.0	17.0	15.5	13.8	9.0								
KOS-1575	11.19	15.0	65	50	29.0	415								7.8	7.5	7.0	6.5	6.0	5.0	[illegible]		

Note: Performance applicable to liquid of specific gravity 1 and viscosity as of water.
All Models are available in Metro Series with Rated Voltage as 415V.

LINKING SYSTEMS

- Thus a pump that produces
  - 1006.3 – 975 = 29.3 meters of head
  - 24 LPS discharge should be suitable
  - E.g. Kirloskar KLS 1537 specified for 100mm pipe, so will need reducer/ expander
- However when we analyze the pumping side, don't have the correct pump
  - Can only produce 7 LPS , because we forgot the pipe friction.
  - Options?
    - 2 in series

Lesson Collection - Fall 202 | Discharge Between Two Res | JupyterLab

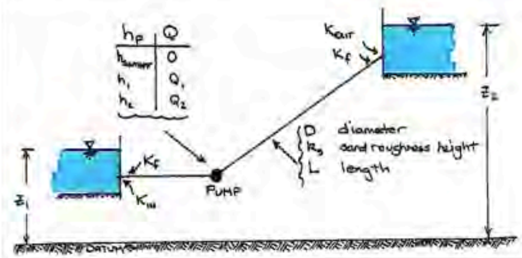
atomickitty.ddns.net/cgi-bin/Hydraulics/2QR

Machine Name : theodore-macbookpro.ttu.edu
Run Date : Mon Sep 7 20:46:58 2020
COMMAND TO RUN : /usr/bin/Rscript 2QReservoirWithPump.R

Return Code : 0

INPUT VALUES			
Pool Elevation 1 (Z1) =	975.0	meters	
Pool Elevation 2 (Z2) =	1006.3	meters	
Pipeline Length (L) =	3200.0	meters	
Pipeline Diameter (D) =	0.127	meters	
Sand Roughness Height (ks) =	7e-06	meters	
Kinematic Viscosity (nu) =	1e-06	meters^2/second	
Gravitational Acceleration (g) =	9.8	meters/second^2	
Inlet Loss Coefficient (Ki) =	0.5		
Outlet Loss Coefficient (Ke) =	1.0		
Fitting Loss Coefficient (Kf) =	2.55		
Fitting Loss Coefficient (Kf) =	0.32		
Pump Shutoff Head (Hp@Q_0) =	40.0	Discharge (Q_0)	0.0
Pump Point One (Hp@Q_1) =	30.0	Discharge (Q_1)	0.028
Pump Point Two (Hp@Q_2) =	14.0	Discharge (Q_2)	0.036

Fittings at pump



COMPUTED RESULT		
Discharge =	0.0076394	m^3/sec
Added Head =	40.35164	m
Friction Losses =	9.051641	m
Static Lift =	31.3	m
Pipeline Friction Factor =	0.01918692	
Fitted Pump Shutoff =	41.48688	m
Pump Constant =	-19452.23	m/Q^2

LINKING SYSTEMS

- Thus a pump that produces
  - 1006.3 – 975 = 29.3 meters of head
  - 24 LPS discharge should be suitable
  - E.g. Kirloskar KLS 1537 specified for 100mm pipe, so will need reducer/expander
- However when we analyze the pumping side, don't have the correct pump
  - Can only produce 7 LPS , because we forgot the pipe friction.
  - Options?
    - 2 in series (Almost works)
    - Probably look for a bigger pump, but for grins, lets try 3 in series

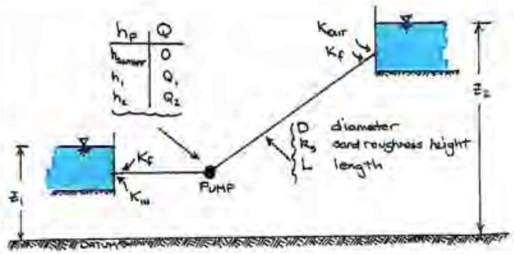
Lesson Collection - Fall 202 | Discharge Between Two Res | JupyterLab

atomickitty.ddns.net/cgi-bin/Hydraulics/2QR

Machine Name : theodore-macbookpro.ttu.edu
Run Date : Mon Sep 7 20:53:15 2020
COMMAND TO RUN : /usr/bin/Rscript 2QReservoirWithPump.R

Return Code : 0

INPUT VALUES			
Pool Elevation 1 (Z1) =	975.0	meters	
Pool Elevation 2 (Z2) =	1006.3	meters	
Pipeline Length (L) =	3200.0	meters	
Pipeline Diameter (D) =	0.127	meters	
Sand Roughness Height (ks) =	7e-06	meters	
Kinematic Viscosity (nu) =	1e-06	meters^2/second	
Gravitational Acceleration (g) =	9.8	meters/second^2	
Inlet Loss Coefficient (Ki) =	0.5		
Outlet Loss Coefficient (Ke) =	1.0		
Fitting Loss Coefficient (Kf) =	2.55		
Fitting Loss Coefficient (Kf) =	0.32		
Pump Shutoff Head (Hp@Q_0) =	80.0	Discharge (Q_0)	0.0
Pump Point One (Hp@Q_1) =	60.0	Discharge (Q_1)	0.028
Pump Point Two (Hp@Q_2) =	28.0	Discharge (Q_2)	0.036



COMPUTED RESULT		
Discharge =	0.01734215	m^3/sec
Added Head =	71.27324	m
Friction Losses =	39.97324	m
Static Lift =	31.3	m
Pipeline Friction Factor =	0.01641738	
Fitted Pump Shutoff =	82.97376	m
Pump Constant =	-38904.47	m/Q^2

LINKING SYSTEMS

- Thus a pump that produces
  - 1006.3 – 975 = 29.3 meters of head
  - 24 LPS discharge should be suitable
  - E.g. Kirloskar KLS 1537 specified for 100mm pipe, so will need reducer/ expander
- However when we analyze the pumping side, don't have the correct pump
  - Can only produce 7 LPS , because we forgot the pipe friction.
  - Options?
    - 3 in series (essentially working)
    - But best look for a bigger pump

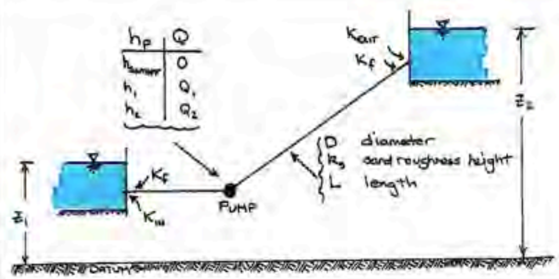
Lesson Collection - Fall 202 | Discharge Between Two Res | JupyterLab

atomickitty.ddns.net/cgi-bin/Hydraulics/2QR...

Machine Name : theodore-macbookpro.ttu.edu
Run Date : Mon Sep 7 20:55:39 2020
COMMAND TO RUN : /usr/bin/Rscript 2QReservoirWithPump.R

Return Code : 0

INPUT VALUES			
Pool Elevation 1 (Z1) =	975.0	meters	
Pool Elevation 2 (Z2) =	1006.3	meters	
Pipeline Length (L) =	3200.0	meters	
Pipeline Diameter (D) =	0.127	meters	
Sand Roughness Height (ks) =	7e-06	meters	
Kinematic Viscosity (nu) =	1e-06	meters^2/second	
Gravitational Acceleration (g) =	9.8	meters/second^2	
Inlet Loss Coefficient (Ki) =	0.5		
Outlet Loss Coefficient (Ke) =	1.0		
Fitting Loss Coefficient (Kf) =	2.55		
Fitting Loss Coefficient (Kf) =	0.32		
Pump Shutoff Head (Hp@Q_0) =	120.0	Discharge (Q_0)	0.0
Pump Point One (Hp@Q_1) =	90.0	Discharge (Q_1)	0.028
Pump Point Two (Hp@Q_2) =	42.0	Discharge (Q_2)	0.036



COMPUTED RESULT		
Discharge =	0.02240409	m^3/sec
Added Head =	95.16888	m
Friction Losses =	63.86888	m
Static Lift =	31.3	m
Pipeline Friction Factor =	0.0157098	
Fitted Pump Shutoff =	124.4606	m
Pump Constant =	-58356.7	m/Q^2