

**COURSE CODE: CE102**

**COURSE NAME: INTRODUCTION TO CIVIL ENGINEERING**

**PROJECT TITLE:**  **PIPE JUSTICE**

**GROUP: 204**

**GROUP NAME: VETERANS**

**TEAM MEMBERS NAMES AND ID’S:**

**HALİL CAN TOPTAŞ 2026540**

**FARUK ÖZENÇ UĞURLUOĞLU 2026649**

**BARIŞ UFUK ŞENTÜRK 2027217**

**BURAK YOLCU 2026797**

**FARUK ÖKSÜZ 2026946**

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**1. PROJECT INTRODUCTION:**

If it is necessary to transport the water over long distances, pipe lines are very useful to do that. The aim of this project is to design a pipe line system which provides water from one main source to two other sources which is located in different villages whose elongation is different from each other. How can it be possible to distribute the water that comes from the main source with the percentages of %50 and 50%. Also, the aim of this Project is to understand how elongations, lengths of pipes and diameters of pipes affect the distribution of the water that come from the main source. By using the given program it is possible to understand how the out puts change when the inputs (lengths, diameters, elongation) are changed. In this Project we are going to design a mini-pipe line system whose data is more suitable to design. However to see how elongation, length and diameter affect the system, we are going to work with more realistic numbers theoretically.

**2.PIPE LINE SYSTEMS AND CIVIL ENGINEERING:**

In daily life, water, natural gases, oil etc. are very vital for humanity. The sources of these can be everywhere but distribution without pipes can't be possible. The water used in daily life,oil used in cars is pumped through pipes.There are many examples just like these. For example, the most nearest is blood in veins. Veins are go every point on body so blood is pumped every point on body. Another example is natural gas. Russia has huge amount of natural gas in their lands. They sell their gases to other countries and transfer with pipeline systems.

The conservation of mass and energy principles are used for pipe flow. While flow in pipes, energy losses can occur and type of loses are mainly grouped into two categories.

* Friction losses because of contact between wall and material
* local losses due to the piping components like valves, bends etc.

[1]One form of resistance to flow is due to the **viscosity** of the liquid.  Every liquid has its own value for this resistance to flow. SAE 30 motor oil has a lower viscosity and flows much easier than SAE 50 motor oil. The values for water are lower than for the motor oil.

Another characteristic of any liquid is its attraction to a surface. It attaches itself to any surface and cannot be moved. The higher the viscosity of the liquid is,  higher the resistance to flow, therefore, the higher the friction loss.

 A layer is formed by this non-moving liquid and reduces the inside diameter of the pipe. This increases the velocity of the liquid passing through it. The head loss from friction is related to the velocity energy (V2/2g) of the liquid squared.

The liquid is not moving at the pipe wall but has a much higher velocity at the center of the pipe.

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The **condition of the inside of a pipe** also has a great effect on the head loss of the flow of liquid. The rougher it is, the thicker the layer of non-moving or slow moving liquid near the pipe wall. This reduces the inside diameter of the pipe, increasing the velocity of the liquid. With the increase in velocity comes an increase in friction losses.

**Pipe Fittings**

Any time a liquid flow changes direction there is resistance. Since all liquids have weight, they also have momentum. This means the liquid will always try to continue moving in the same direction. When the liquid encounters a change in direction (such as an elbow), its momentum carries the flow to the outer edge of the fitting. Because the liquid is trying to flow around the outer edge of the fitting, the effective area of the fitting is reduced. The effect is similar to attaching a smaller diameter pipe in the system. The velocity of the liquid increases and the head loss due to friction increases.

**Energy Loss**

The energy lost by the liquid is converted to heat created by friction. Since the amount of liquid exiting a pipe has to equal the amount entering the pipe, the velocity must be equal. If the velocity is equal, then the velocity energy (head) must be equal. This only leaves one place for the energy to come from: pressure energy. The measured pressure entering the pipe will be higher than the measured pressure exiting the pipe.

Flow from Tank A to Tank B maintained with a pump on the pipeline is illustrated in Figure 2. The energy equation for this system is written as:

𝐻𝐴− ℎ𝑙,𝑒𝑛𝑡𝑟𝑦+ 𝐻𝑝𝑢𝑚𝑝−ℎ𝑙,𝑒𝑥𝑝𝑎𝑛𝑠𝑖𝑜𝑛 − ℎ𝑙,𝑒𝑥𝑖𝑡−ℎ𝑓𝐴𝐵= 𝐻𝐵



**Figure 1. A basic pipe system**

where HA and HB are the total energy in reservoirs A and B; hl,entry , hl,expansion and hl,exit are the

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local energy (head) losses due to the entrance, expansion and the exit respectively, hf is the frictional loss along the pipeline and Hpump is the head provided to the system by the pump. Frictional losses in piplines are commonly evaluated using **Darcy-Weisbach equation** which is:

ℎ𝑓=𝑓𝐷∙𝐿∙𝑉^2/2𝑔.D

where

* hf : Head loss due to friction (m);
* L: Length of pipe (m);
* D: Diameter of the pipe (m);
* V: Average velocity of the flow ( m/s);
* g:gravitational acceleration (m/s2);
* fD: Darcy’s friction factor (dimensionless)

The friction factor f depends on the roughness and a non-dimensional Reynolds number. If the friction factor is known, then the head loss and the flow rate can be computed between two tanks. In order to obtain the total energy at a point along the pipeline, the height of the point from the datum (a horizontal reference line), pressure at the related point, unit weight of the water and the velocity of the flow at the related section are the required parameters.

In Turkey, there are some examples of different kinds of pipeline systems.

**1-) The Turkish Republic of Northern Cyprus Water Supply Project**

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**Figure 2: A ready part of Water Supply Project**

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**2-)BTC(Baku–Tbilisi–Ceyhan Pipeline Project)**

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**Figure 3: A part of Baku–Tbilisi–Ceyhan Pipeline**

**3-)TANAP(TRANS ANATOLIAN NATURAL GAS PIPELINE PROJECT)**

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**Figure 4: A part of TANAP**

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**3.JUNCTION\_DESIGN ANALYSIS**

**3.1 Analysis A: Finding equal-distribution design- optimal design**

Firstly, the elevations of reservoirs entered as input for the program named as "PIPE\_JUNC\_DESIGN". Diameters' and lengths' of pipes were taken same in sample. The result of volumes were taken. Then changes in diameters and lengths was done. By trial-and-error method, optimal length and optimal diameter were found. The amount of distributed water for Village A and Village B are not exactly equal but they are close to each other.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Elevation (m) | Pipe's Optimal Diameter (m) | Pipe's Optimal Length (m) | Volume of Distributed Water (m^3) |
| Dam Reservour | **250** | **1** | **100** | **5000** |
| Village A | **120** | **1,6** | **70** | **2510,67** |
| Village B | **90** | **1,1** | **330** | **2491,712** |

**Table 1: Optimal Design's values**

**3.2 Analysis B: Effect of diameter change**

Except diameter of Pipe 2 (in Village A), all data is kept as their optimal value. Ten different diameters of Pipe 2 with the ratios of (50%, 60%, 70%,80%,90%, 120%, 140%, 160%, 180%, 200%) the optimal diameter were entered the program as input. The results were taken and the table was organized. Lastly, the graph of change of volumes and diameters was made.

|  |  |  |  |
| --- | --- | --- | --- |
| Ratio of Pipe's Diameter-Pipe's Optimal Diameter | Pipe's Diameter(m) | Volume of Distributed Water in Reservour 2 (m^3) | Volume of Distributed Water in Reservour 3 (m^3) |
| 50% | 0,8 | 1537,636 | 3463,707 |
| 60% | 0,96 | 1866,604 | 3133,698 |
| 70% | 1,12 | 2118,698 | 2882,962 |
| 80% | 1,28 | 2299,495 | 2702,662 |
| 90% | 1,44 | 2424,674 | 2577,255 |
| 120% | 1,92 | 2609,834 | 2393,606 |
| 140% | 2,24 | 2658,181 | 2346,522 |
| 160% | 2,56 | 2683,661 | 2322,512 |
| 180% | 2,88 | 2698,383 | 2309,456 |
| 200% | 3,2 | 2707,792 | 2301,929 |

**Table 2: Effect of diameter change**

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**Figure 5: Graph of Diameter vs. Volume of Distributed Water**

**3.3 Analysis C: Effect of length change:**

Except length of Pipe 2 (in Village A), all data is kept as their optimal value. Ten different lengths of Pipe 2 with the ratios of (50%, 60%, 70%,80%,90%, 120%, 140%, 160%, 180%, 200%) the optimal length were entered the program as input. The results were taken and the table was organized. Lastly, the graph of change of volumes and lengths was made.

|  |  |  |  |
| --- | --- | --- | --- |
| Ratio of Pipe's Length-Pipe's Optimal Length | Pipe's Length(m) | Volume of Distributed Water in Reservour 2 (m^3) | Volume of Distributed Water in Reservour 3 (m^3) |
| 50% | 35 | 2523,772 | 2478,703 |
| 60% | 42 | 2521,126 | 2481,328 |
| 70% | 49 | 2518,494 | 2483,942 |
| 80% | 56 | 2515,875 | 2486,542 |
| 90% | 63 | 2513,265 | 2489,133 |
| 120% | 84 | 2505,512 | 2496,834 |
| 140% | 98 | 2500,402 | 2501,912 |
| 160% | 112 | 2495,338 | 2506,945 |
| 180% | 126 | 2490,319 | 2511,934 |
| 200% | 140 | 2485,342 | 2516,88 |

**Table 3: Effect of length change**

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**Figure 6: The Graph of Length vs. Volume of Distributed Water**

**4.DISCUSSION OF THE RESULTS:**

In this project, there is a water resource at 250 m elevation and there are two villages which have different elevations (120m,90m). Water has to transport these two villages at equal amounts.In order to do this, diameter or length of the pipe has to be changed. In given sample, outputs of program which calculates volume of water in pipes and calculates total transferred time, are different(V2=3413.392 m^3 and V3=1589.192m^3). By trial-and-error fashion, the optimal length's and optimal diameter's are found. After finding optimal diameters and optimal lengths of pipes, in order to observe effects of diameter and length of pipe's on distributed water volume , the diameter of second pipe was changed. First, diameter of pipe 2 was decreased at its half of optimal diameter's and entered as input. After that, 9 different diameters also calculated and results were tabulated and graph was drawn. Then same process was used for length of pipe 2. While giving inputs and getting outputs, “PIPE\_JUNC\_DESIGN.EXE”(provided Prof. Dr. İsmail AYDIN in Hydraulics Division at METU), tabulating results and drawing graph, MS Office's Excel was used. After analyzing results and graphs, **direct** proportion **among diameter of pipe, amount of water in pipe and contributed water in reservoir 2** is observed. In addition, inverse proportion between **length of pipe and contributed water in reservoir 2** is observed.

**5.CONCLUSION:**

In this Project we see how a pipeline system should be designed if we try to distribute the water from one source to the two villages with the percentages of %50 and %50. We see how elongation, diameter of pipelines and length of pipelines affect the distribution. We understand whether we should increase or decrease the value of data. Also, because we have do a research about the pipelines, we understand the importance of pipelines. Actually, they are being used in everywhere and the irroles are very important in our lives. Now we all have a knowledge about pipeline systems. Actually, it is good for the fourth year while we are choosing the elective courses or for our master degrees because we have learn something about the division of hydromechanics.

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To come the concept of teamwork, we have gained a lot of things. First of all it is a great chance to meet with the other students that i have not meet before. Working as a team is a perfect experience. We work collectively and learn the things that we do not know. We helped each other and do it as a team. However, it was not easy to bring whole team together. Actually, it was difficult to communicate with each other. It is hard to bring whole team in a single day and a single time because it is possible that one of us is busy in that time. For us, Fortran was a trouble. However, we got it with trial and error method.

**6.REFERENCES:**

**1-)** Retrieved from http://www.hydromatic.com/ResidentialPage\_techinfopage\_headloss.aspx

**2-)** http://www.edie.net/news/0/BTC-pipeline-construction-suspended/8668/

**3-)** http://realestatecoulisse.com/turkey-completes-the-water-supply-project-to-northern-cyprus/

**4-)** http://www.tanap.com/tanap-project/why-tanap/

**7.APPENDIX:**

**A-) Analyses A**:

Case No: 1.00000

For the following input data:

200.000 1.00000 100.000

110.000 1.25000 50.0000

60.0000 0.750000 350.000

Your results are (Volume in m3 and Time in seconds)

V1=5000.000 V2=3282.396 V3=1720.121 T= 267.842

Case No: 2.00000

For the following input data:

200.000 1.00000 100.000

110.000 1.30000 85.0000

60.0000 0.800000 275.000

Your results are (Volume in m3 and Time in seconds)

V1=5000.000 V2=2924.795 V3=2077.418 T= 263.179

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Case No: 3.00000

For the following input data:

200.000 1.00000 100.000

110.000 1.30000 70.0000

60.0000 0.900000 330.000

Your results are (Volume in m3 and Time in seconds)

V1=5000.000 V2=2504.462 V3=2497.443 T= 259.249

Case No: 4.00000

For the following input data:

200.000 1.00000 100.000

110.000 1.60000 50.0000

60.0000 1.10000 350.000

Your results are (Volume in m3 and Time in seconds)

V1=5000.000 V2=1412.447 V3=3590.435 T= 250.709

So, data in case 3 is selected as **OPTIMAL VALUES.**

**B-) Analyses B:**

|  |  |  |  |
| --- | --- | --- | --- |
| Ratio of Pipe's Diameter-Pipe's Optimal Diameter | Pipe's Diameter(m) | Volume of Distributed Water in Reservour 2 (m^3) | Volume of Distributed Water in Reservour 3 (m^3) |
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| 140% | 2,24 | 2658,181 | 2346,522 |
| 160% | 2,56 | 2683,661 | 2322,512 |
| 180% | 2,88 | 2698,383 | 2309,456 |
| 200% | 3,2 | 2707,792 | 2301,929 |

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**C-) Analyses C**

|  |  |  |  |
| --- | --- | --- | --- |
| Ratio of Pipe's Length-Pipe's Optimal Length | Pipe's Length(m) | Volume of Distributed Water in Reservour 2 (m^3) | Volume of Distributed Water in Reservour 3 (m^3) |
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| 160% | 112 | 2495,338 | 2506,945 |
| 180% | 126 | 2490,319 | 2511,934 |
| 200% | 140 | 2485,342 | 2516,88 |

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