PROJECT REPORT

Subject:

Fluid Mechanics - II

Submitted By:

Group # 13

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Submitted To:

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Date:

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Statistics and Specifics:

Problem assigned:	**Problem 2**
Man-hours consumed:	**~80 hours**
Softwares used:	**Microsoft Excel 2013,** **Pipe Flow Expert (by Daxesoft Ltd.)**
Learning points:	**• Better understanding of pressure, static and dynamic heads and their relation to one another,** **• In depth analysis of pipe flow networks,** **• Strengthened concepts about losses throughout a pipe flow network, how they vary from component to component, how they affect the heads and, how can we decrease (or increase) them**
Total cost:	**PKR 500**

Our Understanding of the Given Problem:

We are provided with a test bench with 10 measuring stations. We are required to provide certain static heads in 7 of them ranging from 5 cm to 20 cm (including 2 stations having any variable head). The source flowrate is to be within 300 ml per second.

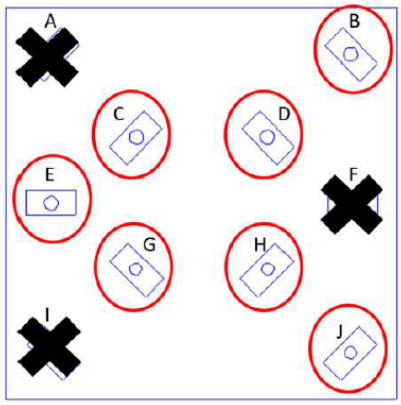
We are allowed to use pipes of any diameter and length, in any configuration using any number of tees, crosses, and joints we might want to use as long as the required head is achieved in the measuring stations.

We have to write an efficient and accurate computer program, linking the concerned variables, to do the calculations to get the required results,

After doing the theoretical grinding and calculations, we have to demonstrate our network on the said test bench and see how close do the practical and on-paper results get. This all is to be done keeping in mind the cost efficiency of the project.

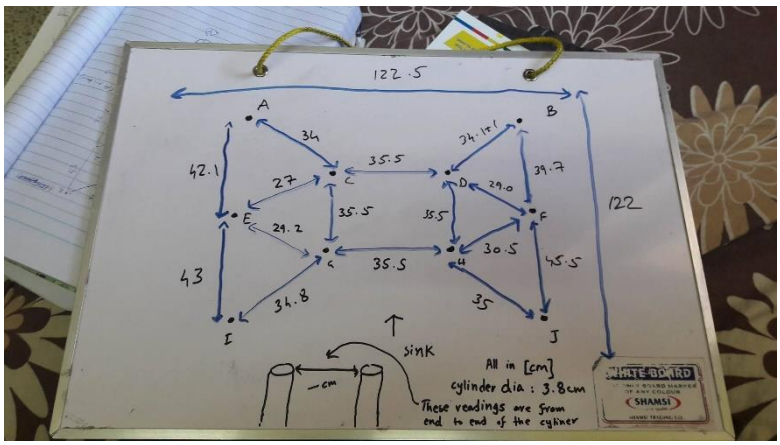
The required heads are as following:

Problem 2



Area	Pressure Heads (cm)
B	10
C	20
D	15
E	15
G	5
H	Variable
J	Variable

The dimensions of the test bench are as following:



The Challenges:

I. Limitations of the test bench:

The tees used to connect the pipes with the measuring stations are only compatible with pipes having 8mm outer diameter. This creates a problem when we want to connect a pipe of an outer diameter other than 8mm. One way to get around this problem is to use nozzles and diffusers which add to the head losses and further complicate the calculations

II. Doing a market survey:

Before we proceeded to doing the calculations, it was important to know what material is available in the market so we don't end up using components we couldn't get our hands onto later in the fabrication process. Through this survey, we came to know the sizes of pipes, the types of tees, connectors, and crosses available in the market and at what price

III. Catering for the temperature:

Several fluid properties (including viscosity and therefore Re, f and, losses) are temperature dependent. It is very difficult to know what the temperature will be at the time of project demonstration. The water from the source can be at any temperature depending the time of the day, the temperature of the room etc. So, all the calculations were performed assuming the temperature to be 20^{o} C

IV. Writing a program:

A program had to be written in order to link all concerned variables in such a way that by changing certain variables (length of pipe, diameter of pipe, adding connecters, tees, crosses), the required head in the stations could be achieved while accounting for the head losses in the used components

Our Approach:

We use the initial head provided which was found when the 5mm pipe discharged a flowrate of 36 ml per second to the atmosphere. As water flows due to difference in the pressure, we assume that at the outlet of the drainage we have 0 gauge pressure. This assumption is correct as verified separately by the following two methods:

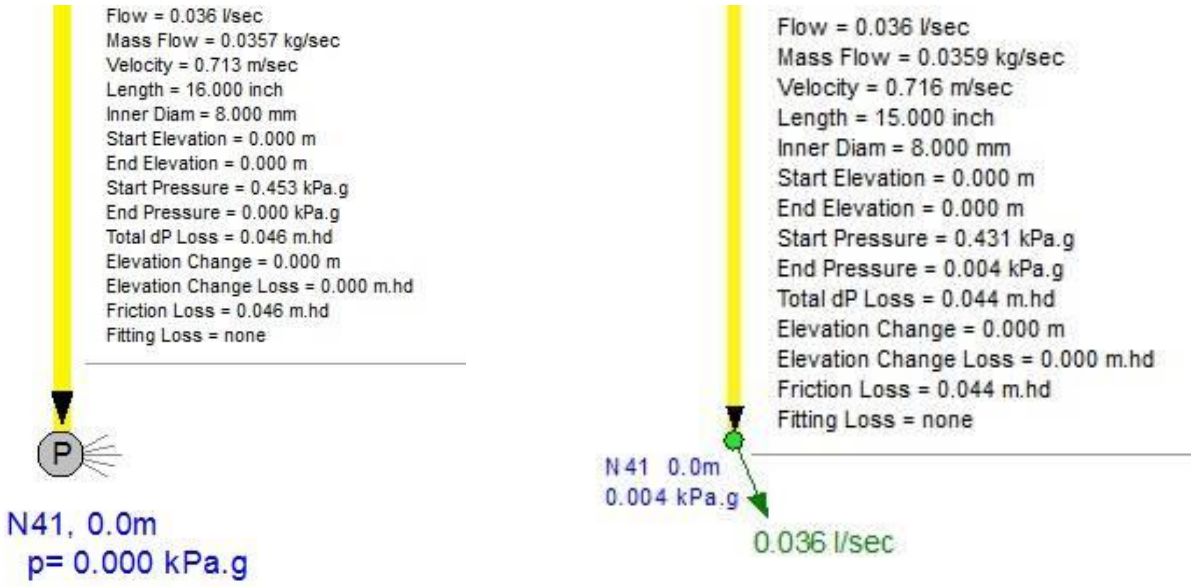
Method 1:

Fixed flow rate and initial pressure head results in the pipe drain outlet at 0

Method 2:

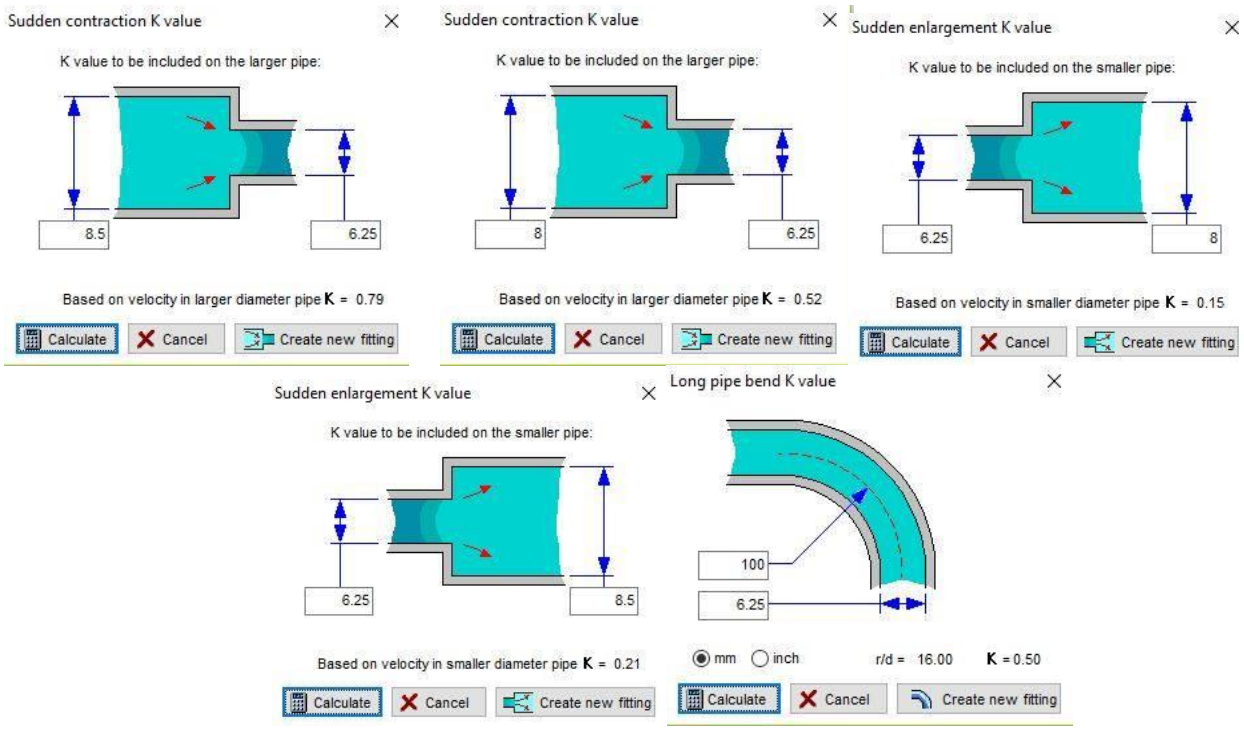
We assumed the initial head conditions and imposed the initial head conditions at the drainage and the result is the same flowrate as assumed

Both methods are verified by the following simulation results:

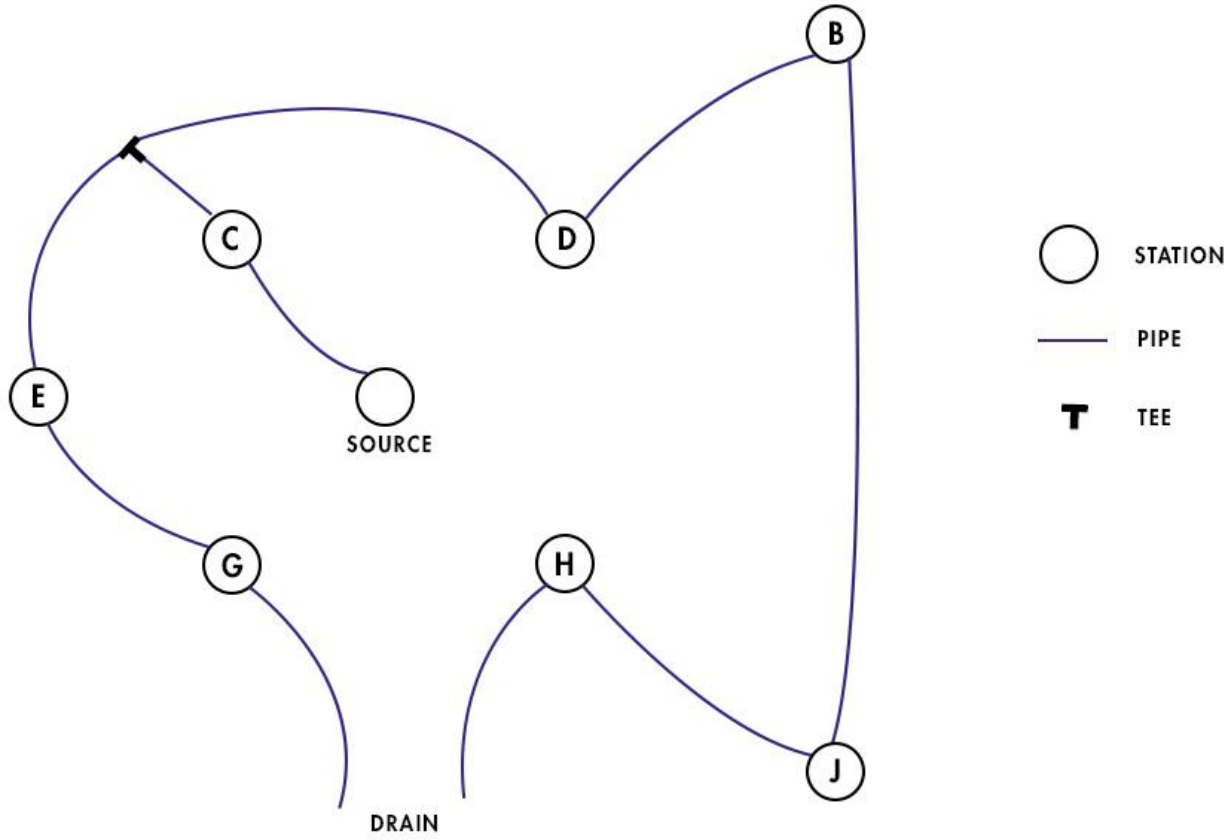


(Screen captures of drain conditions of a pipe flow simulation simulated using Pipe Flow Expert)

We used the following loss coefficients for this simulation:



The Network Design:



Calculations:

STATION	REQUIRED HEAD (cm)	ACHIEVED HEAD (cm)
B	10	10.12
C	20	21.78
D	15	15.52
E	15	15.75
G	5	5.39
H	Variable	0.94
J	Variable	0.78

Right Loop (Q=10mlps)

	Major Loss 1	*Major Loss 2*	*Major Loss 3*	*Major Loss 4*	*KI 1*	*KI 2*	*KI 3*	*Minor Loss 1*	*Minor Loss 2*	*Minor Loss 3*	*Total Loss*	*Total Head*	Static Head
Till Station D	0.000867107	0.070104348	nil	nil	2.14	0.65	nil	0.0043	0.0035	nil	0.0788	0.1572	**0.1552**
Till Station B	0.005780712	0.04439942	nil	nil	1.04	0.3	nil	0.0021	0.0016	nil	0.0539	0.1033	0.1012
Till Station J	0.000578071	0.002336812	1.59184E-06	nil	0.52	0.36	0.79	0.0010	0.0019	0.0013	0.0072	0.0961	0.0941
Till Station H	0.010694317	0.002336812	nil	nil	1.04	0.3	nil	0.0021	0.0006	nil	0.0157	0.0804	0.0783
Till Drain	0.006069747	0.001168406	nil	0.009285085	2.14	0.15	nil	0.0043	0.0008	nil	0.0124	0.0680	0.0660

Left Loop (Q=20mlps)

	Major Loss 1	*Major Loss 2*	*Major Loss 3*	*Major Loss 4*	*KI 1*	*KI 2*	*KI 3*	*Minor Loss 1*	*Minor Loss 2*	*Minor Loss 3*	*Total Loss*	*Total Head*	Static Head
Till Station E	0.003498032	0.036829983	0.023716486	nil	2.14	0.36	0.79	0.017267641	0.007797612	0.005001849	0.0704	0.1656	0.1575
Till Station G	0.040810376	0.047878977	nil	nil	1.04	0.3	nil	0.008391751	0.00649801	nil	0.1036	0.0620	0.0539
Till Drain	0.017490161	nil	nil	0.01857017	1.62	nil	nil	0.013071766	nil	nil	0.0306	0.0314	0.0234

Before the Tee (Q=30mlps)

	Major Loss 1	*Major Loss 2*	*Major Loss 3*	*Major Loss 4*	*KI 1*	*KI 2*	*KI 3*	*Minor Loss 1*	*Minor Loss 2*	*Minor Loss 3*	*Total Loss*	*Total Head*	*Static Head*
Before Station C	0.00459	0.00732	nil	nil	0.52000	0.15000	nil	0.00944	0.00731	nil	0.0287	0.2623	0.2442
Till Station C	0.00229	0.00732	nil	nil	0.52000	0.15000	nil	0.00944	0.00731	nil	0.0264	0.2360	0.2178