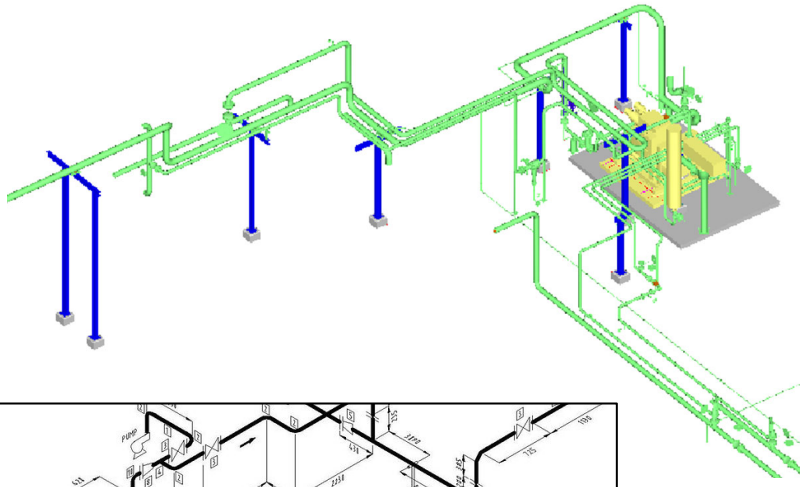
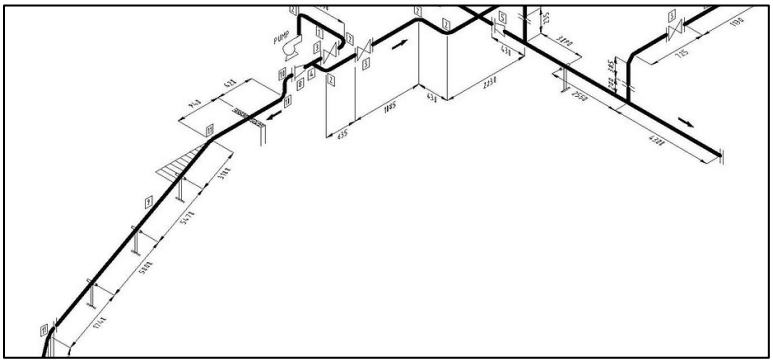
MET 330 Fluid Mechanics

Final Project: Full Pipeline System Design of a Hypothetical Plant





Spring 2015

PROBLEM DESCRIPTION

A company is planning for a new manufacturing facility. As part of the new plant, there will be an automated machining line in which five machines will be supplied with coolant from the same reservoir.

The layout of the planned facility is shown in figure 1. The following data, design requirements, and limitations are given.

1. New coolant is delivered to the plant by railroad tank cars carrying 15,000 gal each. A holding tank for new coolant must be specified.

2. The reservoir for the automated machining system must have a capacity of 1000 gal.

3. The 1000-gal tank is normally emptied once per week. Emergency dumps are possible if the coolant becomes overly contaminated prior to the scheduled emptying.

4. The dirty fluid is picked up by truck only once per month.

5. A holding tank for the dirty fluid must be specified.

6. The plant is being designed to operate two shifts per day, 7 days a week.

7. Maintenance is normally performed during the third shift.

8. The building is one-story high with a concrete floor.

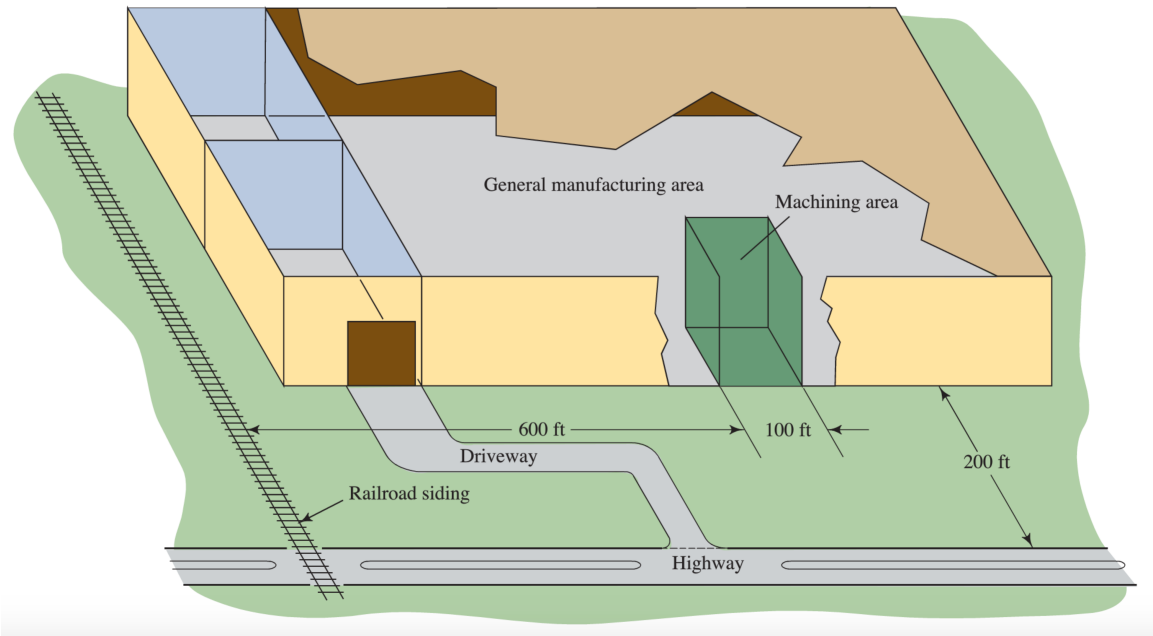


FIGURE 1. Plot plan of a hypothetical factory building for the design problem.

9. The floor level is at the same elevation as the railroad track.

10. No storage tank can be inside the plant or under the floor except the 1000-gal reservoir that supplies the machining system.

11. The roof top is 32 ft from the floor level and the roof can be designed to support a storage tank.

12. The building is to be located in Dayton, Ohio, where the outside temperature may range from -20°F to +105 °F.

13. The frost line is 30 in below the surface.

14. The coolant is a solution of water and a soluble oil with a specific gravity of 0.94 and a freezing point of 0 °F. Its corrosiveness is approximately the same as that of water.

15. Assume that the viscosity and vapor pressure of the coolant are 1.50 times that of water at any temperature.

16. You are not asked to design the system to supply the machines.

17. The basic coolant storage and delivery system is to have the functional design sketched in the block diagram in Figure 2.

18. If pumps are required, only SULZER pumps have to be selected.

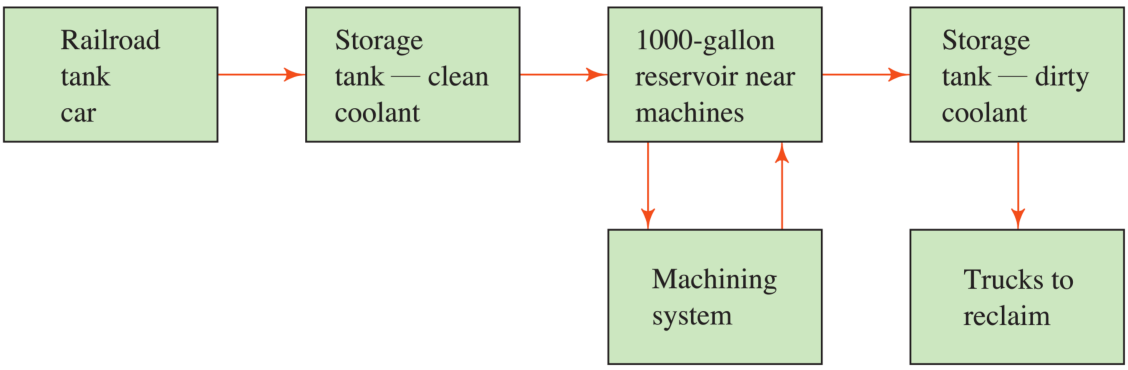


FIGURE 2. Block diagram of coolant system.

ROLE

Consider yourself to be a plant engineer working for the company interested on planning a new manufacturing facility. You are responsible for the design of the system to handle the coolant from the time it reaches the plant in railroad tank cars until the dirty coolant is removed from the premises by a contract firm for reclaim.

AUDIENCE

This project report should be written towards the Engineering Head of the company with plans for expansion. It should therefore be written formally. Assume the reader is familiar with engineering concepts. You will also have to prepare a short presentation written towards the CEO of the same company. The CEO has not engineering background and you have to impress him in just a few minutes.

ENGINEERING REPORT FORMAT

Your design proposal should be submitted in a form of technical report, which should include but limited to:

1. Title Page
2. Abstract

    Brief description of the project with relevant elements of the design

3. Table of Contents
4. List of Figures & List of Tables
5. Report Body
    a. Job site location
    b. Specifications and design philosophy

        Establish design criteria, design requirements and limitations, time required to fill and empty all tanks, and any other criteria you personally decided to use.

    c. Sources
    d. Materials and specifications
        i. Establish the pipe and tank material to use
        ii. Fluid characteristics
    e. Preliminary drawings and sketches
        i. Plot plan
        ii. Elevations

Every engineering work starts with preliminary sketches that help with the design calculations. You should include pipe layout and tanks. The drawings support the Design calculations section.

f. Design calculations
    i. Tank specifications (size, wall thickness, wind load, weight, open channel drainage system, etc.)
    ii. Flow rate.
    iii. Pipe sizing (include a list of pipes with sizes, and lengths. Also specify number, type and size of all fittings). Include here pipe thickness (even though for this you need pressures computed after pump selection).
    iv. Provide pipeline support info.
    v. Energy losses. Analyze them. Which pipeline section has the most energy losses?
    vi. Pump selection (give full characteristics of the pump, i.e., head, power, flow, power, operation point. Also, establish the number of pumps, etc. Check for cavitation and water hammer). Provide all pump specifications.
    vii. Instrumentation selection.

Design calculations must be done by hand. The use of computer programs is allowed but cannot replace your work. Excel spreadsheets are allowed but the used equations must be explicitly stated for grading purposes. Unclear outputs are not permitted.

6. Final drawings
    a. Plot plan
    b. Elevations view
    c. Isometrics

After the design calculations must of the preliminary drawings and sketches must be updated and better represented.

7. Bill of materials and equipment list

With the help of the isometrics you should list all the material that need to be bought for final construction. You should also include the list of selected equipment (if required, use catalogs you can download from the internet).

8. Final remarks

9. Appendix

Add a section where each both of you reflect on or evaluate what was learned in

this project and in this class. Do you think what you learn is important for your professional career? Where do you think you will be using everything you learned?
Add any additional material you consider related to the project.

NOTE: *Verbally explain your ideas and add images, diagrams and graphs needed to explain your solutions. As far as preliminary and final drawing, there is no need for detailed drawings, just simple high-level sketches. Hand sketches are fine, you may take a picture with your camera, phone and insert them to the document or just attach image drawn to your exam. Use appropriate number for images, diagrams and equations used (e.g Figure 1, Figure 2, etc.) for easier understanding and explain what they are in the body of the report*.

TASKS:

1. Specify the size and location of all storage tanks.
2. Specify wall thickness of storage tanks.
3. Specify wind load and weight of storage tanks for our civil engineer colleagues.
4. Consider that one of your storage tanks could fail. If so, the contained fluid will leak. You should design an open channel system to dump the fluid to a location far from the plant (you have to decide that location but you do not need to design anything related to that destination).
5. Determine the time required to fill and empty all tanks.
6. Specify the layout of the piping system, the types and sizes of all pipes, and the lengths required. Please note that if choosing to have a system driven by gravity, the pipe calculations are different to the case of pumped systems.
7. Specify the number, type, and size of all valves, elbows, and fittings. Please note that if choosing to have a system driven by gravity, the pipe calculations are different to the case of pumped systems.
8. Include the analysis of all parts of the system, including energy losses due to friction and minor losses.
9. Specify the number of pumps, their types, capacities, head requirements, and power required. Why did you choose the pump you chose?
10. Specify the characteristics of the chosen pumps, point of operation, and actual pump size and weight. Some of the information is for our civil engineer colleagues.
11. Specify electrical motor requirement for our pump for our electrical engineering colleagues.

12. Evaluate the NPSH available for your design, and demonstrate that your pump has an acceptable NPSH required. Specify the installation requirements for the pumps, including the complete suction line system.

13. Specify pipe wall thickness (schedule).

14. For a particular pipe system, decide the type of supports and determine the force acting upon each support. Our civil engineer colleagues need this.

15. Check your design for water hammer problems.

16. Just for one of your pipeline systems, select the required instruments. This is, pick an instrument to measure the flow (specify its dimensions) and pressure gauges (specify range of pressures to measure).

17. Sketch the layout of your design in both a plan view (top) and an elevation view (side). An isometric sketch should also be included.

18. Prepare bill of material (cost is not required on this project). Include everything you designed/selected.

19. Submit the results of your design in a neat and complete report, including a narrative description of the system, plant operation narrative, the sketches, a list of materials, and the analysis to show that your design meets the specifications. Include a discussion on why your design is cost effective.

20. Submit a presentation where you give an overall description of your design. Think that this will be your opportunity to impress the CEO of the company without going into too much of technical jargon (assume the CEO has no engineering background).

DUE DATES, ACTIVITIES & PROJECT AND GRADING:

Due Date	Assignment	TASKS	
Tuesday 04/21/15	Activity 1	1 - 7	15%
Tuesday 04/28/15	Activity 2	8 - 14	15%
Tuesday 05/05/15	Activity 3 (include in the report)	15 - 20	15%
	Final Engineering Report	Content	25%
		Writing	20%
	Presentation		10%

NOTE: Only one of you will be submitting the assignments through Blackboard. It should always be the same person submitting. This person will keep track of the grade and comments for the group.

Task Rubric (Activities 1 & 2)

	Exceeds Standard	Meets Standard	Approaches Standard	Needs Attention
	4	3	2	1
	100 points	70 points	40 points	0 points
1. Purpose **5%**	The purpose of the section to be answered is clearly identified and stated.	The purpose of the section to be answered is identified, but is stated in a somewhat unclear manner.	The purpose of the section to be answered is partially identified, and is stated in a somewhat unclear manner.	The purpose of the section to be answered is erroneous or irrelevant.
2. Drawings & Diagrams **10%**	Clear and accurate diagrams are included and make the section easier to understand. Diagrams are labeled neatly and accurately.	Diagrams are included and are labeled neatly and accurately.	Diagrams are included and are labeled.	Needed diagrams are missing OR are missing important labels.
3. Sources **5%**	Several reputable background sources were used and cited correctly.	A few reputable background sources are used and cited correctly.	A few background sources are used and cited correctly, but some are not reputable sources.	Background sources are cited incorrectly.
4. Design considerations (safety, cost, etc) **10%**	Design is carried out with full attention to safety and cost.	Design is generally carried out with attention to safety and cost.	Design is carried out with some attention to safety and cost.	Safety and cost were ignored in the design.
5. Data and variables **5%**	All data and variables are clearly described with all relevant details.	All data and variables are clearly described with most relevant details.	Most data and variables are clearly described with most relevant details.	Data and variables are not described OR the majority lack sufficient detail.
6. Procedure **25%**	Procedure is described in clear steps. The step description is in a complete and easy to understand short paragraph.	Procedure is described in clear steps but the step description is not in a complete short paragraph.	Procedure is described in clear steps. The step description is in a complete short paragraph but it is difficult to understand.	Procedure is not described in clear steps at all.
7. Calculations **20%**	All calculations are shown and the results are correct and labeled appropriately.	Some calculations are shown and the results are correct and labeled appropriately.	Some calculations are shown and the results labeled appropriately.	No calculations are shown OR results are inaccurate or mislabeled.
8. Summary **5%**	Summary describes the design, the relevant information and some future implications.	Summary describes the design and some relevant information.	Summary describes the design.	No summary is written.
9. Materials **5%**	All materials used in the design are clearly and accurately described.	Almost all materials used in the design are clearly and accurately described.	Most of the materials used in the design are clearly and accurately described.	Many materials are described inaccurately OR are not described at all.
10. Analysis **10%**	The design is discussed and analyzed. Argumentative predictions are made about what might happen in case of change in the operation and how the design could be change.	The design is discussed and analyzed. Argumentative predictions are made about what might happen in case of change in the operation.	The design is discussed and analyzed. No argumentative predictions are made about what might happen in case of change in the operation and how the design could be change.	The design is not discussed and analyzed.

Engineering Report Content Rubric

	POINTS
1. Title Page	
2. Abstract	100
3. Table of Contents	25
4. List of Figures & List of Tables	25
5. Report Body	
a. Job site location	50
b. Specifications and design philosophy	200
c. Sources	50
d. Materials and specifications	100
i. Establish the pipe and tank material to use	
ii. Fluid characteristics	
e. Preliminary drawings and sketches	200
i. Plot plan	
ii. Elevations	
f. Design calculations	700
i. Tank specifications	
ii. Flow rate	
iii. Pipe sizing	
iv. Provide pipeline support info	
v. Energy losses	
vi. Pump selection	
vii. Instrumentation selection	
6. Final drawings	300
g. Plot plan	
h. Elevations view	
i. Isometrics	
7. Bill of materials and equipment list	200
8. Final remarks	100
9. Appendix	50
TOTAL POINTS	**2000**

(The total points will be converted to a 100 point based grade)

Final Project Writing Rubric

Student Learning Outcomes	Exceeds Standard	Meets Standard	Approaches Standard	Needs Attention
	4	3	2	1
	100 points	70 points	40 points	0 points
1. **Students will be able to clearly state a focused problem, question, or topic appropriate for the purpose of the task.** **Sections 2, 5a, and 5b**	The topic is **comprehensive, clearly stated, creative, focused, manageable**, and demonstrates a **clear understanding** of the purpose of the task.	The topic is **clearly stated**, **focused, manageable**, and demonstrates **adequate consideration** of the purpose of the task.	The topic is **ambiguous** and **too broadly or narrowly focused**, but demonstrates **awareness** of the purpose of the task.	The topic is **weak (or missing)** and demonstrates **minimal knowledge** of the purpose of the task.
2. **Students will be able to identify relevant knowledge and/or credible sources** **Sections 5c, and 5d**	Identified knowledge or sources are **relevant, credible, and high quality**.	Identified knowledge or sources are **mostly relevant and credible.**	Identified knowledge or sources are **minimally relevant and credible**.	Identified knowledge or sources are **not relevant or credible (or are missing).**
3. **Students will be able to synthesize information and multiple viewpoints related to the problem, question or topic.** **Section 5f**	Evidence is synthesized to **reveal insightful patterns, differences and similarities** among multiple viewpoints.	Evidence is synthesized to **reveal patterns, differences and similarities** among multiple viewpoints.	Evidence is minimally synthesized and **may not reveal patterns, differences and similarities** among multiple viewpoints.	Evidence is **not synthesized** to reveal patterns, differences and similarities among multiple viewpoints **(or is missing)**.
4. **Students will be able to apply appropriate research methods and/or theoretical framework to the problem, question or topic.** **Section 5f**	The critical elements of the methodology or theoretical framework are **skillfully developed or described** to address the problem, question, or topic.	The critical elements of the methodology or theoretical framework are **satisfactorily developed or described** to address the problem, question, or topic.	The critical elements of the methodology or theoretical framework are **minimally developed or described** to address the problem, question, or topic.	The critical elements of the methodology or theoretical framework are **weak (or missing)**.
5. **Students will be able to formulate conclusions that are logically tied to inquiry findings and consider applications, limitations and implications** **Section 8**	The stated conclusion **thoroughly evaluates** and organizes **all essential** information and is the logical outcome of inquiry.	The stated conclusion **evaluates** and relates logically to **all essential** information.	The stated conclusion **minimally evaluates** and relates logically to **some essential** information.	The stated conclusion is **absent or weakly evaluates** essential information **(or is missing)**.
6. **Students will be able to reflect on or evaluate what was learned.** **Section 9**	Reflection of results shows a **strong relationship** among content, lessons learned, and/or changes in personal perspective.	Reflection of results shows a **relationship** among content, lessons learned, and/or changes in personal perspective.	Reflection of results shows a **minimal relationship** among content, lessons learned, and/or changes in personal perspective.	Reflection of results shows a **weak or no relationship** among content, lessons learned, and/or changes in personal perspective **(or is missing)**.