

# “Heat Pipe Demonstration Unit”

## Senior Capstone Design- ME476C Final Presentation

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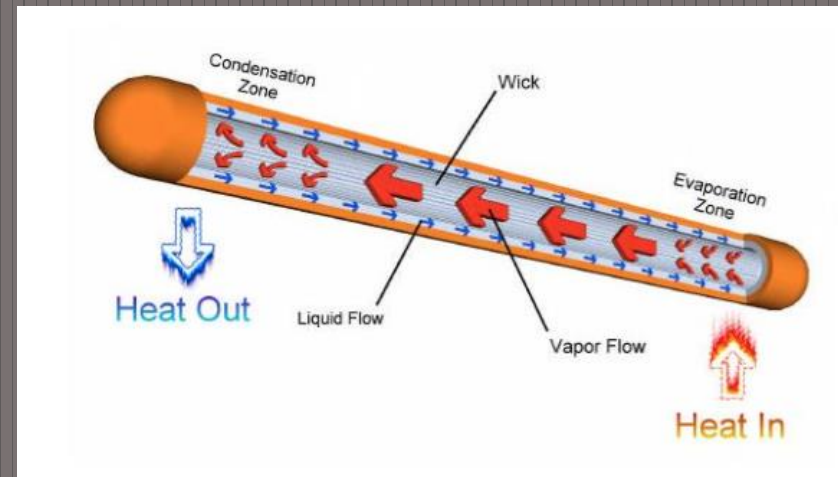


Figure 1: Heat Pipe [1]

Instructor: Dr. David Trevas  
08/06/2018

# Content:

- Project Description
- Design description
- Images of the design
- Design functions
- Design requirements
- Schedule & Budget

# Project Description:

- What is the project about?
  - Heat pipe demo unit.
- Our sponsor?
  - Dr. David Trevas.
- Our stakeholders?
  - Mechanical engineering students and facilities at NAU.
- Why is it important?
  - Learning the principles of mechanical engineering courses.



Figure 2: NAU [2]

# CAD MODEL FOR PROTOTYPE

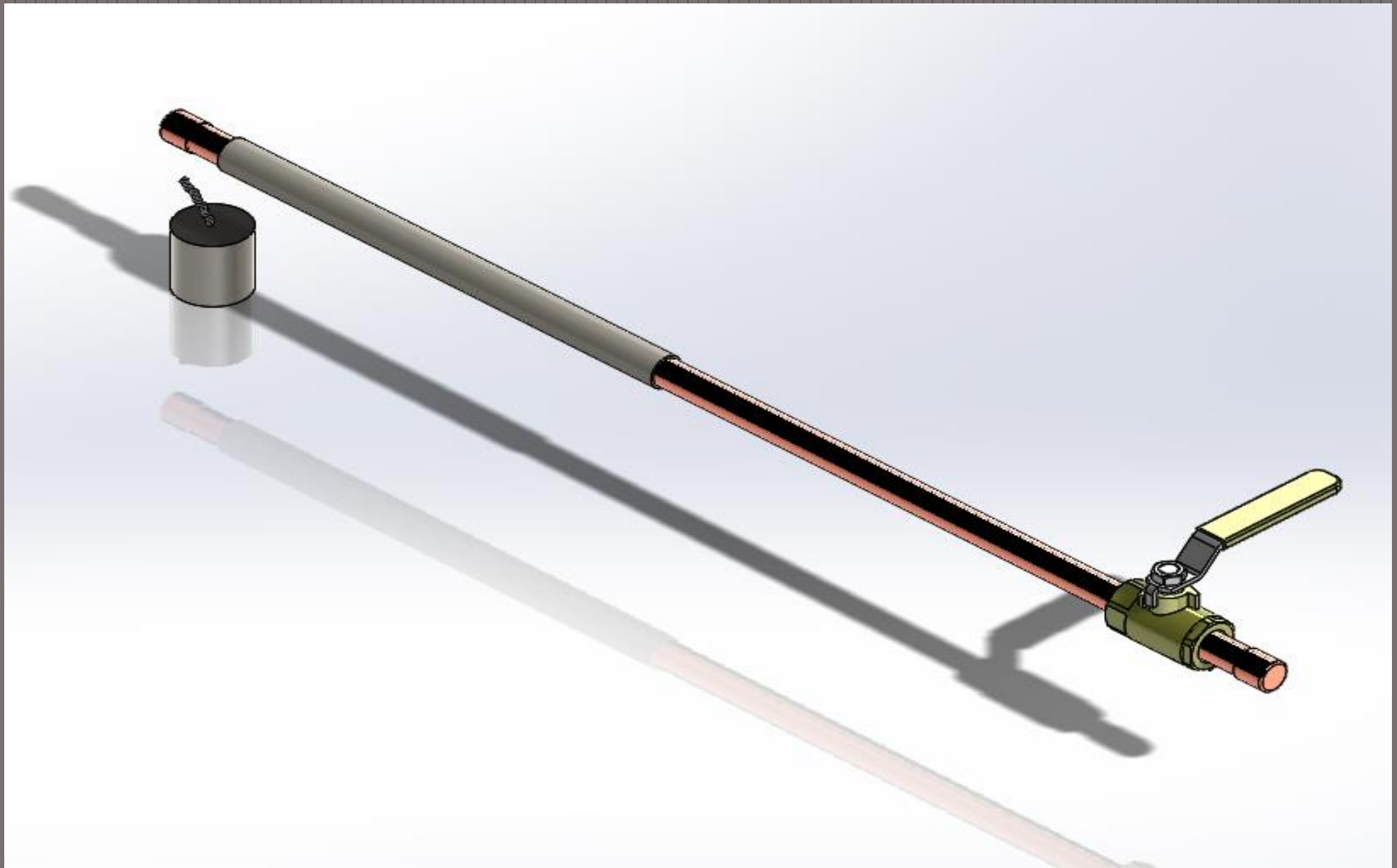


Figure 3: Prototype CAD

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# Bill of Materials for Prototype

Table 1: BOM for Prototype

| Bill of Materials           |  |     |                                      |                             |                                 |                 |                                    |
|-----------------------------|--|-----|--------------------------------------|-----------------------------|---------------------------------|-----------------|------------------------------------|
| Team                        |  |     | Heat Pipe - Team 3                   |                             |                                 |                 |                                    |
| Part #                      | Part Name                              | Qty | Functions                            | Material                    | Dimensions                      | Cost            | Link to Cost estimate              |
| 1                           | copper pipe                            | 1   | vessel                               | copper                      | 2 feet                          | \$4.78          | HomCo Lumber & Hardware @flagstaff |
| 2                           | copper caps                            | 2   | cap                                  | copper                      | ID= 0.5in ,<br>OD=0.63          | \$1.38          | HomCo Lumber & Hardware @flagstaff |
| 3                           | valve                                  | 1   | control                              | copper/c<br>uivre           | 1/2 in                          | \$15.99         | HomCo Lumber & Hardware @flagstaff |
| 4                           | disconnected clip                      | 1   | clip                                 | copper/c<br>uivre/cob<br>re | 1/2 in                          | \$1.99          | HomCo Lumber & Hardware @flagstaff |
| 5                           | foam pipe insulation                   | 1   | insulation                           | foam                        | 70 in                           | \$3.29          | HomCo Lumber & Hardware @flagstaff |
| 6                           | wire trivet                            | 1   | we used it as stand                  | n/a                         | 7 in diameter (17.6 cm)         | \$4.72          | Walmart                            |
| 7                           | ms coasters                            | 1   | we used it as stand                  | n/a                         |                                 | \$5.14          | Walmart                            |
| 8                           | utensil holder                         | 1   | we used it as stand                  | n/a                         | 11.8 cm *<br>11.8 cm *<br>20 cm | \$5.84          | Walmart                            |
| 9                           | candle                                 | 1   | heating source                       | n/a                         | n/a                             | \$0.50          | Walmart                            |
| 10                          | BRS Torch plumber kit                  | 1   | to flux the copper cap with the pipe | n/a                         | n/a                             | \$22.99         | HomCo Lumber & Hardware @flagstaff |
| 11                          | LCD thermoemeter w' thermocouple wires | 1   | measure temperature                  | n/a                         | n/a                             | \$24.79         | Amazon                             |
| 12                          | silverline elite automotive kit        |     | to vacuum pressure                   | n/a                         | n/a                             | \$49.95         | ToolDiscounter                     |
| 13                          | an extension copper pipe               | 1   | extension                            | copper                      | 1/4 in                          | FREE            | HomCo Lumber & Hardware @flagstaff |
| 14                          | syringe                                | 1   | to add and measure fluids            | plasic                      | n/a                             | FREE            | from our client                    |
| 15                          | Water                                  | 1   | cooling fluid                        | Water                       | 1 liter                         | \$0.35          | Walmart                            |
| <b>Total Cost Estimate:</b> |  |     |                                      |                             |                                 | <b>\$141.71</b> |                                    |

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# CAD MODEL FOR FULL DESIGN

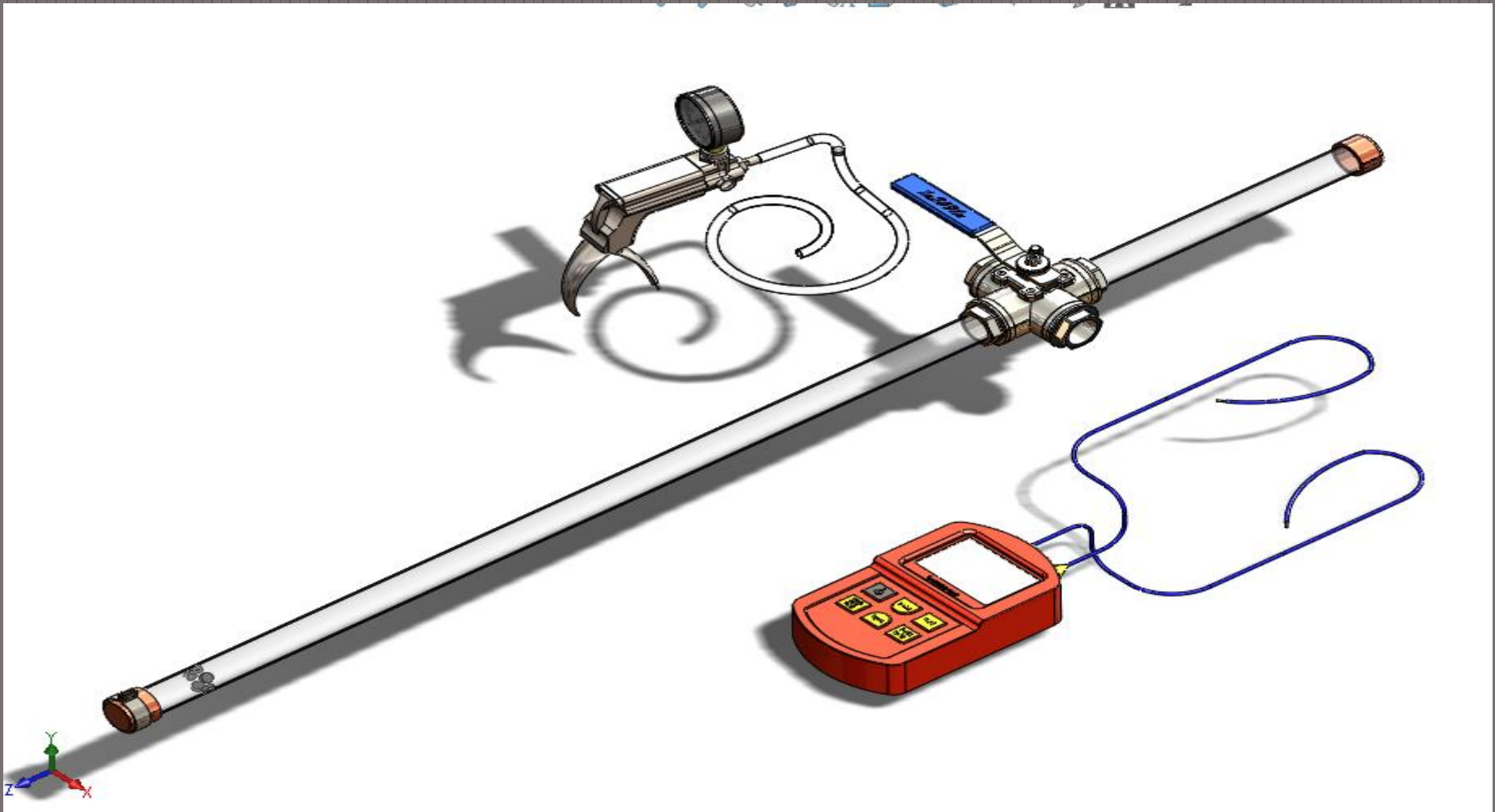


Figure 4: Full design CAD

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# Bill of Materials for Full design

Table 2: Full design BOM

| Bill of Materials           |  |     |                           |                      |                              |                 |                                    |
|-----------------------------|--|-----|---------------------------|----------------------|------------------------------|-----------------|------------------------------------|
| Team                        |  |     | Heat Pipe - Team 3        |                      |                              |                 |                                    |
| Part #                      | Part Name                              | Qty | Functions                 | Material             | Dimensions                   | Cost            | Link to Cost est.                  |
| 1                           | glass pipe                             | 1   | vessel                    | glass                | ID= 22mm, OD= 25mm, L= 2.5ft | \$23.00         | Technical glass products           |
| 2                           | copper caps                            | 2   | cap                       | copper               | ID= 22mm , OD=26mm           | \$1.38          | HomCo Lumber & Hardware @flagstaff |
| 3                           | 4-way valve                            | 1   | control                   | copper/cuivre        | 22.1 mm                      | \$15.99         | HomCo Lumber & Hardware @flagstaff |
| 4                           | disconnected clip                      | 1   | clip                      | copper/cuivre/cobure | 1/2 in                       | \$1.99          | HomCo Lumber & Hardware @flagstaff |
| 5                           | wire trivet                            | 1   | stand                     | n/a                  | 7 in diameter (17.6 cm)      | \$4.72          | Walmart                            |
| 6                           | ms coasters                            | 1   | stand                     | n/a                  | n/a                          | \$5.14          | Walmart                            |
| 7                           | utensil holder                         | 1   | stand                     | n/a                  | 11.8 cm * 11.8 cm * 20 cm    | \$5.84          | Walmart                            |
| 8                           | heater band                            | 1   | heating source            | n/a                  | w= 1.35in                    | \$169.00        | Omega                              |
| 9                           | LCD thermoemeter w' thermocouple wires | 1   | measure temperature       | n/a                  | n/a                          | \$24.79         | Amazon                             |
| 10                          | silverline elite automotive kit        | 1   | to vacuum pressure        | n/a                  | n/a                          | \$49.95         | ToolDiscounter                     |
| 11                          | an extension glass pipe                | 1   | extension                 | copper               | L= 0.8ft, ID= 22mm. OD= 25mm | \$9             | Technical glass products           |
| 12                          | cotton cloth                           | 1   | wick                      | cotton               | 3 yards                      | \$17.97         | Joann Fabric store @Flagstaff      |
| 13                          | Water                                  | 1   | cooling fluid             | Water                | 1 liter                      | \$0.35          | Walmart                            |
| 14                          | Ammonia                                | 1   | cooling fluid             | Ammonia              | 1 liter                      | \$0.43          | ng-tech                            |
| 15                          | Methanol                               | 1   | cooling fluid             | Methanol             | 1 liter                      | \$0.73          | ng-tech                            |
| 16                          | timer                                  | 1   | to keep time              | n/a                  | n/a                          | \$5             | Amazon                             |
| 17                          | syringe                                | 1   | to add and measure fluids | plastic              | n/a                          | FREE            | Got it from our client             |
| <b>Total Cost Estimate:</b> |  |     |                           |                      |                              | <b>\$335.28</b> |                                    |

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# Image of our design

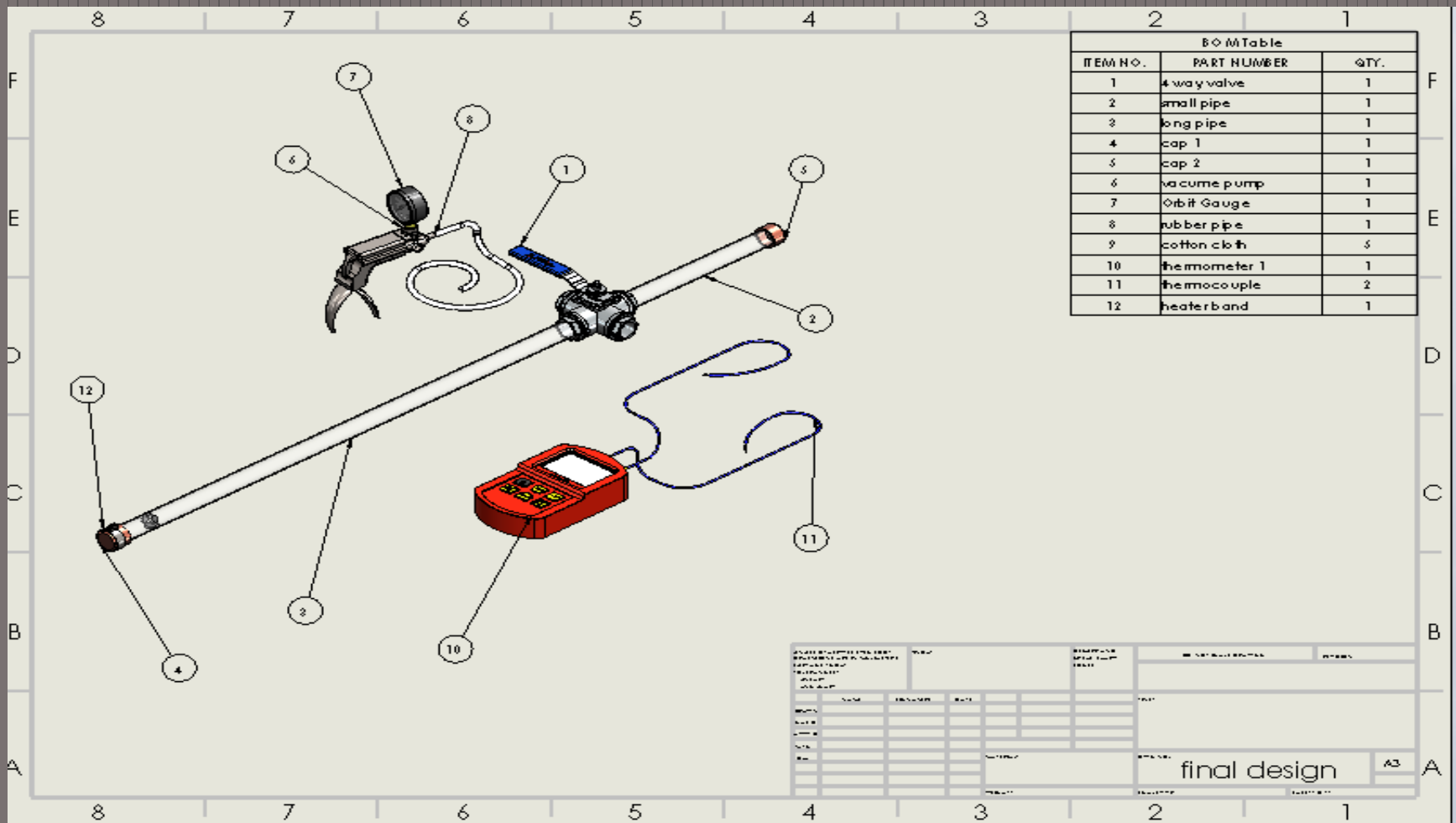


Figure 5: Our design

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# Design Functions

- Pressure will be vacuumed at point B.
- Liquid enters at point B.
- Wick material enters at point B and applied at A.
- Heat is applied at point A.
- Liquid vaporizes and absorbs latent heat at point A.
- Vapor condense at point C.
- IT IS A CYCLE PROCESS.
- Remove the heat source from point A.
- Measure temperature at point A & C.
- Calculations & Collecting Data.

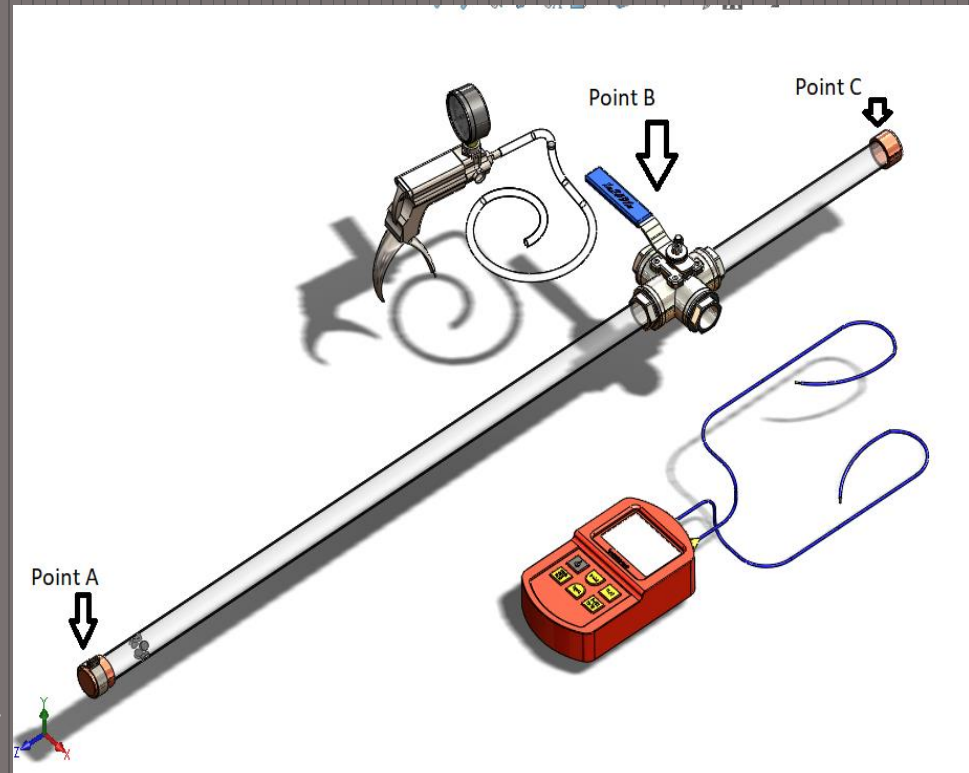


Figure 6: location of points

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# Design Requirements

Table 3: Customer Requirements

| Customer Requirement | Description                                      | Weight |
|----------------------|--|--------|
| Durability           | How long it is withstanding                      | 0.16   |
| Accuracy             | How accurate it will work                        | 0.16   |
| Manufacturable       | Rate which it could be mass produced             | 0.11   |
| Safety               | How safe the heat pipe setup is for the end user | 0.13   |
| Ease of Assembly     | Able to install the parts                        | 0.14   |
| Variability          | Capable of varying with the situation            | 0.17   |
| Easy to Measure      | Measuring of the temperature is easy             | 0.13   |

# Schedule & Budget



## Schedule

Table 4: Gantt Chart








|                                       | A | September |   |   | October |   |   | November |   |   | Dec |  |
|---------------------------------------|---|-----------|---|---|---------|---|---|----------|---|---|-----|--|
| finalization of design                | ■ |           |   |   |         |   |   |          |   |   |     |  |
| canvassing of materials               | ■ |           |   |   |         |   |   |          |   |   |     |  |
| placing of orders                     |   | ■         |   |   |         |   |   |          |   |   |     |  |
| waiting for orders to arrive          |   |           | ■ | ■ |         |   |   |          |   |   |     |  |
| initial implementation of Full design |   |           |   |   | ■       | ■ |   |          |   |   |     |  |
| improvements on the Full design       |   |           |   |   |         |   | ■ |          | ■ |   |     |  |
| testing the full design               |   |           |   |   |         |   | ■ |          | ■ |   | ■   |  |
| write-up                              |   |           |   |   |         |   |   |          |   | ■ | ■   |  |

# Prototype Budget

Table 5: Prototype Budget

| Component Name        | Model Number   | Picture  | Cost    | Supplier                  |
|-----------------------|--|--|---------|---------------------------|
| Copper Pipe           | Copper pipe:<br>L= 2 ft<br>ID = 0.5 in<br>OD = 0.625 in                        |    | \$4.78  | <a href="#">HomCo</a> [3] |
| Copper caps           | Copper caps:<br>Size = 0.5 in<br>ID = 0.5 in<br>OD = 0.63                      |    | \$1.38  | <a href="#">HomCo</a> [3] |
| Valve                 | ½" Ball Valve  |    | \$15.99 | <a href="#">HomCo</a> [3] |
| Disconnected Clip     | Clip<br>Size = 0.5 in  |    | \$1.99  | <a href="#">HomCo</a> [3] |
| Foam Pipe Insulation  | L = 70 inch  |   | \$3.29  | <a href="#">HomCo</a> [3] |
| BRS Torch Plumber Kit | BRS Torch Plumber <a href="#">Kit.No</a><br>MT 200 PK, Magna<br>Industries,PK3 |  | \$22.99 | <a href="#">HomCo</a> [3] |

# Budget Cont....

|  |   |   |         |                                    |
|--|---|---|---------|------------------------------------|
| Vacuum Pump                            | Silverline Elite hand vacuum/ pressure pump w/ <u>2 inch</u> compound gauge w/ rubber boot; |     | \$49.95 | <a href="#">ToolDiscounter</a> [4] |
| Wire Trivet                            | Wire Trivet:<br>D = 7 in (17.6 cm)  |     | \$4.72  | Walmart [5]                        |
| MS Coasters                            | Four pieces   |     | \$5.14  | Walmart [5]                        |
| Utensil Holder                         | Dimension:<br>11.8 * 11.8 * 22 cm   |    | \$5.84  | Walmart [5]                        |
| Candle                                 | Candle as heat source.<br>Weight = 45 g   |   | \$0.50  | Walmart [5]                        |
| Water                                  | 1-liter water as working fluid.   |  | \$0.35  | Walmart [5]                        |
| LCD thermometer w' thermocouples wires | Dimension:<br>7.1 x 4.3 x 1.7 inches  |   | \$24.79 | Amazon [6]                         |

Total cost:  
\$141.71






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# Full Design Budget

Table 6: Full design Budget

| Component Name            | Model Number   | Picture  | Cost    | Supplier                     |
|---------------------------|--|--|---------|------------------------------|
| Glass tubing              | Dimension:<br>L = 2.5 ft<br>ID = 22 mm<br>OD = 25 mm |    | \$23.00 | Technical glass products [7] |
| An extension glass tubing | Dimension:<br>L = 0.8 ft<br>ID = 22 mm<br>OD = 25 mm |    | \$9     | Technical glass products [7] |
| Copper caps               | Copper caps:<br>ID = 22 mm<br>OD = 26 mm             |    | \$1.38  | HomCo [3]                    |
| Valve                     | 4-way valve<br>OD = 22.1 mm                          |   | \$15.99 | HomCo [3]                    |
| Disconnected Clip         | Clip<br>Size = 22.1 mm                               |  | \$1.99  | HomCo [3]                    |

# Budget Cont....

|  |  |  |         |                               |
|--|--|--|---------|-------------------------------|
| Vacuum Pump                            | Silverline Elite hand vacuum/ pressure pump w/ 2 inch compound gauge w/ rubber boot; |    | \$49.95 | <del>ToolDiscounter</del> [4] |
| Wire Trivet                            | Wire Trivet:<br>D = 7 in (17.6 cm)   |    | \$4.72  | Walmart [5]                   |
| MS Coasters                            | Four pieces  |    | \$5.14  | Walmart [5]                   |
| Utensil Holder                         | Dimension:<br>11.8 * 11.8 * 22 cm  |    | \$5.84  | Walmart [5]                   |
| Water                                  | 1-liter water as working fluid.  |  | \$0.35  | Walmart [5]                   |
| LCD thermometer w' thermocouples wires | Dimension:<br>7.1 x 4.3 x 1.7 inches   |  | \$24.79 | Amazon [6]                    |

# Budget Cont....

|              |                                   |  |          |                   |
|--------------|-----------------------------------|--|----------|-------------------|
| Heater band  | Barrel diameter = 1.35 in         |    | \$169.00 | Omega [8]         |
| Cotton cloth | 3 Yards                           |    | \$17.97  | Joann fabrics [9] |
| Ammonia      | 1-liter ammonia as working fluid  |    | \$0.43   | Ng-Tech [10]      |
| Methanol     | 1-liter methanol as working fluid |  | \$0.73   | Ng-Tech [10]      |
| Timer        | To measure time                   |  | \$5      | Amazon [11]       |

Total cost:  
\$335.28

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# References

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**Thank you - Any questions?**

