To Predict ▶ To Design ▶ To Perform

College of Engineering
Department of Mechanical & Industrial Engineering

ME, ECE, BE Capstone Design Programs

Heat Capacitance Testing Device: Team #35

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Objective Statement

Design and construct an automatic heat capacitance testing device that requires little human interaction.

Background

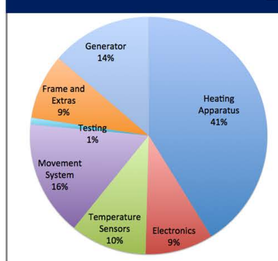
Before hot tapping on process lines, a heat capacitance test is performed. This method requires operators to heat up the pipe surface with a blowtorch and monitor its cool-down with a temperature gun. This exposes a flame directly to a hydrocarbon-filled pipeline creating a potentially hazardous situation.

Phillips 66 has tasked Team #35 to design and build a prototype heat capacitance testing device to replace the current test.

Engineering Specifications

Goals/Constraints	
Weight	< 50 pounds
Volume	< 3 ft^3
Elbows	90˚
Working Clearance	12”
Watt Density	Max Watt Density
Pipe Surface Temperature	500˚ F
Diameters	6”-24”
Piping Specification	Carbon Steel
Safety Requirements	Auto Shutoff
Operational Requirements	Clear Output
	Status Indicator
	Constant Monitoring
Budget	$5,500

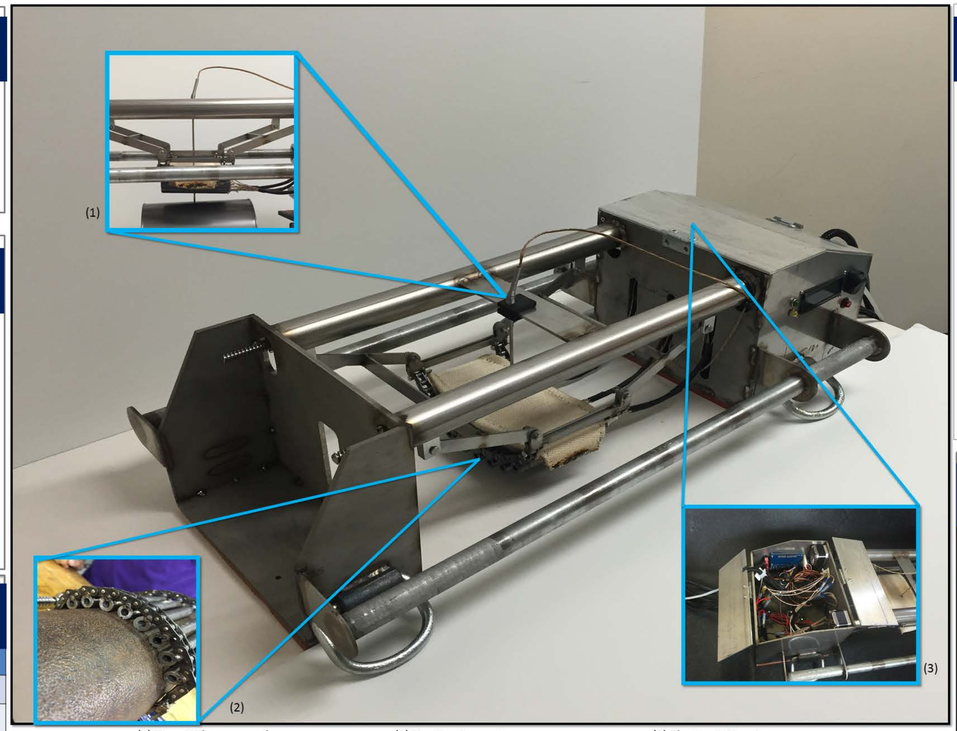
Budget



Predicted Cost: $2,784

Total Project Cost: $5,150.95

Remainder: $349.05



(1) Type-K Thermocouple (2) Heating Apparatus (3) Electronic Housing

Embodiment

Two-part stainless steel 304L frame
- Carrying handles and polyesters straps for secure and easy mobility

Heating Mechanism
- Heating cartridges encased in carbon steel
- Individually linked casings for flexibility of pipe diameters
- Insulated for safety and optimum performance

Movement System
- Two stepper motors to raise and lower heating mechanism

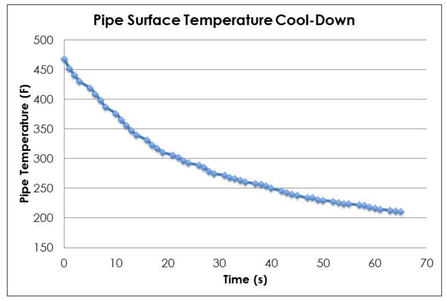
Constant Monitoring System
- K-Type Thermocouple

Electrical Components
- Arduino Due for control system

Safety

- Insulated heating mechanism
- Automatic operation from start to finish
- Indicator lights providing updated device status
- Time and Temperature limit
- Auto shut off for emergencies
- Easy and secure attachment
- Instruction and warning labels

Testing/Validation



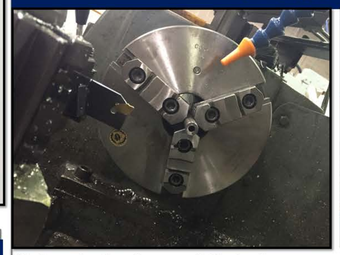
The device reached the goal temperature of 500 ˚F and recorded the pipe surface cool down from 482-212 ˚F.

Full Device Test
- Set-up time: 1:50 minutes
- Lowering System time: 4 second
- Cool-Down Time: 65 seconds

Testing Specifications:
- 9 ft long 4'' SCH 40 Carbon Steel Pipe
- Water flowing at 3.75 GPM at 71 ˚F.

Testing Apparatus

Manufacturing

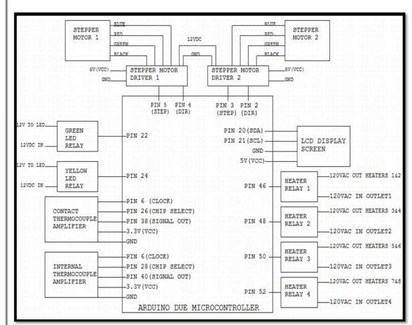


Carbon steel casing was drilled using a 0.25” drill bit and reamed using the lathe.

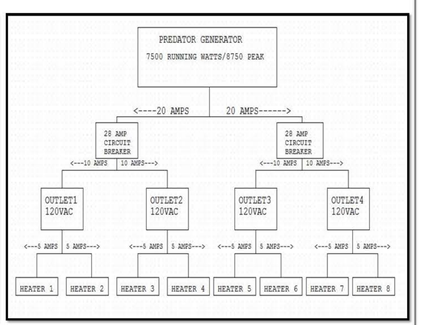
OMAX water jet used to cut 304 Stainless Steel for the device. Pressure 30+ ksi

Frame TIG welded using 308L filler material

Electrical Schematics



(1) Electronics circuit for the control system.



(2) Heating Cartridge circuit schematic.

August Engineering Specs → **September** Concept Generation → **October** Analysis → **November** Embodiment → **December** Purchasing → **February-March** Manufacturing → **April** Testing

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