BYP
In-line Measurement Device

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All_they_do_is_win

Empathize

Benchmarking

USER

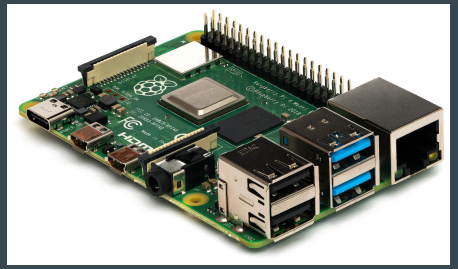
Walmart Canada

amazon

YouTube

TECHNICAL

- Difluid Beer Refractometer
- Beer Wort Refractor
- Raspberry Pie
- ispindel



In-line system Needs

September 30th, 2022

BEYOND THE PALE
· BREWING COMPANY ·

Table 1.1: Transferring Needs to Design Criteria - In-Line System

User Needs	Design Criteria
System needs to display accurate specific gravity values	Accurate Reading of Specific Gravity (% error) Method to Display Results (Plato) Temperature limit (℃)
System needs to read specific gravity measurements every 10-30 seconds	Maximum Reading Value (frequency) Timing (min) Automation Control
Material has to be food grade (silicon, stainless steel)	Safety and standards (Food-grade) Public Safety
Device must fit in a 1-½” piping system between two tri clamps	Maximum diameter (Inches) Attachment Capability (clamping)
Device is yeast resistant and easy to clean	Filtration Support (% filtration) Usability under constant conditions Quick set up/takedown process (min)

Users

Lab technician, head/assistant brewers, and everyday people

Define

User Needs

Wants:

- Device that measures specific gravity
- Does not require manual testing (hydrometer)
- Easy to remove for cleaning
- Food grade material

Does Not Want:

- Read measurement by eye (hydrometer)
- Takes a long time to display results

Problem Statement:

Beyond the Pale needs an accurate and sanitary method to measure, display and store the specific gravity, in a time-efficient and self-regulating process.

Ideate

Possible Solutions

3 subsystems:

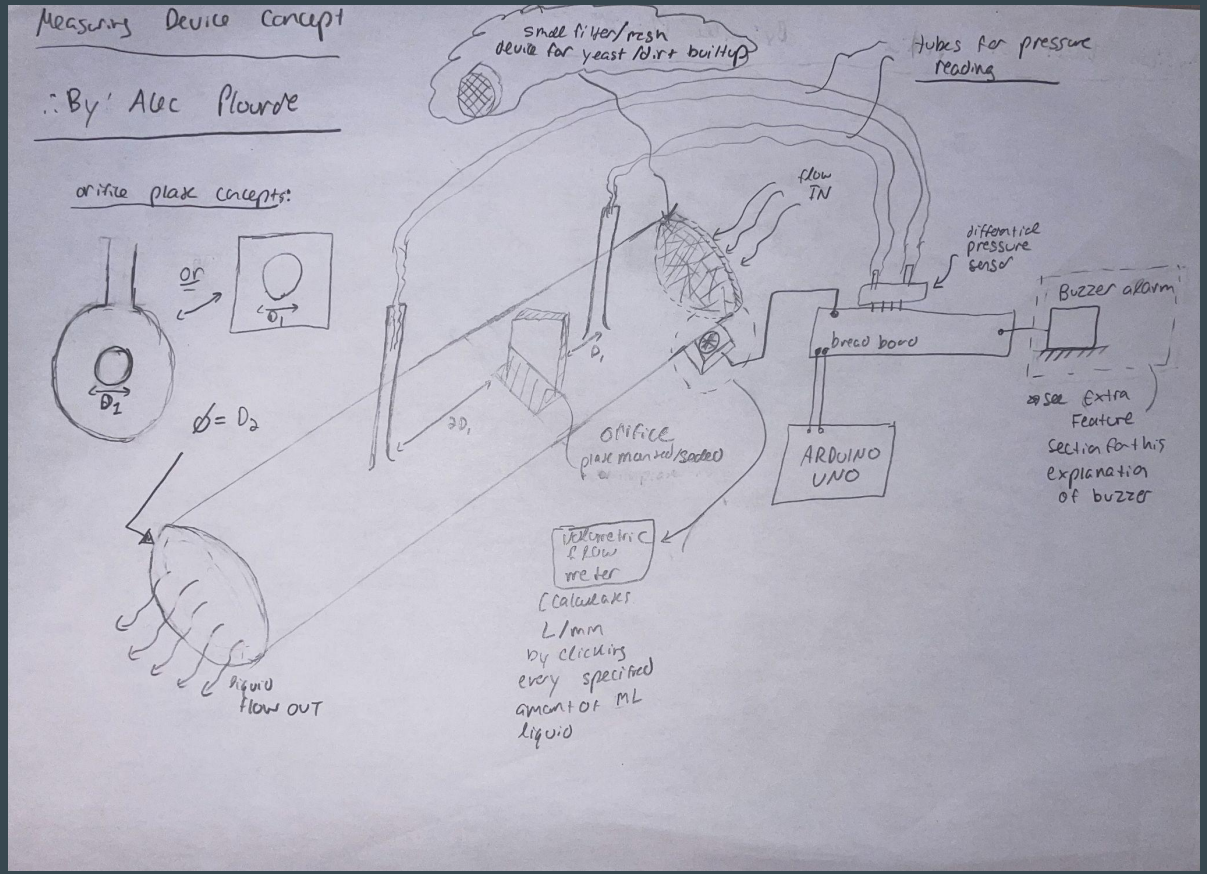
1. Measurement of Specific Gravity → Orifice Plate Flow meter, SG probe, Digital Refractometer, Latch & density sensor
2. Display Method → Bluetooth to device, LCD screen, green/red light
3. Attachment/physical built of devices → Triclamp system, Pressure tap layout, door system

The Chosen Concept

SG = Orifice Plate flow meter

Display = LCD screen

Physical built = as seen in figure



How does it work? - Mathematical Analysis

Using fluid dynamic concepts: Bernoulli Equation and Continuity Equation

$$q = C_d * \left(\frac{\pi}{4}\right) D2^2 * \left[\frac{2\Delta P}{\rho(1-d^4)}\right]^{1/2}$$

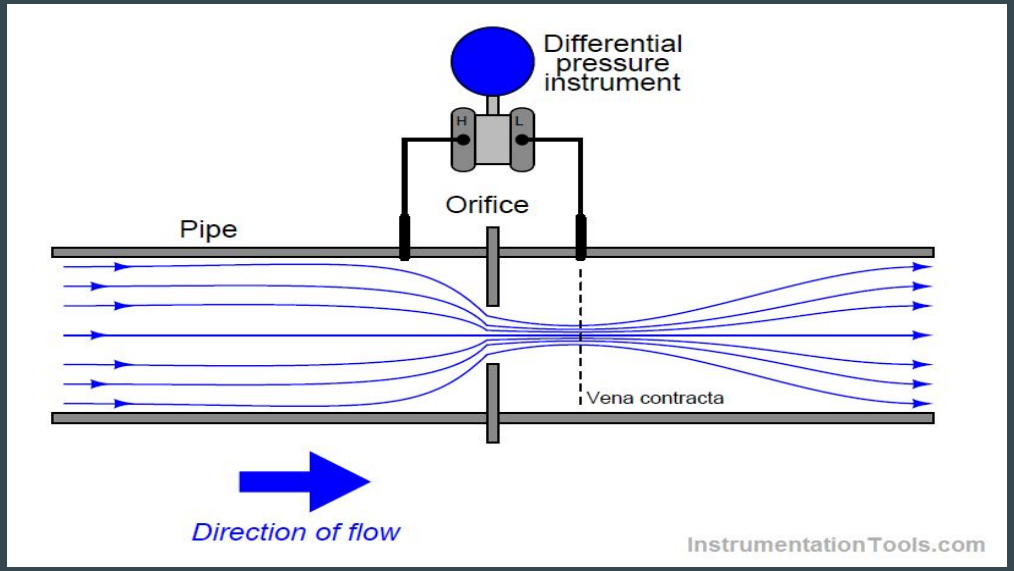
Values to get from sensors

What we want
SG = *p*liq/*p*water

q = volumetric flow (m^3/s)
ΔP = Difference in Pressure
Cd = coefficient of discharge
D2 = orifice plate diameter (3x smaller then main pipe diameter)
d = diameter ratio D1/D2

Sensors Used

Volumetric Flow meter (q value)



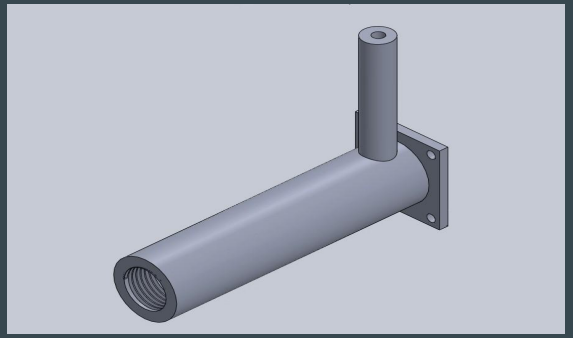
Orifice Pressure Concept

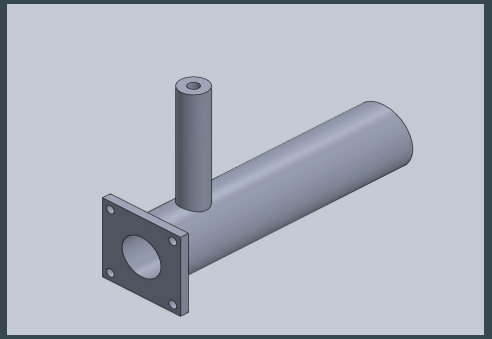
Differential Pressure Sensor (ΔP value)

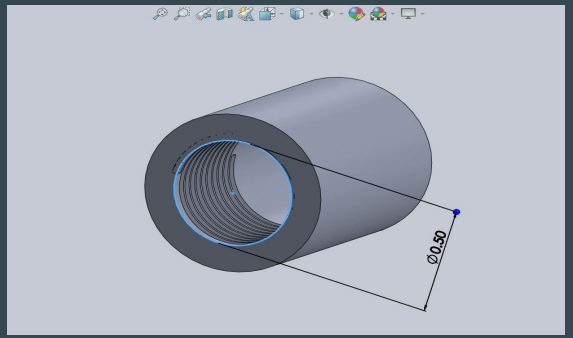
Prototype

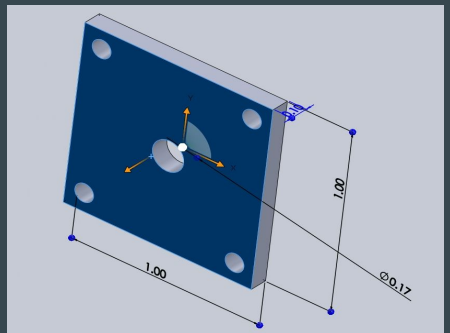
Prototype 1 - SolidWorks Design

- Volumetric Flow Sensor
- Orifice Plate
- Differential Pressure Sensor

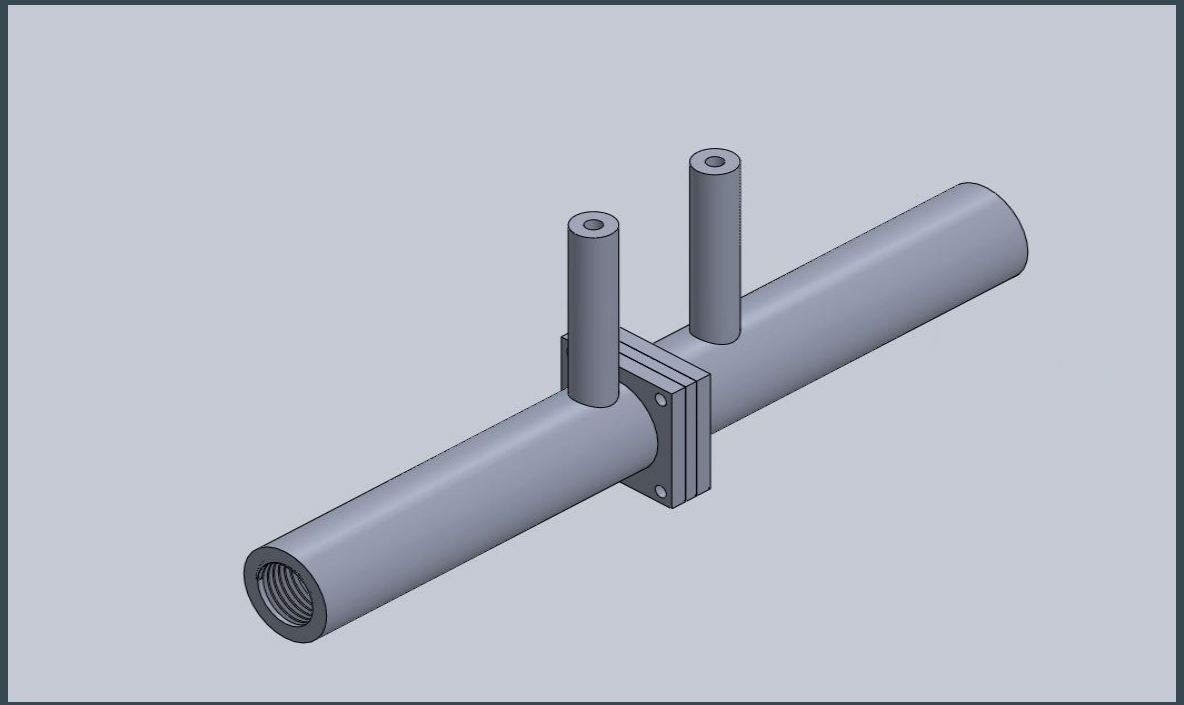






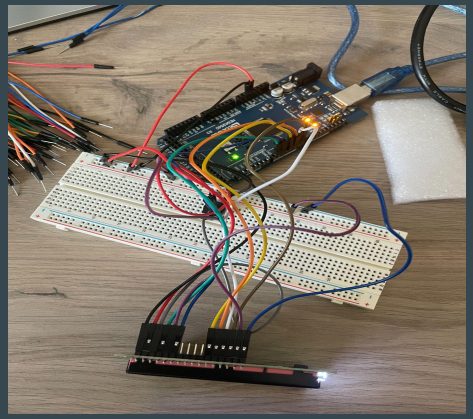


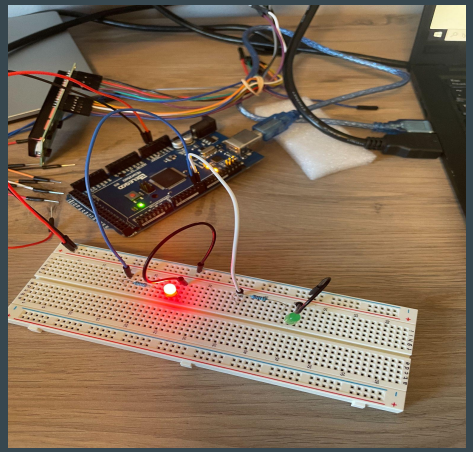
Prototype 1 - SolidWorks Design

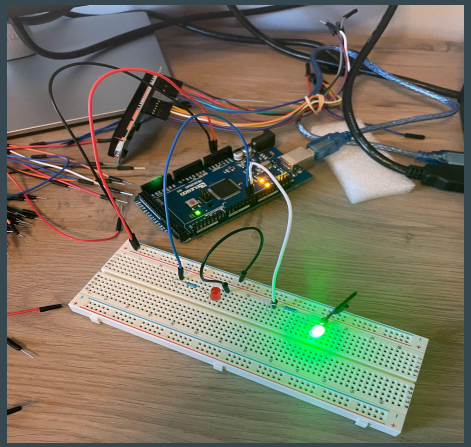


Prototype 1 - Wiring of Components

- Wiring the LCD screen
- Testing LED lights
- Differential Pressure Sensor test







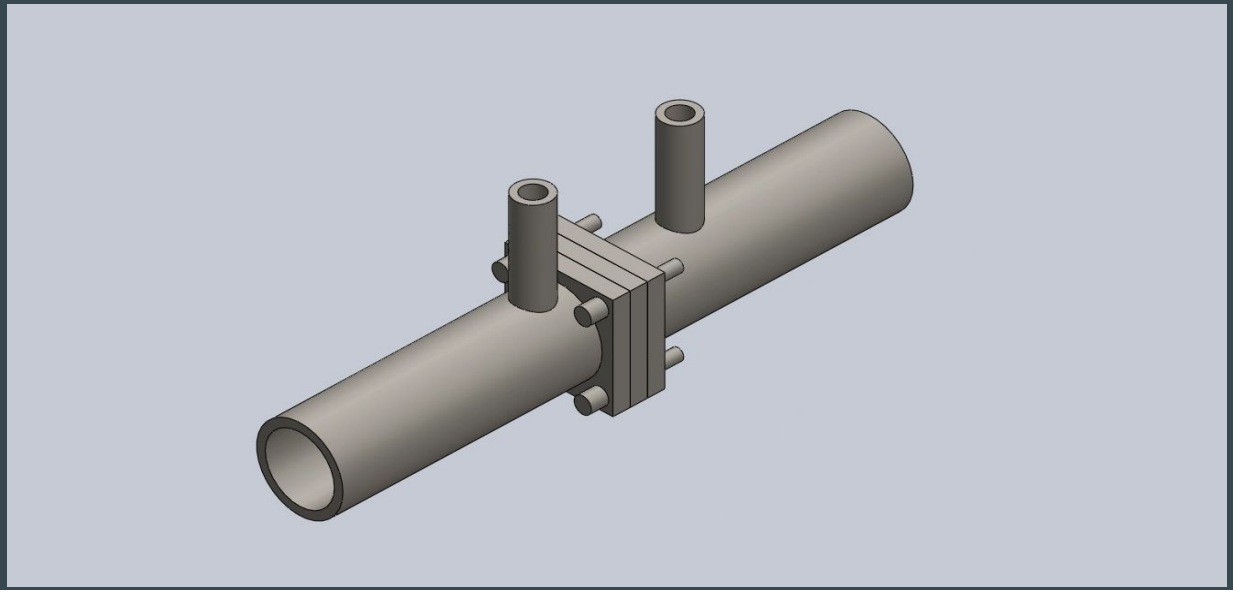
Prototype 2 - 3D Print

Our first 3D print of half of the pipe

First error was the way it was printed

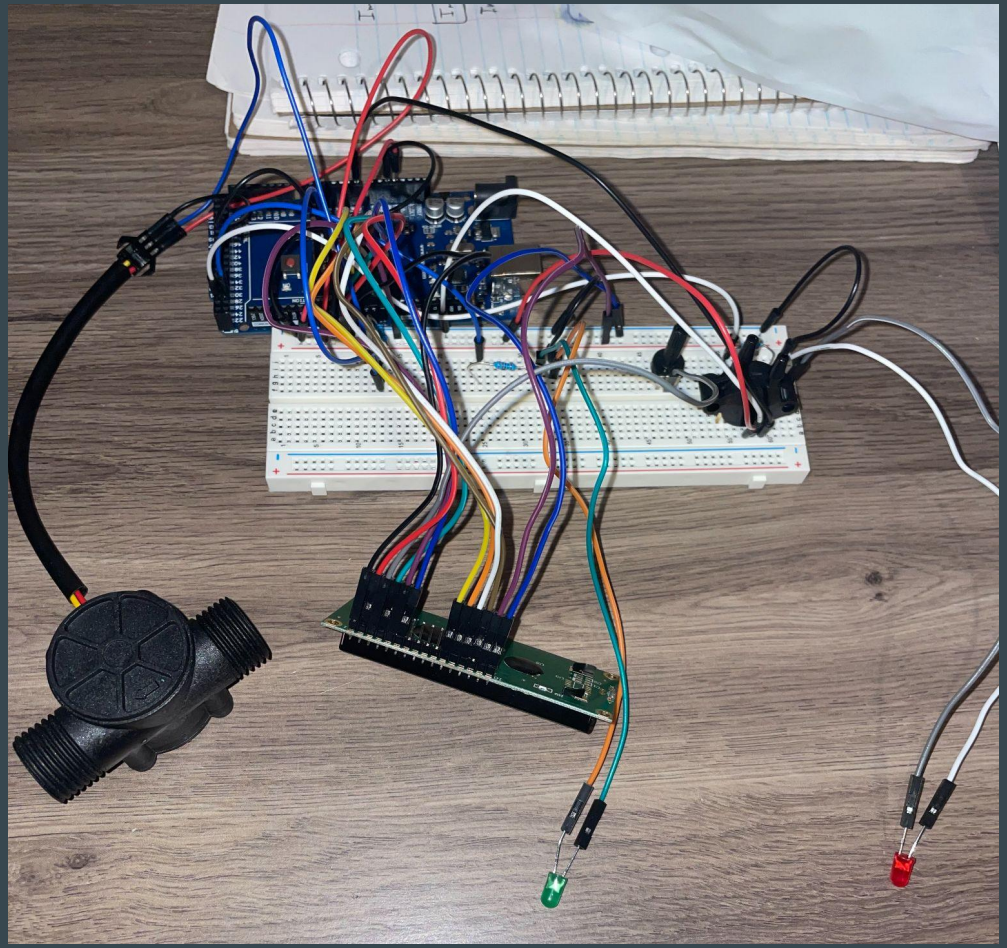
Diameter sizing error for volumetric flow meter

Prototype 2 - Revising SolidWorks Design



Prototype 2 - Wiring Everything Together

- LCD screen
- Red and green LEDs
- Volumetric Flow Meter
- Differential Pressure Sensor



Testing/Conclusion

Next steps

- Testing volumetric flow meter code
- Reprinting some 3D materials
- Testing the design all put together