University of Ottawa

GNG1103 B Engineering Design Project

Deliverable D: Conceptual Design

Group Members:

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Abstract

For this deliverable, each team member designed individual concepts for the project and then presented them to the group. The preferred features from each concept were then noted and incorporated into three new concepts. These new concepts are then ranked in a rating system to determine which is best suited for the criteria of the project.

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1.Introduction

In the previous deliverable, we defined the design criteria of our project as well as the constraints based on the client's preference. Therefore, in this deliverable, we will be using this information as a guide we individually created concepts for each subsystem (Flow control, measurement of specific gravity, and display of data). These individual concepts will be used to make three global concepts that will be graded based on their ability to meet our previously established criteria. Then the most suitable concept will be determined by which concept receives the highest score.

2.Individual concepts

a. Aidan

i. Subsystem 1: Flow diversion

1. So that the measuring unit is able to properly measure density of the sugar water with consistency, the flow in the pipe needs to be laminar (constant with no air bubbles which could skew the readings from the laser).
2. So to ensure that the flow is laminar a turbulence filter would be necessary, a turbulence filter is a funnel of sorts with a goal to achieve laminar flow in a pipe.

ii. Subsystem2: Measuring unit

1. The method of measuring specific gravity would be to find the density of the sugar water and then to compare it to the density of water.
2. To determine the density of the sugar water a laser could be used. By finding the refraction of the laser the density can be determined with maths from a simple computer.
3. The location of impact of the laser would be determined by a laser sensor plate and the point of impact of the laser with sugar water would be compared to the point of impact of the laser with just water to find the angle of refraction.
4. A neck may be necessary so that the laser may travel enough to have a distance between the point of impact with and without water that can be accurately measured.

iii. Subsystem 3: Data display

1. Data display should be able to be done via internet or bluetooth to connect to any device needed to display the measurement in the brewery.
2. Bluetooth also permits the system to still transmit data provided it has an integrated battery in the case that the brewery loses power in the case of a power outage (which are becoming increasingly more common).

b. Gilles

i. Subsystem 1: Flow Diversion

1. A constantly pumping motor that pump the liquid into the measuring unit in order to give out in-time readings for in-time adjustment.

2. A check valve that keep the liquid not flowing back into the tank, so that the customer can get a reading that is not affected by the newly fermented liquid that would probably affect the reading.
3. For output of the liquid we will also need a check valve to make sure the checked liquid is not coming back into the measuring unit.

ii. Subsystem 2: Measuring Unit
1. When the motor of the income liquid is working, we will use the stationary laser beam to shoot thorught the liquid so that we can know how many degrees dose is reflect in the liquid.
2. With a specific piece of glass that is flat on the measuring device, people can observe the color of the liquid.
3. With that flat piece of glass or acrylic we can also put the laser outside the unit which is easier for customers to check if it is damaged or not and because it's out of the water, you will have a lower cost to fix the laser.

iii. Subsystem 3: Data Display
1. According to the position that the laser is at we can use a scale that is a set with the laser to get the specific readings.
2. With a light sensitive panel we can send the reading into customer's application on the phone or a working divice.
3. An notification of the critical reading will be send to customer if the reading is close to where they set which is critical to make a save.

c. James

i. Subsystem 1: Flow control
1. This system will use gravity to maintain flow of the solution.
2. An automatic valve controlled by a small computer will permit or deny the flow of the solution into the isolation pipe.
3. Then a second automatic valve uses a smaller more precise valve to fill the measuring chamber to a specified volume. This valve will have for advantage more controllable flow but at a much slower rate thus needing to be isolated from the constant flow of the main pipe.
4. After being measured the solution will be allowed to renter the main pipe

ii. Subsystem 2: Measuring specific gravity
1. The solution will fill the measuring chamber to the specified volume. This container is suspended by tension cables that are connected to a tension sensor.
2. This will allow the system to measure the gravitational force of the solution inside the container.
3. With this, it will be able to send the downward force to the computer to calculate the specific gravity through a series of equations. (Gravitational Force of solution / Gravitational Constant = Mass →

Mass / Volume = Density of solution → Density of solution / Density of water = Specific Gravity)

iii. Subsystem 3: Displaying data
    1. The data from Subsystem 2 is provided in an attached screen to display constant information to the operators.
    2. On this screen is displayed the specific gravity measured and the time at which this measurement was taken.
    3. Inside a small memory storage unit, data is temporarily stored over time and can be reviewed.

d. Evan Aguiar-Winter

i. Subsystem 1: Flow Control
    1. This system's method of flow control would be gravity based, relying on the force applied by gravity.
    2. Inflow and outflow would be controlled via an automated system. Controlled by a program, in a computer chip.
    3. As the fluid flows through the external piping, the measuring device will do its task of measuring the different properties of the liquid.
    4. After the liquid has passed through, inflow will close and outflow will follow after being emptied.

ii. Subsystem 2: Measuring system
    1. The fluid will flow through the external piping via gravity flow.
    2. Once this has happened, as the fluid flows through the piping, a ultrasonic density meter
    3. This ultrasonic density meter will send out a frequency that humans are unable to hear. This frequency will travel in a cone shaped beam by using vibrating devices known as transducers.
    4. These frequencies travel in a constant pattern, until they reflect off of the presence of your target. Depending on the size of your target, you will need to adjust the size and precision of your transducer. For a situation like this, we will need an ultrasound density meter on the molecular level.
    5. Once the beam is reflected off the projected target, just as any sound wave, a part of it comes back to the origin. The echo is then reabsorbed.
    6. These waves can create an image of the system it flowed through. Depending on when the echo returns to the receiver. The only issue is that for something like this, there is a temperature range of about 0.2*C+/- before it can influence the outcome of the ultrasound imaging. Velocity is directly proportional to temp.
    7. Using the ultrasonic waves, (assuming temperature is constant), we now have an accurate depiction of the amount of sugar content depending on the velocity of the beams after some computer calculations.

iii. Subsystem 3: Data Display
    1. Data display will be able to be done via internet or Bluetooth. Capable of connecting to any interface, may that be laptop, desktop, tablet, etc.
    2. Depending on the levels of filtering, the system will notify the user if the temperature in which the ultrasonic waves were transmitted was off the

typical range, thus affecting the results. (Indicating the test must be taken again)

e. Benjamin

i. Subsystem 1: Flow Control
   1. This system will rely on one variable pump controlled by a microcontroller and powered by a system power source, connected via cable to source the fluid, then use gravity to return the fluid into the tank.
   2. The variability in power output from the pump will be controlled in order to not disturb or effect the sample, as well as time samples so that they are adjustable in increments. i.e. every minute, every two minutes.
   3. The first pump will feature a food grade PVC or CPVC pipe which extends from the top of the tank, deeper towards the center of the tank in order to gather an accurate fresh sample.
   4. This sample will be drawn into the measuring system.

ii. Subsystem 2: Measuring system
   1. The fluid will flow into two different chambers externally.
   2. These chambers are held above the entrance to the port hole, where the sample will be returned to the fermentation after measurement.
   3. The first of two chambers acts as a prime, prepping the sample to maintain consistency. This tank allows the sample to rest from the motion of the pump, as well as thermally regulated using an isolation to regulate temperature before being measured.
   4. The second chamber will act as the measuring chamber featuring a food grade and water-resistant ultrasonic sensor with a refraction lens opposite the sensor to return the signal.
   5. The microcontroller will collect data using as Arduino data collection shield outputting to Wi-Fi through an SD slot.
   6. Once the data is received the sample will return to the tank via gravity.
   7. All the valves and electronics run off the system power source, connected by cable to an outlet.

iii. Subsystem 3: Data Display
   1. Data display will be outputted to a mini-PC running an ultrasonic to specific gravity data translation program allow data to be visible and useable.
   2. Live data can be translated to a graphing software such as Graphana to monitor both graph and numeric value if each sample.
   3. Data in table of value format will also be translated into an expandable external storage unit which can be recalled at any time into a graph on Graphana
   4. Data can be translated to multiple monitors via Wi-Fi or cable connection.

Ali
*Absent due to family constraints

3.Global concepts

a. Concept 1

i. Flow Diversion

Turbulence filter with a constant flowing liquid through a single pipe. Create section in which the fluid is subject to laminar flow, which means it flows without impurities (air bubbles, gaps, precipitations…).

ii. Measuring system

A laser is placed against a clear window and projects the beam through the solution, hits the sensor on the opposite side. The side bearing the sensor would be flat. A neck might be necessary to extend the range of the laser to increase the distance between the two impact points, allowing for more accurate data.

iii. Display

A screen that shows the reading of the measurement system with time and the readings will be stored into a memory unit.

b. Concept 2

i. Flow Diversion

Again a turbulence filter can be used to induce a laminar flow allowing consistency to be identical throughout the pipe.

ii. Measuring system

In this concept we would use an ultrasonic density meter which will measure the density as long as the temperature in the pipe remains consistent. It is a very precise device and can be used at high frequencies for very precise results.

iii. Display

The display would be identical and also transmit data via bluetooth to a compatible device that would then display the data collected.

c. Concept 3

i. Flow Diversion

It's an individual pipe that collect a certain amount of liquid and control these liquid to go into a smaller valve that could fill the measurement chamber.

ii. Measuring system

Exterior container has liquid at a specified volume and is suspended by tension cables to find the weight. Weight is compared to weight of water and density can be determined.

iii. Display

A computer that calculates the specific gravity and ideally time of the calculation, then would send the data via bluetooth to a compatible device. This is to prevent loss of data due to power outages.

4.Concept comparison

Product Criteria/Specifications	Concept #1	Concept #2	Concept #3
Precision (1>6)	4	6	2
Price (1>3)	2	1	3
Frequency (1>3)	3	2	3
Durability (1>3)	1	3	2
Ease of maintenance (1>3)	2	1	3
Error Rate (1>3)	2	3	1
Overall Score	14	16	14

5.Finalised global concept

According to the table, we can know that the second global concept will be the best concept to be used in this product.

The ultrasonic design of the measurement unit is extremely precise and it will have no problem giving specific readings in the liquid that have impurities in it.

6.Conclusion

In this deliverable, the three main concepts were described. Their features were compared to determine what they excel in and what they lack as to make an educated decision on choosing the main design concept to impress the client. The concepts were compared using criteria that was determined in the previous deliverables and received a rating from 1 to 3 except for precision which carried more weight because of its importance to the client. The design concept with the most points was selected for future cost estimation and prototyping.

7.Reference

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Evaluation of ultrasonic propagation to measure sugar content and viscosity of reconstituted orange juice - ScienceDirect

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8.Appendix

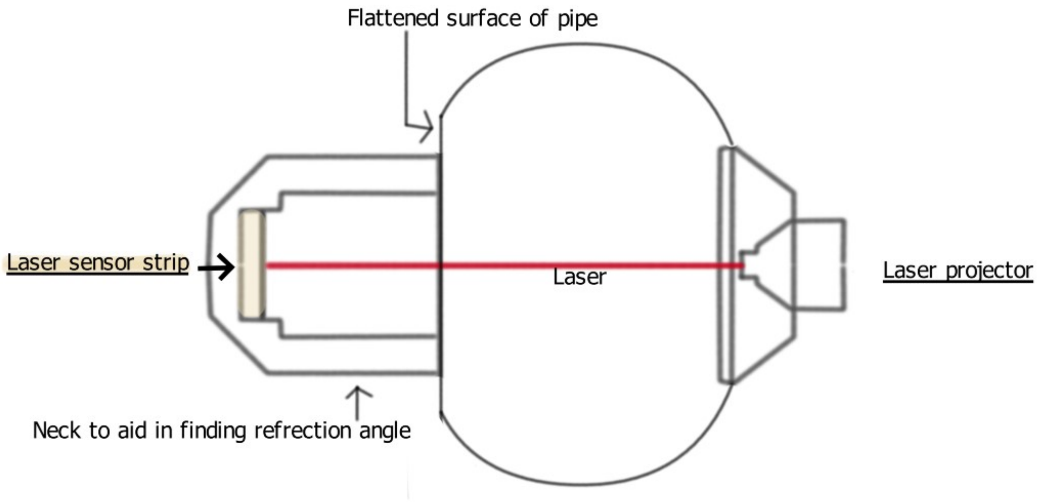

Fig 1.Concept 1 sketch 1

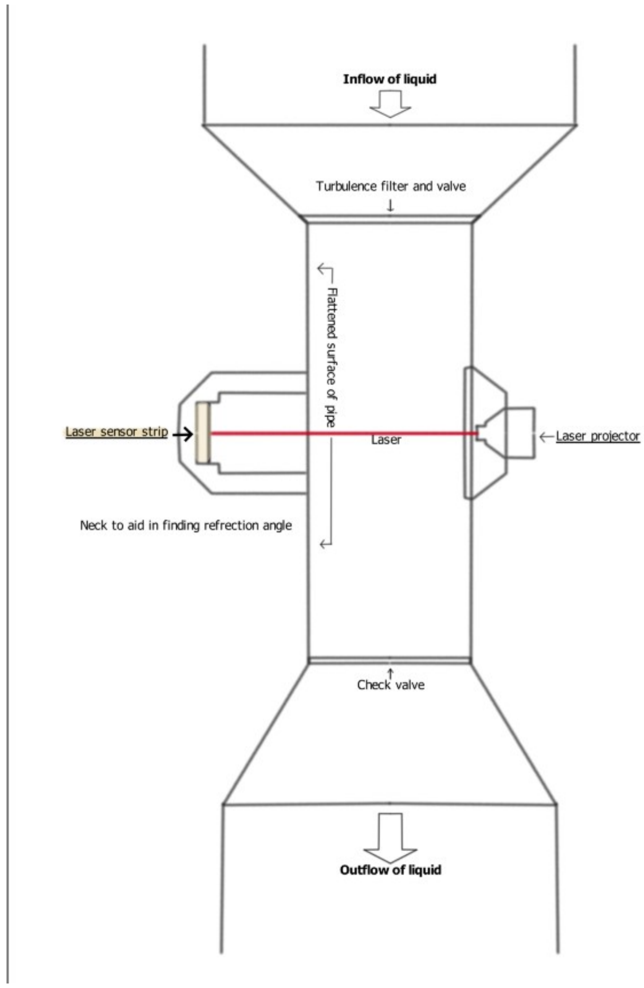

Fig 1.Concept 1 sketch 2

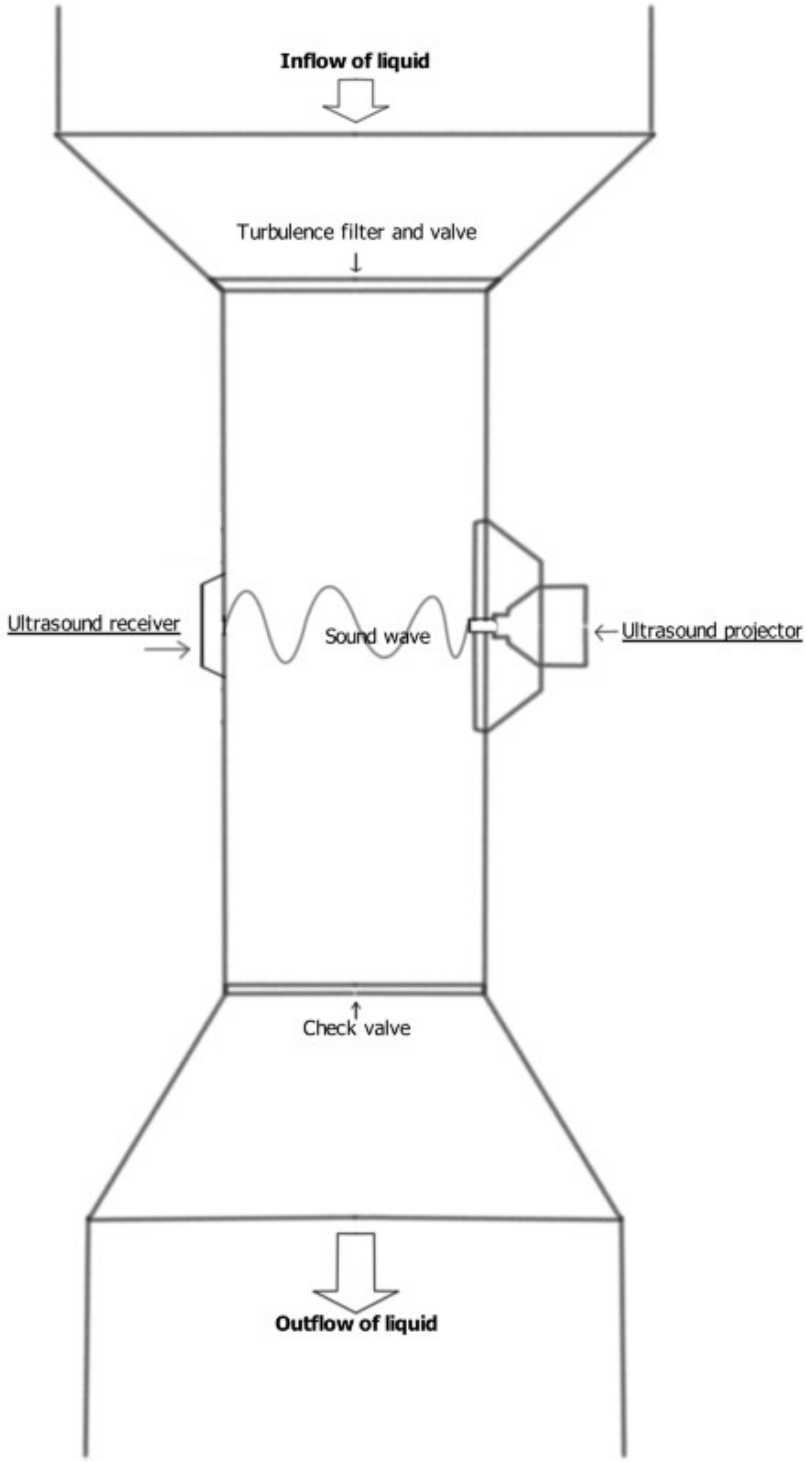

Fig 1.Concept 2 sketch 1