Deliverable C - Design Criteria

GNG 1103
Introduction to Engineering Design

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Table of Content

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1. 0 - Introduction

Beyond the Pale- Brewing Company is a microbrewery residing in Ottawa since 2012. They offer various beers to suit every client. During COVID, the company decided to enter an expansion phase. They require a device to measure specific gravity on their 'in-flow' contraption to alleviate the pressure off their workers. In addition, they'd also like a separate device to measure the specific gravity and temperature of the fermentation liquid during the brewing process.

The following deliverable addresses the design criteria, constraints, functional requirements, non-functional requirements, and technical and user benchmarking of the in-line system.

2.0 - Design Criteria Organization

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

User Needs	Design Criteria
System needs to read specific gravity measurements every 10-30 seconds	Maximum Reading Value (frequency) Timing (min) Automation Control
System needs to display accurate specific gravity values	Accurate Reading of Specific Gravity (% error) Method to Display Results (Plato) Temperature limit (°C)
Device needs to be resistant to yeast build-up and easy cleanup process	Filtration Support (% filtration) Usability under constant conditions Quick set up/takedown process (min)
Device must fit in a 1-½" piping system between two tri clamps	Maximum diameter (Inches) Attachment Capability (clamping)
Device needs to allow for gravity-driven flow	Flowing Method (Gravity)
Material has to be food grade (silicon, stainless steel)	Safety and standards (Food-grade) Public Safety
Device needs to have upfront cost versus monthly subscription costs	Upfront Cost($)

Table 1.2: Functional requirements

	Design Criteria	Relation (=,<,or>)	Value	Units	Verification method	Description
1	Accuracy (% error)	<	1	%	Analysis and Test	The result the user reads of the display must be accurate to no more than 1% error in order to get accurate results during analysis
2	Display Visual presentation of specific gravity	=	yes	n/a	Test	When the user glances at the device, the resulting specific gravity is displayed via a display in order to determine the adequate SG range
3	Filtration Support (% filtration)	>	95	%	Test	The device must have an adequate filtration efficiency to ensure the yeast buildup does not ruin the device readings while it's running
4	Natural Flow Process Controlled	=	yes	n/a	Design and Test	The device must allow for free flow of the liquid during the reading process, without the use of any pumping device.
5	Needs to be Automated	=	yes	n/a	Design and test	Device has to be fully automated during its specific gravity readings to eliminate the need for user interaction
6	Quick set up and take down time	<	5	min	Test	The device must have a quick set up and takedown time for when staff clean the device

Table 1.3: Design Criteria & Metrics

	Design Criteria	Relation (=,<,>)	Value	Units	Verification method	Description
1	Frequency (Time)	<=	5-10	Second	Test and analysis	The device needs to measure the specific gravity of the in-flow contraption
2	Maximum Diameter (size- hole)	=	1-½	Inch	Analysis and test	The design must fit in a circular hole of 1 inch on two sides while connecting safely and securely onto the current contraption installed on the in-line device
3	Accuracy (pressure)	>	12-14	Psi	Analysis and test	The device needs to handle the pressure of the inflow while computing
4	Operating Conditions (temperature)	>	70	℃	Test	The device needs to handle the higher temperature values of the wort which is approximately 60-70℃
5	Cost (upfront)	=	100	CAD dollars	Estimate, final check	The materials of the device must cost exactly 100$ (taxes included)
6	Functionality (Size-dimensions)	<=	18x16x18	Inches	Test	The device must fit in the *Beyond the Pale*'s brewing space
7	Functionality (mass)	<=	20-30	lbs	Test	To ensure that the users can pick up the device.

Table 1.4: Non-Functional Requirements

	Design Criteria	Relations (=,<,or>)	Value	Units	Verification method	Description
1	Reliability	=	Yes	n/a	Test	The specific gravity must be very accurate and should be working at all times. The measurement of the specific gravity is important throughout the entire brewing process and workers at Beyond the Pale should be able to rely on this device.
2	Safety	=	Yes	n/a	Test	The product must be made of food-grade materials.
3	Corrosion resistance	=	yes	n/a	Test	The product must be able to withstand and resist constant exposure to liquids at hot temperatures. The product must also be able to be cleaned and withstand sanitizing substances.
4	Product life	>	5	Years	Test	There was no direct statement regarding the product life but Beyond the Pale is looking to purchase something upfront and would rather not spend money in the future. Therefore the product should be able to last for approximately 5 years so new products don't need to be purchased.
5	Aesthetics	=	yes	n/a	Test	There were no descriptions of the aesthetics/looks of the product and is not an important part of the design. However, an unattractive device can be unappealing

Table 1.5: Target Specifications

	Design Criteria	Ideal Value	Acceptable Values	Units
1	Frequency of SG reading (Time)	Every second (1s)	Every 5-10 (s)	Second (s)
2	Weight of device (mass)	10	At most 30 (so one employee can easily move it)	Pounds (lbs)
3	Filtration efficiency (% filtration)	100	At least 95	Percentage (%)
4	Operating Conditions (temperature)	75-90 (for additional security and reliability measures)	At least >70 (for normal operating conditions)	Degree Celcius (℃)
5	Prototype Cost (upfront)	50-80	At most 100$	Dollars ($)
6	Product Life	10	At least 5	Years
7	Device size (with hole diameter)	10”x4”x4” (inside diameter of 1-½”)	No more than 18”x16”x18” (hole diameter is 1-½”)	Inches (“)
8	Accuracy of Specific Gravity Value from device	100%	At most 1% error	Percentage (%)

Table 1.6: Technical and User Benchmarking

	Device Name	Features	Pros	Cons	User feedback
1	Difluid Beer Refractometer	Solves specific gravity measurement problems and solves data sorting and storing problems.	- Device can measure the specific gravity of beer at ± 0.1 percent accuracy - Drop proof and unaffected by external lighting - After calibrating the machine using pure water, it only will need one drop of the sample to measure the specific gravity within 2 seconds. - Can be moved around or used on different samples. - Takes one hour to charge and will last thirty days on one charge. - Automatically sends the data taken from the sample to an app that can be downloaded on your phone.	- It is two hundred and sixty dollars which are over our budget of one hundred dollars. - Still needs a sample that needs to be removed from the vats. But this sample is very small.	- Users find it very easy to use and very compact. Users also find it very accurate and they like how the app saves the measurements of the refractometer. -Users do find that the app that the refractometer sends the data to, needs some polish. Sometimes the app can lose connection to the refractometer, in this case, you need to reset the app and the refractometer. The biggest problem the users find with this product is the price. - Overall even with the problem of the price and connection problems, the reviews are overall very positive.
2	Beer Wort Refractor	Solves specific gravity measurement problems	- Compact in size and lightweight, comes with a case convenient to store and carry around - Specifically created for brewing beer. - Specific gravity measuring range is from	- Still needs a sample that needs to be taken out from the vats, though it is a smaller sample. - No way of	- The reviews are mainly very positive but one complaint is that sometimes the focusing dial is a little loose so you have to twist the

			1.000 to 1.130, with an accuracy of ±0.001. - Only takes two to three drops of the sample into the refractometer. - Only twenty-five dollars so it is in our price range of one hundred dollars.	storing the data. - Could be subject to user error, as the data is recorded where the user sees the blue line. If the user has a problem with eyesight, all recordings could be skewed. - Usually used for home brewers rather than bigger breweries.	refractometer a an lot, to refocus it. - Overall the user reviews are very positive for a home brewing situation but can face more problems in a larger brewery.
3	Raspberry Pie	Solves data sorting and storing problems.	- Tailored for simple jobs, which is perfect as we only need it to record values. - Works with python, c and other easy-to-use applications which are all applications that our group is familiar with. - On board WI-FI, Bluetooth, HDMI outlet, and multiple USB outlets. - Has a long lifetime.	- Overheating problem. - The price is two hundred and five dollars which is way over our budget of one hundred dollars.	- All user reviews are very positive. They find that it lasts a long time and is very user-friendly with the many different ways to access the board, (WI-FI, Bluetooth, HDMI outlet, and multiple USB outlets). - Some of the problems that the users found were that it has an overheating problem and that the price is very high. - Overall, the user reviews are positive when given simple codes to execute but can overheat if the codes are very complicated.

Device #1:
https://www.amazon.ca/Refractometer-Companion-Fermentation-Precision-Resolution/dp/B0B9GWM9FJ/ref=sr_1_4?crid=188L4S38C32BX&keywords=specific+gravity+sensor+beer&qid=1665082869&qu=eyJxc2MiOiIxLjMwIiwicXNhIjoiMC4wMCIsInFzcCI6IjAuMDAifQ%3D%3D&sprefix=specific+gravity+sensor+beer%2Caps%2C64&sr=8-4

Device #2:
https://www.amazon.ca/Refractometer-V-Resourcing-Specific-Gravity-1-000-1-130/dp/B06XSYH9L8/ref=asc_df_B06XSYH9L8/?tag=googleshopc0c-20&linkCode=df0&hvadid=459470607295&hvpos=&hvnetw=g&hvrand=7941815698460574966&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000668&hvtargid=pla-420135946715&psc=1

Device #3:
https://www.amazon.ca/Raspberry-Model-2019-Quad-Bluetooth/dp/B07TC2BK1X/ref=sr_1_1_sspa?crid=198SV0UO6EUSZ&keywords=raspberry+pi&qid=1665087312&qu=eyJxc2MiOiI2Ljg1IiwicXNhIjoiNi4xMyIsInFzcCI6IjUuNDcifQ%3D%3D&sprefix=rasberry+pie%2Caps%2C98&sr=8-1-spons&psc=1&smid=A3IHVSMSAY70CP&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUExWUsxR1o0QVpEMDhMJmVuY3J5cHRlZElkPUEwOTMyNzc2M0FHNkxGVVRKOExBWiZlbmNyeXB0ZWRBZElkPUEwNzI3MTA0MTM5RTBFM0JOUVZVSSZ3aWRnZXROYW1lPXNwX2F0ZiZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNrPXRydWU=

3.0 - Reflection on Client Meeting

The client meeting impacted the development of our design criteria and specifications when looking at the device itself. Prior to the meeting, our team was under the impression that one device is needed for each section, and later came to the conclusion that two different devices are required. When speaking with Shane, he provided very informative details that redirected our thinking and narrowed down possible solutions. He mentioned that designs involving a refractometer will not work, as it is not very accurate, and cannot be used when alcohol is present. This helped us steer clear of any ideas that would have ended up wasting our time in the design process. The meeting also provided us with specific information, including: possible dimensions and budget. This helped us invision the device and keep us on track regarding materials and expenses. Shane made it very clear his explicit wants and needs in this device, which helped us when deciding the importance in the design criteria. For example, one of his needs was that the device must be food grade. Considering this is a must, we as a team decided that it was one of the priorities in the design criteria. Another example being, the frequency of the specific gravity reading. He asked that the reading be available every five to ten seconds, although, ideally every one second. Overall, the information we gathered from the client meeting impacted the development of our design criteria and specifications immensely, which will help us in the design process when the time comes.