Deliverable C

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February 5, 2023

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1. Introduction

After extensive user and technical benchmarking, a set of design criteria and constraints has been determined. There are six separate categories that have been prioritized in conjunction with the associated needs in Deliverable B.

2. Design Criteria and Requirements

As discussed in Deliverable B, the main needs of the dust detection system have been outlined as pre-emptive dust reading, ease of operation, reasonable cost, handleability of all dust qualities, safety, and applicability to the current process. These needs have thus been matched with one or more design criteria and categorized as either a functional requirement, non-functional requirement, or a constraint, as outlined in Table 1.

Categorizations of the criteria are predicated on the following understandings of each term:

- Functional requirements are criteria that affect the solution's function;
- Non-functional requirements are criteria that do not affect the solution's function;
- And constraints are limitations that must be considered in the solution's design.

Table 1. Design Criteria and Categorization for each product and user need.

Need	Design Criteria	Categorization
Pre-emptive dust reading	1-second damping time	Functional requirement
	Measures dust level as malt leaves silo	Functional requirement
	Alarms workers if there is a problem	Functional requirement
Ease of operation	Data is accessed and monitored via computer	Functional requirement
	The sensor can be cleaned without stopping operation	Non-functional requirement
	Operable by one brewery employee	Non-functional requirement
Reasonable cost	$10,000–$15,000 initial cost	Constraint
Handleability of all dust qualities	Can handle up to 6% moisture content	Functional requirement
	Works with particles above 2.2 mm	Functional requirement
	Can handle 6% dust content	Functional requirement
Safety (MICHAEL)	Doesn't affect malt flow rate	Functional requirement
	Doesn't raise malt temperature above 250ºC	Functional requirement
Applicability to current process	Mountable on pipe walls	Non-functional requirement
	Sensor must fit inside the pipes	Constraint
	Operating conditions –35°C to 45°C weather and conditions	Constraint

3. Technical Benchmarking

Envea's Air Safe 2

The Air Safe 2 (AS2) is a dust detection system that pre-emptively measures dust content in flow streams with an adjustable dust level limit which, when surpassed, signals an alarm[2]. This feature guides the design criteria of pre-emptive dust measurement and alarm. Additionally, the AS2 has a 1-second damping time to report dust levels, thus providing a metric for efficiency. Furthermore, the AS2's compact design, allowing it to be set up almost anywhere, influences the design criteria of measuring the dust levels at the exit of the silos, since it should be feasible to implement a dust detection system almost anywhere.

Malt Certificate of Analysis

Montana State University analyzed malt, providing information on its common and ideal properties upon which design criteria can be predicated. Malt moisture content is ideally 4-6%, thus it is unlikely that the client will operate above 6%, as that risks mold and infection.[3] Therefore, the realistic maximum moisture content is 6%

Dust Sentry Pro

Aeroqual's Dust Sentry Pro (DSP) is a dust monitoring system designed for outdoor use, with solar shielding and lockability.[1] It guides for the design criteria of operating in –35°C to 45°C weather. This temperature range encompasses the full range of Toronto weather, allowing the dust detection system to be operable year-round.

Dust Measuring Device PCE-PQC 32US

The PCE-PQC 32US is a dust detection system that utilizes a particle counter for real-time measurement. This device can be remotely controlled and monitored via a web browser which allows workers anywhere to access it. Additionally, this device allows the selection of particle size for measurement, to avoid counting other materials present of different size. The laser measurement system also avoids obstructing any of the measured dust particles allowing for complete flow.

4. User Benchmarking

Temtop Air Quality Monitor 8 in 1 AQI PM2.5 PM10 HCHO TVOC Temperature Humidity Particle Matters Number Meter w/ Histogram TFT Display Indoor Air Pollution Detector for Home Office (LKC-1000S+).

This is an 8-in-1 multifunctional device used to detect air quality, temperature, and particles. It measures 5 key air pollutants which include PM2.5, PM10, HCHO, TVOC, and AQI. With this product, you could also purchase a smart monitor, which would allow to measure all these pollutants, and be able to download the data to your phone, straight to your computer [5].

Amazon Smart Air Quality Monitor with Information Relay To Smartphone

Alerts were sent to the individual's smartphone when dangerous/ unwanted levels of CO, CO2 and other gases were detected. Main issue was its technical complexity, so usability on the part of most competent users is important for all monitoring systems.

5. Target Specifications

Pre-emptive Dust Reading

A 1-second damping time will be used, as it provides continuous information about the dust levels. Additionally, the dust will be measured outside each silo. These two specifications allow the duster enough time to change its operating intensity when needed. Furthermore, the dust sensor will work in conjunction with the client's current alarm and error messaging system to notify workers of dust levels.

Ease of operation

The silos and attached piping lie outside away from the filter and worker supervision. Access to the measured data via a computer would allow workers anywhere in the building to monitor the dust levels quickly and easily. Any maintenance done to the sensor must not halt any operation to avoid slowing production in the brewery. The clients also specified that whatever system is created must be operable by any single worker.

Reasonable cost

As stated by the clients the cut-off price range is around $10,000–$20,000. To limit cost and avoid any chance of falling over budget an initial cost of $10,000–$15,000 is a realistic goal.

Handleability of all dust qualities

The dust detection system must be able to handle moisture content up to 6%. Furthermore, it must be able to detect up to 6% dust, as that offers a large safety factor above the 3% dust composition as stated by the client. Finally, it must not have an issue processing grains greater than 2.2 mm, as that is the typical size used in brewing process.[4]

Safety

Firstly, it is important that safety not be compromised in the design of this monitoring system. Hence, thus far, two specifications have been created. They are that the filter does not affect the malt flow rate and that the temperature in the system is maintained below 250°C. The malt flow rate cannot be affected as that could lead to pressure build ups and blockages that could potentially lead to bursting of the pipes. Furthermore, the temperature requirement is well below the 282°C combustion temperature for malt dust so the risk of explosion is very minimal.

Applicability to Current Process

The key components for this are that the sensor needs to be in the pipe, allowing the sensor to scan the dust within the malt. The monitor being put onto the silos would allow the workers to have easy access to the information for that certain silo. Finally, the product should be prepared for all weather conditions that it can be met with as well.

6. Client Meeting Reflection

The client meeting was beneficial in that it provided a good baseline for the basic procedures of the brewery and a good description of the task at hand. The categorization of the data was heavily influenced by this meeting as the brewery presenters laid out their requirements. For example, they stated that they did not have a current system in place that could pre-emptively monitor dust collection and that was their main interest in a new design hence it is our first design criterion. Furthermore, a new client meeting will be required to ascertain more specific information regarding measurements and metrics. Specifically, the AS2 is 0.012 m^3, but too few details on the client's process were provided to consider this for the volume specification. Finally, the development of our specifications was greatly enhanced by the meeting as extremely important, needed criteria were provided such as a 3% dust processing requirement.

Works Cited

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