Deliverable D

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Abstract

In this project, a set of conceptual designs will be developed to address the problem statement, based on previous user and technical benchmarking, and a list of prioritized design criteria. Each team member will generate at least one concept for each of the three required subsystems, which will then be discussed and refined as a team. The boundaries between the subsystems must be clearly defined to ensure interchangeability. The final conceptual designs will be documented using sketches and descriptions, including the benefits and drawbacks of each concept. The subsystems will then be combined into three global concepts, which will be evaluated using a selection matrix and the best one will be chosen for further development. The other concepts should also be recorded and kept safe for future reference. The chosen concept will be used in future project deliverables and may be modified if necessary.

1. Introduction

Dust particles range in diameter from 0.1 to roughly 70 micrometers are airborne, they become an occupational nuisance, not to mention health hazard. As a source of physical discomfort, lost materials and wear on conveying pulleys, idlers, belting and motors, such dust is a significant factor in reduced productivity and added operating costs. Our objective is to create needed equipment that requires a cost-effective, low discharge, and low maintenance cleaning system with an intelligent dust sensor for safe operation and easy use. We decided to split the process into three different components, each connected to each other to help maintain different types of dust build up. The dust sensor portion would alert the stoppage system from stopping extra dust build up which would then alert the dust removal system to either suppress or alert cleaning staff to maintain the dust collector.

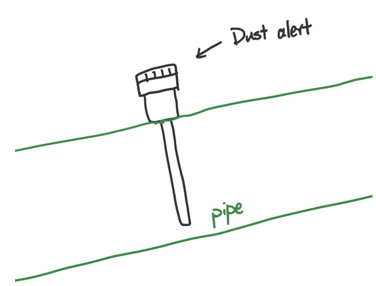
2. Related Work

Related work in the field of dust management systems has focused on improving the efficiency and accuracy of dust sensors and alert systems, as well as reducing the environmental impact of dust disposal methods. Other researchers have also developed innovative water suppression systems that effectively reduce dust levels. There have also been studies on the use of data systems to collect and analyze dust data in real-time. The integration of these subsystems into a comprehensive dust management system has been a key area of research, with a focus on creating a system that is easy to use and effective in reducing dust levels. Our proposed dust management system builds on this prior work by combining these subsystems into a single, integrated system, with a focus on meeting the design criteria outlined above.

3. Dust Sensors

3.1 Dust Alert Sensor

The Dust Alert Sensor with integrated electronics, and sensing probe alerts when dust emissions exceed a preset point. As particles flow past and over a sensing probe, they induce a charge into the probe that creates small electrical currents in the picoamp (pA) range. The signal is processed by the sensor’s integrated electronics converting it into an output proportional to mass. Charge induction is highly reliable and minimizes the influence of sensor contamination and particulate velocity change.



Benefits:

1) Maintenance-free inductive sensing technology
2) Fully insulated probes prevent false alarms caused by moisture, buildup, or conductive particles

3) Low-cost, high-value single-piece unit

Drawbacks:

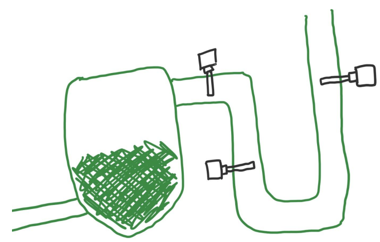
1) Only suitable for preventing metal duct/pipe blockage

3.2 Data system

The Alert Dust Sensor sends information/messages through signals to a monitor to be viewed.

3.3 Installation of the Dust Alert

Installation of Dust Alert



a) Only trained professionals should install/maintain this product.
b) Shutdown processes that include high temperatures, high pressures, toxic gasses, hazardous particulate, or explosion risks prior to installing or removing equipment.
c) Installation must be in grounded metal duct/pipe, because static electricity within a dust collection system can generate substantial DC voltage, which is not safe.
d) Outlet Locations
   i) Ensure good access.
   ii) Straight runs and laminar flow best for measurement.
   iii) Accessible negative pressure locations may be preferred to prevent exposure to toxic gasses and particulates.
e) Straight Run Considerations
   i) Straight run can be horizontal or vertical.
f) Horizontal Pipes/Ducts
   i) Side or top mount recommended.
   ii) Bottom mount is not recommended.
   iii) Proper mount and installation location will prevent buildup.

4. Dust Suppression

Watersuppression (fog/mist spraying technology)

Water suppression subsystem would connect to the dust disposal system where the measured amount by the dust sensor and dust level detector would alert if dust particles are rising.

Summary(Soaking dusts to make extra space and pervent dust buildup in the air)

Benefits

1) removes any dust particles in the air when ready to dispose
2) disposable in bulk or chunks at a time instead of piles of dust
3) easy to operate
4) Low cost material/ single piece

5) usage of natural resource (water)

Drawbacks

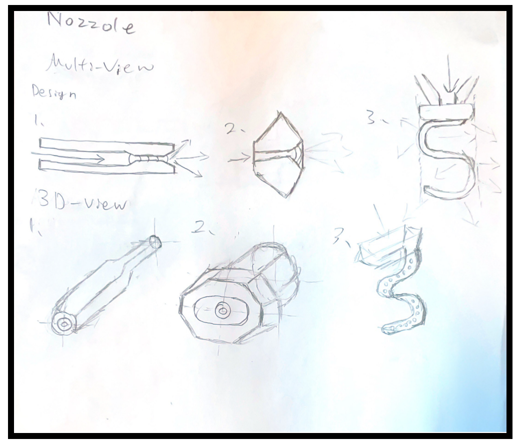
1) difficult to clean/ maintain
2) may keep environment too humid which can grow mold if left for long periods of time

4.1 Subsystem 1

Nozzole:

Capabilities:

Spray nozzles are available in a variety of shapes, sizes, and spray patterns, making them suitable for a range of applications, such as irrigation, cleaning, and industrial processes.Any liquid capable of being pumped into the nozzle is vigorously sheared into fine droplets by the acoustic field. Air bypassing the resonator carries the atomised droplets downstream in a soft plume shaped spray. The droplets have low mass and low forward velocity with low impingement characteristics. Fine atomisation ensures uniform distribution of the liquid with minimum over spray and waste.



Pro:

Nozzles operate at very low liquid pressures and have large orifices. The large orifices and low pressure virtually eliminate orifice wear and prevent deterioration of the quality of atomisation while significantly extending nozzle life.

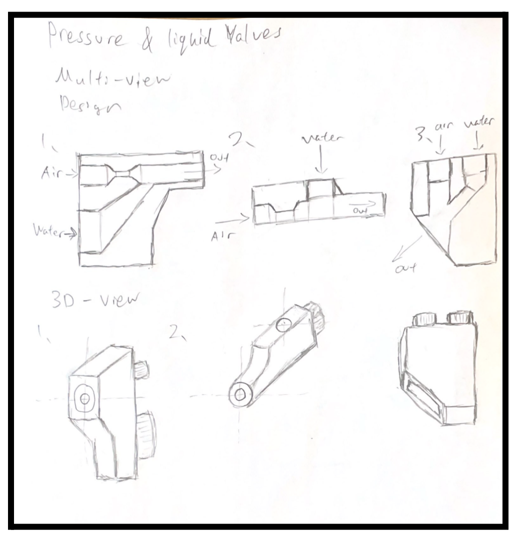
Con:

Nozzole would be carrying dust on top or around it’s components, may clog the water exit

4.2 Subsystem 2

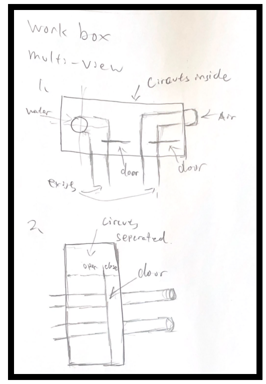
Pressure & Water valves:

When using the suppression system two control valves are necessary for both air and fluid to supply to the system in a timed sequence so it ensures the nozzle doesn't drip during shut off. The control valves would have various designs to ensure every angle of the system is covered. Components of the valve would measure no bigger than 50x40x60mm.



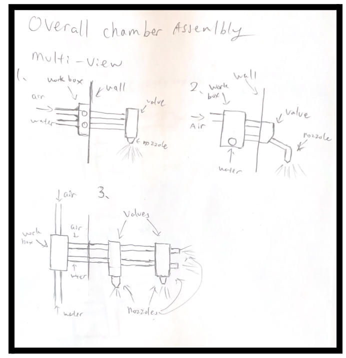
The valves can be attached to the outside of the dust collector to insure no damage to the valve’s entrance and exit. The components can be unscrewed by a wrench.

4.3 Subsystem 3



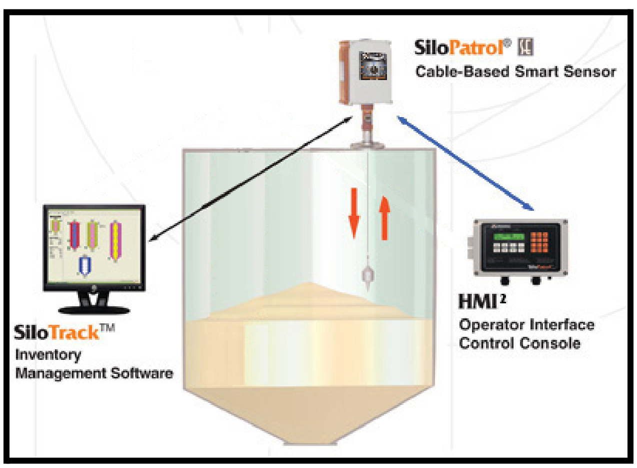
Work box:
The box would operate once alerted, shutting off pipe lines from inputting extra liquids. Coding the software to ensure proper shut off is done instantly.Making variations of operations like lowering the pressure of air or water can also be considered. The system would be operated automatically as the stoppage sensor is alerted. Every component is assembled using pipe screws and easily taken apart by a wrench.

4.4 Subsystem 4



Overall chamber:
The chamber would be mounted on either side of the dust collector's walls, two holes would need to be drilled for the passage of the liquid and air with extra smaller holes for stabilizing pins to insure no random collapsing of the entire system inside or outside. On the Outside work box would be connected to 2 different pipes, liquid and air. On the inside there will be 2 pipes connected to the valve where it will be attached to the nozzle.

5. Dust disposal system



The stoppage system will include three level sensors fitted in the three silos. These sensors will provide continuous data reading to the PLC which also monitors the dust sensors and alarms when dust level is high. Our recommendation is to add programming to the PLC so that it stops grain flow from the silo which has the least level of grain as it is the silo producing the highest amount of dust because dust sits on top of the grain in the silos and is released from the bottom of the silo. The PLC will stop output from one or two silos as soon as it detects high dust levels from the dust level sensor to prevent the dust collector from working hard and clogging from high amounts of dust.

5.1 Subsystem 1:

Detection System: This subsystem is responsible for detecting when a blockage or clog occurs in the dust cleaner. It includes sensors and algorithms to monitor the flow of dust and identify any disruptions. An example of a detection system for a dust cleaner in a brewery could be a series of pressure sensors installed along the dust flow path. These sensors can detect changes in pressure that indicate a blockage has occurred and send an alarm signal to the control system.

5.2 Subsystem 2:

Isolation System: This subsystem is responsible for isolating the affected area of the dust cleaner to prevent further dust buildup and minimize the impact of the blockage. This could include valves or other mechanical components that can control the flow of dust. An example of an isolation system for a dust cleaner in a brewery could be a series of pneumatic valves that can shut off the flow of dust to the affected area. This can prevent the blockage from spreading and minimize the impact of the disruption.

5.3 Subsystem 3:

Clearing System: This subsystem is responsible for clearing the blockage and restoring normal operation. This could include the use of mechanical tools, such as augers or brushes, or the application of compressed air or water to clear the blockage. The clearing system should be able to effectively clear the blockage while minimizing the risk of damage to the dust cleaner or other equipment. An example of a clearing system for a dust cleaner in a brewery could be a motorized auger that is activated when a blockage is detected. The auger can rotate and loosen the blockage, allowing it to be cleared from the system. Alternatively, a high-pressure air jet could be used to blow the blockage out of the system. The clearing system should be able to clear the blockage quickly and effectively without causing damage to the dust cleaner or other equipment.

5.3.1 Emergency Stop Button:

The Emergency Stop button is a crucial component of the Stoppage System. It is designed to stop the dust cleaner in case of any emergency or malfunction. The Emergency Stop button is usually located in a convenient position, such as on the control panel, where it can be easily accessed by the operator. The button should be easily recognizable, typically in red color and labeled “Emergency Stop”.

5.3.2 Disassembly and Installation:

Disassembly and installation are critical processes in the maintenance and repair of the dust cleaner. Disassembly involves taking apart the dust cleaner to access its internal components for repair or replacement. This process should be done by a qualified technician and requires proper tools and equipment.

Installation, on the other hand, involves putting the dust cleaner back together after maintenance or repair work is completed. The installation process should also be done by a qualified technician and requires proper tools and equipment. During installation, it is essential to ensure that all components are properly installed and that the dust cleaner is functioning correctly.

5.3.3 Benefits of the Stoppage System:

The Stoppage System, Emergency Stop button and Disassembly-Installation are important components of the dust cleaner in a brewery, as they ensure the safety and reliability of the machinery. The Emergency Stop button provides a quick and easy way to stop the dust cleaner in case of an emergency, preventing any harm or damage to the machinery and workers. The Stoppage System and Emergency Stop button also provide peace of mind for the operator, knowing that they can quickly stop the dust cleaner if necessary.

The Disassembly and Installation processes are important for maintenance and repair work, as they allow technicians to access the internal components of the dust cleaner. Proper disassembly and installation also ensure that the dust cleaner is functioning correctly after maintenance or repair work is completed.

The stoppage system also provides an added benefit of monitoring the amount of inventory in the silos and makes inventory management easy.

5.3.4 Drawbacks of the Stoppage System:

The main drawback of the Stoppage System and Emergency Stop button is that they require regular testing to ensure they are functioning correctly. If the Emergency Stop button is not tested regularly, it may not work in case of an emergency, putting the machinery and workers at risk.

Disassembly and Installation can be time-consuming and require proper tools and equipment, as well as a qualified technician. If the Disassembly and Installation processes are not done correctly, it can result in the dust cleaner not functioning properly or even causing harm or damage to the machinery and workers.

5.4 Dust disposal

The Dust removal team will be alerted once the level sensor is triggered, giving them enough space and time to clean out the disposal bin with no reminiscence of dust particles in the air, although the weight of the waste will be increased, it acts safer for the workers environment.

6. Conclusions and Recommendations

Dust Management System: This system combines the subsystems related to dust management into one cohesive system. It includes the dust sensors, water suppression system, and the alert system for predicting dust clogging. The design criteria for this system would include efficiency, accuracy, and ease of use.

Data System: This system combines the subsystems related to data collection and analysis. It includes the data system, installation and working of sensors, and the stoppage system. The design criteria for this system would include reliability, accuracy, and real-time data collection.

Dust Disposal System: This system combines the subsystems related to dust disposal. It includes the subsystem on how dust gets into disposal bags. The design criteria for this system would include ease of use, environmental impact, and efficiency.

The best system is chosen based on which one meets the most design criteria and compares favorably to benchmarked products.

7. References

Installation & Operating Manual - Proconsystems.com. https://www.proconsystems.com/wp-content/uploads/2020/07/Manual-DD-3000.pdf.

Murray, Mike. “Grounding a Dust Collection System.” *The Geek Pub*, 15 Dec. 2019, https://www.thegeekpub.com/3621/grounding-a-dust-collection-system/.