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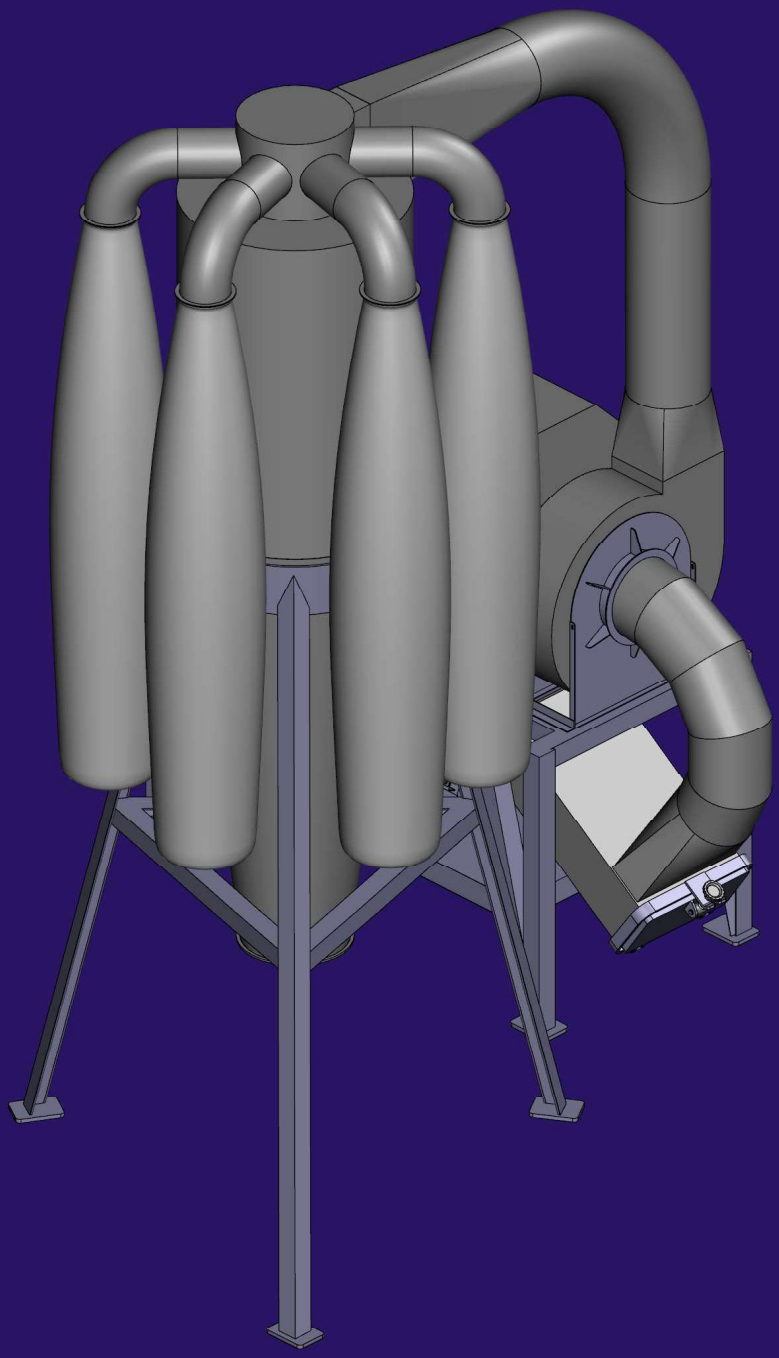
Solar-powered multipurpose hammermill

Construction guide delivered to **FIRST PRODUCTS ENTERPRISE**, in fulfilment of the project 'Design and development of direct-coupled photovoltaic powered agri-processing machinery' funded by Agri-Tech Catalyst

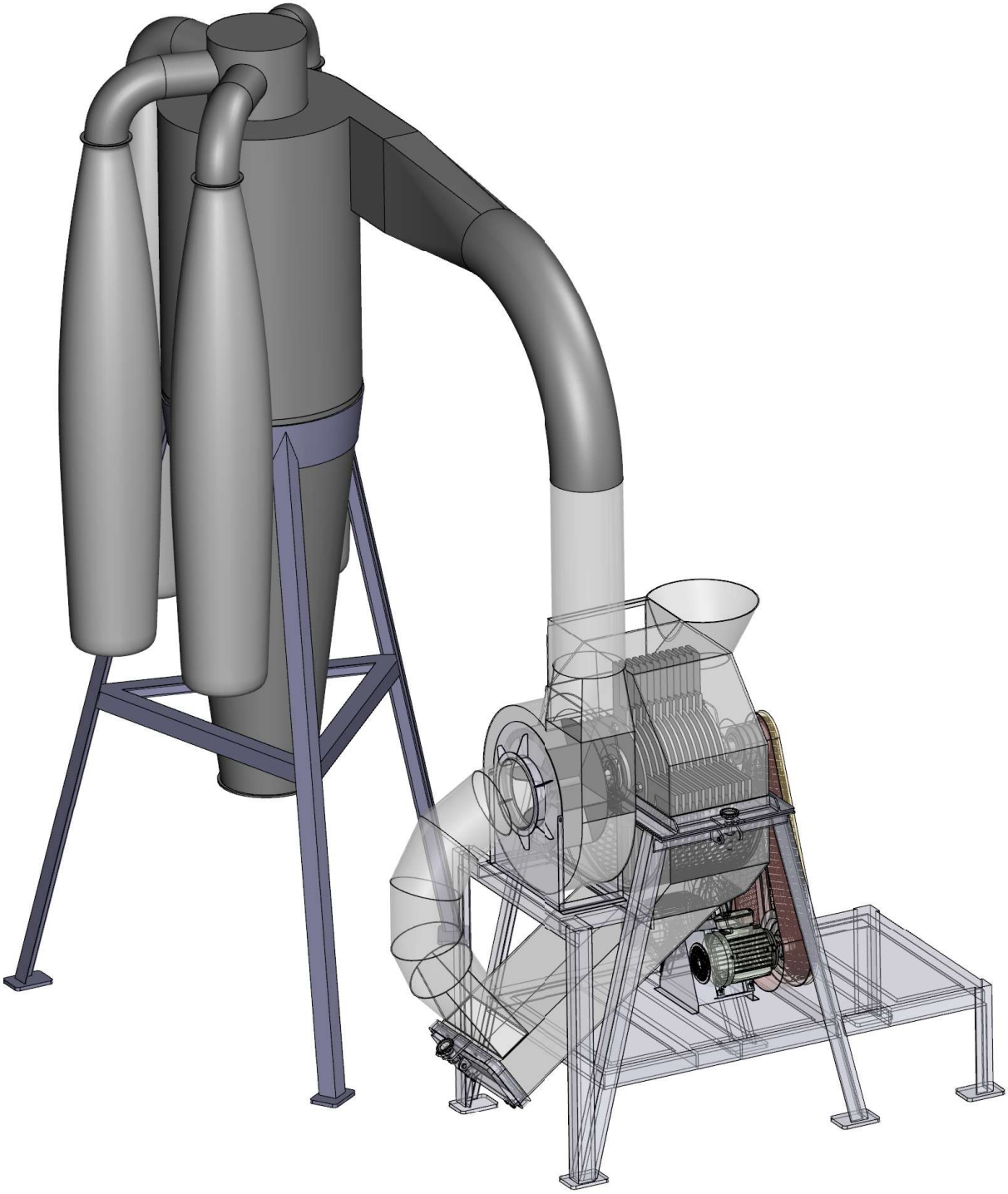
February 2021



Dr Marcelo Precoppe

Solar-Powered Multipurpose Hammermill

Construction Guide: Part 2



Dr Marcelo Precoppe | Natural Resources Institute | University of Greenwich | Chatham Maritime | United Kingdom

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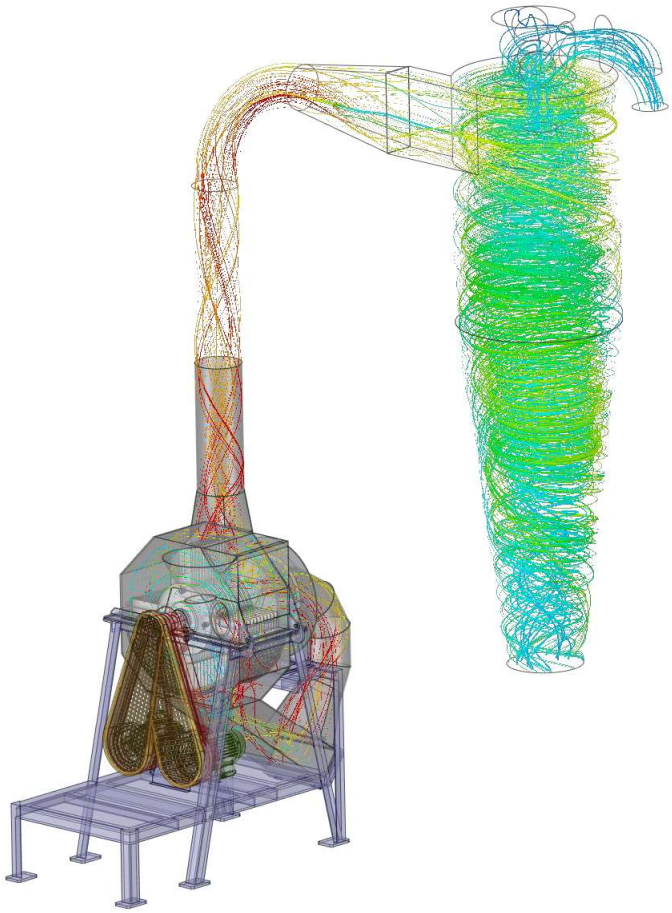

About the Natural Resources Institute

The Natural Resources Institute (NRI) is a specialist research, development and education organisation of the University of Greenwich, UK, with a focus on food, agriculture, environment, and sustainable livelihoods.

About the author

Dr Marcelo Precoppe is NRI's Crop Postharvest Technologist. He obtained his PhD at the University of Hohenheim in Germany. His research interest lies in using Participatory Approach coupled with the Engineering Design Process to develop technologies for small-sized enterprises.

Disclaimer

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About this guide

This guide is part of the project entitled *Design and development of direct-coupled photovoltaic powered agri-processing machinery*, funded by Agri-Tech Catalyst (Innovate UK). It was prepared to instruct Mr Emmanuel K. Duah (First Products Enterprise's Managing Director) on how to build a novel solar-powered multipurpose hammermill to be used for cassava processing. This is Part 2 of the Construction Guide. Part 1 instructed how to build the hammermill itself and this Part 2 instructs how to build the cyclone separator and assemble its filter bags (Figure 1).

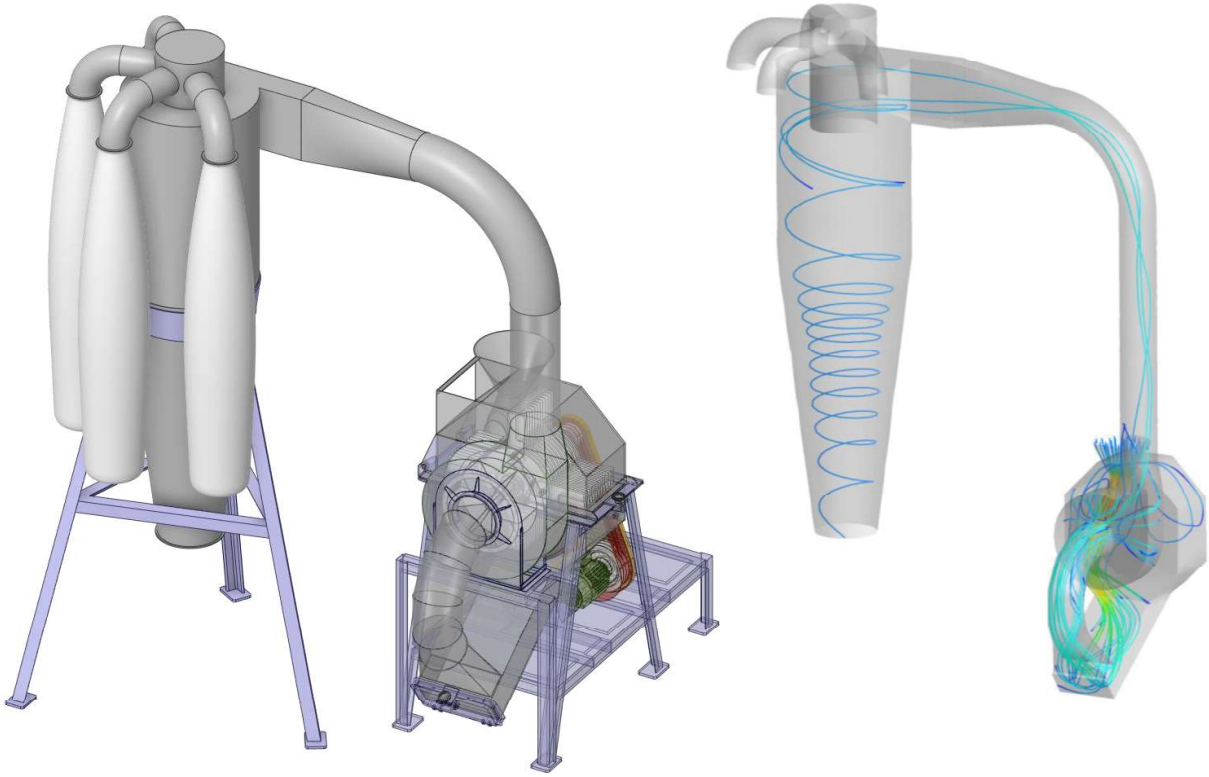


Figure 1 *This Construction Guide provide instructions on how to build the hammermill's cyclone.*

Introduction

Cassava (*Manihot esculenta*) is a perennial root crop native to South America but nowadays cultivated throughout the humid tropics. The roots are rich in starch and are the main source of calories for many people living in sub-Saharan Africa. However, two days after harvested, the cassava roots become unsuitable for human consumption and consequently, post-harvest losses are high. To extend cassava shelf-life the most common practice is to process the roots into flour; a dried product that can be used later as the basis for many dishes. To process cassava into flour, the roots are peeled, grated, pressed, pulverized, dried, and milled.

Solar-powered multipurpose hammermill milling function

This novel solar-powered multipurpose hammermill can be used to grate the cassava roots into a mash, pulverize the press cake into wet grits and mill the dried grits into flour. Because of the density of the cassava root and the press cake, both can move through the hammermill simply by the force of gravity. However, due to the lower density of the dried cassava grits, the force of gravity is not enough to move it through the equipment and thus forced airflow is used. Air is induced by a radial blower and at its outlet, a cyclone is used to separate the particles from the air. In addition, bags are placed at the cyclone air outlet to collect small particles that the cyclone are not able to separate (Figure 2).

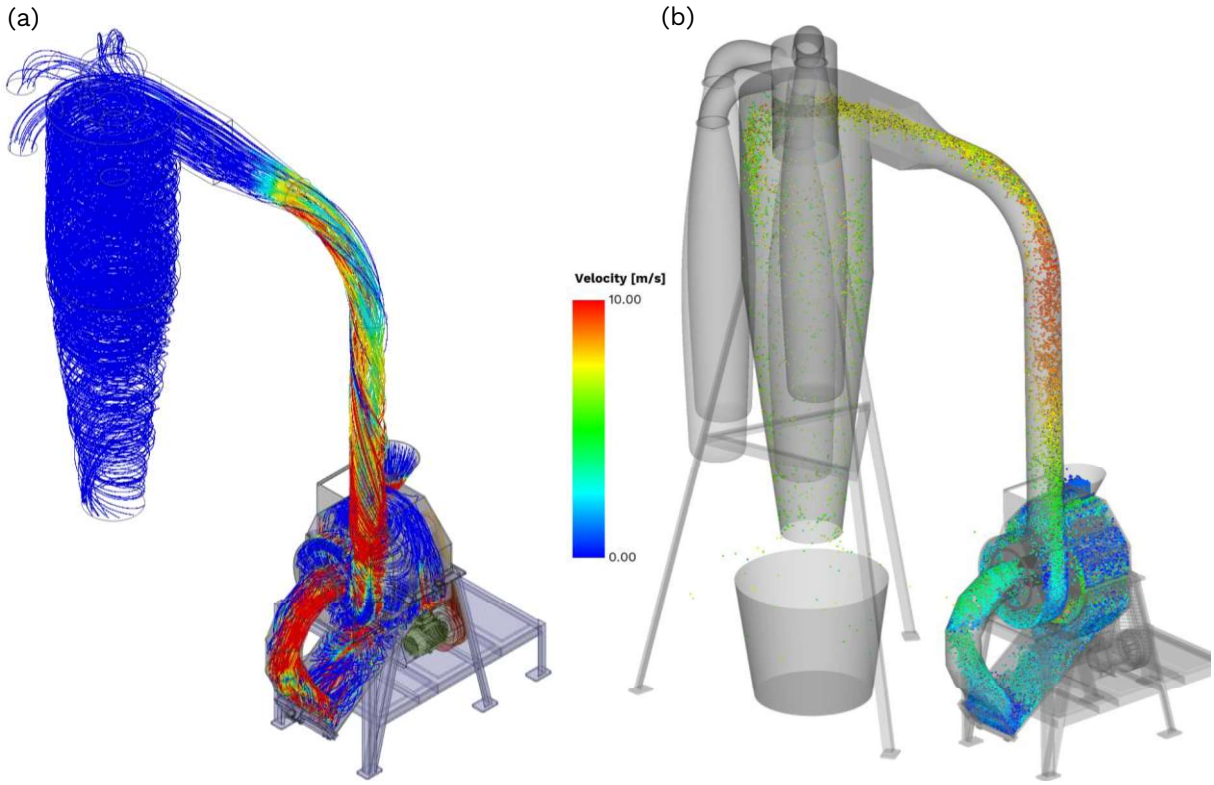


Figure 2 *For milling dried cassava grits (a) forced airflow is used to move (b) the material through the equipment and at its end, a cyclone is used to separate the material from the air.*

Cyclone separators

Cyclones are devices used to separate gas and solid using centrifugal sedimentation. In a cyclone, the heavier solid leaves from its bottom and the lighter gas leaves it from the top (Figure 3). Cyclones have the advantage of having no moving parts, thus requiring very low maintenance. However, cyclones are unable to separate particles smaller than 15 microns and therefore filter bags can be installed at its air outlet to avoid the spreading of dust.

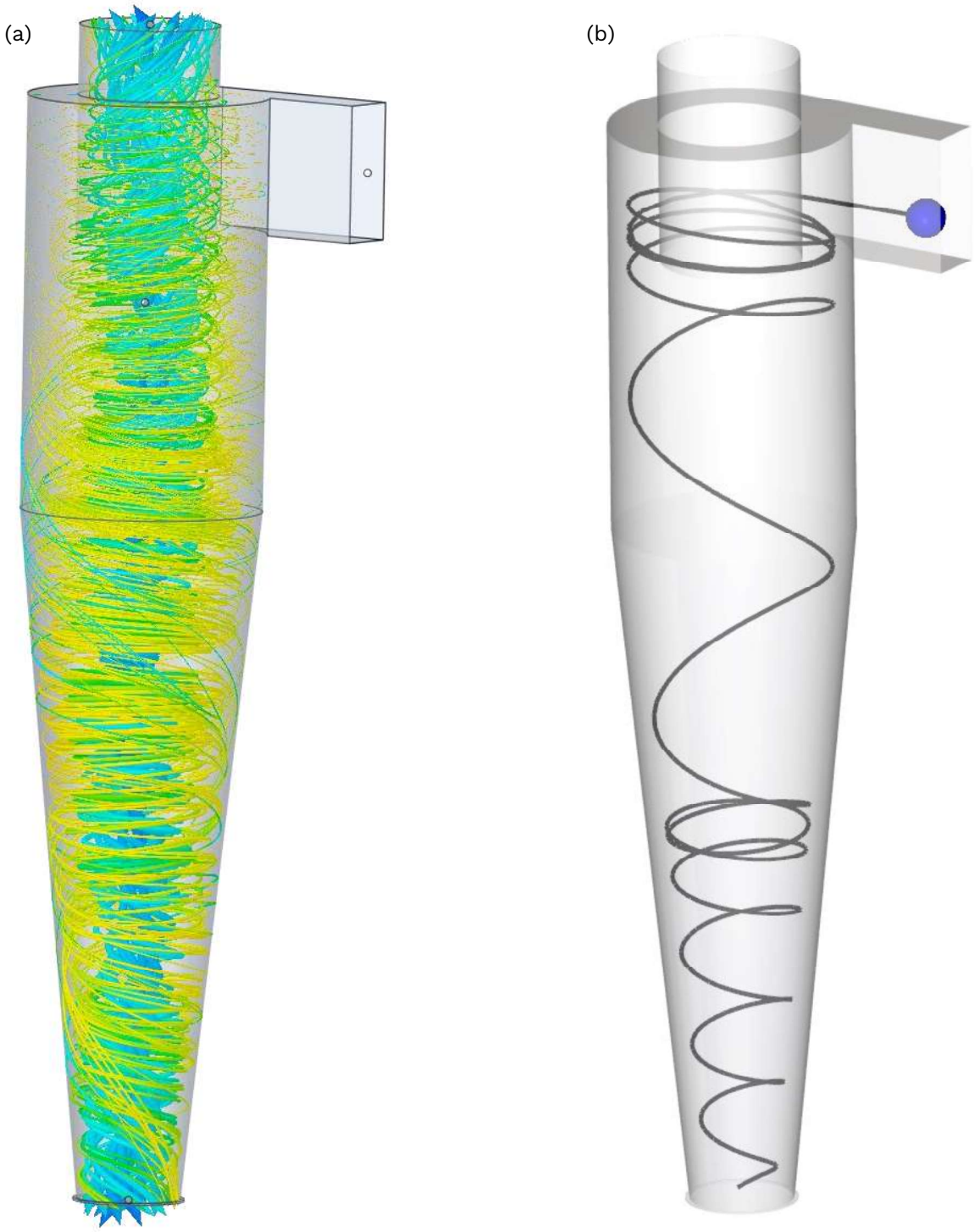


Figure 3 *Cyclones are used to separate gas and solid using centrifugal sedimentation, where (a) most of the air leaves from its top and (b) the solid leaves it from its bottom.*

Components

Overview

The cyclone is supported by a stand and connected to the hammermill by a duct. At the cyclone air outlet, filter bags are placed to collect small particles still mixed with the air.

Cyclone

The main dimensions of the cyclone are shown in Appendix 1 and Figure 4 provides an overview. The structure is 1.9 m high with a diameter of 0.5 m (Figure 4).

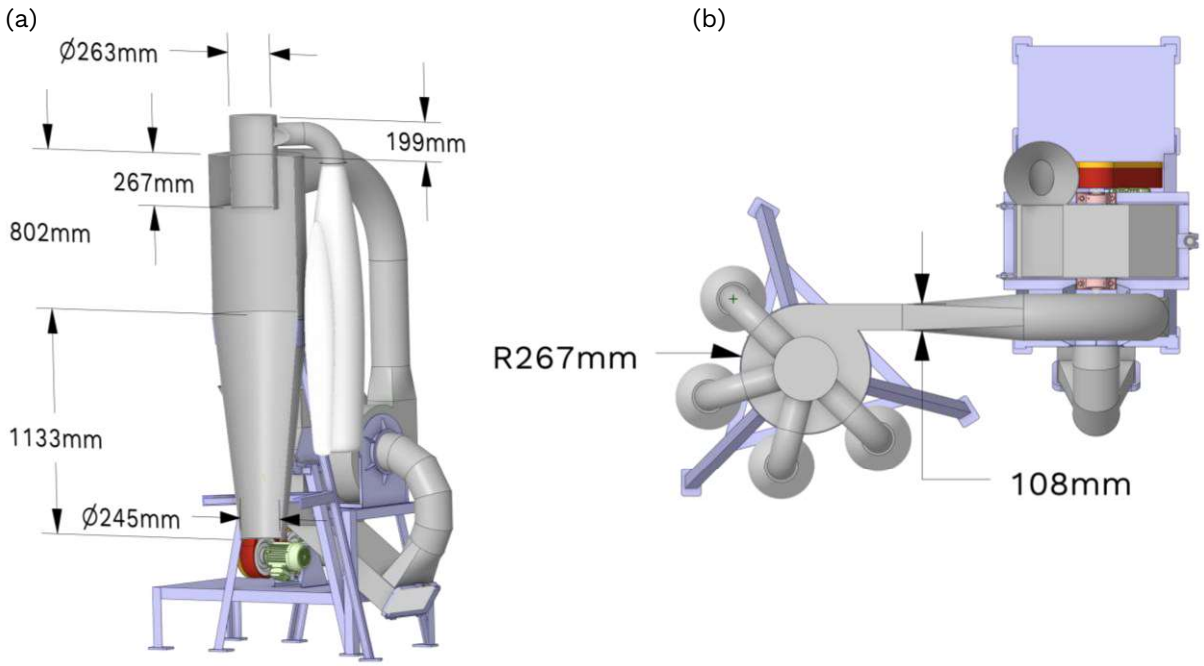


Figure 4 *Cyclone (a) cross-sectional view and (b) top view, with its main dimensions.*

Filter bags

Filter bags should be made of thin breathable and washable cloth. It should be easy to remove from the hammermill to clean the small particles collected inside of it (Figure 5).

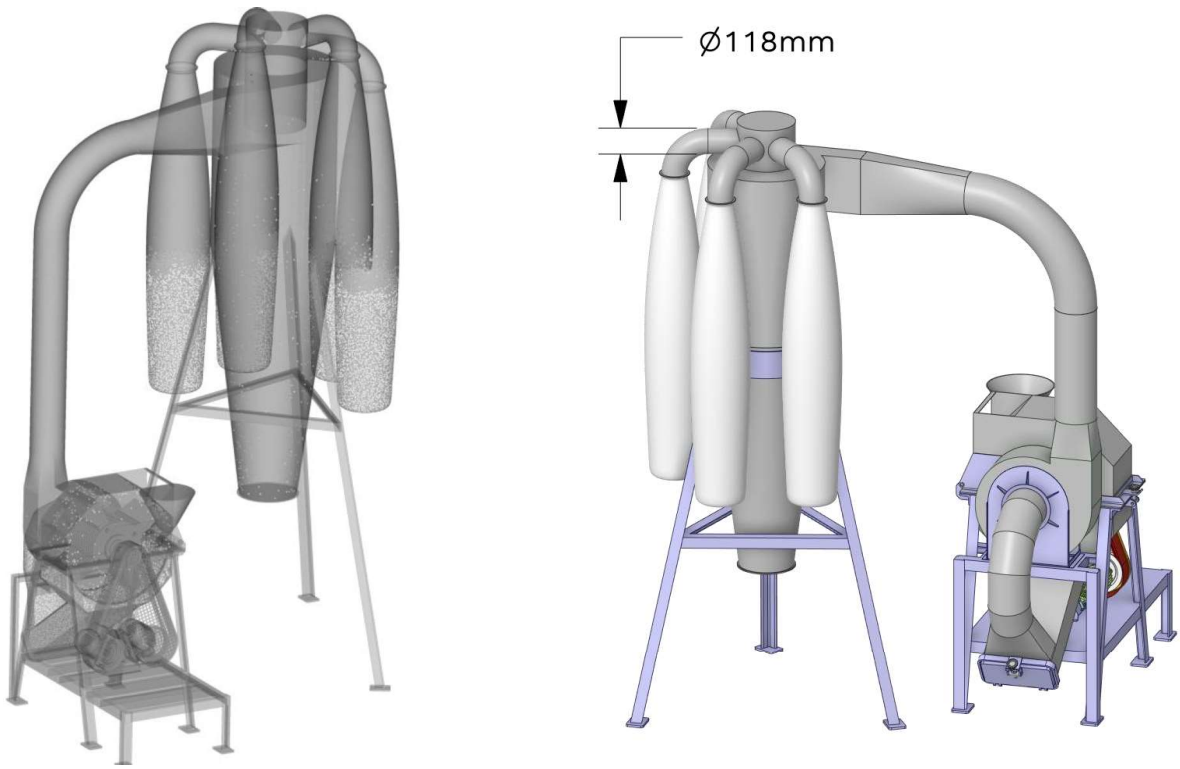


Figure 5 *Cloth bags placed at the cyclone air outlet to collects small particles and avoids dust.*

Connecting duct

A duct with a 0.5 m radius bend connects the hammermill to the cyclone (Figure 6). Appendix 2 and Appendix 3 contain the main dimensions of the connecting ducts.

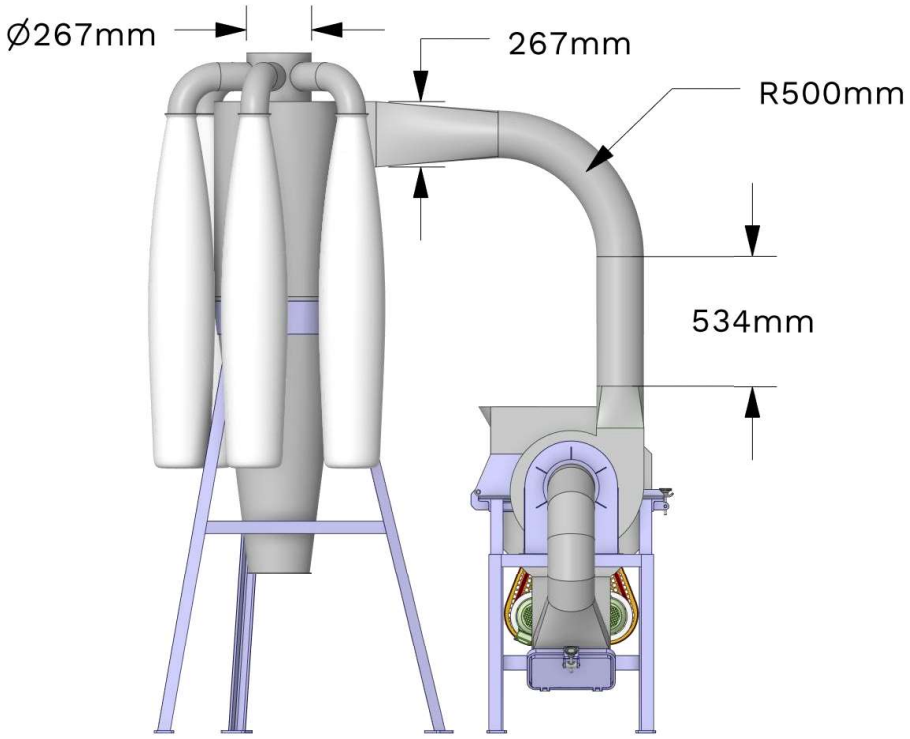


Figure 6 *Main dimensions of the duct connecting the cyclone to the hammermill.*

Stand

The cyclone is supported by a stand as shown in Figure 7. Appendix 4 contain its main dimensions.

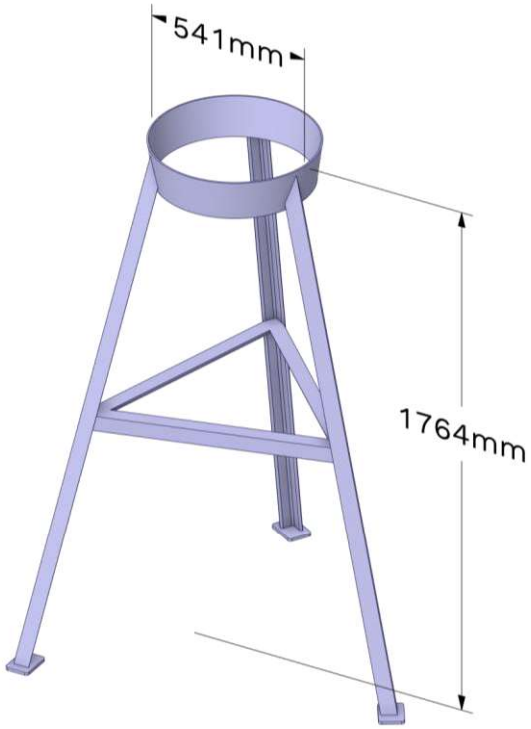


Figure 7 *Stand to support the cyclone.*

Construction material

All parts that come in direct contact with the cassava particles should be built with food-grade stainless steel. Parts that do not come in direct contact with the cassava particles, like the support for the cyclone, if not made of stainless-steel, must be coated with corrosion-resistant paint.

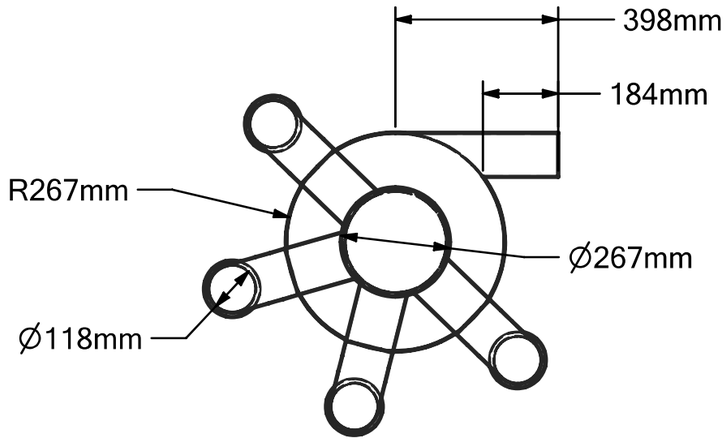
Equipment dimensions

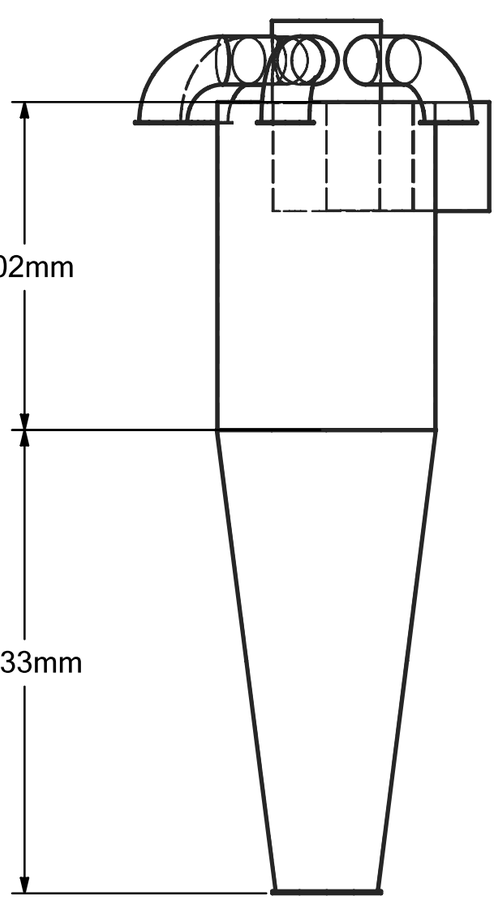
Equipment dimensions should be obtained from the 3D CAD assembly available at https://a360.co/302ZJlc. This link allows visualization and downloading of the file in IGES, STEP and other commonly used 3D CAD formats (Figure 8).

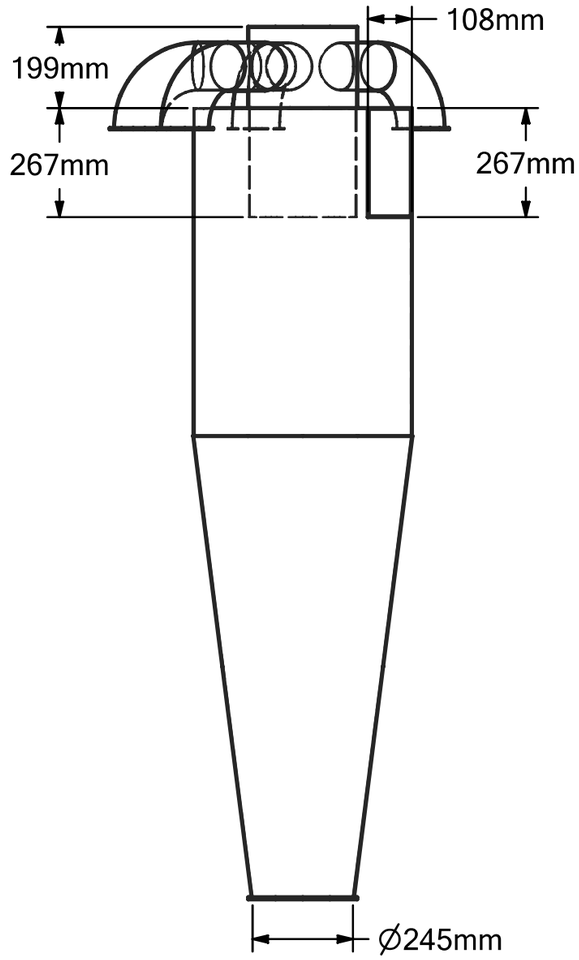
Figure 8 *Equipment dimensions should be obtained from the 3D CAD assembly available online.*

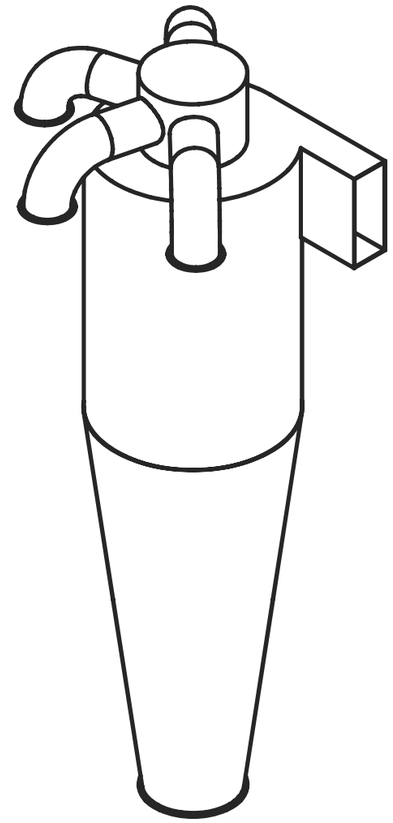
Modifications to the design

The experience of First Products Enterprise is highly valued and appreciated. It is strongly encouraged that Mr Emmanuel K. Duah analyses the proposed design and make suggestions for improvements. However, any modification needs to be approved by Dr Marcelo Precoppe in writing.









Appendix 1

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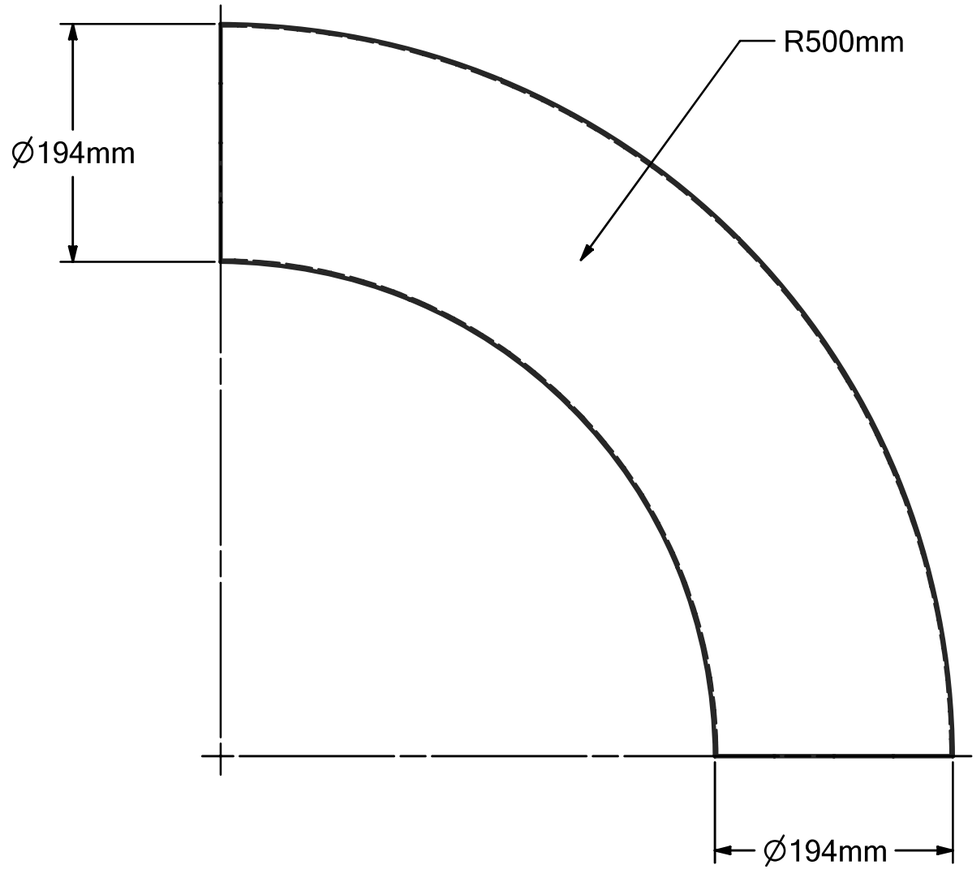

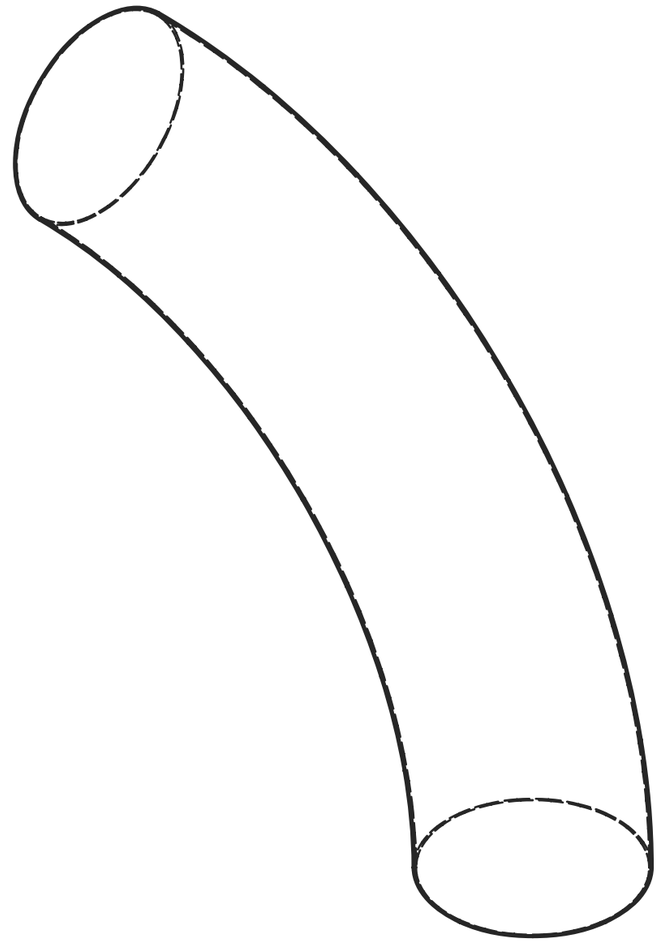

Appendix 2

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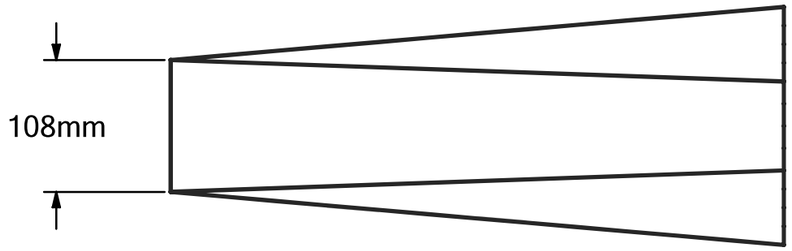

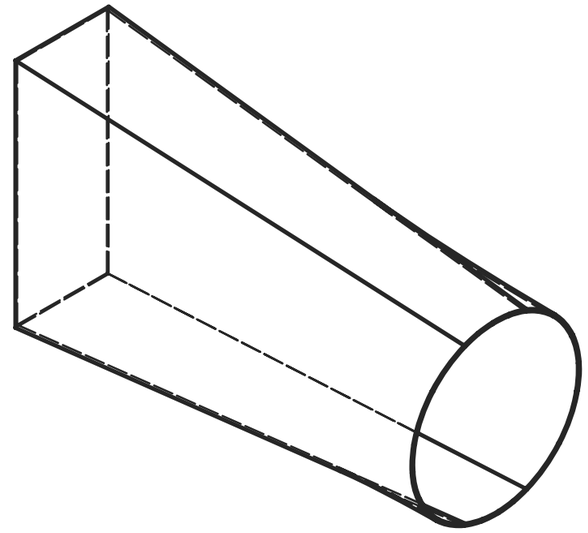

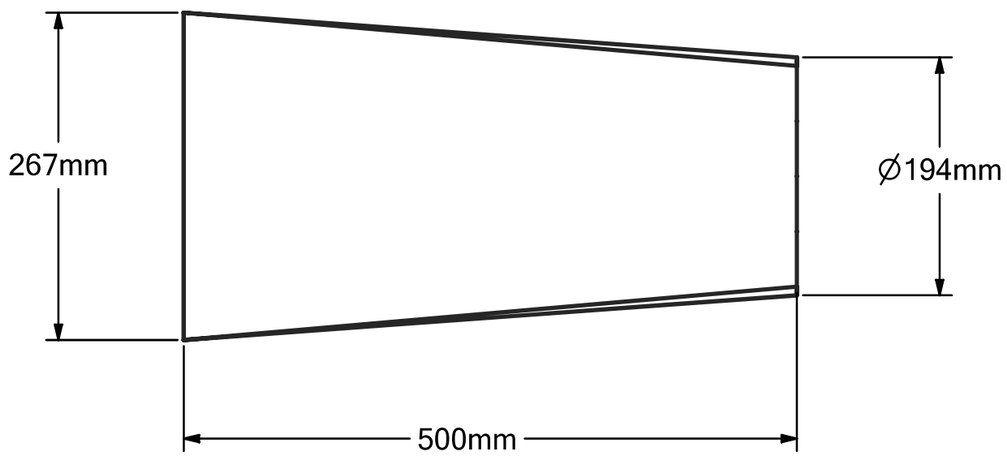

Appendix 3

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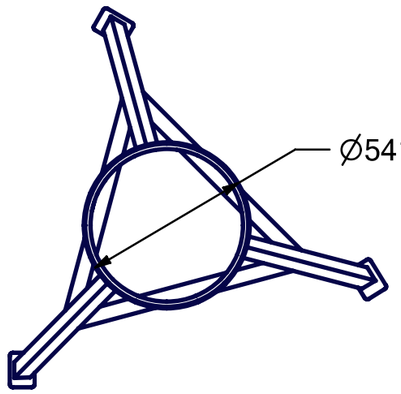

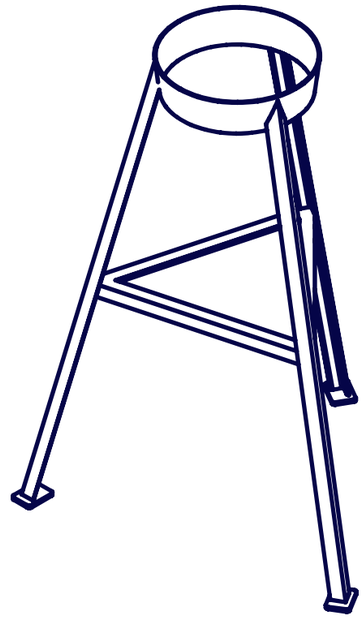

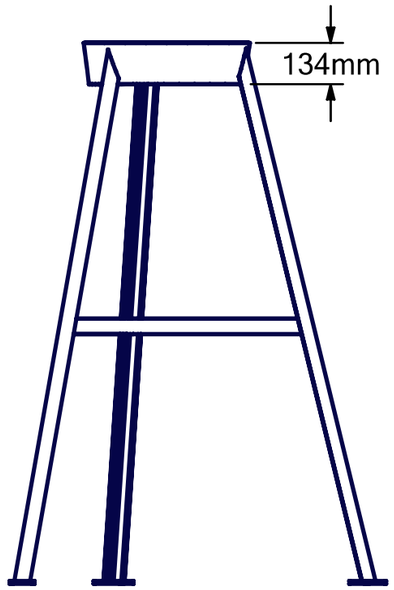

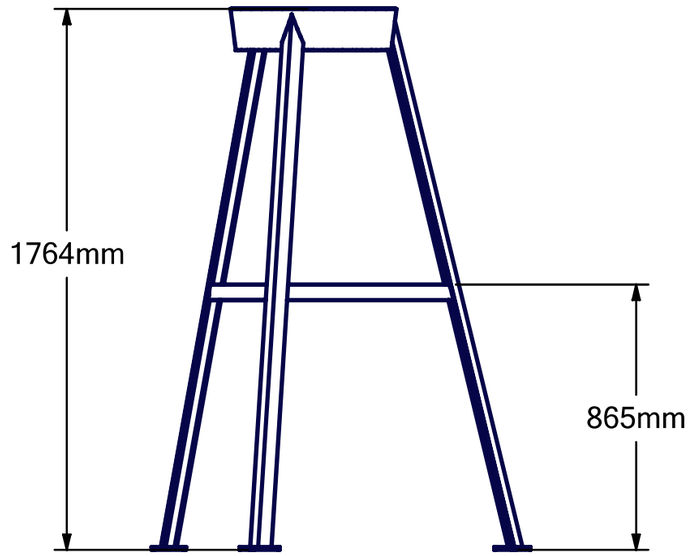

Appendix 4

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