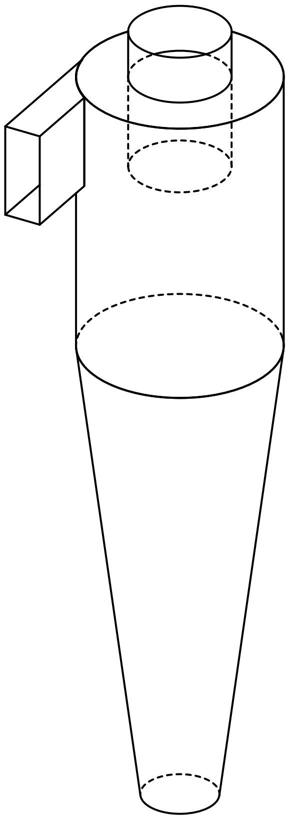
CASSAVA: ADDING VALUE FOR AFRICA PHASE II

How to evaluate the performance of CYCLONES

Aditya Parmar & Marcelo Precoppe



Booklet 5

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Preface

This booklet is the fifth of a 6-part series of booklets on performance evaluation of cassava processing equipment. These technical booklets are developed keeping in mind their target audience of local equipment manufacturers in developing countries, particularly Sub-Sharan Africa. The purpose is to determine the various performance parameters with simplistic techniques requiring no sophisticated instruments.

The online version of these booklets is available at: www.cassavatech.com.

At cassavatech.com we help cassava processors to learn how to choose suitable equipment and what performance parameters to ask for. These booklets series are a complement to that information provided, where equipment manufacturer can demonstrate to their potential customers the performance of the machine regarding the listed performance parameters.

A list of all the booklets in this series is provided below.

Booklet Number	Name
1	How to evaluate the performance of CASSAVA PEELING MACHINES
2	How to evaluate the performance of CASSAVA GRATERS
3	How to evaluate the performance of CASSAVA PRESSES
4	How to evaluate the performance of CASSAVA PNEUMATIC DRYERS
5	**How to evaluate the performance of CYCLONES**
6	How to evaluate the performance of HAMMERMILLS

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CAVA II

Cassava: Adding Value for Africa (CAVA II) is a project led by the Federal University of Agriculture Abeokuta, Nigeria, working closely with the Natural Resources Institute. CAVA II aims to improve the livelihoods of smallholder farmers and processors in Nigeria, Ghana, Tanzania, Uganda, and Malawi.

CAVA II works across the value-added cassava chain, it interacts directly with farmers to improve the profitability of cassava sales, both through increasing overall market demand and through boosting farmer yields.

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CYCLONES

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Contents

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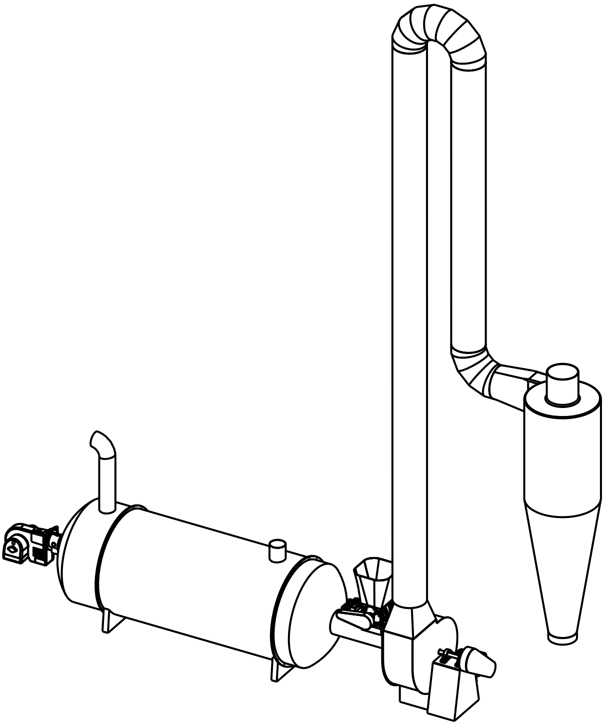
Cyclones in the food industry

Cyclones are devices that separate particulate material from the airstream using centrifugal sedimentation. Cyclones are present in diverse industrial processes and its dimensions are determined by the air flow rate. For large air flow rates, the resulting cyclone may be so big that the centrifugal force generated is low, and the cyclone does not operate properly. In those cases, a possible solution is to split the air flow into smaller cyclones operating in parallel. In theory, smaller diameter cyclones have higher centrifugal forces, resulting in better collection efficiency. However, when replacing a large cyclone with smaller ones, arranged in parallel, it is necessary to ensure the airflow is distributed equally to each one. Equalizing the air flow rates into each cyclone is difficult and, in practice, rarely achieved. If air is not distributed equally to each cyclone, they end up operating worse than a single large cyclone. Therefore, cyclones in parallel should be avoided and only used when is not possible to fit a single cyclone into the available height.

Cyclones in cassava processing

In cassava processing, cyclones are installed at the end of the drying duct of pneumatic dryers. In this kind of dryer, the hot airstream is responsible for both transporting and drying the cassava grits. The cyclone, at the end of the dryer separates the dried grits from the airstream. The dried grits exit from the bottom of the cyclone and the air from the top. This air may still contain particles that are too small to be separated by cyclones.



Performance assessment

Various parameters are used to assess the performance of cyclones, the most important ones being **collection efficiency** and **pressure-drop**. The aim is to have the highest collection efficiency with the lowest pressure-drop. However, those parameters are interconnected and often a higher collection efficiency results in an increased pressure-drop.

Collection efficiency

Collection efficiency indicates how well the cyclone is separating the cassava grits from the airstream. Collection efficiency is expressed in percentage (%) and is the ratio between the weight of the material collected by the weight of the material that entered the cyclone mixed with air. To measure **collection efficiency**, it is necessary to have:

- Dried cassava grits
- Weighing scale

Step 1. Separate 100 kg of dried cassava grits (use the weighing scale).

Step 2. Start the pneumatic dryer but leave the heater switched-off.

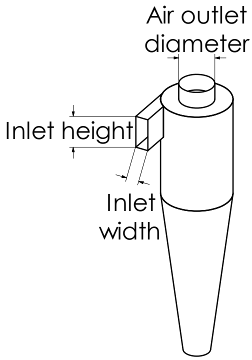
Step 3. Running the dryer at ambient temperature add the 100 kg of dried cassava grits to its feeder.

Step 4. Gather the material collected by the cyclone and measure its weight. This is the **weight of the collected material**.

Step 5. Now divide the weight of the collected material by 100 kg (the weight of the material that entered the cyclone). This is **collection efficiency**.

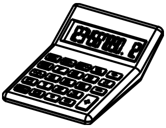
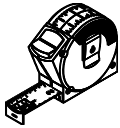
Pressure-drop

Pressure-drop indicates how much resistance the cyclone creates to the air movement. Pressure-drop is normally expressed in hectopascal (hPa), a unit used to quantify pressure. There are many ways to calculate pressure-drop of a cyclone. The equation below has been adapted for cyclones attached to pneumatic dryers used to process cassava. The equation accounts for the critical dimensions of the inlet and air outlet.



$$\text{Pressure-drop} = 4 \times \frac{\text{Inlet height} \times \text{Inlet widht}}{(\text{Air outlet diameter})^2} = 4 \times \frac{\text{Inlet height} \times \text{Inlet widht}}{\text{Air outlet diameter} \times \text{Air outlet diameter}}$$

To measure **pressure-drop** it is necessary to have:

- Calculator
- Measuring tape

Step 1. Measure the cyclone inlet height and width. Measure the cyclone air outlet diameter (use the measuring tape).

Step 2. Use the formula above to calculate **pressure-drop**.

Worked examples

Collection efficiency

To measure the collection efficiency of a cyclone used in a pneumatic dryer,**100 kg** of dried cassava grits was separated and inserted into the dryer running on an ambient temperature (heater switched-off). The material that left the cyclone was collected and its weight measure. The weight of the collected material was **95 kg**. What is the collection efficiency of this cyclone?

$$\text{Collection efficiency} = \frac{\text{Weight of the collected material}}{\text{Weight of the material fed}}$$

$$\text{Collection efficiency} = \frac{95\ \text{kg}}{100\ \text{kg}} = 0.95 = 95\%$$

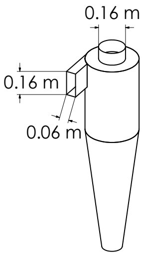
*The collection efficiency of the cyclone is **95%**.*

Pressure-drop

To determine the pressure-drop of a cyclone the dimensions of the in letand the air outlet was measured. The inlet height was 0.16 m, and the inlet width was 0.06 m. The diameter of the air outlet was 0.16 m. What is the pressure-drop generated by this cyclone?

$$\text{Pressure-drop} = 4 \times \frac{\text{Inlet height} \times \text{Inlet widht}}{\text{Air outlet diameter} \times \text{Air outlet diameter}}$$

$$\text{Pressure-drop} = 4 \times \frac{0.16\ \text{m} \times 0.06\ \text{m}}{0.16\ \text{m} \times 0.16\ \text{m}} = 1.5\ \text{hPa}$$



*The pressure-drop generated by the cyclone is **1.5 hPa**.*

In cassava processing, cyclones are present on pneumatic dryers to separate the dried cassava grits from the drying air. In this booklet, performance indices for evaluating cyclones are described, and a step-by-step guide to calculating them is presented, along with practical examples.

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