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Studies on the use of new technologies to improve the technological process of grain sorting.

Elena Iulia Lazăr[1], Ovidiu Tiţa[2*]

[1]Doctoral School of *"Lucian Blaga,, University of Sibiu, 550024, Sibiu, Romania,*
[2]*Faculty of Agriculture Science, Food Industry and Environmental Protection, "Lucian Blaga" University of Sibiu, 550012, Sibiu, Romania;*

Abstract

The technological operations of preparing the wheat for grinding performed at the reception and storage in the silo, continue in the cleaning with the elimination of impurities and the conditioning of the wheat. For the study we used the SORTEX B DualVision Optical Sorter that recognizes many color defects and foreign materials and has a size detection software to eliminate nonconformities. The device features RGB cameras of high r front and rear resolution that can be configured to identify up to five color defects eliminating the need for repeated springing for each color defect. With the help of high-resolution cameras, you can scan an amount of 8 to / h from which are removed the elements that are not in the color range of the category of wheat from light brown - reddish brown - slightly dark brown. Numerous tests were performed in the laboratory, on different wheat mixtures, with different proportions of impurities / grains with defects and the efficiency was high. Wheat can be selected grain by grain, and the possibility of grinding non-compliant wheat clean atis very low.

Keywords: sorting, color defect, conditioning, impurities,efficiency

1.Introduction

The technology in the milling industry has evolved in recent years, machines have been developed that have the ability to sort, in an amazing percentage, not only impurities but also grains with defects that directly affect the quality of the flour obtained.

″Through its superior power and vision systems combined with its processing resources, the SORTEX B MultiVision delivers the most effective sorting performance to date, using a combination of unique Buhler technologies for the detection of more subtle colours.″ (Buhler UK LTD, 2022)

″The Sortex range can remove diseased grains, discolouread, damaged or bug infested grain and can reduce cross contaminations from Barley, Oats, Soya and a range of other grains foreign materials.″ (Buhler UK LTD, 2022).

2.Methods and materials

In this study we used the Sortex B DualVision machine, as well as the set of ISO 5223-1983/E laboratory sieves that we used to determine the impurities in the grain, to determine the degree and type of infestation.

″**The Sortex B** is a machine for bulk sorting, by optical wavelength, of a wide range of granular foodstuff. Product is introduced into hoppers at the top of the machine and deliveried on to chutes by vibrations. The product accelerates down the chutes through an optical viewing zone, past banks of ejectors, into receptacles. The optical zone comprises two optical boxes which contain LED lamps to illuminate the product, cameras to view the product, and various other facilities that enhance the accuracy of detection including automatic wipes for the viewing windows, and adjustable reference backgrounds. The images from the cameras are analysed and processed by an electronic system, housed in an electronics cabinet, which controls a bank of pneumatic valves. The pneumatic valves. Housed in an ejector box, deflect defective product from the main stream into different sections of the receptacles.″ (Buhler UK LTD, 2017)

Corresponding authors: ovidiu.tita@ulbsibiu.ro

Principles of sorting

In order to operate the Sortex B , it may help to understand the three main stages involved in optical sorting;

1.Feed. The product feed system is carefully aligned to deliver the product flow at a predictable rate, to a predictable point, where it can be viewed by optical system . If this system goes out of alignement, or if there is any disturbance to the product flow, or product is feed into the system too fast, the sorting efficiency will be reduce.

2.Optical System. At a fixed point in its flow, the product stream is imaged by the cameras. The machine processes these images and discriminates good and defective product. If the optical windows become obscure by dust, sorting efficiency will be reduce, because the cameras will not be able to see the product properly.

3.Ejection. Accordind to decisions made by the machine, airpowered ejectors fire at defective product, puishing it past an adjustable diving edge, leaving good product to travel through the system untouched. (Buhler UK LTD, 2017)

Basic Operation

The Sortex B is designed to sort product automatically, with settings designed to produce the best results for the product. The machine has the ability to track any changes in factors which might affect performance, and to make adjustmens to correct for these. (Buhler UK LTD, 2017)

The Control Screen is touch-sensitive and responds to light finger pressure. By pressing the Facilities Menu button, a list of commands will appear, touch those commands and a new screen will appear giving access to the command you want. (Buhler UK LTD, 2017)

Sort Sensitivity

Increasing the sensibility means that more of that defect type will be rejected. Decreasing the sensibility means that less of that defect type will be rejected, that may mean that more bad product is accepted. (Buhler UK LTD, 2017)

Sort Type

A Dark sort- in which the machine rejects defects which are darker tan the normal product,or Light sort, in which the machine rejects defects which are lighter than normal. Normal sorting is- light coming from both siode, product being imaged from both side, against a background light on both soide-and decisions being made as to the quality of the product on basis. In Transparent sorting, the Rear Foreground lighting is swiched off, but cameras on both side still image the product. The front cameras view the product normally- with reflected light from the front fporeground, against the background lighting in the rear box. (Buhler UK LTD, 2017)

Color defect 'Window'

This selects the size of the 'window' which the software will use to make its calclations-in pixels. The software will examen a square of 4 pixel per side, centred on each target pixel. For this square, the machine will assess whether a defect exist or not. It will then shift window one pixel to right, and re-calculate.

Rounding up even numbered Windows. In this example, a defect window size of 6 has been selected. This would surround the central, target pixel ■ with a 6x6 block of ■ pixels

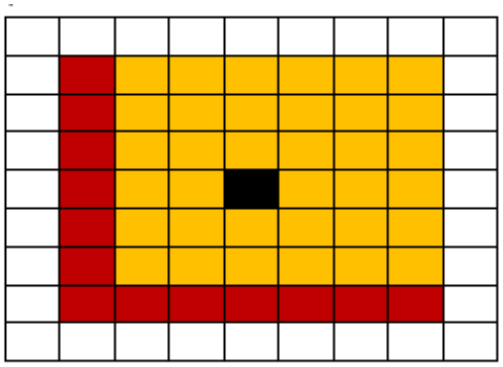
But this would be asymmetrical, with a smaller area of interest below and to the left then the above and to the right, which would make the calculation less useful. So, the software adds a block ■ to balance the 'window'.

The software will examen this block for defects, before moving the whole blo ck one pixel to the right, to repeat the process. (Buhler UK LTD, 2017)

Color defect area/spot defect area , it's selects the size of the color dfecty which will trigger an ejection. In this case, a color defect 10 pixels/ 1 pixel in size will be recognized as a color defect, and trhe item will be rejected. These extensions can be applied to each or both types of defects, the slider is used to lower or remove the numbers, the two numbers to be adjusted being the pixel numbers.

Pulse Extension

With some products, the ejector might miss defective product, due to variations in product speed, the screen allows an extensions, in milimeters, to be added to the 'defect size' of faulty product, so that the rejector fire a little longer (Buhler UK LTD, 2017).



Visible defect Programation/IR Defect Progamation

In the simple terms, defect programation adds a little to the perceived width of a defect. If a wheat grain, with a spot defect at one end, falls past the camera in a horizontal orientation, the main body of the grain may fall to the left or right of the defect. If so, the ejector may fire at the defect, but miss the grain. So, defect programation allows the width or a defect to be exaggerated, so the next ejector will also fire, and eject the defective grain. (Buhler UK LTD, 2017)

Object Width/Length

The minimum object width & length are set so as to ignore all object less than a certain size. The maximum object width & length are set so as to ignor all clusters of touching grains. Hence, the maximum object width & length should be set to the dimensions of the largest expected grain. The machine interprets these maxim limits as a maxiumum area and then ignores any region in the image with a area greater than tis calculated maximum area. (Buhler UK LTD, 2017)

Set ISO 5223-1983/E laboratory sieves; Sieve, provided with cover and collecting tray, with elongated holes of 3.5 mm x 20.0 mm, 2.2 mm x 20.0mm, 2.0mm x 20.0mm, 1.9mm x 20.0mm, 1.8mm x 20.0mm, 1.0mm x 20.0mm, in accordance with the specifications of ISO 5223.

3. Results

The laboratory tests were carried out with the help of the set of ISO 5223-1983/E laboratory sieves, together with the standards SR EN 15587:2008 + A 1 Cereals and cereal products. Determination of the content of impurities in wheat (*Triticum aestivum* L.).

Terms and definitions

Impurities: all the components of a cereal sample, other than the whole and healthy seeds basic cereals;

Broken grains: all grains belonging to the basic grain that are not attacked by insects and whose endosperm is partially exposed, including grain damaged at threshing and grain whose germ has been removed;

Defective grains: Fraction made up of grains, other grains, grains attacked by pests, grains with germs modified color (only for common wheat and durum wheat), spotted grains (only for wheat durum) and burnt grains during drying;

Grains with germs of modified color, grains that are either

a) with germs of a modified color, in which the skin of the germ is colored from brown to black, and the germ is normal and not sprouted

b) spotted, respectively presents a brown to black coloration on other areas of the grain outside the germ and especially in the ditch;

Foreign bodies: all the components of the cereal sample retained by a sieve with 3.55 mm holes and passing through a sieve with holes of 1.0 mm, as well as stones, sand, fragments of straw and similar impurities in the sample which pass through a sieve with 3.55 mm holes and are retained by a sieve with 1.0 mm holes; (ASRO, 2017)

The principle of this method is to separate by sifting and manual selection from the normal grains, of base, all fractions of impurities.

Procedure

A representative sample of about 250 g is prepared by division and weighed accurately 0.1 g.

The set of sieves is mounted so that immediately on top of the collecting tray is the box with the eyelets smaller.

This sample is sieved through sieves placed one above the other (the upper one, with 3.5 mm holes and the lower, with 1.0 mm holes) for 30 s either with a sieving equipment or manually. If sieving is done manually, it must be done by movements parallel to the length of the holes (approximately one movement come and go per second).

The components retained by the sieve with elongated holes of 3.5 mm and those that pass through the sieve with holes elongated of 1.0 mm, with the exception of the grains of other cereals, especially the large grains of the basic grain of the rye horn, must be weighed together and are considered bodies foreign. Stones, clods of earth, straw, chaff and similar impurities retained by the sieve with holes elongated 1.0 mm must be selected manually. Both fractions are weighed and considered foreign bodies. Sieve the partial sample from which all the impurities have been separated for 30 s through a sieve with holes of 2.0 mm for common wheat. Everything that passes through the sieve is considered grain. Weigh the material retained on the 1.0 mm sieve from which all impurities have been removed fractions of impurities with a precision of 0.01 g. The determination is not valid and must be analyzed a the new partial sample if the sum of the components broken grains, stale grains, other grains, grains attacked by pests, grains with germs of modified color) and the mass of the material retained by the 1.0 mm sieve, free of impurities, differs by more than 0.5°/o from the mass of the partial sample. (ASRO, 2017).

The content of each fraction of impurities is expressed as mass percentage reported to the mass of the initial sample, using the formula below:

$$Bx = x * \frac{a - b}{a * s} * 100$$

In which:
Bx - is % of the impurity component;
x- is the mass of the impurity component considered;
a- is the mass of the average sample;
b- it is more of foreign bodies;
s - is the total mass of the impurity components.
(ASRO, 2017)

It is very important that the bread wheat is in a state of good sanitation. Any trace of mold, spoiled wheat or other forms of defects directly affects the quality of the flour. The impurities were determined according to the SR EN 15587 standard.

As you will be able to see,(table. 1 vs table 2) in all cases, the grains with defects and impurities have been significantly reduced.

All these impurities and defects must be excluded from the wheat mass. The importance of sorting and cleaning machines is very high.

Table 1.

Technological Phase	broken grains,%	Black point,%	Fusarium,%	foreign material %
Silo nr 3	2.5	10.5	0.5	3.2
Input Combicleaner	2.6	8.6	0.6	3.4
Output Combicleaner	2.2	8.5	0.5	2.3
Trior input	1.9	7.6	0.4	2
Trior output	1.5	7.4	0.3	1.5
Input Peeler I	1.5	6.3	0.4	1.4
Output Peeler I	1.2	6.2	0.4	1.3

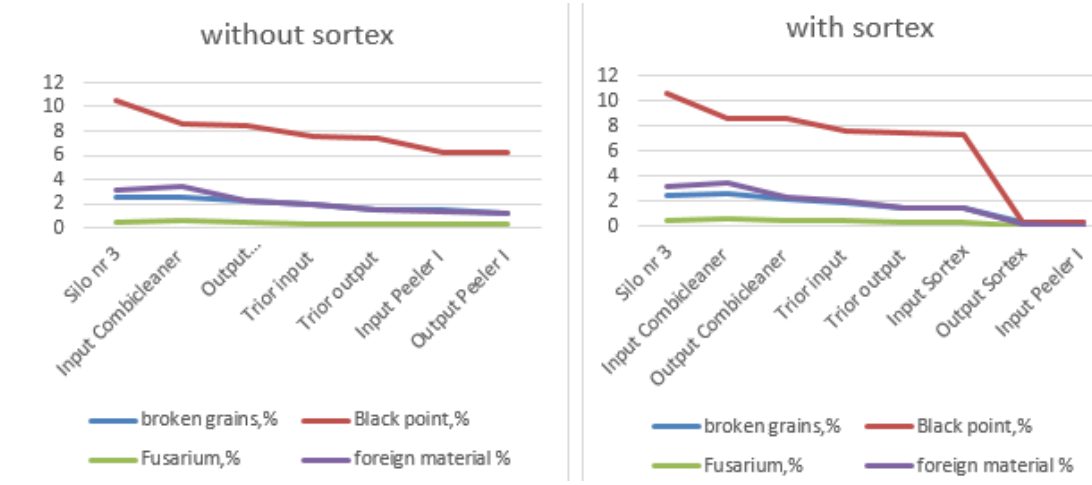


Table 2.

Technological Phase	broken grains,%	Black point,%	Fusarium,%	foreign material %
Silo nr 3	2.5	10.5	0.5	3.2
Input Combicleaner	2.6	8.6	0.6	3.4
Output Combicleaner	2.2	8.5	0.5	2.3
Trior input	1.9	7.6	0.4	2
Trior output	1.5	7.4	0.3	1.5
Input Sortex	1.4	7.3	0.3	1.4
Output Sortex	0.3	0.3	0	0.1
Input Peeler I	0.3	0.3	0	0
Output Peeler I	0.1	0.2	0	0

Cutting-edge technology helps millers produce ultra-pure flour, and this is where SORTEX B optical sorting comes in handy.

The most dangerous impurities are:

Horn of rye is a phytoparasitic fungus. Due to the high content of alkaloids, prolonged consumption of contaminated grains can lead to serious chronic intoxications such as ergotism or St. Anthony's fire. Fusarium wilt in wheat is one of the most dangerous diseases of cereal crops, as it causes both qualitative and quantitative losses. There may be a risk that, although fusarium has developed superficially, mycotoxin levels will be elevated and significantly reduce the quality of the wheat crop. Mycotoxin is also dangerous for humans and animals.

4. Discussions

The technological flow in the cleaning comprises a series of machines for removing impurities from the wheat mass. Elimination of mild impurities is made by aspiration, for the elimination of spherical bodies is made with the trior, metallic impurities it is eliminated with the help of the permanent magnet, to eliminate the wheat disease with defects it is used new technologies, of the last generation - optical sorters.

5. Conclusions

- The optical sorter SORTEX B also sorts, coffee, nuts, legumes, seeds and plastic materials with flows of up to 8 t/h per hour. Detects more color defects and foreign materials and has size detection software to remove unwanted objects
- It features high-resolution RGB front and rear cameras. They can be configured to target up to five color defects. This minimizes the need to resolder the product to remove more than one color defect.
- SORTEX B is built to withstand hazardous environments in processing plants. Its critical components are IP5X sealed for dust protection. In addition, wear parts such as broadband LED lighting and ejectors are modularly arranged so that they can be easily serviced or replaced, thus minimizing sorter downtime.
- With the help of the optical sorter, these categories of impurities and defects are ejected in a very high yield. With the help of high-resolution cameras, an amount of 8 to/h is scanned from which the elements that are not in the color range of the healthy wheat category from light brown - reddish brown - slightly dark brown are "blown".
- Wheat can be selected grain by grain, the possibility of grinding non-cleaned wheat is low.
- The product tracking software installed on the SORTEX B accurately classifies each grain as accepted or rejected. This minimizes the recirculation of ungradable grains and reduces false ejection of good grains

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human or animal subjects (if exist) respect the specific regulation and standards.

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