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NOVEL SUBASSEMBLY ASSOCIATED TO CYLINDRICAL SIEVES, USED FOR SEPARATING SEED GRAIN BY SIZE, IN ORDER TO OBTAIN CERTIFIED REFERENCE MATERIALS (CRM)

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Abstract: In research and development, demonstration of appropriate quality level is essential. Using an applicable international quality standard and official accreditation/certification is the best approach for laboratories to formally show their quality. A broad range of international and professional organizations recognize and encourage the use of certified reference materials (CRM) in analytical chemistry for quality control objectives. The production of certified reference materials (MRC) for cereals, used in the production of superior flour is generally an expensive and difficult operation. The present paper proposes a new subassembly model that is mounted inside the rotating sieves, in order to separate the grain seeds more effectively according to their size. The proposed subassembly has a high level of customization and adaptation for a wide variety of processes and types of seeds, and can be mounted in the form of a helical coil, a thresher or a harvester. In compared to other seed separation systems, wheat seed sorting equipment that uses cylindrical rotating sieves offers various benefits. Because a more intensive mixing of particles may be performed, cylindrical sorting equipment can be employed with great efficiency in circumstances where a more aggressive processing of the seeds is required. When compared to flat vibrating sieves, it has a relatively simple design, compact size, and low power consumption, as well as cheaper maintenance and repair costs and lower noise levels. The paper presents a new interior element design that can be adapted to rotating cylindrical sieves with the role of achieving a better separation of seeds.
Keywords: certified reference materials (MRC); grain sorting; cylindrical sieve; separation efficiency

1. INTRODUCTION

A broad range of international and professional organizations recognize and encourage the use of certified reference materials (CRM) in analytical chemistry for quality control objectives. However, regardless of geographic location or laboratory economic status, present certified reference materials applications in many analytical domains is insufficient (*IAEA-TECDOC-13505, 2003*). Testing and calibration laboratories are frequently asked to produce confirmation of their quality. This is required especially in circumstances involving legal constraints, such as for food and environmental analysis or clinical chemistry.

In research and development, demonstration of appropriate quality level is essential. Using an applicable international quality standard and official accreditation/certification is the best approach for laboratories to formally show their quality.

A CRM is a material accompanied by a certificate whose property values are certified by a procedure that establishes traceability to an accurate realization of analysis, being sustained by an uncertainty at a stated level of confidence. Wheat grain is the most widely consumed cereal in the world, being classified in a variety of ways all around the world. Each type of wheat is utilized for different specific purposes depending on quality. Deterioration of wheat seeds may occur either in the growing season as well as after harvest due to poor handling and storage, and the level of damage can be important to human health (Mircea et. al, 2020, Nenciu et al, 2021).

Mixing different wheat classes may cause problems in the processing activity and usually lowers the quality of the finished goods. Wheat of poor quality cannot create high-quality end goods, as a result, advanced methods are required to assess wheat quality as well as to detect interclass contamination and foreign item contamination (Jayas et al., 2016).

There are over 420 standard test methods, (at least 75 of which are internationally relevant), and therefore it is clear that grain character varies greatly. Many assessments are specialized to a commodity, a product, or an end user. For most forms of grain, bulk density and foreign matter are the most typically measured qualities (Proctor, 1994). The sieves used to analyze foreign matter from wheat grain content should, according to most grain quality standards, be made of perforated metal plate that meets the criteria set out by national or international standards organizations. The composition and thickness of the metal plate, the form and size of the perforations, and the placement of the holes on the sieve are covered by these parameters.

The efficiency of a sieve is dependent upon two factors: the dimensions of the apertures in the screen, and the proportional volume of material which will not pass through the apertures. As a general rule, the percentage sieving area' of a screen with small perforations is less than that of a screen with larger holes, and its capacity for sieving efficiently is correspondingly reduced. Furthermore, when the volume of material that will not pass through the holes surpasses a particular quantity, the sieving effectiveness of a perforated metal screen with set specifications drops dramatically.

Certified reference materials (CRM) are critical resources for calibrating measuring instruments, validating analytical procedures, and ensuring measurement quality.

Researchers and manufacturers haven't advanced much to improve the cleaning function in recent years on rotating sieves, therefore the sieve capacity is limited. Park (1974) reported important advantages in using rotating sieves separator instead of flat-screen separators. The advantages include high capacity, insensitivity to slope, compact ness, and the ability to separate seeds from trashy materials.

In compared to other seed separation systems, wheat seed sorting equipment that uses cylindrical rotating sieves offers various benefits. Because a more intensive mixing of particles may be performed, cylindrical sorting equipment can be employed with great efficiency in circumstances where a more aggressive processing of the seeds is required. When compared to flat vibrating sieves, it has a relatively simple design, compact size, and low power consumption, as well as cheaper maintenance and repair costs and lower noise levels.

2. MATERIALS AND METHODS

Performance, loss ratio, and cleaning ratio are the three essential evaluation indicators for a cleaning equipment performance, especially for wheat grain processing conditions. The plan vibrating screen equipment that is extensively employed in most large combine harvesters, present a lot of weight and volume, as well as intensive vibration, and it's not always suited for muddy fields or small hill fields.

Cylindrical sieves are used in the process of cleaning and sorting seeds with a cylindrical or prismatic polygonal working subassembly. The cylindrical sieve can be made so as to have various types of holes size along its entire length, separating the seed mixture into several varieties. Cylindrical sieves, compared to other separate machines, have the advantage of achieving an intense mixing of particles, in a simple construction, having low construction dimensions and low electricity consumption.

The main movement of the particles on the inner surface of the cylindrical sieve consists of the following three states:

≡ relative rest (on the surface);
≡ relative motion (sliding on the surface);
≡ free movement (independent)

The paper presents a new interior element design that can be adapted to rotating cylindrical sieves with the role of achieving a better separation of seeds.

The inner coil is an element constructed of a customizable number of propellers fixed on a shaft. Each propeller can also be customized by adjusting two internal elements in order to obtain an even greater variation of the internal parameters. The screws adjust the propeller blades, an element that determines the level of aggressiveness applied to the seeds. The screw determines the attachment of the blade on the shaft, which regulates the pitch of the coil.

The behaviour of wheat seeds in rotating sieves, presents a very complex movement particularly those with inner coils. Inner coils are particularly efficient in the processes of mixing the mass of material from the rotating sieves and they can take on a variety of forms and functions (Drumond et al., 2019, Yuan et al.,2020). As a result, one of our goals was to create a changeable inner coil model for the pilot experimental stand that could be evaluated in various operating regimes.

3. RESULTS

The cylindrical sieves have recommended working regimes for low speeds, however in this case the productivity of the sieve is usually low. Any attempt to increase the working speed of the cylindrical sieve in order to increase its productivity, leads implicitly to the transition to the second type of movement, to the appearance of the phase of relative rest and as a result to the complete annihilation of the working capacity of the sieve.

The proposal of an innovative element is designed to eliminate the phase of relative rest and increase the working speed of the cylindrical sieve in order to increase its productivity.

The innovation relates to a subassembly called "Cylindrical sieve coil element" which allows versatile operation inside the cylindrical sieve, and can be converted in the form of a helical coil with variable pitch, blade separation type, or a stirrer. The subassembly is mounted inside a rotating cylindrical sieve, in order to separate from the processing mass, the high-value seeds good for grinding, leaving on the sieve the seeds with a larger diameter than the holes of the sieve.

The coil element for cylindrical sieves, according to the invention, consists of a bushing (A) (Figure 1.b), with inner diameter (d), outer diameter (d1), width (b), and threaded holes 3 x M , in which a series of rods (B) are fixed by screwing, on which the blade body (C) (Figure 1c) and the flap (E) (Figure 1d) are mounted, having the possibility to achieve the angle α between them, variable between 90º-180º, and adjusted vertically, in order to achieve the diameter (D), with the help of the nuts (F), leading to the achievement of an optimal space between the elements of the coil and the inner surface of the cylindrical sieve.

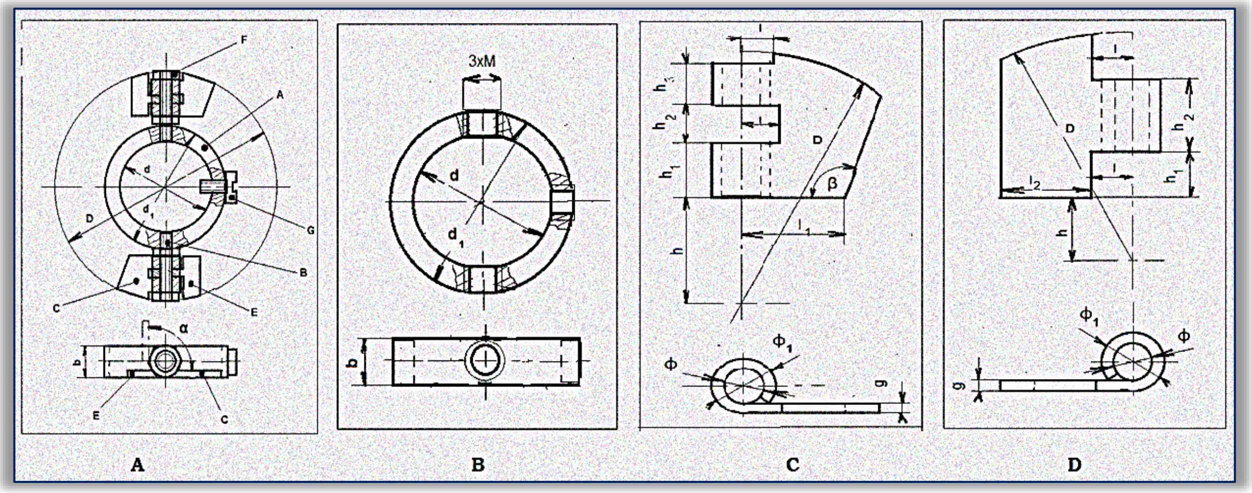

Figure 1- The configuration of the coil element, which can be easily customized
A) overview; B) sleeve; C) pallet body D) flap

Because the big blades (1) and little blades (2) are attached on a hinge system, the angle between the two blades from each wing may be simply changed.

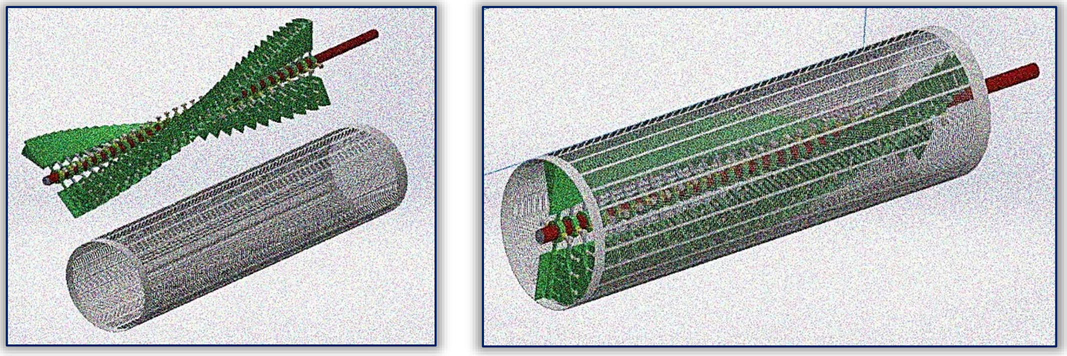

Figure 2. Depict of the subassembly and rotary sieve used to separate the grains

The main element that improves the process is the high level of customization of the interior element, due to its innovative construction.

Figure 3 depicts the blades of the newly constructed coil in detail. The coil is very adaptable, with the ability to change the rotation pitch and blade angle to modify the equipment in the event of significant changes in pollutant levels or humidity, and to retain high efficiency independent of the row material used.

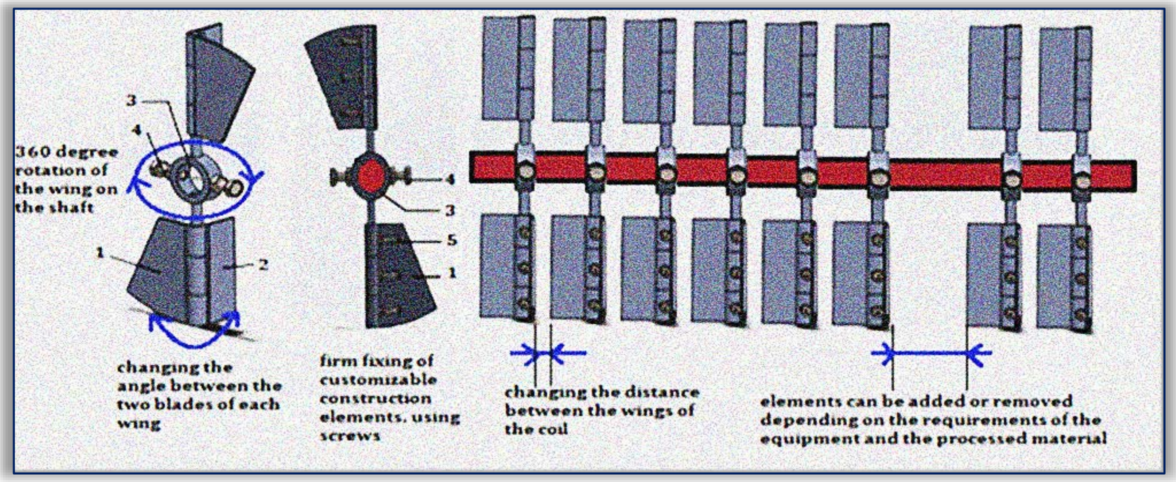

Figure 3. Description of the various ways of customizing the subassembly blades

Figures 4-6 show the three possible configurations that can be assigned to the inner subassembly, positioning the subassembly either as an inner coil, a grain separator with blades, or as a stirrer.

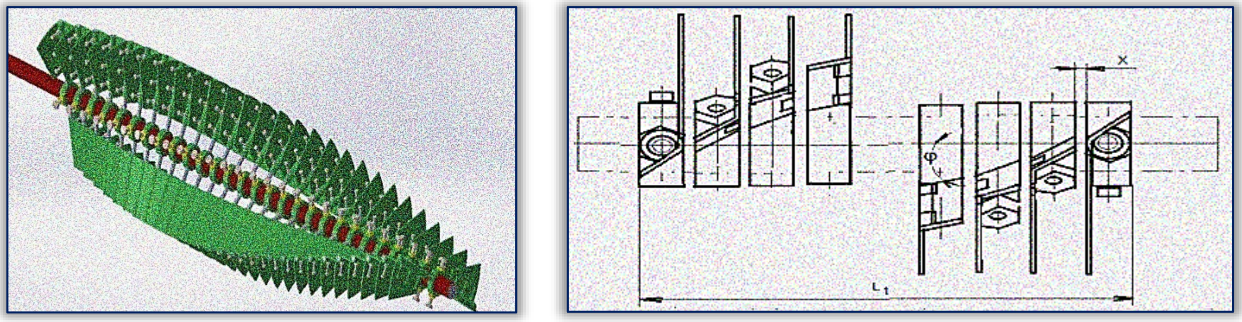

Figure 4. Positioning the subassembly as an inner coil

The positioning of the subassembly in the form of an inner coil that rotates in the opposite direction to the sieve, produces a longer duration of the time the seeds spend on the sieve. In this way, the impurities have more time to be evacuated through the holes of the cylindrical sieve, therefore the final quality of the material under processing is higher. Positioning the subassembly in the form of an inner coil is especially preferred for short cleaning equipment, when the processing must take place in a short time.

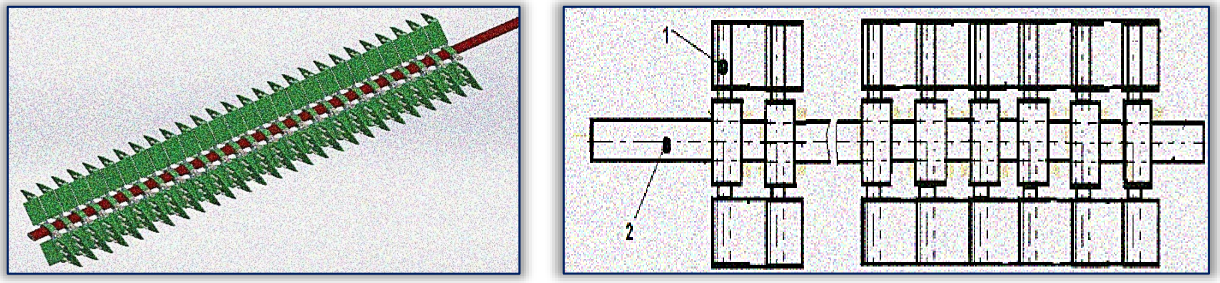

Figure 5. Positioning of the subassembly as a grain separator with blades

Positioning the subassembly as a grain separator with blades, produces a high level of agitation, which allows a better separation of impurities by an energetic mechanical agitation. Unlike the stirrer, the grain separator with blades has no space between the blades, which does not allow the easy passage of seeds along the length of the sieve.

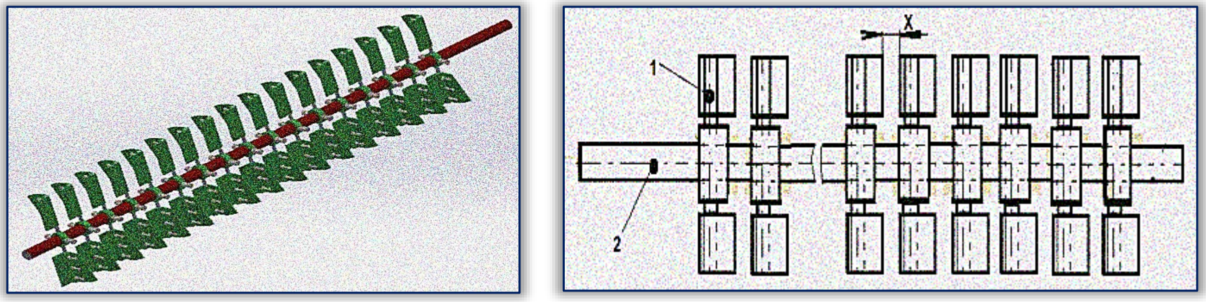

Figure 6. Positioning the subassembly as a stirrer

When working as a grain stirrer the subassembly allows an easy passage of seeds along the length of the sieve, due to the space between the blades. This space is easily adaptable due to the high level of customization of the subassembly elements. It can be modified depending on the type of seeds to be separated or their quality.

In combination with other elements that have an impact on the equipment functioning (such as the angle of inclination of the sieve, the rotational speeds of the sieve and the subassembly, the flow rate of the material, etc.), complex and highly efficient modes of operation can be created.

4. CONCLUSIONS

There are several advantages of the proposed solution, the main novelty being the elements of the subassembly, consisting in the special shape of the coil that improves the separation process. The mixing is influenced by the angles associated to the sieve blades as well as the special designed shape. The possibility to make changes to the inner coil by varying the pitch or angle of inclination of the blades gives it a higher level of versatility depending on the degree of contamination of the inserted material. The elements of the subassembly can be mounted such as to obtain the shape of blades, an agitator/stirrer, or that of a coil with variable pitch. The new design offers the possibility of increasing the speed of the sieve, increasing the efficiency of the equipment. This is especially important for seed processing sites with limited space. In addition, complex and highly efficient modes of operation can be created only by easily modifying the elements of the subassembly.

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