Engineering

COMPARATIVE ANALYSIS OF POTATO SORTING AND SIZING MACHINES

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ABSTRACT:

POTATO, A PLANT THAT IS USEFUL IN THE HUMAN DIET, IN THE ANIMAL FORAGE AND FOR INDUSTRIAL PROCESSING, IS BEING CONDITIONED MAINLY THROUGH THE OPERATIONS OF SORTING AND SIZING. IN THIS PAPER, THERE ARE ANALYZED COMPARATIVE THE MACHINES FOR POTATO SORTING AND SIZING OF THE MAIN FIRMS THAT PRODUCE EQUIPMENT FROM THE POTATO INDUSTRY, USING THE BIBLIOGRAPHIC STUDY AND DESCRIPTIVE STATISTICAL ANALYSIS (THE DIAGRAM AND THE BOXPLOT TECHNIQUE) AND MULTIVARIATE METHODS (THE ANALYSIS IN MAIN COMPONENTS). THERE ARE BEING ESTABLISHED THE ACTUAL TENDENCIES OF THE SORTING AND SIZING TECHNOLOGIES FOR THE POTATO AND THERE IS DONE A CLASSIFICATION OF THE MAIN TYPES OF POTATO SORTING MACHINES, ON THE BASIS OF THE TECHNICAL DATA THAT REFER TO THE PRODUCTION CAPACITY, THE NECESSARY SPACE AND THE ELECTRICAL POWER.

KEY WORDS: POTATO, SORTING, SIZING, STATISTICAL ANALYSIS, ACTUAL TENDENCIES.

INTRODUCTION

Potato (Solanum tuberosum) is a very useful plant in the human diet, in the animal forage and for industrial processing and is being cultivated on all the continents, but mainly in Europe, the first written certification is dating from the XVI century[1].

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[1] Ştefan, V., *Cartoful – tehnici de cultivare,* Nemira, Bucuresti, 2005.

Potato is an annual ryegrass plant that is multiplying by seeds. In the creation of the breeds, it is used the semen[2]. The potato tuber is a thicken hypogeal stem and has specific shapes, depending on the potato breed[3].

The conditioning of the potato consists mainly by sorting and sizing. Sometimes, it is necessary to apply other operations (cleaning, washing and chemical treatment)[4].

Sorting is the operation of separating the products on categories, depending on the external aspect (color, shape). The main role of sorting is the acquiring of a mass consisting only by healthy potatoes. At potato harvesting there is done a presorting, discharging a part of the foreign bodies and this facilitates the sorting process[5].

Potato sizing represents their separation on groups of sizes. The sizing can be done depending on the product's dimensions (diameter or length) or depending in the charge. The sizing is done with the occasion of the sorting or separately and offers the possibility of separating products by their destination (industrialization, different qualities – seed potato)[6].

The sorting machines are composed by some facilities that do the potato sorting, the elimination of the foreign bodies, the elimination of altered or damaged potatoes[7].

The goal of this paper is to realize a comparative analysis of potato sorting and sizing machines of the main firms that produce equipment from the potato industry, as to obtain an image upon the technologies involved and the performances obtained.

RESEARCH METHODS

In a first phase, it was done a bibliographic study of the specialized literature and there were analyzed the principle schemes for the potato sorting and sizing machines [6,7]. On the basis of that study, it was done a classification of the potato sorting and sizing machines, as a block scheme.

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[2] Ghimbăşan, R., *Bazele agrobiologice ale mecanizarii agriculturii,* Transilvania University of Brasov, Brasov, 1992.
[3] Constantinescu, E., *Cartoful,* Agrosilvica, Bucureşti, 1969.
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[6] Ţane, N., *Masini, instalatii si utilaje pentru prelucrarea legumelor si fructelor,* Transilvania University of Brasov, Brasov, 2002.
[7] Mănişor, P., Bria, N., Ruxandru, C., Florescu C., *Masini si instalatii pentru uscarea si conditionarea produselor agricole,* Agrosilvica, Bucuresti, 1963.

Further (on), it was realized an analysis of the constructive types of sorting/ sizing potatoes of the main firms that produce equipment from the potato industry, at witch's functioning is based on the classical principles, presented in the bibliographical study. The source of information is represented by a data base recognized internationally in the potato industry[8]. After analyzing the constructive types of potato sorting/ sizing, it was done a synthesis regarding the actual tendencies in their construction.

It was also done a comparative analysis of the production capacities at potato sorting/ sizing machines. The data was presented graphically as diagrams, but also using the Boxplot technique, in Excel and SPSS.

The descriptive technique Boxplot shows the distribution of a variable in a graphical manner. There can be observed the asymmetry, the dissipation and the aberrant points of the observed values. From the types of sorting/ sizing machines, there were chosen the ones that had the technical data as complete, with the aim of processing them using the statistical method in main elements, in SPSS.

The analysis in main elements is a multivariate method and consists in the simplifying of a chart of data, starting from a great number of variables and reaching at a smaller number of variables that are obtained by the assorting of the initial ones, but also the structuring and the data interpretation, with the help of the new variables.

RESULTS

According to the synthesis of the bibliographical study, it was proposed a classification of potato sorting and sizing machines, based on their functioning principle:

a) mechanical machines for potato sorting/ sizing; special types, that use some properties of the elements that are sorted (dimensions, shapes);
b) optical machines for potato sorting;
c) gravimetrical machines for potato sizing;
d) automatic machines and installations for the separation of the potatoes from foreign bodies.

Below (Fig. 1), there is presented the scheme of classification for the potato sorting and sizing machines.

[8] http://www.potatopro.com/Lists/Companies/Processing%20Equipment.aspx.

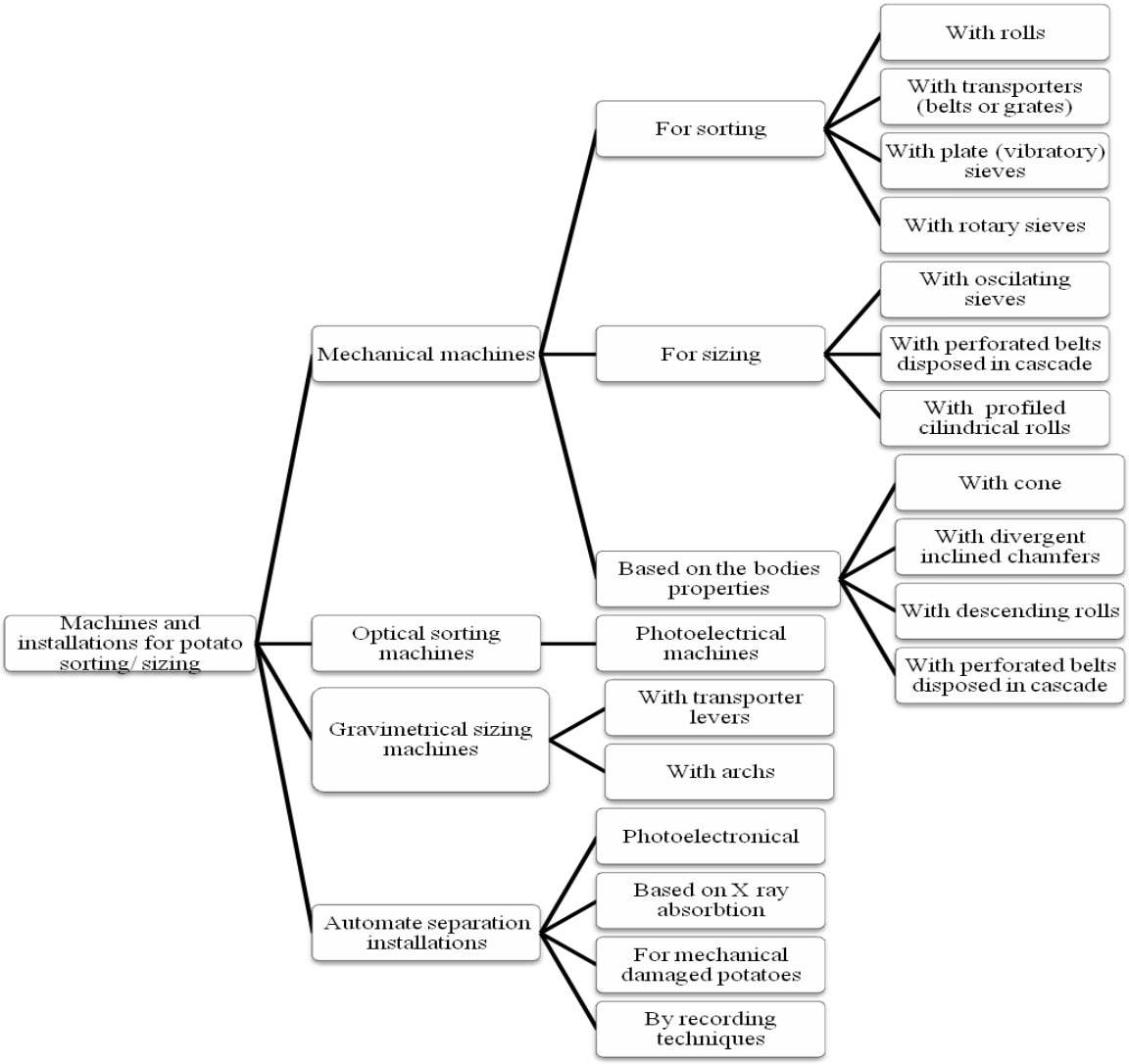

Fig. 1 – Classification of sorting and sizing machines

Forward on, there were analyzed the some types of sorting/ sizing machines from the data base http://www.potatopro.com and there were observed the following tendencies:

- at present times, the majority of potato sorting/ sizing machines function on optical principles;
- optical systems use modern technologies (laser sensors, the scanner module), as other techniques, that are useful in the accomplishment of a qualitative sorting (e.g. the product's anti- spinning technique);
- the optical machines have some constructive technologies that can allow the identification of some special properties of the sorted bodies like the size, the geometry, the shape, the color, the defects or the mechanical damages);

- the sorting/ sizing machines tend to be more and more automatized, taking in to account that the manual sorting is not efficient;
- both the mechanical and the optical sorting machines are built with some devices that can facilitate the products conveyance and the acquiring of a smaller degree of bruising at the sorted or sized potatoes;
- the potato sorting/ sizing machines, both the mechanical as the optical ones, have high production capacities, as to respond to the technological and commercial requirements, in the conditions of enhancing their degree of automation;
- the constructive solutions for potato sorting and sizing machines are flexible and can allow the adjustment of other equipment (e.g. modular construction, mobile assemblies).

In the following stage, it is done a comparative analysis from the point of view of the technical data of potato sorting/ sizing machines.

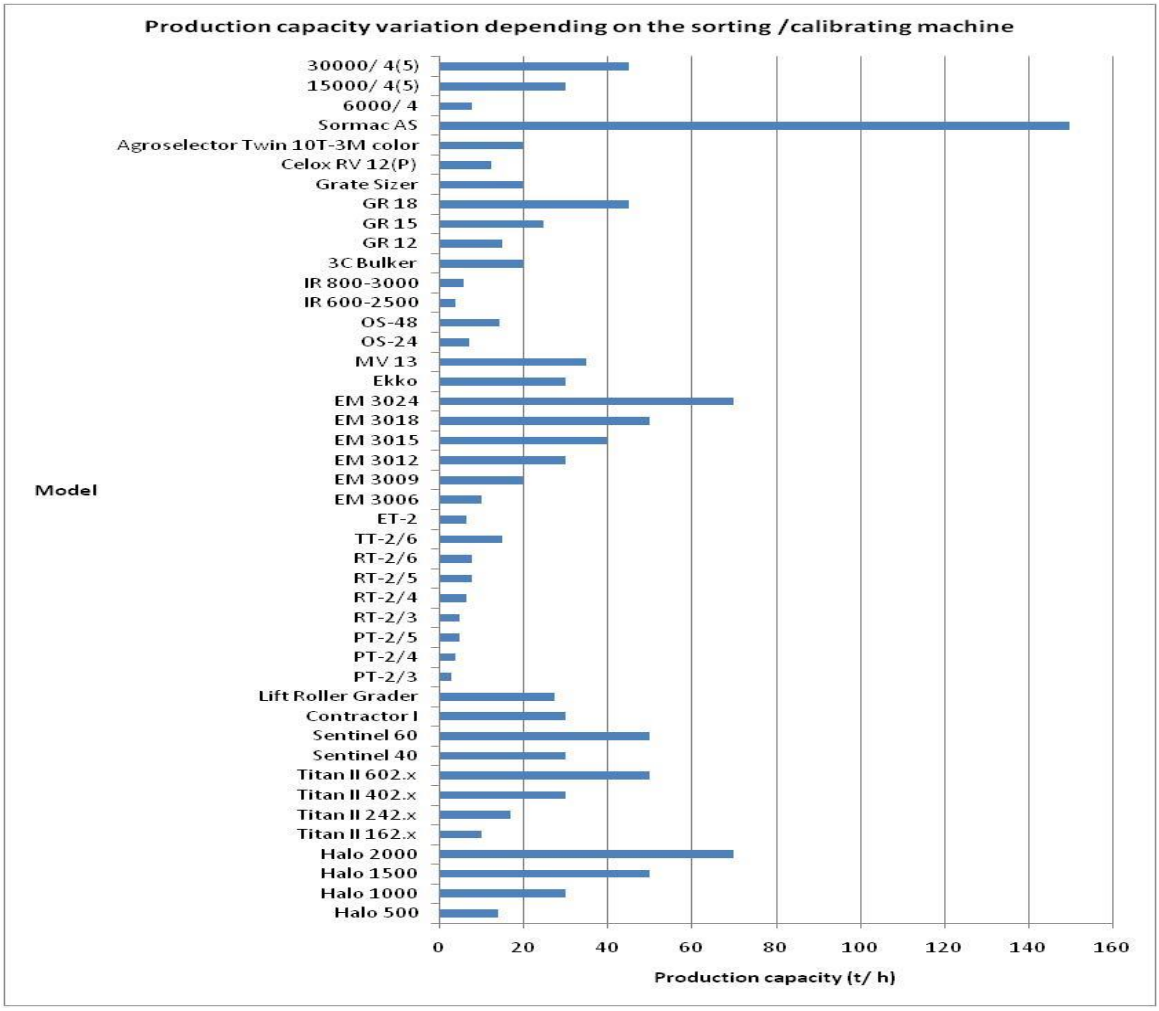

Fig. 2 – Diagram of the production capacities of potatoes sorting/ sizing machines

In the above diagram (Fig. 2), that is done by graphical processing in Excel, there are presented 44 types of sorting and sizing machines and their production capacities. It can be observed that from these, 24 models have a productivity of 20 tones/ hour, 11 models have a productivity of 20…40 tones/ hour and 9 models have productivities greater than 40 tones/ hour. The maximal value (150 tones/ hour) is represented by Sormac AS, the rest of models recording a variation between 3 and 70 tones/ hour.

In the below figures (fig. 3, fig. 4), it is represented the distribution of the above models, depending on their production capacities, by applying the Boxplot analyze technique, both in Excel as in SPSS.

By arranging the production capacities in ascending order (fig. 3 and fig. 4), it results a symmetrical disposal of the data, the superior half (above the median) has almost the

same dimension as the inferior half, that indicates a similar production of models regarding the production capacities.

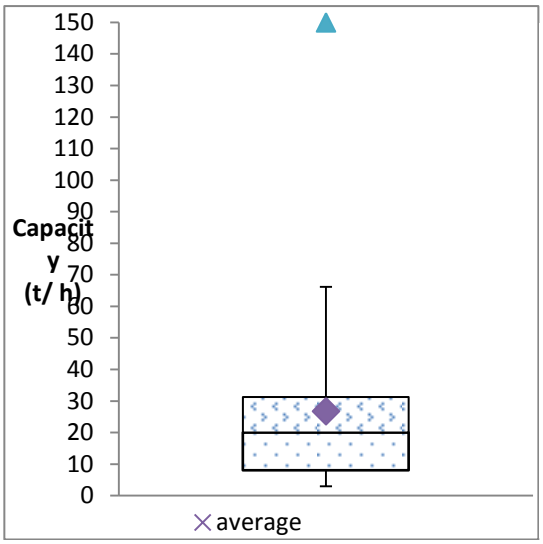

Fig. 4 – Boxplot of production capacities Excel

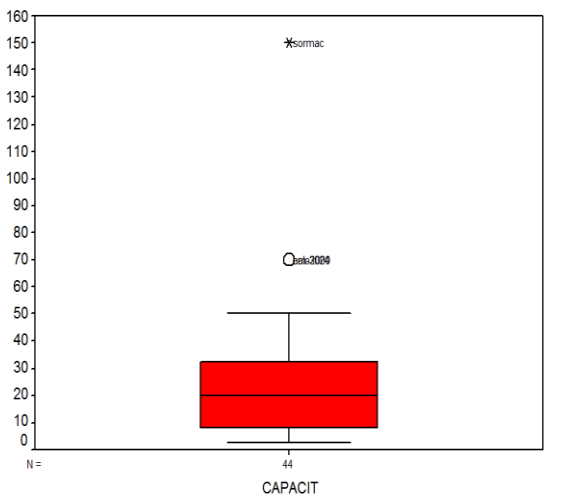

Fig. 3 – Boxplot of production capacities SPSS

In Excel (Fig. 3), it can be observed an average of production of 26,74 tones/ hour, that is biggest than the median of 20 tones/ hour and it is situated in the third quarter of models. This represents the fact that less than 50 % of the models fulfill the medium production capacity. It can be remarked (fig. 4) the 3 points of maximum absolute, that are represented by the models Sormac AS (150 tones/ hour), EM-3024 (70 tones/ hour) and Halo 2000 (70 tones/ hour), that have values above the maximum considered in each of the cases.

In the statistical analysis in main components, it was used the package of programs of SPSS and there were considered as observed parameters the main variables: the production capacity, the length, the width, the depth, the feeding belt and the electrical power.

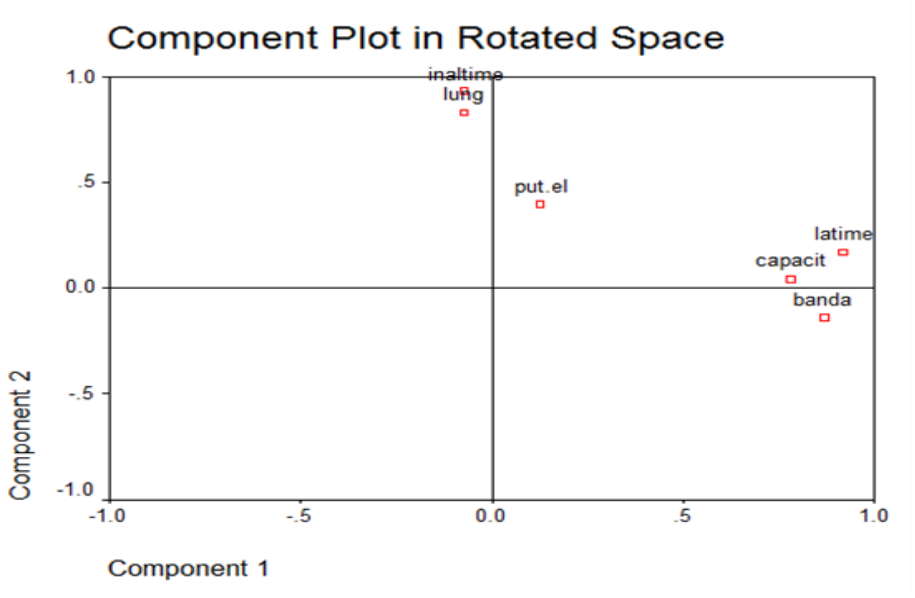

Fig. 5 – The correlations graph

The principle is to reduce the number of 6 variables considered initially at a number of 2 variables that represent an assortment of the initial variables.

Hence, from the Correlations graphic (fig. 5), the first component reunites the effects of the following characteristics: the width, the feeding belt and the production capacity. This first component could define "production characteristics". The second component includes the characteristics regarding the depth, the length and in very small part electrical power (because it is not situated at the end of the Oy axe) and could define "technical characteristics".

The interpretation of the subjects graph (Fig. 6) may lead to the formulation of an image upon the position of the analyzed models depending on the two components of identified in the observed variables: the Ox axe corresponds to the component 1 (production characteristics) and the Oy axe corresponds to the component 2 (technical characteristics).

Taking into account Fig. 6, it is remarked the fact that the models situated in the positive part of the Oy axe have the greatest technical characteristics, that are length, depth and electrical power.

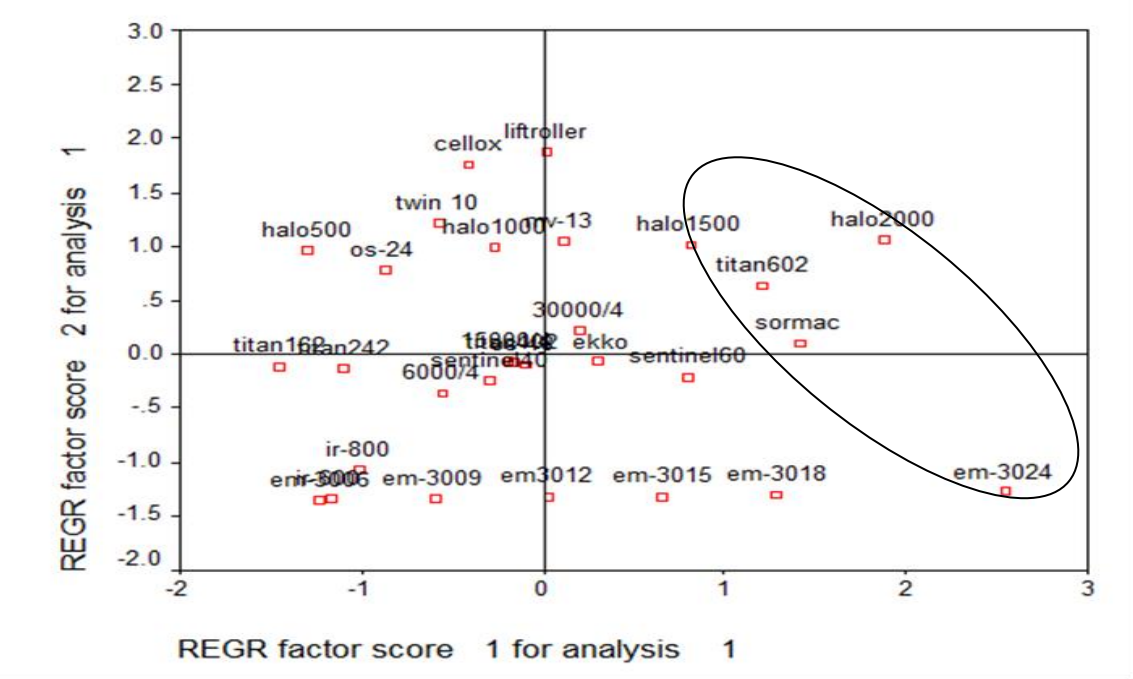

Fig. 6 – The subjects graph

Thereby, depending on the position of the models, there are distinguished the following classes:

- With high productivity and medium technical characteristics: Sormac, Titan 602, Halo 2000, Halo 1500 and 30000/ 4 – quadrant I;
- With high productivity and small technical characteristics (small space and consumption): EM-3024 - quadrant IV;
- With medium productivity and small technical characteristics: EM-3018, EM-3015 and EM-3012 - quadrant IV;
- With small productivity and large technical characteristics: Halo 500, OS-24, Halo 1000, Twin 10 and Cellox - quadrant II;
- With small productivity and medium technical characteristics: IR – 800, EM-3006, IR – 600, EM 3009 and 6000/ 4- quadrant III;
- The rest of the models, with medium production and technical values – on the axes.

It can be observed that the models EM 3006…3024 have the smallest technical characteristics (small space and consumption), but varied production characteristics.

Thus, the best models regarding the technical variables observed are: EM 3024, Sormac, Titan 602, Halo 2000 and Halo 1500.

CONCLUSION

At present times, the majority of the sorting/ sizing machines function on optical principles and use modern technologies (laser sensors, the product's anti-spinning, the identification of some special characteristics of the bodies).

After the statistical analysis, it was obtained a medium of the production capacities for the sorting/ sizing machines of 26.74 tones/ hour, that is greater than their median and this means that more than 50 % of the models are above the medium production capacity.

There are noticed the 3 point of absolute maximum, that are represented by the models Sormac AS (150 tones/ hour), EM-3024 (70 tones/ hour) and Hallo 2000 (70 tones/ hour), that have values upon the maximum of the production capacities. These models are also the best in the case of the analysis in main components. In the case of this method, analyzing fig. 6, it can be observed that models from quadrant IV are the best, with high production and small space and consumption, while models from quadrant II have small productivity, need much space and have large consumptions. The models form quadrants I and III are similar, with high production capacities and technical characteristics (they produce a lot and consume a lot), respectively with small production capacities and technical characteristics (they have small productions and they produce less).

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