

**THE PROGRAM FOR SELECTION OF VERTICAL FORMING- FILLING- AND SEALING
MACHINES FOR DRY PRODUCT PACKING IN SOFT PACKAGE,
BASED ON THE CRITERIA ANALYSIS METHOD**

Savenkova Irina Aleksandrovna

The Moscow State University of Printing Arts of Ivan Fedorov, Russia

Abstract

Packaging industry has one of the most important parts in economics of all countries in the world. But, there is no uniform system of classification for vertical forming-, filling- and sealing machines, depending on packaging materials and dry products.

The complete analyses of equipment were made and the succession was researched: a dry product - a packaging material - a filling system of dry products – a vertical forming-, filling- and sealing machine.

In this paper the algorithm for an optimum selection of VFS-machines was developed by the method criteria analysis, which takes into account the errors of packing processes such as vibration, stroke, knock, pushes and pulsation.

Following the results of work the computer program was created. It works with four large databanks and allows choosing the most suitable fillers, packing materials and the optimal vertical forming-, filling- and sealing packing machines for any dry product according to individual user's requirements (productivity, automation, the price etc.).

Key words: *packaging, forming-, filling- and sealing machines, dry products, the criteria analysis method, computer program for optimum selection.*

1. INTRODUCTION

Packaging industry has one of the most important economic parts of all countries in the world. The world market of packing equipment numbers more than 20 billions of Euros. In spite of this fact there are only few scientific and technical books about modern packaging materials, packing processes and vertical form fill and seal machines in Russia today. And there is no one uniform system of classification for vertical form fill and seal machines too.

So there are not enough practical recommendations for an optimum selection of vertical form fill and seal machines in the world.

Very often sales managers foist expensive machines off customers, but even very expensive equipment sometimes is not suitable for the product. For this reason the equipment is used inefficiently. It works with a small loading and a very low productivity [3].

I have made the complete analyses of equipment and scrutinize the succession: a dry product - a packaging material - a filling system of dry products - a vertical form fill and seal machine.

In this project I worked out the algorithm for an optimum selection of vertical form fill and seal machines by means of a methods criteria analysis and value analysis.

2. APPROACHES, TOOLS, DATA, DOMAINS AND NESTING

1.1. The value analysis

Value analysis is an approach to improving the value of a product or process by understanding its constituent components and their associated costs. It then seeks to find improvements to the components by either reducing their cost or increasing the value of the functions.

The value analysis was used for determination of several main characteristics of vertical forming-filling- and sealing machines [4].

On the first value analysis phase 33 characteristics for assessment vertical FFS-machines were found out. They define economic and technical characteristics of vertical FFS-machines.

On the second phase all 33 characteristics were ranked, each of them got the priority. In conclusion, only 12 main characteristics were determined from 33. For achieving this goal I worked with seven experts. All these people work at packaging industry. The data bank of vertical FFS-machines was created according these important characteristics:

1. Number of dry product's types for packaging;
2. Product change-over time 9 (clean-up, set-up, start-up times);
3. Dosing accuracy;
4. Product performance;
5. Electric power;
6. Variety of bag types;
7. Type of sealing;
8. Payback period and so on.

2.1. The criteria analysis theory

The criteria analysis theory takes into account the errors of packaging processes (they are called «the negative factors»). The errors include vibrations, strokes, knocks, pushes and pulsations. It is possible to realize theory in the form of special synthesis criteria K_j or «criteria indexes» j (t, d, c, n).

I have analyzed more than 246 fillers of 36 firms by criteria analysis during this work.

Criteria indexes are the main tools of this analysis:

1) T – criterion of complication. It is any difficult winding trajectory of dry product in packaging machine. Each of its must be marked on the functional scheme of packaging process. In conclusion it is necessary to count up their total sum.

$$t = \sum t_j \quad (1)$$

$\sum t_j = 0$ – the ideal packaging process (without any difficult winding trajectories of dry product).

2) D – criterion of dynamic. It is the sharp change trajectory of dry product during packaging process. Dry product changes it's trajectory at an acute angle. Each of its must be marked on the functional scheme of packaging process. In conclusion it is necessary to count up their total sum.

$$d = \sum d_j \quad (2)$$

$\sum d_j = 0$ – the ideal packaging process (without any sharp change trajectory of dry product).

3) C – criterion of cyclicity. It depends on working speed of packaging process (meters per second).

$$C = 1/V \text{ (s}^{-1}\text{)} \quad (3)$$

V is the working speed of the packaging process.

$c_0=0$ - the ideal packaging process (with indefinitely high working speed of the packaging process). It is necessary to calculate cyclisity for each packaging process under consideration.

4) N – number of operations. It is the quantity of operations of packaging machine. Each of its must be marked on the functional scheme of packaging process. In conclusion it is necessary to count up their total sum.

$n_j = n_{\min}$ - the ideal packaging process (it has minimum operation of the packaging process) [1].

5) DA – criterion for accuracy of a dry product doses measure (dosing accuracy).

$$DA = \frac{(D^3 - d^3) \cdot \pi}{4V} \quad (4)$$

Where D is the diameter of a volumetric capacity, d is the mean diameter of dry product granule and V is the volume of the volumetric capacity.

6) ET– criterion for efficiency of transmission a dry product doses (efficiency of transmission).

$$ET = (1 - \frac{f_{outlet}}{f_{inlet}}) \quad (5)$$

Where f_{outlet} is cross area of outlet of product dose from conveying channel and f_{inlet} is cross area of inlet of product dose into conveying channel.

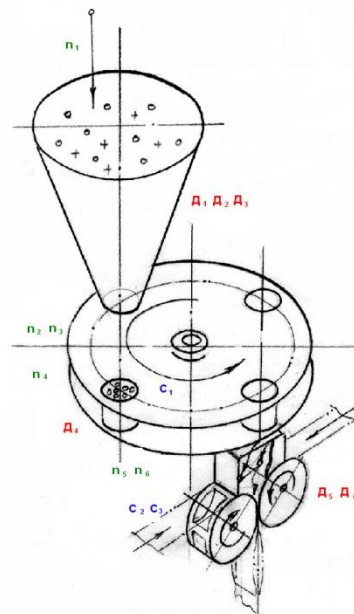


Fig. 1. The functional scheme of disk type volumetric cup filler of vertical FFS-machine AR-I3 (company “Packmarket”).

Table 1. The importance factors (f_i) conform to criteria indexes (j).

T	D	C	N	DA	ET
$f_t = 0,17$	$f_d = 0,14$	$f_c = 0,13$	$f_n = 0,20$	$f_{da} = 0,12$	$f_{et} = 0,13$

The importance factors (f_i) are necessary for assessment of importance of each criteria index and for determining of the main index. It is “n” – the number of operations in printing process, because it has the highest importance factor [2].

During the work I made:

1. The analysis of Russian and foreign markets of the packing equipment for dry products.
2. The analysis of dry products in accordance with vertical form fill and seal machines.
3. The analysis of the fillers and their classifications depending on dry products.
4. Worked out recommendations for the packaging materials of dry products.
5. Worked out recommendations for choosing types of packages, which made of the polymeric and combined materials.
6. The analysis of classifications vertical form fill and seal machines depending of packaging types.

During the work I have created (with possibility of their further filling):

1. A databank of the typical dry granulated products.
2. A databank of vertical form fill and seal machines.
3. A databank of fillers for vertical form fill and seal packing machines.
4. A databank of packing materials for the typical dry granulated products.

All dry products were separated into groups according their different properties. Optimum fillers were determined for each product's group. Packing materials were individually chosen for each dry product according to its physicochemical properties.

3. APPLICATION VALIDATION

Necessity of storing and rapidly processing of the large volume of date was the main reason for computer program creation. Following the results of work I created the program which allows finding the most suitable filler, packing materials and the optimal vertical FFS-machine for any dry product according to individual user's requirements (productivity, automation, the price etc.).

This program was written on computer language JavaScript + HTML.

Markup Language (HTML) was used for making graphic design of the program and creation of human-engineered interface. Programming language Java was used for processing of text data banks and calculation values according to the formulas.

In the program importance factors were taken into account. The importance of each criteria index depends of its importance factor.

4. EXAMPLE OF PROGRAM WORK

There is one simple example of program work; it selects the optimum variant of vertical FFS-machine for packaging coffee beans.

On the first step a user chooses his dry product (coffee beans), and then program automatically makes analysis of physicochemical properties of product and gives recommendations for packaging materials and fillers. The user can choose one the most suitable types of packaging materials allowed by program.

After that, program asks the user to input necessary information about mass of single dose and the percentage of accuracy of doses measure for the dry product. According this information, program chooses the most suitable filler for this product.

Then the user inputs information about the thickness of packaging material, chooses a type of package, a percent of package filling with product (a mark to space ratio), the quantity of product streams and the performance of the package.

According this information program automatically makes all necessary calculations:

1. The volume of the mass of single doss;
2. The volume of a package for the mass of single doss;
3. The length of the package;
4. The length of the package drawing;
5. The width of the package drawing (or a width of the packaging material).

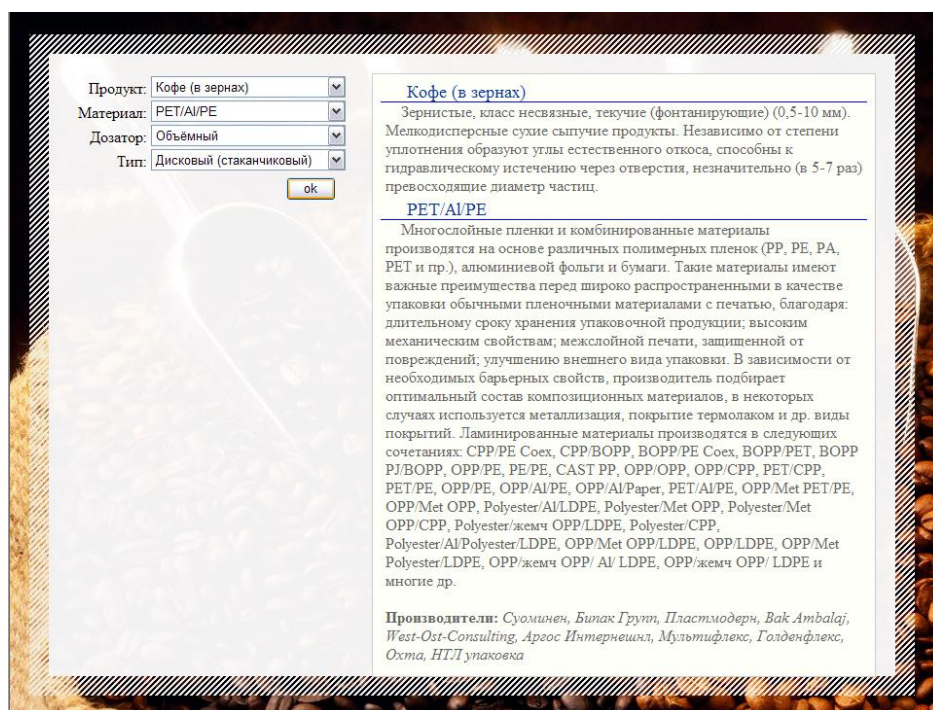


Fig. 2. The dialog box №1 (choosing of a dry product, a packaging material and a type of filler).



Fig. 3. The dialog box №2 (inputting of the dose of mass, the measure accuracy, the thickness of packaging material, the percent of package filling with product (a mark to space ratio) and choosing a type of package).



Fig. 4. The dialog box №3 (inputting of the required package high, the width and allowances; program calculates the package length, the width of package film and the length of package drawing).

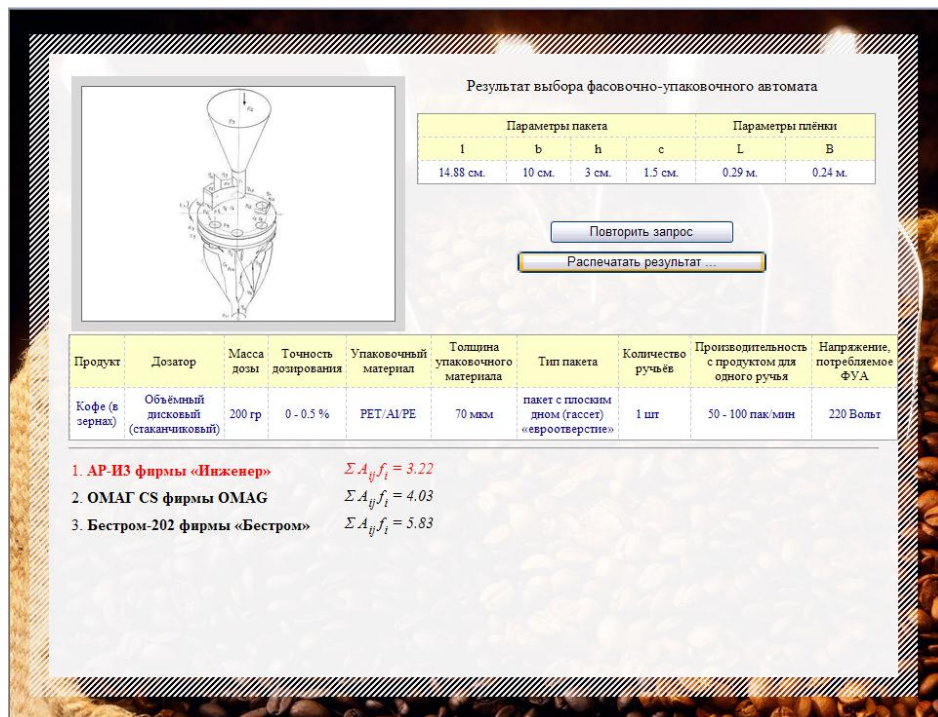


Fig. 5. The result of program's work – there are three the most optimum vertical FFS-machines, ranked by the criteria analyses method. There is the total sum of criteria indexes near each FFS-machine.

In conclusion, on the first step of work program creates a list of the most suitable for user vertical FFS-machines according user's conditions. The list could contain two or more machines and for choosing the most optimum process it is necessary to compare them by criteria analysis method.

On the second step the program automatically compares all vertical FFS-machines from the list and outputs their names into user's display in order of their ranking by the criteria analysis method. The first vertical FFS-machine in the list is highlighted by red color and it is the most optimal for chosen dry product.

After this, the user could connect with suppliers of these vertical FFS-machines for receipting of additional information (an availability on the store, a price end etc.)

4. CONCLUSIONS

The volume analysis and criteria analysis methods are very universal and they both can be used for choosing different types of equipment for wide variety of packaging processes. I have just showed the simple example of their application together.

This program is useful for:

1. Food industry companies can choose the optimum vertical form fill and seal packing machine for packing of dry granulated products.
2. Producers of vertical form fill and seal packing machines. They can choose with my program analogues of developed automatic machines and make their analysis.

**Journal of International Scientific Publications:
Materials, Methods & Technologies, Volume 6, Part 2**

3. Institutions of higher education can use it for studying and researching of dispensing and packaging processes.
4. Producers of packing materials for dry products can use it for optimum selection of films according to different types vertical form fill and seal packing machines.

REFERENCES

Panishev V. G. Laboratory works for technological packaging equipment: student's tutorial/ V. G. Panishev. Moscow, MSUP, 1991.-74 p.

Panishev V. G. Technology of packaging production: laboratory works/ Panishev V. G., Bydnikova O. A. – Moscow.: MSUP, 2003.-35p.

Aksenova T. I. – Packing of dry products/ T. I. Aksenova, V. V. Ananov, E. G. Lubeshkina// PakkoGraff. – 2000. – № 1.

Efremov N. F. Packaging and its producing: student's tutorial/ N. F. Efremov. MSUP publishing – Moscow 2001. – 312 p.