Analele Universităţii din Craiova, seria Agricultură – Montanologie – Cadastru (Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series) Vol. XLIII 2013

RESEARCHES ON AUTOMATION OF DOSING AND SACKING PROCESS OF FINISHED AGRICULTURAL PRODUCTS

BRĂCĂCESCU C., MILEA D., PĂUN A., GANEA I., GĂGEANU I.
INMA Bucharest / Romania
Tel: +40 212693255; E-mail: carmenbraca@yahoo.com

Keywords: dosing, sacking, automated management, dosing auger, PLC.

ABSTRACT

Researches whose results are presented in this paper are on the topic of optimizing the dosing and sacking process in small and medium capacity productive units..

The technological equipment for weighing and automated management EWAM, developed at INMA Bucharest performes simultaneously two operations: automated bag weighing of the programmed quantity of product and automated management of the quantities of sacked finished products on an indefinite period of time.

In this paper there are presented the experimental researches for this equipment, working quality indices determined with highlighting the advantages of using this type of technical equipment in the flow of small and medium capacity milling units in villages.

INTRODUCTION

Preparing agrifood products for market placement or for delivery as feedstock for other manufacturing industries requires performing dosing, weighing and packaging operations on them.

Weighing, dosing and automated management are processes that eliminate, totally or partially, human intervention in the actual operations. Modern weighing, dosing and automated sacking devices represent ingenious technical solutions that comprise fields from both the mechanics and electronics, being characterized by a high precision and sensitivity. [3]

Usually, operations involving direct action on the processed material are exclusively done by mechanical mechanisms or components, but also the command and dosage adjustment operations are frequently done by mechanical systems, the electronic systems having a surveillance and fine adjustment role. [1]

Technological operations of weighing and dosing are not independent in the manufacturing process of products, but are integrated into various technological processes, so that the result of the operation does not emerge distinctively, but cumulated in the resulted final product, and as a result, the quality of the dosage/weighing directly influencing the quality of the final product. [4]

Aligned with the most modern equipment in the field and encompassing innovative constructive solutions, the *Technological Equipment for Weighing and Automated Management EWAM* (fig. 1), developed at INMA Bucharest has a direct applicability in rural small and medium capacity milling units in the technological processes of packaging finished products in open bags, performing two very important operations:

- automated bag weighing of the programmed quantity of product with a precision that fits within the prescribed limits;
- automated management of the quantities of sacked finished products on an indefinite period of time.

Fig. 1. – Equipment for weighing and automated management– EWAM - Overview – [2]

The machine is equipped with two workstations served by the same electronic command and management system, thus eliminating equipment downtime when changing the bags. Also, a manual solution was chosen for attaching bags on the filling spout using an adjustable strap provided with a special lock, renouncing at the pneumatic attaching device that takes more time to change the bag and equipping the unit with a compressed air installation, from this resulting additional investment expenses.

The equipment can also be successfully integrated in the technological flows of units producing concentrated fodder or in other specific units that practice packaging granular or powdered product in bags.

MATERIAL AND METHOD

In figure 2 is presented the constructive scheme for the *Technological Equipment for Weighing and Automated Management EWAM.*

The dosing group (fig.3) is the subassembly that realizes the dosage of products that will be sacked. The augers (pos. 2,3) are mounted in the framing (pos. 1) through some bearings with oscillating ball bearings that ensure a good sealing against any type of dust.

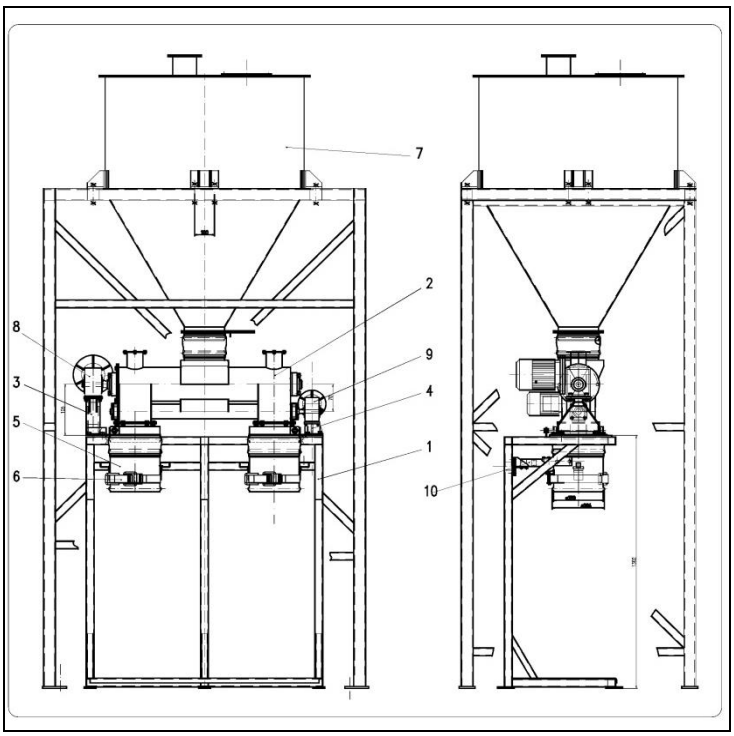

Fig.2 - Constructive scheme for the Technological Equipment for Weighing and Automated Management EWAM [2]

1. Support frame; 2- Dosing group; 3- Gearmotor holder 1; 4- Gearmotor holder 2; 5- Filling spout; 6- Bag fixing strap; 7- Bunker; 8- Gearmotor 1; 9- Gearmotor 2; 10- Tensometric dose

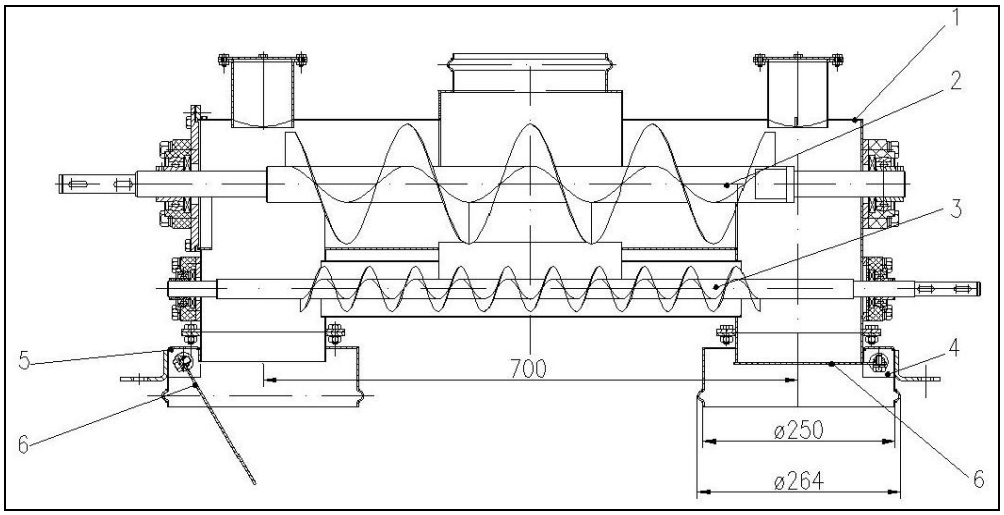

Fig.3. Constructive scheme for the Dosing group [2]
1- Framework; 2- Auger for coarse dosing; 3- Auger for fine dosing; 4- Evacuation 1; 5- Evacuation 2; 6- Flap

The command and control of the dosing operations, weighing and recording the work parameters is made by the automation installation.

In figure 4, the block scheme for the automation installation is presented.

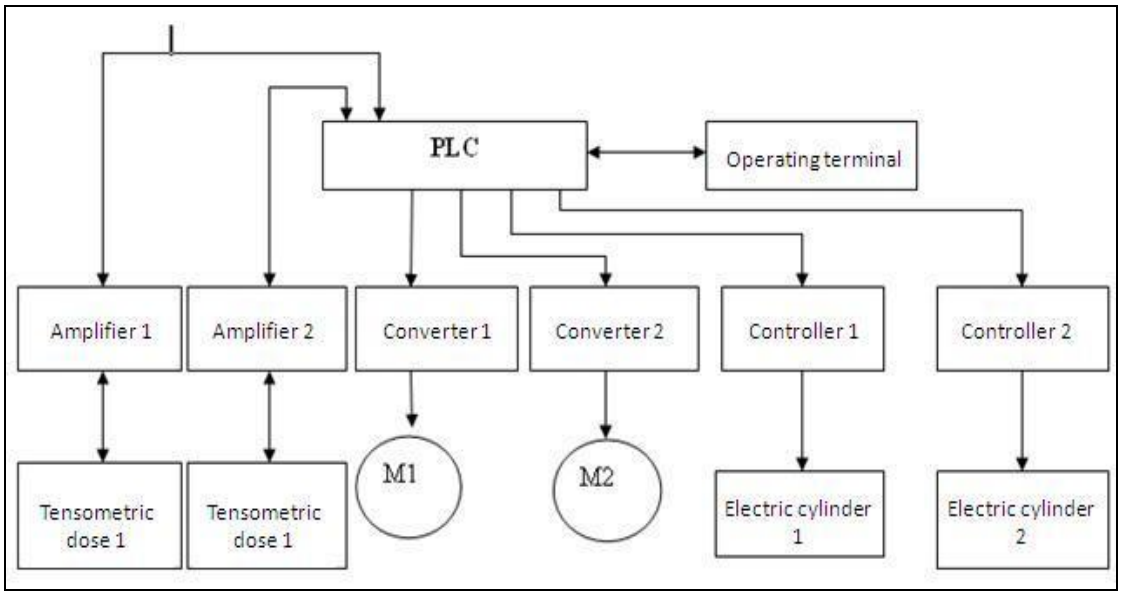

Fig. 4 - Block scheme for the automation installation [2]

The software component of EWAM is formed by two independent programs installed on the operating terminal and on the installation's PLC.

The program loaded on the operating terminal acts as a graphic interface for the user and was developed with the GT Designer 3 graphic programming software. This program has three visualizing windows: Start Page, Parameter Settings and Weighing.

In the Settings Page the work parameters of EWAM are established and management data is visualized: number of bags and the quantity of sacked material on each working station.

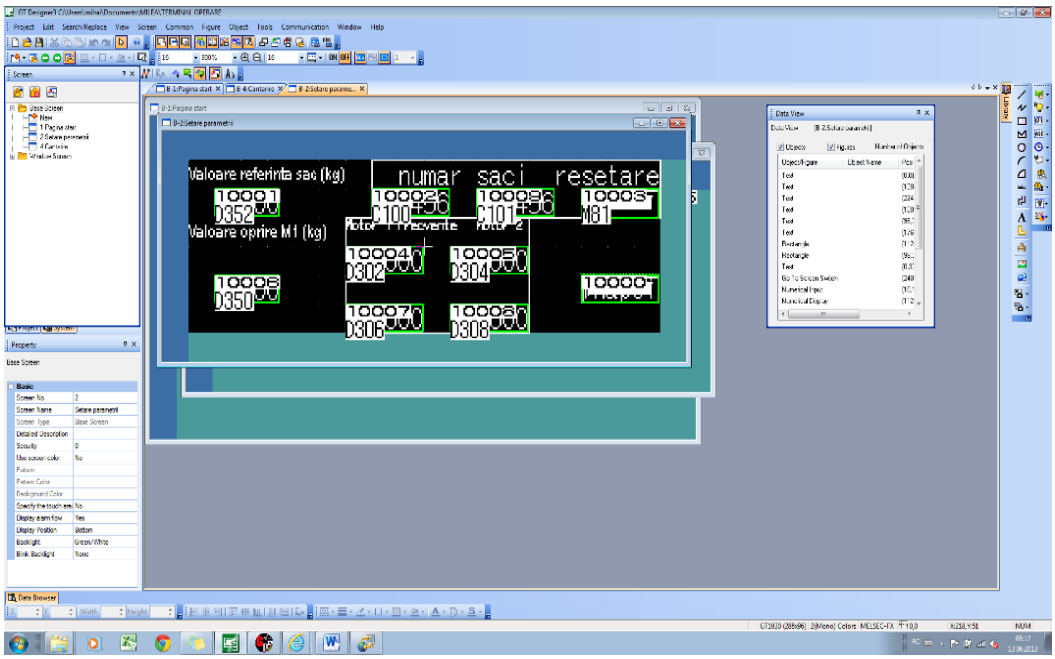

Fig. 5 - Parameter Settings Page [2]

The program loaded in the PLC of the automation installation is developed with the GXDEveloper software program, being structured in the form of logic instructions presented as a ladder diagram, and the transmission of signals to and from the PLC is made both analogically and digitally.

The weighing and automated management equipment has the following constructive and functional characteristics:

- overall dimensions, mm:

	without bunker	with bunker
- length	1300	1640
- width	560	1200
- height	1739	3000

- dosing auger speed, rot/min 60...560
- coarse dosing auger motoreducter drive power, kw 0,75
- fine dosing auger motoreducter drive power, kw 0,37
- productivity, no. bags /min 3-4
- weighing precision, % ± 0,1
- dosed quantity, kg 15 -60

The testing of the EWAM equipment was made at INMA, in laboratory and exploiting conditions, using its own experimental methods, carrying out the following activities: preliminary checks, initial technical expertise, experimenting operation without material, calibrating the weighing system, checking the functioning of the automation installation in simulated mode, experimenting operation under load.

For the experiments in working conditions, two types of combined fodder and 650 type flour were used.

The active power consumed by every motor was determined using the following relation:

$$P=\sqrt{3}U*I*\cos\rho, \quad (1)$$

where:

P - active power consumed;
U - tension of electric power;
I - intensity of electric power;
cosρ –power factor for the electric motor (can be read on motor label).

The total consumed power will be calculated summing the active electric powers for each motor and the power of the stabilized tension source inside the electric control panel.

The weighing precision was determined with the relation [4]:

$$P = [(m_c – m_p)/m_p] \% \quad (2)$$

where:

P - weighing precision (deviation from the programmed value);
m_c - product quantity introduced in the bag determined by weighing;
m_p - product quantity programmed and recorded in the system.

RESULTS AND DISCUSSIONS

The results obtained after testing the equipment in operating conditions are shown in table 1 and 2 and figures 6 and 7.

Table 1.

Operating indices [2]

		$m_{bag\ prog.}$ (kg)	Motor loading frequency (Hz)	Noise A (db)	Auger speed n (rot/min)	Tension U_I (V)	Power I_I (A)	Tension U_{II} (V)	Power I_{II}	$P_{post\ I}$ (W)	$P_{post\ II}$ (W)
Without load	$Auger_M$	-	5	64	54,7	35	2,8	35	2,6	137,32	127,51
	$Auger_m$				51,3	34	1,36	34,8	1,26	61,59	58,40
	$Auger_M$		10	67,2	138,2	55	2,34	55,3	2,35	180,34	182,10
	$Auger_m$				105,3	55	1,32	55,3	1,32	96,710	97,237
	$Auger_M$		15	69,1	170,4	75	2,36	75	2,37	248,03	249,08
	$Auger_m$				167,4	75	1,34	75	1,33	133,87	132,87
With load	$Auger_M$	25	5	65,7	54,9	35	2,8	35	2,6	137,32	127,51
	$Auger_m$				51,3	34	1,36	34,8	1,26	61,59	58,40
	$Auger_M$		10	69,4	138	55	2,34	55,3	2,35	180,34	182,10
	$Auger_m$				105,6	55	1,32	55,3	1,32	96,710	97,23
	$Auger_M$		15	70,1	170,6	75	2,36	75	2,37	248,03	249,08
	$Auger_m$				167,3	75	1,34	75	1,33	133,87	132,87
	$Auger_M$	30	5	65,2	54,5	34	2,34	34	2,33	111,48	111,01
	$Auger_m$				51,2	34	1,34	34	1,39	60,69	62,95
	$Auger_M$		10	67,8	138,2	54	2,4	55	2,4	181,60	184,97
	$Auger_m$				105,6	54	1,33	55	1,33	95,67	97,44
	$Auger_M$		15	69,5	170,3	74	2,37	74	2,37	245,76	245,76
	$Auger_m$				167,1	74	1,33	74	1,33	131,10	131,10
	$Auger_M$	35	5	65,2	54,8	34	2,8	34	2,8	133,40	133,40
	$Auger_m$				51,2	34	1,37	34	1,37	62,04	62,04

$Auger_M$ –big auger (coarse dosing auger)
$Auger_m$ –small auger (fine dosing auger)

Table 2.

Functional and energetic parameters [2]

		$m_{bag\ prog.}$ (kg)	$m_{weighed}$		Motor loading frequency (Hz)	Filling time		Nb. Bags pcs		Weighing precision *(%)*	
			$m_{weig.\ bag\ I}$ *(kg)*	$m_{weig.\ bag\ II}$ *(kg)*		t_I	t_{II}	PI	PII	PI	PII
With load	$Auger_M$	25	25,02	25,01	5	14	12	4	4	+0,08	+0,04
	$Auger_m$		25,02	25,01		12	13	4	4	+0,08	+0,04
	$Auger_M$		25,01	25,02	10	15	12	4	4	+0,04	+0,08
	$Auger_m$		25,02	25,02		13	16	4	3	+0,08	+0,08
	$Auger_M$		25,02	25,01	15	12	13	4	4	+0,08	+0,04
	$Auger_m$		25,02	25,02		12	12	4	4	+0,08	+0,08
	$Auger_M$	35	30,03	30,02	5	17	16	3	4	+0,1	+0,07
	$Auger_m$		30,03	30,01		15	16	3	3	+0,1	+0,03
	$Auger_M$		30,00	30,03	10	14	17	4	3	0	+0,1
	$Auger_m$		30,02	30,03		14	16	4	3	+0,07	+0,1
	$Auger_M$		30,02	30,02	15	16	15	3	4	+0,07	+0,07
	$Auger_m$		30,01	30,03		17	17	3	3	+0,03	+0,1
	$Auger_M$	35	35,01	35,03	5	19	19	3	3	+0,03	+0,08
	$Auger_m$		35,03	35,02		19	18	3	3	+0,08	+0,06

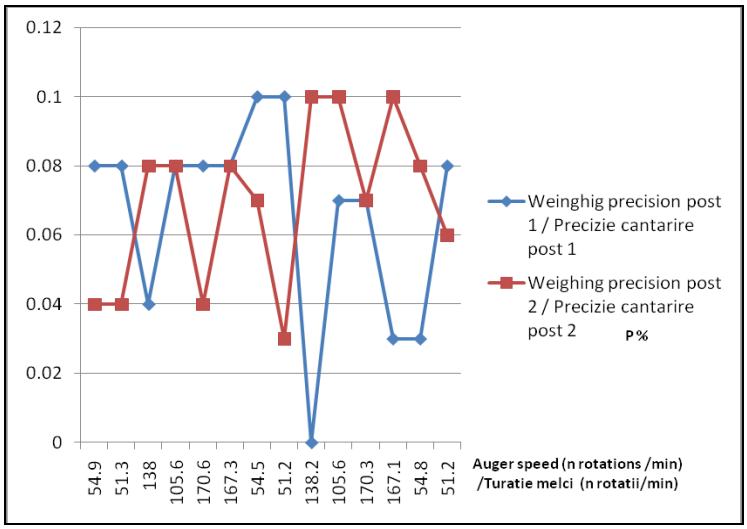

Fig. 6–Variation of weighing precision depending on auger speed

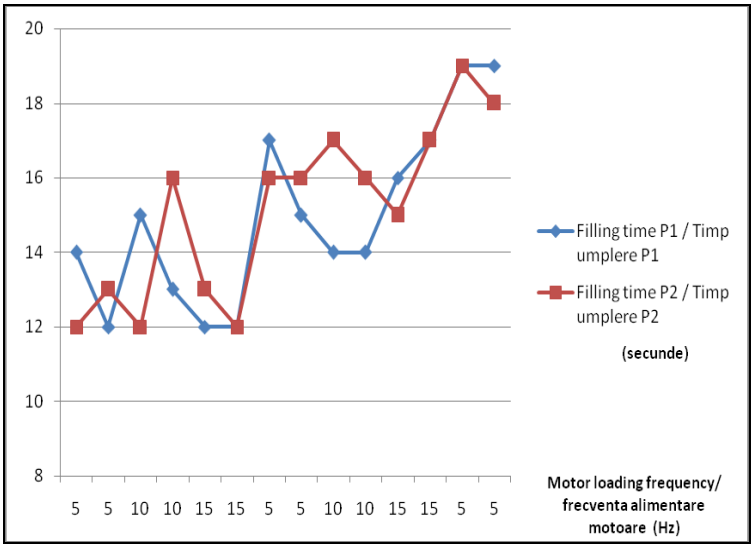

Fig. 7– Variation of filling time depending on the motor loading frequency

CONCLUSIONS

Through the constructive and functional solutions adopted after the experimental investigations it was found that the Technological equipment for weighing and automated management– EWAM ensures:

- increased productivity due to reduced service time by overlapping some activities in the packaging process, which is made possible by that fact that the machine is equipped with two workstations served by a single operator;
- easy and fast management of quantities of finished agricultural products resulted from the manufacturing process;
- safe storage in the memory of the equipment for a period of time of the data regarding sacked product quantities, data that can be made available to interested parties;
- securing the packaging process by the fact that the programming and work parameter modifications, as well as the system configuration, can only be made by authorized persons based on access passwords only known by those persons;
- increasing operator's yield due to the reduction of supplementary physical effort.

Therefore, we can conclude that the usage of methods and technologies for weighing and automated dosage brings a growth in the economic efficiency and has an immediate impact on the evidence of supplied materials, also leading to the growth in the quantity of products packed in bags and in the weighing precision [2].

The experimental model for the Technological equipment for weighing and automated management was achieved in the NUCLEU Program and was the object of a Pattent application no. A-00433/05.06.2013 with the title “Technical equipment for weighing and automated management for granulary and powdery products”.

BIBLIOGRAPHY

[1]. **Merticaru, V.**, 1997 – *Packings and packaging mechanisms*. The Office for Documented Informing for the Machine Building Industy, Bucharest;

[2]. **Milea, D. and others,** 2013 – *Innovative technology and achieving a complex technical equipment for sacking finished agricultural products in small and medium capacity milling units* – Experimenting report for the Equipment for weighing and automated management EWAM, contract no. 15 N / 27.02.2009 / Add. no. 1/2013, INMA Bucureşti;

[3]. **Ola, D.**, 2005 - *Experimental Researches Upon the Dosing Accuracy of Screw and Vibration Dosing Systems destined for Agro-Foods Bulk Solids*, Bulletin of The Transilvania University of Braşov, vol. 12(47), Braşov;

[4] **Popescu, S.**, 2005 - *Influence of functional parameters of the gravimetric dosing process of granular agro-food material*, Bulletin of The Transilvania University of Braşov, serie A, vol. II (47), pag. 169-176, Braşov.