ENERGY SPECIFIC CONSUMPTIONS AND AFFERENT EMISSIONS IN THE MECHANIZED PROCESSES OF CERTAIN AGRICULTURAL PRODUCTS CONSERVATION

CONSUMURILE SPECIFICE DE ENERGIE SI EMISIILE AFERENTE IN PROCESE MECANIZATE DE CONSERVARE A UNOR PRODUSE AGRICOLE

S. DOVEN, A. MITROI, D.-G. EPURE, VASILICA POPA-UDREA

University of Agronomical Sciences and Veterinary Medicine of Bucharest, Romania

Abstract: *In this paper there have been analyzed the specific consumptions of fuel and electric energy in the drying processes and afferent operations of seeds conservation, as well as the CO_2 afferent emissions and there have been identified the possibilities to reduce the energy specific consumptions and implicitly, the polluting emissions.*

Rezumat: *In lucrare au fost analizate consumurile specifice de combustibil si de energie electrica in procesele de uscare si a lucrarilor aferente la conservarea semintelor unor produse agricole, precum si emisiile de CO_2 aferente si au fost identificate posibilitatile de reducere a consumurilor specifice de energie si implicit a emisiilor poluante.*

Key words: agricultural *products drying, energy consumption, equivalent CO_2 emissions*
Cuvinte cheie: uscare produse agricole, consum de energie, emisii echivalente de CO_2

INTRODUCTION

For conserving of the cereals, various mechanized works as related to cleaning, drying, storing shall be applied, all the latter being accompanied by a large number of transportation and handling works. For most of the aforementioned works, the use of electromotors is based on the energy consumption. Depending on the primary sources of energy, which are used for the production of the electric power, as delivered within the network, any electric power consumption is associated with a certain quantity equivalent to CO_2. The main pollution risk of the global environment is indirectly expressed, through the emissions from the production of the electric power.

In the event of the use of the drying installations, not only electric power is used, but also the fossil fuels, propane or liquefied natural gases, and when the latter are burned, a great amount of CO_2 as well as other greenhouse gases appear. Based on a number of researches, there have been established the CO_2 emissions, as related to the drying processes, and there have been identified the possibilities to lower the specific consumptions of electric power and implicitly the changes of reducing the polluting emissions, especially through the configuration of the material and drying agent flows. One special part is played by the recirculation of the drying air and thus the recovery of a significant part of the energy.

MATERIALS AND METHOD

In order to perform the researches, it has been used Dryer type DPX 12 t Series 240 V-3p. The latter is a high efficiency and high capacity continuous flow grain dryer with dry and cool continuous flow.

Wet grain enters by a filling auger to grain chamber, the opening of grain slide wet grain enters to dryer chamber with 50 cm dryer columns with perforated walls. Automatic sensors give start to the burner engine to produce 70 °C heated and dry air. With help of the burner the produced heated dry air moves to dryer chamber with an axial fan. Continuous flow grain starts to dry to the willing limits controlled by automatic sensors, after drying grain enters to cooling chamber and with unloading drager carries to storage units (Figure 1).

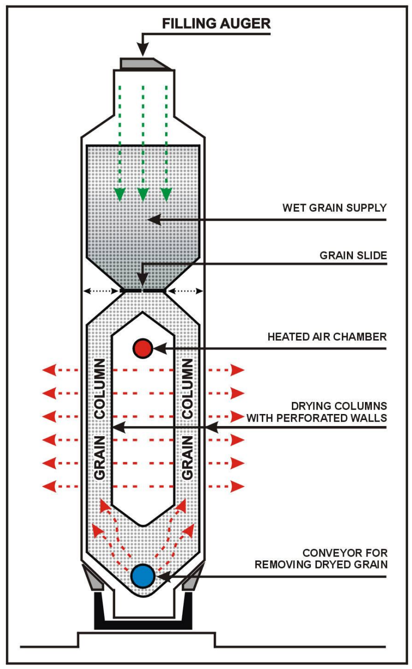

Figure 1. The design of the vertical dryer for cereals

The main constructive and functional characteristics of the dryer are:

Grain columns: Compartmentalized every 15”, thickness 12”-14”. Grain columns feature full height vertical. Free air access openings: Uniformly distributed along the dryer to allow free-air access to all fans. Quiet wide-vane axial fan: Industrial grade fan provides super-quiet, safe operation. Unique design keeps fan clean, maintaining proper balance and air flow. Burner assures a complete, controlled burn and maximum heat transfer with minimum fuel consumption. SCR metering and discharge: With feed roll monitor. Feedroll monitor: Assures additional safety control of metering system. Feedroll monitor: Located in the Plenum Chamber away from the flame, it eliminates repeated adjustments caused by fluctuating flame length. Meets Commercial insurance codes. Accra-matic metering and discharge system: Self cleaning concave aluminum metering rolls are designed for consistently measured discharge, eliminating grain damage. Grain column slide gates provide simple cleanout. Flip-up doors offer easy access to the metering and discharge system. Unique fuel train: Features fuel economizing modulating heat control. Operates the entire system on single or multiple burners. Exhaust air column controls: Exhaust air sensors will detect high plenum temperatures and uneven grain movement through the grain columns before an emergency can occur. Optional exhaust air column controls meet commercial insurance codes and may result in reduced insurance rates.

The technical features of the dryer are displayed in table 1.

Table 1

Technical characteristics of the cereals dryer

Model specifications		
Overall Frame Length	m	9.33
Grain Columns	m	9.15
Grain Holding	kg	50760
Dryer Weight	kg	14628

The driving power of the installation components is presented in table 2.

In order to measure the values of the parameters of the process have been used: thermometers, product moisture content meter, electrical measuring instrument, fuels flow rate.

All tests done at 21°C air temparature and 60% relative humidity. Grain temparature arranged as 70°C for drying. For all grain types tests done for one hour with double checks.

Table 2

The power of the driving electromotors

Power units	Power kW
3 Fans 1750 rpm /rot/min 109 cm	37.5
Filling Auger 25.4 mm	3.75
Unloading Drager 20.3 mm	2.25
Metering	0.75
Burner	75.00
Total Power	119.25

In order to warm up the air, as a drying agent, propane together with the liquefied natural gases shall be used. The energetic value of the fuels is: for the propane 23,5 MJ/l, for the liquefied natural gases 19,4 MJ/l. The specific fuel consumption has been calculating by reporting the consumed fuel quantity to the dried product quantity.

The released CO_2 quantities, through burning the fossil fuels, have been calculated. The CO_2 quantity as related to the energy unit upon the burning of the propane in the blowpipe is:

$C_{CO2} = 70$ g/MJ

As related to the energetic content of the propane it comes out:

$Es_{CO2} =$ 1645 g $CO_{2\ echiv}$./l propane

The same process shall be carried out for the liquefied natural gases:

$C_{CO2} = 60$ g/MJ

As related to the energetic content of the liquefied natural gases it comes out:

$Es_{CO2} =$ 1164 g $CO_{2\ echiv}$./l liquefied natural gases.

The parameters of the drying process have been established upon the drying of the wheat and of the corn for consumption. The dryer can be used for drying other products as well: soya, sorghum, sunflower, and others alike.

RESULTS AND DISCUSSION

There have been submitted to the drying process the seeds of corn, cereals, rice corn, sunflower. During each experience the temperature was automatically maintained at 70 ^{0}C. The energy consumptions were kept constant as the following values:

Propan consumption = 585 l/h

Liquefied natural gas consumption = 639 l/h

Energy from fuel consumption = 14950 MJ/h

Energy from electricity consumption = 429 MJ/h

The seeds flow was adjusted automatically too, in terms of the recirculated air, correlated with temperature. Thus, the operating capacity was larger and the energy specific consumption was smaller. Results are shown in table 3.

Table 3

Parameters of the drying process

Grain type/ Parameter		Corn	Wheat	Barley	Oat	Sunflower
Initial moisture	%	20	18	18	18	15
Final moisture	%	15	13	13	13	10
Capacity	kg/h	58400	56210	44550	31740	41500
Evaporated water	kg/h	3440	3240	2570	1830	2310
Specific energy cons.	MJ/kg grain	0.280	0.290	0.366	0.514	0.392
Evap. specific energy cons.	MJ/kg ev. water	4.471	4.747	5.984	8.404	6.658

The energy specific consumption for water removing from the product is illustrated in figure 2. For the above-mentioned conditions, the values for this parameter are small, reflecting the energetic efficiency of the drying process in the installation.

In table 4 there are illustrated the energy specific consumptions and the afferent emissions in the drying process.

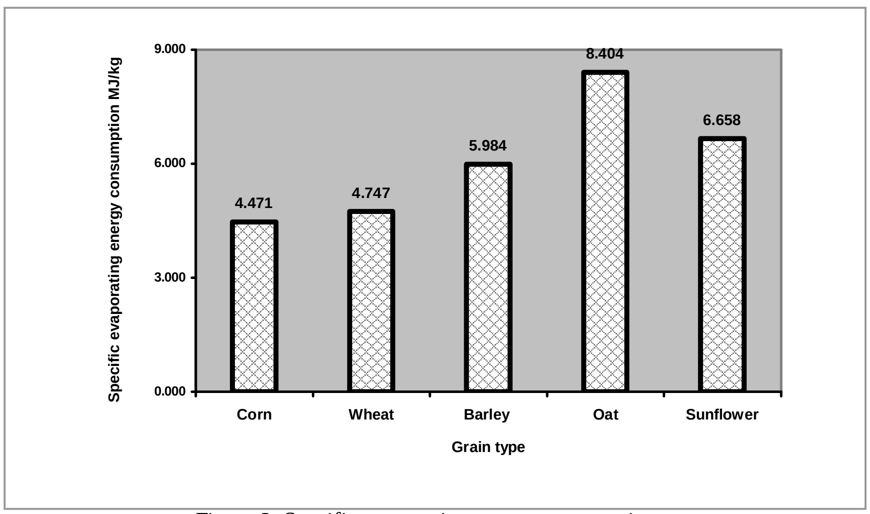

Figure 2. Specific evaporating energy consumption

The good results that were obtained owe to the system's accuracy, which automatically measures the product's temperature and moisture values, adjusting the hot air recirculation, enabling the recovery of an important quantity of energy.

In figure 3 it is represented the CO_2 emission per kg of evaporated water from the product, corresponding to the fuel consumption and in figure 4 it is represented the CO_2 emission per weight unit from the product submitted to the drying process. In the experiment of oat seeds drying, the CO_2 emission corresponding to the fuel specific consumption is larger, due to the fact that the material's features required a slower flow of product that had to be submitted to the drying process.

Table 4

Energy specific consumptions and afferent emissions in the drying process

Grain type	Corn	Wheat	Barley	Oat	Sunflower
Propan consumption l/t product	10.010	10.409	13.134	18.434	14.099
LNG consumption l/t product	10.940	11.363	14.338	20.124	15.391
Propan spec. cons. l/kg evap. water	0.170	0.181	0.228	0.320	0.014
LNG cons. l/kg evapor. Water	0.186	0.197	0.249	0.349	0.277
CO_2 emissions kg/kg product	16.640	17.288	21.813	30.616	23.416
CO_2 emissions kg/kg evapor. water	282.485	299.923	378.113	531.011	420.671

All tests done at 21°C air temparature and 60% relative humidity.
Grain temparature arranged as 70°C for drying.
For all grain types tests done for one hour with double checks.

Since the electric energy consumed for the operation of the dryer elements as well as of the auxiliary equipment comes exclusively from hydroelectric power station, the consumption of electric energy is not accompanied by CO_2 emissions.

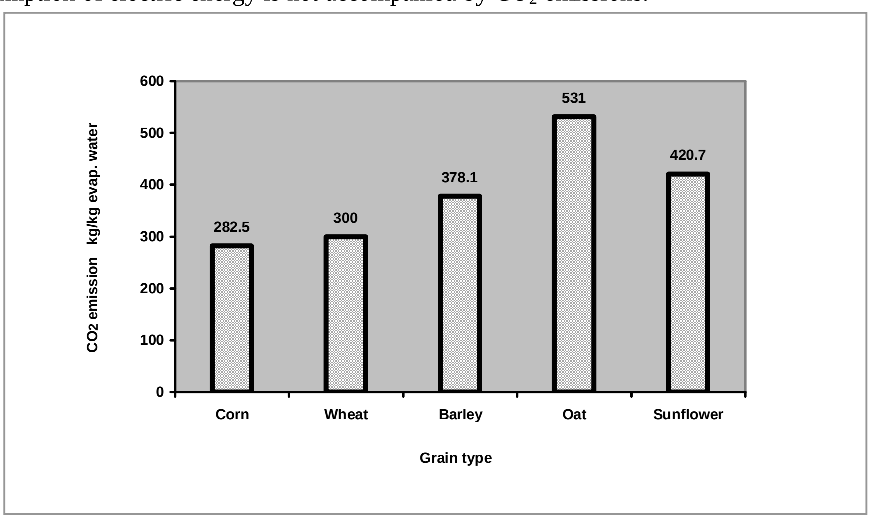

Figure 3. CO_2 emissions per water unit evaporated from the product

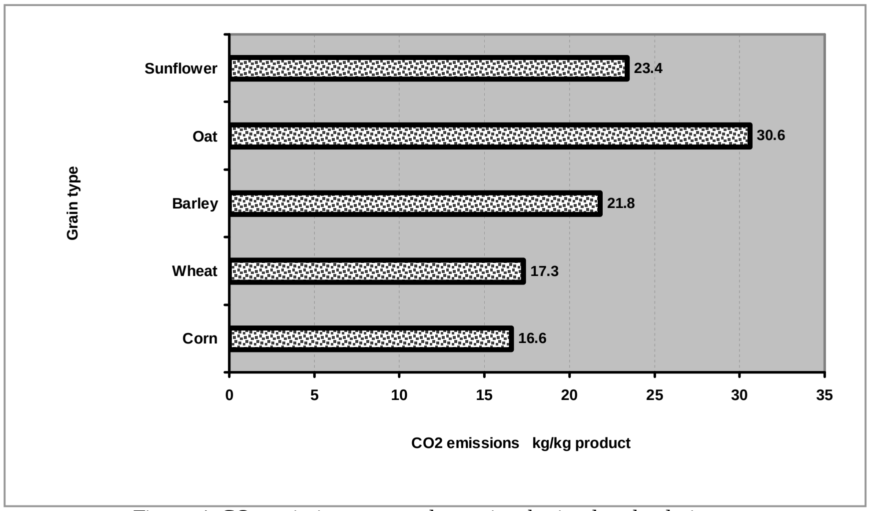

Figure 4. CO_2 emissions per product unit submitted to the drying process

CONCLUSIONS

1. The fuel consumption for heating the drying agent is small due to the system of automatic correlation for the drying process and due to the configuration of the drying and cooling areas in the dryer. The large plenum chamber permits uniform air and heat distribution, eliminating common hot and cold spots and delivering uniform, gently dried grain. The large cooling chamber recaptures warm clean air from the grain, blending it with outside air to help reduce fuel consumption.

2. Afferent issues of CO2 are quite low due to a small consumption of fosil fuel and using the electric energy for operations in a network where the energy is obtained from hydroelectric power stations.

LITERATURE

1. DOVEN S., *The Storage and Drying Units in Turkey*, University of Cukurova , Adana, Turkey, 1998.
2. DOVEN S., *Capacity and Energy Consume Study of Grain Drying in Dryer DPX 12 t Series 240 V-3p*, Turkish Grain Storage Center, Adana, Turkey, 1998.
3. GHIOCEL, GEANINA, A. MITROI, D.-G. EPURE, *Emisiile de CO_2 la mecanizarea lucrărilor la culturi de câmp în condiţiile din zona Mavrodin, jud. Teleorman*. Lucrări Ştiinţifice, U.Ş.A.M.V. Bucureşti, Seria A, Vol. L., 2007.
4. MITROI A., A. UDROIU, A. CIUBUC, *Regimul de temperatură la uscarea boabelor de porumb destinate consumului*. USAMV Bucureşti, Lucrări ştiinţifice, Seria A, Vol. XLVII, Agronomie, 2004.
5. MITROI, A, *Efecte poluante la executarea mecanizată a lucrărilor în agricultură*. Mecanizarea Agriculturii. Editura AGRIS - Redacția Revistelor Agricole, Bucureşti. Anul LV, Nr. 11, 2005, p. 27-32.
6. MITROI, A., GEANINA GHIOCEL, D.G. EPURE, *Diminuarea emisiilor de CO_2 la folosirea energiei de către utilajele agricole*. Lucrările celei de a 8-a Conferințe Naționale pentru protecția mediului prin biotehnologii şi a celei de a 5-a Conferințe Naționale de ecosanogeneză, 26-27.2007, Braşov.