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EVALUATION OF DRYING-PLANT SCHIEF CBS 16-4 POWER PARAMETERS AT DRYING MAIZE

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Summary. The aim of this paper was to find out the power consumption of drying-plant SCHIEF CBS 16-4 in working condition at drying maize grain without interference into regularization and technological running. On the basis of the listed facts it can be said, that the measured heat consumption for drying is reduced by using a drying-plant with new constructional and technological solutions.

Key words: power consumption, drying-plant, maize, new solutions

INTRODUCTION

Drying is the most common procedure of conservation grain and other agricultural product today. Nowadays high density drying-plant consumes for its running relatively a great deal of thermal and electric energy.

For these reasons it is necessary to pay attention to energy indicators that indicate technical perfection of individual types of drying-plants and their economy in running.

The aim of this paper was to find out the power consumption of drying-plant SCHIEF CBS 16-4 in working condition at drying grain maize without interference into regularization and technological running. In this case the next aim was an evaluation of the working process organization.

MATERIAL AND METHODS

Experimental measurements were realized on stack drying-plant SCHIEF CBS 16-4, that was re-formatted on continuous operational mode.

Methodology of tests was prepared for efficiency drying-plant estimate, energy, gas consumption, and other parameters necessary for tests interpretation. For monitoring of work quality and operation parameters the following methodology was used:

a) Estimating of relative humidity and grain maize temperature

Temperature and relative humidity of grain was determined from in and out placed hygrometer installed in drying-plant and consequently also checked by digital hygrometer and thermometer COMMETER TH21 type.

b) Estimating of temperature and specific atmospheric moisture on inspection chamber and ascent from drying-plant

During tests the grain maize temperature was measured in time interval throughout the day and night. The temperature was measured on inspection chamber and ascent from drying-plant. An analogical procedure was used at specific atmospheric moisture measuring on inspection chamber ascent from drying-plant at the same time.

Specific atmospheric moisture measured on inspection chamber and on ascent from drying-plant was processed from date out registration equivalent arid and wet temperature and through the medium i-x diagram. Relative atmospheric moisture was measured through the medium termohydrograf and digital hygrometer and thermometer.

c) Electric energy consumption

Consumption of electric energy was monitored from electrometer, which was installed on after-harvest line. Allowance consumption was monitored every day.

d) Estimating of gas consumption

Consumption of gas was monitored in a specified time period (1 time behind 24 hour) with gasometer installed nearby.

e) Estimation of weighted flash, evaporation, specific evaporation, heat consumption and efficiency of drying-plant were calculation according to stale formula:

– Weighted flash of damp material (m_{MA}):

$$m_{MA} = \frac{MA}{\tau}, \text{ kg·h}^{-1}$$

– Weighted flash of dry material (m_{MB}):

$$m_{MB} = \frac{100-\omega_A}{100-\omega_B}, \text{ kg·s}^{-1}$$

– Evaporation (m_w):

$$m_w = m_{MA}\frac{\omega_B-\omega_A}{100-\omega_B}, \text{ kg·h}^{-1}$$

– Measuring evaporation (o):

$$o = \frac{m_w}{V_u}, \text{ kg·m}^{-3}\text{·h}^{-1}$$

– Consumption heat on 1 kg transpiration water (q_o):

$$q_o = m_{LS} \frac{(t_{LA} - t_{LO}) \cdot 1.0048}{m_w}, \ \mathrm{J{\cdot}kg^{-1}}$$

where:

M_A – excess material at drying-plant, kg
τ – time, after which it was subject to material
ω_A – elementary share damp material, %
ω_B – ultimate share damp material for dried mass, %
V_u – effective volume drying-plant, m^{-3}
m_w – evaporation water (humidity), $kg{\cdot}h^{-1}$
m_{LS} – weighted flash drying environs, $kg{\cdot}h^{-1}$
t_{LA} – temperature drying environs on inspection chamber, °C
t_{LO} – temperature atmospheric air, °C.

RESULTS AND DISCUSSION

Concise characterization following Links

After-harvest modification centre of grains where measurements were realized consist of several parts. Figure 1 shows flow-sheet line with its technical and store element. Two especially technical line elements (cleaner and drying-plant) are drawn in section plan. In the line there are installed two PETKUS K-547A cleaners and two SCHIEF CBS 14-6 drying-plants that work parallel. The line with floor warehouse has 10 000 ton storage capacity.

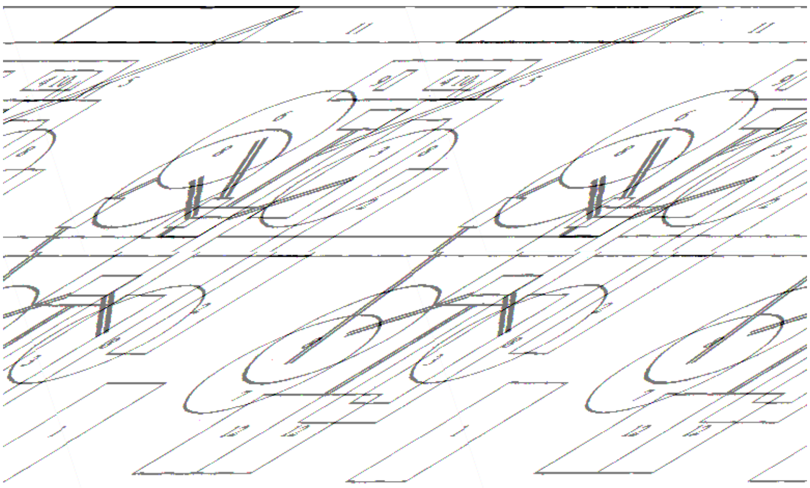

Fig. 1. Technological design of after-harvest line for processing grain in land business Selice:
1 – weighing-machine, 2 – basket, 3 – in front of-hoower dam, 4 – rude waste,
5 – genteel waste, 6, 7 – drying-plant, 8 – store reservoir, 9 – separator,
10 – hoower dam, 11 – store space(indoor warehouse), 12 – reservoir

Drying-plant grain SCHIEF CBS 14-6 is the most important element of after-harvest line (Fig. 1, 2).

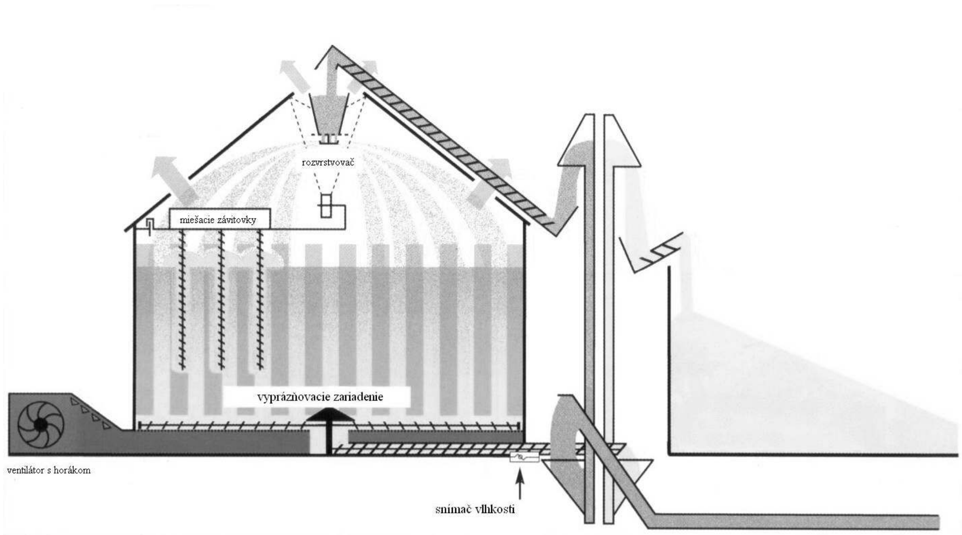

Fig. 2. Design of the drying-oven activity – SCHIEF CBS 14-6

The biggest credit of this equipment is well-preserved grain quality. For this reason work quality and exploitative parameters of drying-plant were evaluated.

The presented drying-plant is a bin countercurrent flow drying-plant heated by natural gas. It is re-formatted and works continually according to adjustment parameters. The basic technical parameters of the drying-plant are listed in Table 1.

Table 1. Technical parameters of the drying-plant SCHIEF CBS 14-6

a) largeness reservoir:	
- diameter reservoir	12.80 m
- altitude near border	4.90 m
- altitude near summit	8.91 m
b) efficiency drying-plant	15 t•h^{-1}
c) consumption natural gas	70–194 m^{3}•h^{-1}
d) maximum cut-down damp	2000 kg•h^{-1}
e) consumption el. energy	60 kW•h^{-1}
f) installed el. performance	120 kW

Self-drying process runs in a drier furnished with diameter 12.8 m and the floor is perforated. Humid grain is equally allocating into drying space by stratified worm equipment (Fig. 2). The level of grain layer is adjustable and is kept by the grain-level sensor. The motion of listed screw (Fig. 2) is radial and circular.

The source of heat is air-heating set on natural gas. Motion of drying media-air and drying material is countercurrent. The required air temperature is adjusted on the burner by on ventilation regulation i.e. the quantity of the delivered gas.

The whole process of drying is mostly influenced and controlled through the CALC-DRI computer system. The system prohibits grain maize with higher than required moisture to leave the drying-plant but also to dry the already scorched grain.

EFFICIENCY OF DRYING-PLANT AND ENERGY PARAMETERS EVALUATION.

For an assessment of the efficiency of a drying-plant we have worked out check measurement parameters, which are listed in Table 2. The authorized measurement procedures are determined according to the formula (1 till 5) in methodological calculation:

- heat per kilogram consumption of transpiration water, $MJ•kg^{-1}•year^{-1}$,
- energy consumption per ton of transpiration water, $kWh•t^{-1}$,
- natural gas consumption per ton of transpiration water, $m^3•t^{-1}$,
- electric energy consumption per ton of dried material, $kWh•t^{-1}$,
- natural gas consumption per ton of dried material, $m^3•t^{-1}•year^{-1}$,
- average hour efficiency of drying-plant per season in year 2005, $t•h^{-1}$,
- costs per ton of transpiration water, $sk•t^{-1}$,

The listed results are summary processed in Table 3.

Apart from the measured data also the data from 1995 to 2005 were added to Table 3.

Specific heat consumption per one kilogram of transpiration water during 11 years of running drying-plant represents an average value 5.54 MJ, which is not a good result (Tab. 3). Heat consumption per kilogram of transpiration water in individual years is in range from 4.37 to 6.41 MJ (Tab. 3), it represents 100% dispersion. The listed facts require a deep analysis of consumption reasons.

The listed heat consumption difference is caused by the fact, that a drying-plant works also in November and December, when the processed grain maize has a low temperature (7–10°C), and the air temperature is also low (5–9°C), Table 2. The other factors are measurement accuracy of control system, drying uniformity, technological discipline and special knowledge of operators.

Heat consumption per heating air for hot drying-plant according to Pawlicu [1988] should not go over 4.80 MJ•Kg-1 of transpiration water. Jurik [2005] gives a classification of drying-plants according to the measured heat consumption:

- specific heat consumption higher than 4.0 $MJ•Kg^{-1}$ – uneconomical old drying-plants,
- specific heat consumption lower than 3.0 $MJ•Kg^{-1}$ – the most economical drying-plant,
- specific heat consumption lower than 2.70 $MJ•Kg^{-1}$ – technically unrealistic.

According to the presented drying-plants classification, the measured drying-plant SCHIEF belongs already to the group of rusty drying-plants.

The efficiency of drying-plant in the year 2005 was in the range from 11 to 15 $t•h^{-1}$.

An average hour efficiency per whole season was 8.35 t. Gas and electric energy consumption are listed in Table 3.