ASPECTS REGARDING WHEAT WETTING BEFORE GRINDING USING THE MECHANIC HUMIDIFIER WITH CURBED PIPES

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Abstract. The paper presents some aspects regarding construction and the working process of a mechanic humidifier with curbed pipes, a calculus regarding water consumption as function of seed flow for arriving from the storage moisture to the primary milling stage humidity. Based on connection between this parameters it was graphically represented the variation of water flow for seeds wetting at different initial moisture contents of seeds with the purpose to arrive at a final moisture content of 15.5%, respectively 16.5%. Aspects presented in this paper are useful for designers and manufactures of seeds humidifiers but especially for users of such equipments.

Key words: wheat milling, cereal seeds, wheat wetting, humidifier (damper), wetting process modelling

1. INTRODUCTION

Wetting of wheat seeds is achieved with the purpose to grow the moisture content between their anatomical parts, respectively seed bran and endosperm, due to the fact that in the milling process their physico – mechanical properties are different. Thus, by growing moisture seed bran become more elastic and endosperm more plastic, so that in the grinding process seed bran to be fewer breaks up and its separation achieved easier. Wetting of seeds is not a continuous process, it is performed (process and it is performed) in stages.

Thus, in the first stage, it is absorbed a quantity of water which determine seed volume growing, moisture content growing up at the beginning, then it remain constant. New tensions appear in seed which creates new capillary duct which encourage wetting and the process is performed from one stage to the other.

In large milling factories wetting is performed in 2–3 stages. In stages I-II is performed a deep wetting in the purpose of water content growing in all seed anatomical parts, followed by a rest period of 2-16 hours as function of wheat quality. Internal tensions which appear in this period change cohesion between seed bran and endosperm. In the IIIth stage it is obtain a superficially wetting of seeds with the purpose to change the seed bran physic-mechanical properties (elasticity modulus), rest period being now of 15-30 minutes.

It is recommended, based on practical data, that wheat moisture content at first milling stage to be 14.5–16.5% with small differences function of the adopted milling system.

2. DEVICES, MATERIALS AND METHODS

To achieve wetting of wheat seeds can be used different kind of devices and wetting installations: wetting devices with cans, pneumatic humidifiers, humidifiers with disks, humidifiers with dose and electrical heating, a.s.o., with a automation degree function of mill capacity and investment level.
The mechanic humidifier with curbed pipes (made-up INMA Bucharest – fig.1) is used in grain seeds condition department for improvement of grinding properties and presents the advantage of using the kinetic energy of seeds to move the humidifier propeller.

Seeds penetrate in the interior of the device through a feeding inlet. A part of material strikes palettes of the propeller determining a rotation movement. Propeller with palettes is coupled with curbed pipes rotor, and the movement is transmitted from the first to the second. Pipes rotor contained in the mechanic humidifier is composed by six pipes curbed in half circle. All this six pipes make the link with a central pipe which collects water from them and from this pipe through a vertical drain and a pipe to the wetting funnel of seeds (diffuser D2).

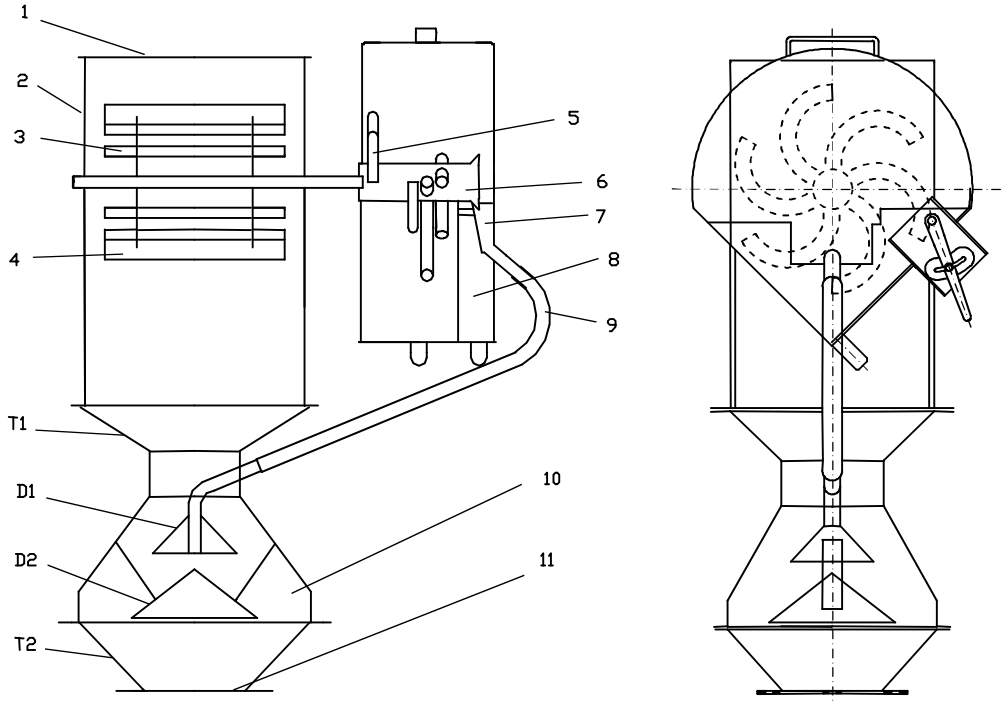

Fig.1. Schematic diagram of the mechanic humidifier with curbed pipes
1.grain feeding; 2.proppeler; 3.proppeler with palettes; 4.palet shell; 5.curbed pipes; 6.water collecting pipe from the curbed pipes; 7.outlet funnel; 8.liquid level chamber; 9.water pipe outlet; 10.wetting chamber; 11.wet grain outlet

This design of pipes rotor determines that its working to be similar with a bucket batching device in rotational movement from which liquid gravitationally flow through the linking pipes to the water pipe outlet. All the six pipes curbed in half circle have a nominal diameter of 12 mm and 42 mm for curbed circle. These make the link with water collecting pipe with a 35 mm interior diameter.

By its rotation movement, curbed pipes of the rotor pass trough a water tank, with adjustable level, and fill with water at a degree function of tank water level.

At the moment when curbed pipes filled with water arrive in a horizontal position, water flow to the collecting pipe. Water from the curbed pipes must be evacuate until curbed pipes arrive in a vertical position to avoid water loss (water can be blow out due to centrifugal forces created by rotation movement). Water from the curbed pipes must be evacuated at a quarter turn of the rotor.

By grain impact on palettes of the propeller seeds are dispersed in the outlet funnel on a conical strain of material over which fall water from the main collecting pipe.
In this way seeds and water are blended in necessary ratio and then evacuated to the resting cells or intermediate bins of the technological flux.

Material flow determine rotation speed of the propeller with palettes and the quantity of water dispersed for wetting seeds necessary to arrive at milling wet. Wetting of wheat seeds which pass through propeller taking place in the wetting chamber of the humidifier, where seeds are dispersed in a fin layer on the walls of funnels T1 and T2 in the diffusers D1 and D2.

Seeds slow slipping on funnel walls is guaranteed if their wall angles with a horizontal plane are grater then seed friction angles, for dry or wet material, referring to funnel steel walls.

At funnel T1 and diffuser D2 wheat seeds have the initial moisture contents u_i, as they arrive from the silo. Corresponding to dry seeds (at initial moisture contents u_i = 11–13%) friction angle is in the range 18–20^o and for wet seeds is in the range 25–30^o. Real wall angles of UG-1 humidifier (made in Romania), are 33^o and 45^o for funnel T1 and diffuser D1, respectively 35^o and 48^o for diffuser D2 and funnel T2, which ensure a normal seeds flow.

3. SEEDS WETING PROCESS MODELLING

The link relation between water flow A which is necessary to bring seeds from the initial moisture content u_i(%) to the final moisture content u_f(%) for milling and seeds flow rate Q_m, is given by:

$$Q_m\left(100-u_i\right)=\left(Q_m+A\right)\left(100-u_f\right) \tag{1}$$

or:

$$A=Q_m\left(\frac{100-u_i}{100-u_f}-1\right) \tag{2}$$

Water quantity which arrives on diffuser D2 is dispersed on its walls and absorbed by seeds in their movement on diffuser walls. If humidifier flow rate is 1000–1200 kg/h (about 0.2–0.35 kg/s) and using relation (2) for water flow rate which is necessary to bring seeds at the moisture content of about 16.5%, it can be obtain values in the range 0.5–1.5 l/min (see fig.2,b) for water flow as function of seeds initial moisture content (between 10.5–13%).

To bring seeds at the moisture content of 15.5%, water flow rate is lower in the range 0.35-1.25 l/min, for the same initial moisture content of seeds (see fig.2,a). Water density was considered 1000 kg/m^3.
Due to flow relation, water speed at humidifier outlet pipe is:

$$v=\frac{Q_a}{s}\ \text{m/s} \tag{3}$$

Taking into consideration flow relation for liquids:

$$Q_a=\mu\cdot s\cdot\sqrt{2\cdot g\cdot H} \tag{4}$$

it can be estimate water flow section at the bottom of the diffuser D2 in which: μ is a flow coefficient ($\mu \approx 0,7$ for liquids with low viscosity); s – flow section at the bottom of the diffuser; H – falling high referring to water pipe outlet.

Flow section is determined by diffuser perimeter at its bottom L and h_w – water stream high at diffuser bottom, so:

$$h_w = \frac{s}{L'} \tag{5}$$

From calculus for UG-1 humidifier results that water flow which arrives on seeds strata is a thin film which determines a uniform wetting of seeds.

Wet seeds fall in funnel T2, where take place an uniformisation through rolling down on funnel walls and then fall in a screw conveyer which realised a final homogenisation before arrive in the rest cell and then to milling.

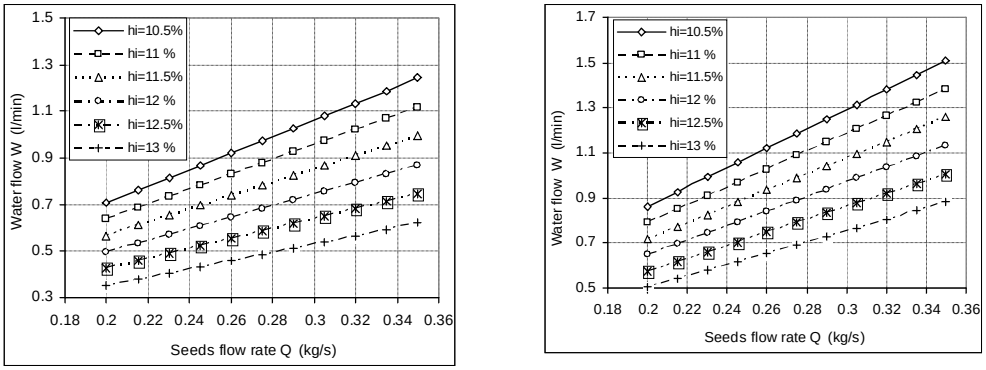

Fig.2. Water flow rate which is necessary to bring seeds at final moisture content of 15.5%, respectively 16.5%, as function of seeds flow rate

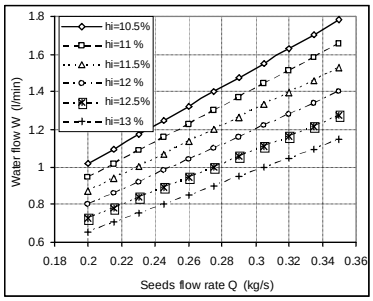

Fig.3. Water flow rate which is necessary to bring seeds at final moisture content of 17.5 as function of seeds flow rate

4. CONCLUSIONS

Moisture of wheat seeds influence physico-mechanical properties of their components: break resistance and bran plasticity.
Milling wet of wheat seeds depend of their physico–mechanical properties, but it was found the range 16 – 17%, values at which the energy consumption is lower and less break of the seed bran.

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