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Considerations on Inner Side Fitting Out Construction of Rotary Drum Dryers

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Abstract

The herein work illustrates the influence of inner side fitting out construction upon the drying process (retention time, power, flow capacity, partial coefficient for heat remittance heat quantity)

Key words: *inner fitting out, rotary drum dryer, retention time, flow capacity, power.*

Foreword

Technical literature studies resulted in: the more advanced technology is, more numerous the problems are, pointing out how pure is our knowledge in the direction at the moment. Rotary dryer still is configured as a "black box", as there no flow capacity sensor to monitor the mineralogical changes an gaseous atmosphere changes in dryer areas, so that optimisation potential of burning process to be high.

From constructive stand point, the dryer (inner blades, flow capacity, cylinder inclination, the way of heat remittance) is chosen function on the material subject to drying process and on fuel used. Rotary Dryer sizing is not made exclusively based on theoretical calculations. Drying material behaviour must be determined in pilot stations, considering informative thermal calculations [3]. Rotary drum dryers developed due to the progress obtained in the field of rotary drum units. The leading position in the rotary dryer technology is taken by the dryer with two support groups, continuously and systematically improved along time and probably from now on as well. A variety of items are fitted within the rotary dryers, both metallic and ceramic items, wishing to improve the heat exchange. Material movement inside the rotary dryer influence considerably the heat exchange produced.

The drying period of the material inside the dryer is function on the fittings out type.

Devices for Heat Transfer Actuation

Drying is performed both by convection and by conduction as well [4]. Material comes in touch with the hot air drying agent or combustion gas from which it gets 80-90% convection out of the whole heat quantity needed for drying process. Drying agent parameters (speed, temperature, relative humidity, etc)as well as the connection between humidity and material determines the heat and mass transfer during the drying process. Usually, during the process, drying agent changes its temperature, relative humidity and even the circulation speed, in time, and wet material changes its specific heat, density, thermal conductivity and even dimensions. Furthermore, during the process, transfer coefficients of heat and mass, water viscosity, superficial tension, etc. vary. Therefore, in order to know exactly the way process undergoes, it is necessary to have a real correlation between theoretical results obtained and direct experimental researches, made for each material aside and each type of inner side fitting out.

To enhance the contact surface between material and dryer, we propose a new type of inner side fitting out: inner side fitting out made of helical band (fig.1).

To perform the blades of helical flat bar, a steel flat bar is used having a width of 0.020m and thickness of 0.004m

Inner side fittings out made of bar, have 6 coils at 0.230 m. Coils are attached by welding points on the inside cylinder made of 0.001m thick sheet, which is introduced in the existing dryer drum.

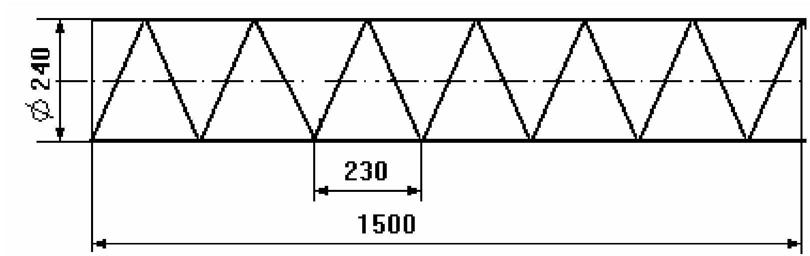

Fig. 1. Inner fitting out made of helicoidally metallic tape scheme [6]

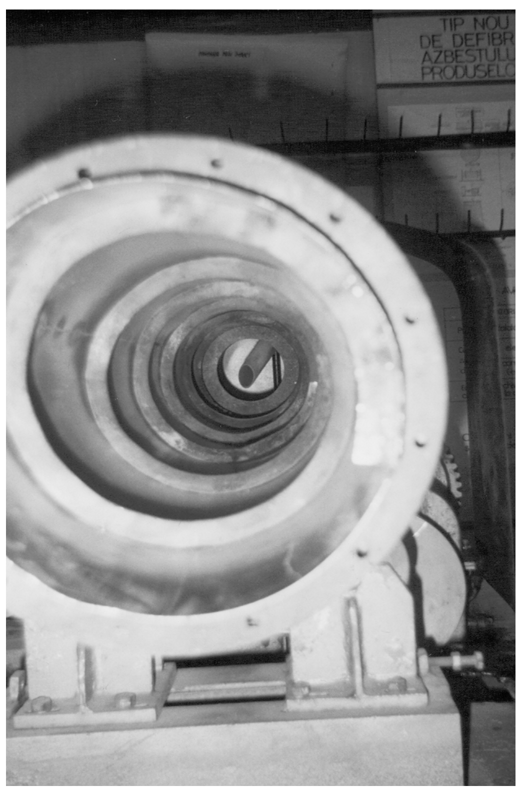

Fig. 2. Inner fitting out made of helicoidally metallic tape installed on drum [6]

The Influence of Inner Devices on Filling Coefficient, Output, Flow Capacity, Retention Time, Partial Coefficient of Heat Remittance and Heat Quantity

There are extremely rare the cases when a rotary drum is empty inside; it is usually provide with various metallic devices mend to enhance the contact surface between materials, gases and heated surface.

Inner side devices, on one side, help the material to be lifted and allow it drop into the gas flow, and on the other hand, enables the material conveyance. Gas flow heat during the descending motion, is transferred to the material by direct contact (when the blades are covered by the material)[2].

Filling coefficient ψ may take values between 0.1 and 0.3 [4]:

- for blade dispatched in "frame" shape 0.2 – 0.3;
- for blade dispatched in "cross' shape 0.2;
- for radial blades 0.08 -0.15.

Power required to activate the drum is determined by the relation [1]

$$N_1 = \frac{G\ D\ (1-\cos\rho_1) n\psi K_1}{1000\rho_1} \quad [\text{kW}] \tag{1}$$

where: G is the total weigh of dryer rotary side: refractory coating, slings, crown gear and material inside the dryer in (N), D – heater diameter (m), ρ_1 – natural slide angle, n – revolution [rot/min], ψ - filling degree [%], K_1 – coefficient which characterises the influence of the inner fittings.

The dryer flow capacity for radial blades may be calculated by the relation [5]

$$Q = 42(1+2{,}2/Z)\delta\ \ D_i^3 n\ \ tg\delta\ \ \rho_M g \quad [\text{kg/h}] \tag{2}$$

where: Z is the number of radial blades, n – cylinder revolution, δ – propeller gradient described by the material on the rotary drum shell;

$$t_r = \frac{D\psi}{0{,}07(\sin\delta+\cos\delta)h}\left(\frac{L}{D}\right)^{0{,}9}\frac{1}{n}K \quad [\text{s}]\ \ [6] \tag{3}$$

where: D – dryer dia [m], ψ- filling degree [%], L – dryer length [m], δ- drum gradient, n – revolution [rot/min], h – material high entering the dryer [m], K – coefficient function on inner fittings type.

Heat remittance partial coefficient proposed in $J/m^2 h$ grd may be calculated by formula:

- for blades out of helical bar

$$\alpha_1 = \sqrt{\frac{\lambda c_p \rho\left(\pi D_i + 2l_p\right)^2}{t_{min}}} \cdot 4{,}18 \cdot 10^3 \quad [6] \tag{4}$$

where: λ – thermal conductivity [J/m h grd], c_p – specific material heat [J/kg grd], ρ – density [kg/m^3], t_{min} – minimum time duration [h], D_i – inner dia of the dryer [m], l_p – bar length [m].

Heat quantity remitted for 1m^3 of material:

- helical bar blade

$$q_1 = \frac{\pi \left(D_i + 2l_p\right)^2 \alpha_1}{60 V_m Z} \cdot 4{,}18 \ \text{[kJ/ m}^3\text{ h grd] [6]} \quad (5)$$

where: D_i – dryer inner dia [m], α_1 – heat conveyance coefficient [J/m^2 h grd], V_m - material volume [m^3], Z – no of coil per 1 m length drum r, l_p – bar width [m].

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Considerații asupra construcției amenajărilor interioare ale uscătoarelor cu tambur rotativ

Rezumat

Lucrarea prezintă infulența construcției amenajărilor interioare asupra procesului de uscare (timpul de retenție, puterea, debitul, coeficientul parțial de transmiterea căldurii, cantitatea de căldură).