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Mathematical Model of Heat Transfer for Contact Dryer

The paper presents a part of the experimental and theoretical researches related to engineering and the application of the contact drying method. There are given the tests of the system parameters of the cylinder dryer with the layer of the dried material on the surface of the rotating cylinder of the contact dryer in the exploitation conditions. On the basis of the tests, heat transfer coefficient, heat transfer model, and other process relevant parameters are determined.

Keywords: Heat transfer model, contact dryer, rotating cylinder.

1. INTRODUCTION

The drying on the contact cylinder dryers is the common diffused technological process in chemical, food-processing and textile industry. Those are devices for drying colloidal solutions, suspensions, viscous fluids, textile materials and other.

Relatively simple construction and low specific energy consumption make these devices very attractive for applications in the mentioned industries. There are about them only few quantities data the tenable the estimate. For designing these dryers the data about the experimental plants are necessary. The cylinder dryers and drying technique improving is the aim at the efficiency and thrift of these plants, i.e. the reduction of the power and investing costs.

2. THE EXPERIMENTING APPARATUS AND RESULTS OF MEASUREMENT

The tests were done on the industrial plant of the cylinder dryer with the cylinder diameter $d_2 = 1220$ mm and the length $L = 3038$ mm that is heated inside by steam vapor. The scheme of the industrial plant is given in figure 1. When the cylinder is heated and the constant working pressure of $p = 4$ bar is released, the necessary experimental measurements in the stationary conditions are being done.

Under the stationary conditions is meant the stationeries during a great number of rotations (when non-stationeries that appears in every cylinder rotation separately is excluded). The tests were done under the following conditions:

1) The environment temperature in the closed room, the dry thermometer temperature $t = 18°C$,
2) The atmospheric pressure $p_a = 1$ bar,
3) The water vapor pressure $p_p = 4$ bar,
4) The water vapor temperature $t_p = 140°C$,

5) The number of cylinder rotations $n = 7.5$ min^{-1},
6) The thickness of the dried material moisture $\delta_2 = 0.25$ mm,
7) The cylinder surface $A = 11.5$ m^2,
8) The dried material moisture
   − at the beginning of the drying it was $w_1 = 65\%$,
   − at the end of the drying it was $w_2 = 5\%$,
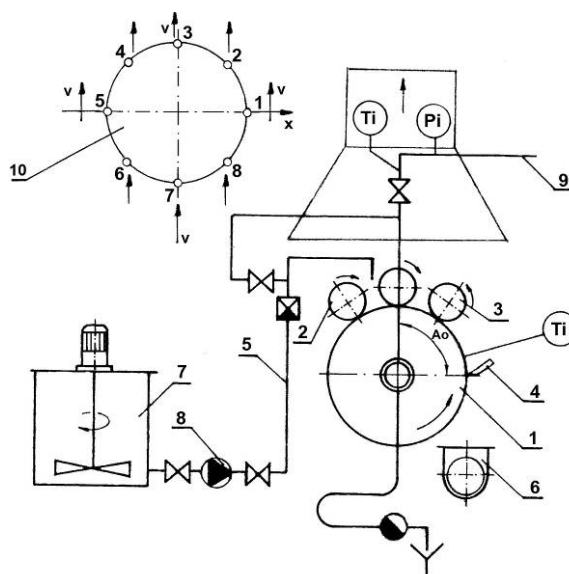9) Water vapor consumptio $m_p = 220$ kg/h

Figure 1. The technological scheme of the cylinder dryer plant and the experimental apparatus; 1-cylinder; 2-bringing cylinders; 3-scattering cylinder; 4-knife; 5-pipeline for the wet material transporting; 6-the worm conveyer; 7-the reservoir for the suspension preparing; 8-the screw eccentric pump; 9-steam pipeline; 10-the scheme of the measuring places.

During experimental measurements the following measuring instruments and accessories were used:

1) For measuring of water pressure it was used membrane manometer of 0-10 bar measurability, of 1.6% precision;
2) Water power temperature was measured by bimetal thermometer of 0-200°C, measurability, of ±2.5% precision;

3) Measuring the surface of cylinder temperature and temperatures in direct vicinity of the cylinder was performed by digital thermometer, type KD-23; sensor: thermo par NiCr-Ni, measurability from -69 to 199.9°C, ±0.1°C precision.

4) Vicinity temperature – of closed work room was measured by glass mercury thermometers (dry and humid) 0-50°C measurability.

5) Air speed in direct vicinity of the cylinder was measured by anemometer with incandescent wire, type: TA 400, Airflow Developments Canada - LTD, 0-2 m/s measurability, ±0.02 m/s precision.

6) Moisture of drying material was measured by digital meter for humidity type: Metler- LP16;

7) Water power consumption was found out on the basis of condensate mass measuring at the way out of the dryer with the balance "Scalar 100", 0- 100 kg measurability.

In the table 1, are given physical characteristics of the used fluids and material:

Table 1. Physical characteristics of the used fluids and material at 20°C

Media	Density	Raising level density	Viscosity	Specific heat
	[kg/m³]	[kg/m³]	[m Pa s]	[kJ/(kgK)]
Water	998.2	-	1.010	4.187
Starch	1.164	550	-	-
35% mass solution of starch and water	1.055	-	8.330	3.150

The results of temperature measuring with dried materials layer on cylinder surface are given in the table 2, and the results of measuring of air convection speed in direct vicinity of cylinder are given in the table 3. The measuring was performed in the plane of cylinder cross-section according to the scheme of experimental points given in figure 1.

Table 2. The results of temperature measuring with dried material layer on the cylinder surface

Number of measurements points	Distance from cylinder, x [mm]				
	0	10	20	30	40
1.			2.		
1.	89.0	43.5	39.8	37.2	35.0
2.	98.0	40.0	38.0	37.0	35.5
3.	96.0	41.0	39.0	33.0	34.0
4.	81.0	42.0	40.0	31.0	30.0
5.	82.0	35.0	31.0	30.0	29.0
6.	85.0	36.0	28.5	38.0	27.0
7.	83.0	30.0	27.3	26.0	25.0
8.	86.0	38.0	35.0	32.0	30.0
Mean value t [°C]	85.0	37.8	34.2	31.6	30.2

Table 3. The results of measuring of air speed with the layer of dried material on the cylinder surface

Number of measurements points	Distance from cylinder; x [mm]				
	5	10	20	30	40
1.			2.		
1.	0.48	0.32	0.28	0.26	0.24
2.	0.48	0.34	0.30	0.28	0.26
3.	0.48	0.38	0.34	0.30	0.28
4.	0.48	0.46	0.38	0.32	0.28
5.	0.48	0.36	0.32	0.28	0.24
6.	0.48	0.45	0.34	0.32	0.28
7.	0.48	0.44	0.36	0.34	0.32
8.	0.48	0.40	0.34	0.30	0.26
Mean value v [m/s]	0.48	0.40	0.33	0.30	0.27

3. DEFINING OF TOTAL COEFFICIENT OF HEAT TRANSFER

Relevant parameter for defining energetic balance of cylinder dryer presents the coefficient of heat transfer from condensing vapor at cylinder interior onto surrounding air.

Total heat flux from vapor onto surrounding air, can be given in the following form:

$$q_u = h_t \cdot (t_p - t_v) \tag{1}$$

For big cylinder diameters in relation to envelope thickness, we can, with the great punctuality, use the term for the coefficient of heat transfer as for flat wall the equation (2).

So, for example, for cylinder diameter $d_2 = 1220$ mm and cylinder wall thickness $\delta_1 = 35$ mm, if we define the heat transfer coefficient for flat wall, the error is 1.66% in relation to the variable of the heat transfer coefficient for cylinder body. Because of that a simpler form for total coefficient of heat transfer, given by the relation (2) will be applied.

When in the cylinder surface the level of drying material is raised, the coefficient of heat transfer is defined according to the following equation:

$$h_t = \cfrac{1}{\cfrac{1}{h_1} + \cfrac{\delta_1}{k_1} + \cfrac{\delta_2}{k_{2v}} + \cfrac{1}{h_{2m}}} \tag{2}$$

Influential parameter on the mechanism of heat transfer is the coefficient of heat transfer (h_m). The value of Nusselet's number is defined out of the equation.

$$Nu = \frac{h_m \cdot d_2}{k_v} = B \cdot Re^c \tag{3}$$

On the basis of grouping influential parameters that most influence the coefficient of heat transfer, the results of experimental and theoretical researches are correlated by the form of the equation of Nussele's type [1]:

$$h_m = \frac{k_v}{d_2} B \left(\frac{d_2 \cdot G}{\mu} \right)^c \tag{4}$$

The constants B and C are defined by the method of the least squares.

4. THE RESULT OF EXPERIMENTAL RESEARCHES AND DISCUSSION

Applying correlation theory on experimental results of measuring, we have got empirical equations of change of temperature t, in the function of x, distance, from the elevation of cylinder surface at every measuring point.

The temperature curve in the plane of the central cross-section of cylinder with the presentation of standard deviations is given in the figure 2.
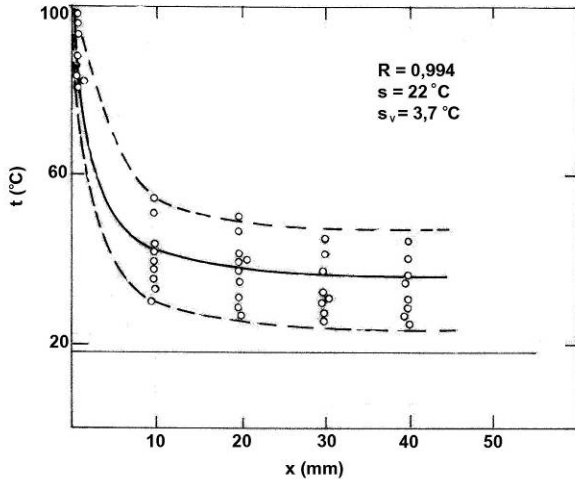

Figure 2. The curve of temperature in the plane of central cross – section of cylinder with the presentation of standard deviations

The empiric equation dependence of mean temperature and distance x, from the elevation of cylinder surface has the following form:

$$t_{sr} = 80 - 3.80 \cdot x + 0.07 \cdot x^2 \qquad (5)$$

Applying correlation theories on experimental results of measuring, we have got empirical equation of speed v, in the distance function x, from the elevation of cylinder surface at every measuring point.

The speed curve of convection in the plane of central cross – section of cylinder with the presentation of standard aberrations, is presented in the figure 3.
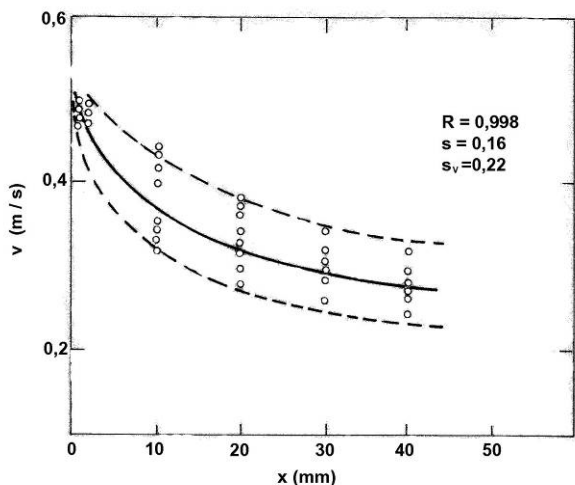

Figure 3. The curve of air convection in the plane of center cross – section of cylinder with the presentation of standard aberrations

Empirical dependence of mean speed of air v, in direct surroundings of cylinder and distance x, from the elevation of cylinder surface, has the following form:

$$v_{sr} = 0.48 - 0.009\,x + 1 \cdot 10^{-4} \cdot x^2 \qquad (6)$$

During such researches are defined: the coefficient of heat transfer from the drying material on surrounding air (h_{2m}) and total coefficient of heat transfer (h_t).

The results of experimental and theoretical researches are correlated with correlated equation of Nusselet's type, equations (7, 8).

There is also fixed temperature gradient and temperature flux, figures (4, 5 and 6).
Applying correlation theory on the results of experimental and theoretical researches, we have defined the empirical equation of heat flux dependence and temperature gradient presented with the expression (10).

In the figures 4, and 5, are presented the results of defining temperature gradient and temperature flux.

It can be noticed that local values of temperature gradient and heat flux have variables along the cylinder size. These variables of given values are formed due to varied air convection in cylinder vicinity, i.e. air mixing and thermo siphon effect of the hood for conducting away heat air and evaporated fluid. So, at certain places (on cylinder surface parts) with greater air convection speed, appear higher temperature gradients as well, figure 4.

On the lower "forehead" part of cylinder are higher temperature gradients, taking into account that the air in the room, where is the cylinder, performs the first conditioning (cooling) of the cylinder "forehead side".
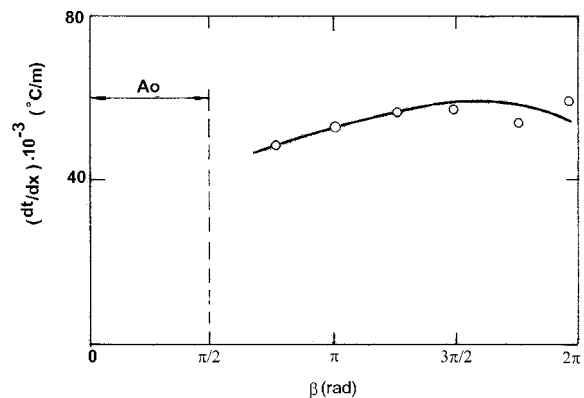

Figure 4. Change of temperature gradient near cylinder surface (d_2=1220 mm, t_m=85°C).

Greater variables originate in the lower part (zone) of cylinder, figure 5. The dominant effect on the heat flux extent in the given cylinder zone has flux that originates by humidity evaporation from drying material surface. In the given cylinder zone in drying process (the first drying zone), according to the literature [2], there appears intensive humidity evaporation out of drying material. Heat flux that originates with evaporating humidity, convection and radiation, presents total heat flux, figure 5. There is also fixed temperature gradient and heat flux, figure 7. So, e.g. the mean value of heat flux in the upper part of cylinder is

about 11,000 (W/m^2), while on the lateral side (at the place of the position of the knife for removing dried material) it is 8,000 (W/m^2), figure 5.
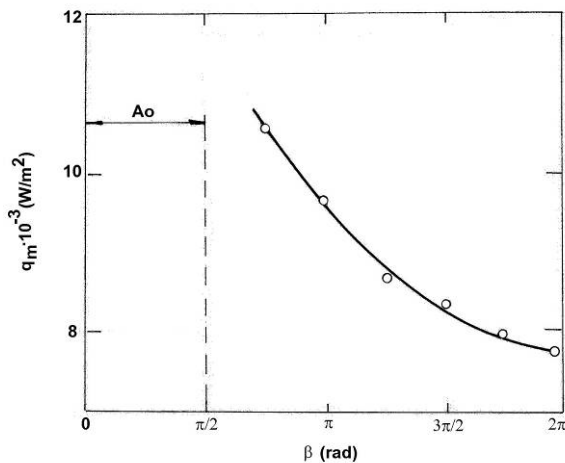

Figure 5. Heat flux change along the cylinder size
(d_2=1220 mm, t_m=85°C)

When there is a layer of drying material, total heat flux contains part of flux equal to the produce of heat conductivity of humid material and temperature gradient and flux part equal to the produce of material flux of humidity and specifically humidity enthalpy, i.e. the flux originating with evaporating humidity. Heat flux originating with evaporating humidity in its intensity is a relevant factor in total heat flux when there is drying material on the surface.

On the basis of local heat fluxes values, figure 5, heat flux has a variable along cylinder size. In the second drying period, and especially in the end of drying, temperature gradient has a rising tendency, figure 4. Due to research results [2], during drying process at cylinder dryers, humidity remnant near the end of drying is taken away at temperature rising on material surface; because of that, there are higher variables of temperature gradient in the end of drying as well.

Mean variables of temperature gradient along cylinder size, figure 4, are: at the cylinder lower part $57 \cdot 10^3$ °C/m, on the cylinder lateral sides they are $55 \cdot 10^3$ °C/m and on the top side of cylinder they are $50 \cdot 10^3$ °C/m.

In the figure 6, are given the results of defining temperature gradient in distance function from cylinder surface.

Mean variables of temperature gradient are:

- in the zone at cylinder surface $55.41 \cdot 10^3$ °C/m ;
- at the distance of about 5 mm from cylinder surface $6.65 \cdot 10^3$ °C/m ;
- at the distance of about 40 mm the cylinder surface $0.0115 \cdot 10^3$ °C/m etc.

In view of that, change of temperature gradient is the highest on the very cylinder surface, and it is in accordance with [3], and [4].
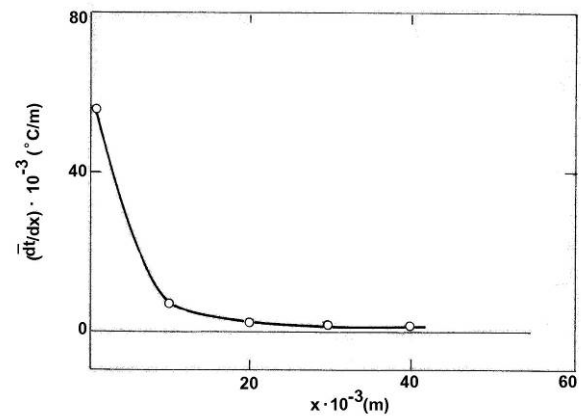

Figure 6. The mean variable of temperature gradient in distance function from the elevation of cylinder surface (d_2=1220 mm, t_m=85°C)

During acting of heating surface of drying material on surroundings in view of heat emitting, temperatures on the surface of the drying material layer are higher than the temperatures at greater distance of surface layer of drying material, so that temperature gradients are also on the surface layer of drying material higher, figure 6.

We can see two zones of air layer. The first one is in direct vicinity of cylinder surface at the distance of 10 mm. The second zone is distant more than 10 mm, figure 6. In the zone of the nearer cylinder surface of temperature gradient is steeper, figure 6, it is in accordance with [3] and [5]. These points out higher temperature gradient nearer to the layer surface of drying material.
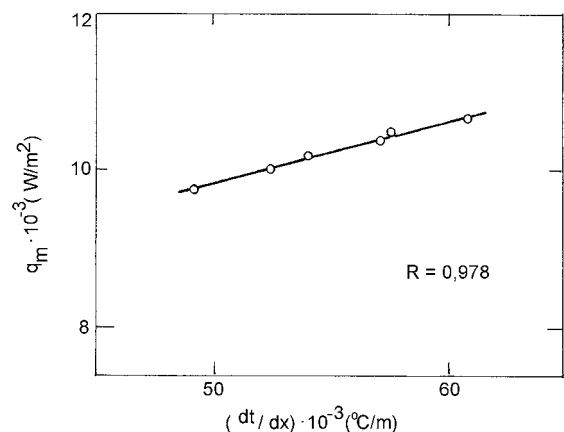

Figure 7. Dependence of change heat flux, and temperature gradient with cylinder (d_2=1220 mm, t_m=85°C)

Because of poor heat conductivity of air, layers more distant from the cylinder surface have lower temperature and with it lower temperature gradients too than air layer directly near the layer surface of drying material.

In the table 4 are presented the results of defining heat transfer coefficient by convection (h_m), heat transfer coefficient through radiation (h_r), heat transfer coefficient through evaporating humidity (h_h) and combined heat transfer coefficient (h_{2m}).

In the figures 8, 9 and 10, are given the research results correlated by the relation of Nusselet's and Reynolds's number.

Table 4. Combined heat transfer coefficient (h_{2m}), heat transfer coefficient through convection (h_m), heat transfer coefficient through radiation (h_r) and heat transfer coefficient by evaporating humidity (h_h)

Number of measuring place	Heat transfer coefficient through convection	Heat transfer coefficient through radiation	Heat transfer coefficient through evaporating humidity	Combined coefficient of heat transfer
	h_m	h_r	h_h	h_{2m}
	[W/m^{2}K]	[W/m^{2}K]	[W/m^{2}K]	[W/m^{2}K]
1.	2.	3.	4.	5.
4	15.0	7.2	475	497
5	15.8	7.2	335	358
6	17.0	7.1	189	214
7	17.8	7.2	128	153
8	14.7	7.3	87	109
1	16.9	7.1	41	65
Mean value	15.8	7.2	210	233

It is noticed that heat transfer coefficient by convection from drying material layer on (to) air is a variable along cylinder size.

Mean value of heat transfer coefficient is $15.8 \, \text{W/(m}^2\text{K)}$. Maximal value of heat transfer coefficient is in lower part zone of cylinder, and it is $17.8 \, \text{W/(m}^2\text{K)}$. Higher temperature gradient, figure 4 suits as well to greater values of Reynolds's number, figure 10, and accordingly greater values of heat transfer through convection and Nusselet's number as well, figures 8 and 9.
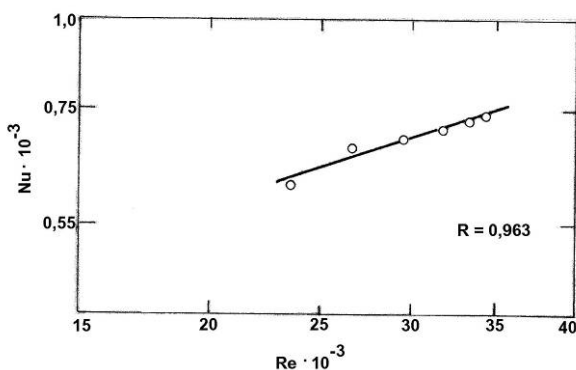

Figure 8. Dependence of change of Nusselet's and Reynolds's number with cylinder (d_2=1220 mm, v = 0.35 m/s, t_m=85°C)

On the basis of Reynolds's number value according to the figure 10, $Re = 29,950$; which is less than $Re_k = 5 \cdot 10^5$, [6], [7], Convection in direct vicinity of cylinder is laminated.

Changeable speed of air convection in direct vicinity of cylinder has effects on change of temperature gradient. Figure 4 and heat flux, figure 5, and what is in accordance with [8], [9]. So, local values of temperature

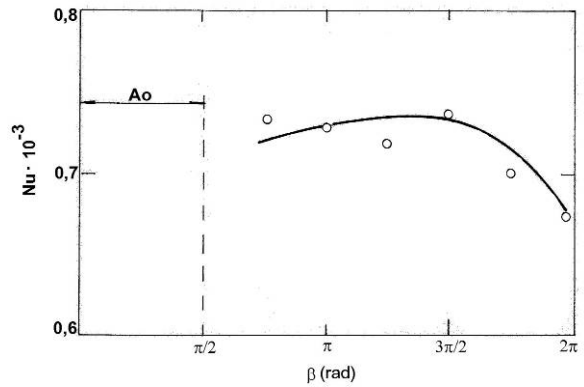gradient and heat flux have variables along cylinder size.

Figure 9. Nussele's number change along cylinder size (d_2=1220 mm, v = 0.35 m/s, t_m=85°C)
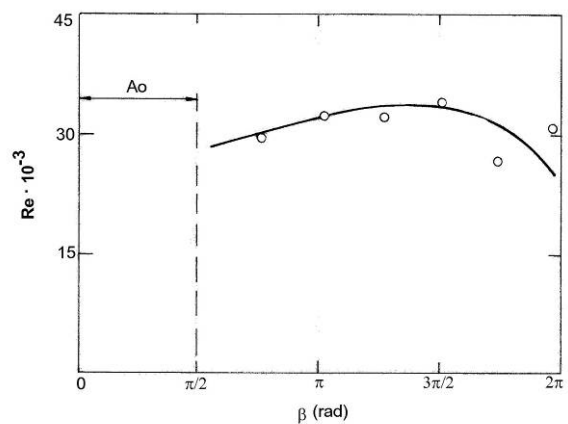

Figure 10. The change of Reynolds's number along cylinder size (d_2=1220 mm, v = 0.35 m/s)

Applying the correlation equation (3) and (4) to the results of experimental and theoretical researches, figure 7, we get the following empirical equation:

$$Nu = 0.569 \cdot Re^{0.691} \qquad (7)$$

This is Nusselet's type equation and at the same time it correlates the results of experimental and theoretical researches. Taking into account the equation (4), we can define heat transfer coefficient through convection from drying material surface coefficient into surrounding air with the help of the following relation:

$$h_m = 0.569 \cdot Re^{0.691} \frac{k_v}{d_2} \qquad (8)$$

For the equation (7), correlation coefficient is ($R = 0.863$) and standard error of coefficient ($c = 0.691$) is ($s = 0.05$), i.e. 5%, and which are defined by the method of the least squares.

On the basis of the relation (8) and the results of experimental and theoretical researches, the empirical equation for thermal resistance of convection heat transfer was defined in the following form:

$$R_{hm} = \frac{d_2}{0.569 \cdot Re^{0.691} \cdot k_v} \qquad (9)$$

In the figure 11 are given the results of total coefficient of heat transfer (h_t).

The thermal resistance representative that contains in itself the combined coefficient of heat transfer ($1/h_{2\mathrm{m}}$) has important effect upon total coefficient of heat transfer (h_{t}), what we can see in the table 5.

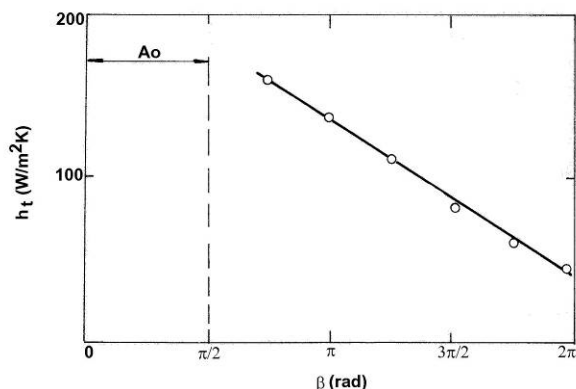Lower values of total coefficient of heat transfer suit to greater values of thermal resistance of heat transfer.

Figure 11. The change of heat transfer total coefficient along cylinder size (d_2=1220 mm, t_{m}=85°C)

Table 5. The total coefficient of heat transfer (h_t)

Number of measuring place	Thermal resistance of heat transfer				Total coefficient of heat transfer
	$1/h_1 + d_1/k_1 + d_2/k_{2\mathrm{v}} + 1/h_{2\mathrm{m}}$				h_{t}
	$10^3\ [(\mathrm{m}^2\mathrm{K})/\mathrm{W}]$				$[\mathrm{W/m}^2\mathrm{K}]$
1.	2.	3.	4.	5.	6.
4	0.1	0.76	3.1	2.0	167
5	0.1	0.76	3.1	2.7	150
6	0.1	0.76	3.1	4.6	117
7	0.1	0.76	3.1	6.5	96
8	0.1	0.76	3.1	9.1	76
1	0.1	0.76	3.1	15.3	52
Mean value	0.1	0.76	3.1	4.3	118

The mean value of heat transfer coefficient $h_{\mathrm{t}} = 118\ \mathrm{W/(m^2 K)}$ suits to the mean value for thermal resistance of heat transfer of $0.00826\ \mathrm{(m^2 K)/W}$, the table 5. According to the data from literature [10], heat transfer coefficient amounts to $105\text{-}345\ \mathrm{W/(m^2 K)}$.

Taking into account that local values of combined heat transfer coefficient are ($h_{2\mathrm{m}}$), the table 4, the variables along the cylinder size, as result they also give changeable technical resistances of heat transfer from the cylinder to air ($1/h_{2\mathrm{m}}$). So originate also changeable values of total heat transfer (h_{t}) along cylinder size, the figure 11.

The dominant effect on changeability of total heat transfer coefficient (h_{t}), figure 11, has the coefficient of heat transfer through evaporating humidity, the table 4. This effect is also represented in thermal resistance of heat transfer ($1/h_{2\mathrm{m}}$). The research results for these dryers include various values of Reynolds's number (which covers air convection speeds from 0.1 to 1 m/s) i.e. $Re = 10000\text{-}34500$, for standard cylinder size of 1220 mm .

Applying correlation theory to the results of experimental and theoretical researches, an empirical equation is fixed equation for dependence of heat flux and temperature gradient, figure 7.

$$q_{\mathrm{m}} = 4750 + 0.1 \cdot \frac{\mathrm{d}t}{\mathrm{d}x} \tag{10}$$

The total brought energy of vapour as thermal flux is:

$$q_{\mathrm{p}} = \frac{m_{\mathrm{p}} \cdot r}{A} \tag{11}$$

The energetic balance is presented in order to check the acquired results. For the mean value of temperature gradient $(\mathrm{d}t/\mathrm{d}x)10^{-3} = 55°\mathrm{C/m}$, figure 4 and 7, heat flux is $q_m = 10.250\ \mathrm{W/m}^2$, equation (10). On the basis of the equation (1), we get heat flux $q_{\mathrm{u}} = 10.620\ \mathrm{W/m}^2$. We considered here that the air temperature at the distance from the cylinder $x = 10\ \mathrm{mm}$, $t_{\mathrm{v}} = t_{\mathrm{sr}} = 50°\mathrm{C}$, according to the equation (5).

The total brought energy of vapour as thermalflux is $q_{\mathrm{p}} = 11.335\ \mathrm{W/m}^2$, equation (11). The received results for the heat flux q_{m}, and q_{u}, differ by 3.5%, due to the measurement error.

If we compare this with the brought energy of vapour $q_{\mathrm{p}} = 11.335\ \mathrm{W/m}^2$, we can see that the difference is $(715 - 1085)\ \mathrm{W/m}^2$. This in fact is heat loss. On the basis of that, the thermal degree of the use is $\eta_{\mathrm{T}} = (0.904 - 0.936)$, i.e. mean value is $\eta_{\mathrm{T}} = 0.92$. During contact drying there is a high degree of heat use due to direct contact of the drying material layer with the heated surface of the cylinder.

5. CONCLUSION

On the basis of the established experimental results and their analysis, the following conclusion can be drawn:

1. Local values of temperature gradient, heat flux and heat transfer coefficient have variables along the cylinder size, figures 4, 5 and 11.
2. Maximal values of heat flux originate in the upper cylinder zone (i.e. in first drying period) according to the literature [2]. The mean value of heat flux in the top zone of the cylinder is about 11,000 W/m², and on the lateral cylinder side (at the place of knife position) it is 8,000 W/m², figure 5.
3. Change of temperature gradient is the greatest on the cylinder surface, figure 6. Higher temperature gradients are in the presented cylinder zone, figure 4.
4. The values of heat transfer complex coefficient from the surface of drying material onto the surrounding air, the table 4, give changeable thermal resistances to heat transfer, the table 5. So, do originate variables of total heat transfer coefficient along the cylinder size. Here, the

greatest effect has heat transfer coefficient through evaporating humidity.

5. On the basis of the research results, the mean value of total heat transfer coefficient is h_t=118 (W/m^{2}K), the table 5, and the figure 11.

6. On the basis of the results of experimental and theoretical researches, we have got the critical equation (7), of Nussele's type, which correlates the research results.

In the scope of the research was applied thermodynamical approach to the problem. There were defined: temperature gradients, heat flux and heat transfer coefficients. In this way is given a new approach to the drying theory, which has been done during last the fifteen to twenty years.

In the final equation system setting the approach of classical thermodynamics was used. In this way the problem of presenting potentials of humidity spreading was avoided. Basic parameters are fixed for heat transfer in the process of contact drying, taking into account that various kinds of materials unequally react during drying, as well as that characteristics of drying material change dramatically.

The research results can serve:

• for defining essential dependences and parameters of heat transfer with rotating cylinders which are heated inside by vapor;

• with designing and developing of new contact cylinder dryings or selecting optimal parameters of heat transfer;

• for technical foreseeing of energetic characteristics of rotating cylinders for cylinder dryers as well as for similar drying processes.

The research results have usability because they are based on experimental data taken at a real plant.

In this way the results of experimental and theoretical researches can usefully serve to: researchers, designers and manufacturers of such and similar drying systems, as well for education purposes.

The objective of total researches of relevant parameters of heat transfer have has also been more complete energetically describing of rotating cylinders for cylinder dryers and drying in order to complement the existing knowledge and explanations of some so far incompletely explained phenomena in the appearance of simple devices.

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NOMENCLATURE (Helvetica 9 pt, bold)

A	cylinder surface, m^2
d_2	roll diameter, m
G	mass speed stream warm air, $kg/(sm^2)$
h_1	coefficient of heat transfer from condensing vapor on cylinder wall, $W/(m^2K)$
h_{2m}	heat transfer coefficient from drying material on surrounding air, (W/m^2K)
h_t	is total coefficient of heat transfer from condensing vapor in cylinder interior on surrounding air, W/m^2
k_1	thermo conductivity of cylinder envelope, (W/mK)
k_{2v}	mean thermo conductivity of material at drying $W/(mK)$
k_v	termical conductivity of air, $W/(mK)$
n	number of roll rotations, min^{-1}
Nu	Nuselts number
p	pressure, bar
q	heat flux, W/m^2
r	heat evaporation steam water, kJ/kg
Re	Reynolds number
R_{hm}	thermo resistance of convection heat transfer, $(m^2K)/W$.
t_p	water vapor temp. for cylinder heating, °C
t_v	air temperature of surroundings, °C
x	distance, m
v	speed, m/s
w	moisture, %
δ_1	thickness of cylinder envelope, (m)
δ_2	mean thickness of drying material layer, (m)
μ	dynamic viscosity warm air, kg/(sm)

МАТЕМАТИЧКИ МОДЕЛ ПРЕНОСА ТОПЛОТЕ ПРИ КОНТАКТНОМ СУШЕЊУ

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У раду је приказано експериментално постројење контактне ваљкасте сушаре, која се користи за сушење скробних раствора и суспензија у прехрамбеној индустрији. Експериментална мерења и испитивања су извршена на реалном индустријском постројењу ваљкасте сушаре у процесу производње.

Изложен је део експерименталних и теоријских истраживања везаних за технику и примену методе контактног сушења. Приказана су испитивања и мерења параметара сушења са слојем сушеног материјала на површини ротирајућег цилиндра контактне сушаре у експлоатационим условима. На основу резултата испитивања, одређени су релевантни параметри процеса.

Прорачун и димензионисање ових сушара врши се по приближној методи састављања енергетског биланса. У оквиру овог рада дат је екзактнији приступ решавања овог проблема путем термодинамичког модела. Тако су дефинисани кеофицијенти преноса топлоте, топлотни флукс и модели преноса топлоте, код овако сложеног система у условима ротације ваљка сушаре. На основу експерименталних мерења утврђене су критеријалне једначине преноса топлоте и дата њихова анализа.