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Analysis of cylinder drying intensity on cut strips based on enthalpy method

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Abstract

- Cylinder drying of cut strips is one of the key technologies during cigarette manufacturing process, which involves complex mass transfer and heat transfer phenomena.
- During the cylinder drying process, the heat exchanged between the cut strip and the wall of the cylinder by conduction and between the hot air by convection. The heat obtained by the cut strip is mainly used for the temperature rise of cut strip and the evaporation of moisture inner the cut strip.
- How to quantify the drying strength of cylinder drying is one of research hotspots of cylinder drying technology.

Table 1. Calculation and Analysis results of thermophysical parameters for cut tobacco

Batch \ index	Q_v kJ/h	Q_s kJ/h	Q kJ/h	η %
1	2180906.24	178222.93	2359129.17	7.55
2	2205049.99	181831.16	2386881.15	7.62
3	2198933.73	192989.70	2391923.43	8.07
…	…	…	…	…
26	2205492.73	200983.86	2406476.59	8.35
27	2181694.48	204471.41	2386165.90	8.57
Average value	2205279.25	197252.83	2402532.08	8.21
Standard deviation	22016.38	7368.49	24185.42	0.28
Coefficient of variation%	1.00	3.74	1.01	3.43

$$Q = Q_s + Q_v$$

$$Q_v = W(2490 + 1.88t_{outlet}) - 4.187\,Wt_{inlet}$$

$$Q_s = (1.968 + 4.187\,X_{outlet})\,G(t_{outlet} - t_{inlet})$$

$$\eta = {}^{Q_s}/_{Q} \times 100$$

- heat for water evaporation in cut strips Q_v, heat for temperature rising of cut strips Q_s, total heat quantity Q and thermal efficiency coefficient η

Objecties

- In order to study the actually cut strip heating and heat distribution in the process of cylinder drying, on the basis of obtained accurate temperature data of cut strips inside cylinder dryer, a thermodynamic model for cut strips during cylinder drying was established viewing from actually cut strip heating inside cylinder dryer.
- The relationships of technical parameters of cylinder drying with heat for water evaporation in cut strips Qv, heat for temperature rising of cut strips Qs, total heat quantity Q and thermal efficiency coefficient η were investigated with canonical correlation analysis.

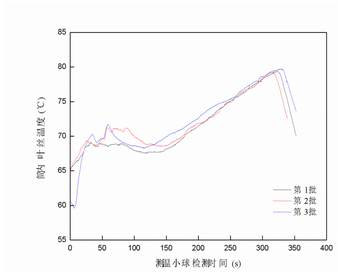

Fig.1 Raw temperature distribution of cut tobacco inside cylinder dryer duiring the drying process

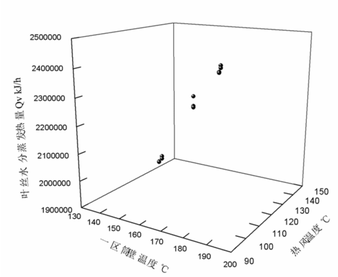

Fig. 2. Variation trend of water evaporation heat $\boldsymbol{Q_v}$ of cut tobacco under different processing conditions

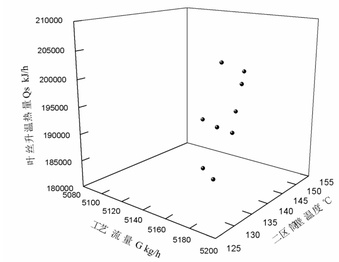

Fig. 3. Variation trend of special heat for cut tobacco heated $\boldsymbol{Q\_s}$ of cut tobacco under different processing conditions

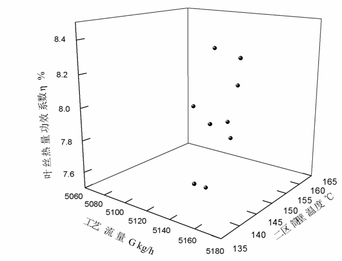

Fig. 4. Variation Trend of thermal efficiency coefficient $\boldsymbol{\eta}$ of cut tobacco under different processing conditions

Results and Discussion

- The established thermodynamic model well explained the actually cut strip heating and heat distribution in the process of cylinder drying, and the variation coefficients of the four thermophysical parameters of cut strips under the same processing conditions were all less than 5.0 %；
- The cylinder wall‘s temperature in the first section and hot air temperature significantly positively correlated to the heat for water evaporative；The cylinder wall‘s temperature in the second section significantly positively correlated to heat for temperature rising of cut strips；The throughput of cut strips significantly negatively correlated to heat for temperature rising of cut strips.
- How to obtain the accurate moisture and temperature of the inlet material, the moisture and temperature of the outlet material and is the basis of thermophysical analysis of the heating process of cut strips.

Conclusions

- The established thermodynamic model for cut strips during cylinder drying is feasible.
- The thermodynamic model is suitable for the stability evaluation between batches and the consistency evaluation of multi-point processing cylinder drying cut tobacco quality

References

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