ECOLOGICAL DRYING OF FINE MATERIALS

Sulaymanov Abduraxmon
Fergana Polytechnic Institute, Fergana Uzbekistan

Madaminova Gulmiraxon
Fergana Polytechnic Institute, Fergana Uzbekistan

Xalilov Ismoiljon
Fergana Polytechnic Institute, Fergana Uzbekistan

Alizafarov Bekzod
Fergana Polytechnic Institute, Fergana Uzbekistan

Xusanboyev Muhammadbobur
Fergana Polytechnic Institute, Fergana Uzbekistan

Abstract

The paper studies the possibility of environmentally friendly drying of fine materials in a contact dryer with a fast-rotating rotor. An equation for calculating a rotary dryer is given. The possibility of organizing wear-free drying during continuous operation of the device is shown.

Keywords: fine material, rotary drying, eco-friendly drying, continuous operation.

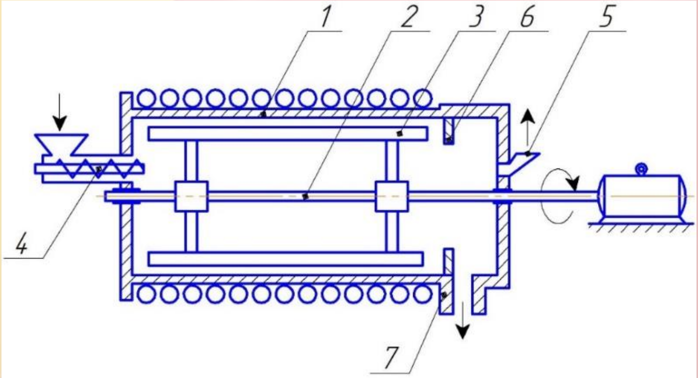
Introduction

Most modern dryers operate on a convective drying method and use heated air mixed with fuel combustion products as a drying agent. This method is very energy-intensive, long in relation to the drying time and consists of several stages, using expensive and metal-intensive drying units [1-4]. Energy costs due to the need to heat the drying agent and transport it increase many times, so the efficiency of these installations does not exceed 50-60%. In addition, due to the use of fuel combustion products in drying, the quality of the final product is significantly reduced [5-9].

The Main Part

If it is necessary to dry wet fine materials with particle sizes of 0.5-50 microns, the use of convective dryers is not always effective. The reason for this is that some of the product is carried away by waste gases and pollutes the environment [10-17]. As a result, it becomes necessary to purify secondary air with fine material particles, which requires rather cumbersome equipment for dust collection and several stages of purification. Convective drying is particularly undesirable for low-tonnage industries with a wide range of products, in some cases having environmentally harmful components, the loss of which affects the environmental situation, especially when drying toxic materials [18-26]. These industries include a number of "small" chemical and dye companies, which require a fairly frequent change of assortment and, consequently, a more thorough cleaning of equipment from the previous product.

In such cases, it is necessary to use non-entrainment dryers of the contact type, for example, rotary drum machines. In the drying units developed by us, the principle of contact drying is applied, which allows you to dry an environmentally friendly product in a short period of time and preserve its marketable qualities. And drying units that use this method are characterized by small dimensions, mobility, high productivity and a certain degree of versatility [27-34]. This type of dryer has been developed in a number of countries, but as far as we know, it is not widely used in the industry. These drying units can be used in the food, chemical and pharmaceutical industries for drying various fine materials. The mobile drying units developed by us, in comparison with the drying equipment currently used, will provide high drying performance with minimal energy consumption, as well as high throughput of the dried material with small dimensions. The design and operating principle of the proposed dryer is shown in Fig.1. Drying in the contact apparatus under study occurs in a thin mixed layer, which is formed in the gap between the blades and the heated drum wall under the action of centrifugal force generated by the fast-rotating rotor [35-42]. We considered it expedient to study the drying process of aggressive, environmentally harmful fine materials in this type of apparatus, since it became necessary to use them in production. Studies were carried out with a number of fine materials (less than 20 microns) - for deep drying (up to 0.01%) of phenylone C2 (pressed powders), for drying high-humidity activated carbon paste and other fine materials [41-46].



1. Diagram of the experimental setup: 1-housing; 2-rotor; 3-blades; 4-screw feeder; 5-secondary steam connection; 6 – discharge threshold; 7-discharge connection.

The device is a stationary horizontal heated drum (diameter = 180 mm, length=300 mm), inside which there is a rotating rotor with six blades; when the rotor rotates with the blades, the material is thrown to the periphery, where a moving mixed layer is formed in contact with the heated wall. Heating of the drum wall is carried out in an experimental installation due to electric heating, and in industrial conditions the drum is heated by water vapor supplied to the steam jacket of the drum. Drying of the material takes place in a layer, the maximum thickness of which, and, consequently, the residence time of particles in the apparatus, is determined by the size of the gap between the body and the blades (the layer thickness may be less). The required heat flow was kept constant or regulated, if necessary, to maintain a constant wall temperature by a voltage regulator [44-48]. Secondary steam with a small amount of non-condensable gases was removed from the apparatus along its axis and condensed in the heat exchanger, so product losses and environmental pollution were excluded. The drying kinetics was studied in periodic and continuous processes (material samples were periodically taken). The temperatures of the material in the layer and the inner surface of the wall were measured. Based on experiments, kinetic curves of changes in the humidity and temperature of the dried material in the periodic process were obtained at different rotor speeds. Data analysis showed that as the rotor speed increases, the drying intensity increases and the material temperature approaches the heating surface temperature at the end of the process. The effect of the speed on the heat transfer coefficient at different initial humidity of the material was also studied. With an increase in the initial humidity, the heat transfer coefficient significantly increases and reaches large values-about 500 W/m2K, but significantly decreases with a decrease in humidity (less than 200 W/m2K). It was interesting to identify changes in the heat transfer coefficient along the perimeter of the drum. Experiments were conducted with dry material and local values of the heat transfer coefficient were measured with a thermistor sensor. The heat transfer coefficient was measured at 8 points along the inner perimeter of the drum. Experimental data showed that at low rotor speeds, the heat transfer coefficient is low, which is explained by poor mixing of the layer, and in the upper part of the drum there is a separation of particles, since at these rotor speeds the centrifugal forces are small compared to gravitational forces. Because of this, the heat transfer coefficient profile is uneven around the drum perimeter. With a further increase in the angular velocity of the rotor, the heat transfer coefficient increases, since the mixing of particles improves and the number of their contacts with the hot surface increases, while the centrifugal forces also increase. As the angular velocity of the rotor increases, the ratio of centrifugal force to gravity increases rapidly. This leads to a uniform distribution of the material in the gap along its perimeter and, as a result, an increase in the contact heat exchange surface due to the use of the upper part of the drum with an increase in the angular velocity of the rotor and to equalization of local heat transfer coefficients. Analysis of studies on heat and mass transfer processes occurring during drying in rotary dryers shows that based on existing studies of the drying process, it is impossible to take into account all the characteristic features and changes in the kinetics of such a process.

A more complete model would be one that takes into account the change in the temperature of the material in each of the drying stages, the balance between the wet material, the additional heat input from energy dissipation due to the rapid movement of the dispersed material and the heated structural elements of the drum, as well as the effect of longitudinal mixing of the dispersed material. On the basis of general ideas about drying and its laws, we have considered the physical picture of the process by stages occurring in the drying unit, described the developed mathematical models and presented their solutions. The development of the mathematical model is based on the well-known laws of conservation of energy and mass of matter, provisions from the theory of drying and the laws of equilibrium between the material and the drying agent. Let's consider the characteristic components of the processes occurring during drying. The period of removal of free moisture is characterized by the fact that evaporation follows the laws of transformation of free liquid into steam. During this period, the drying process is mainly determined by the rate of heat transfer from the heated wall to the material being dried. One of the most important parameters determining the drying mode is the wall temperature. In the continuous drying process, the temperature of the wall along the length of the dryer changes due to the return of heat to the evaporation of the liquid, to the heating of the material and the rotor blades.

The calculation of the period of removal of bound moisture differs from the calculation of the period of removal of free moisture in that the surface temperature of the material increases, it is necessary to calculate using a modified relationship between the wall and the material to be dried. As a result of thermal contact of the material with the hot walls and rotor blades, a layer of dried material appears, the thickness of which gradually increases. And in the dried state, the dispersed material in terms of heat-conducting properties is not so far from the properties of thermal insulation materials. This is due to the fact that the main resistance to heat transfer is concentrated in the area of the material in contact with the heat-transferring surface. The processes occurring in this zone depend significantly on the Lykov criterion. If its values are small, the liquid will not have time to be supplied from the inner layers of the material to the contact surface, and a layer of dry material will appear separating the contact surface and the evaporation surface. The temperature of this layer on the contact surface is the same as the temperature of the heated wall, and on the opposite side it is equal to the evaporation temperature of the liquid, determined by the pressure in the drying drum.

The research results were used by us in the design and testing of a pilot plant, in particular for fine material with a capacity of 100 kg of moisture per hour. The dimensions of the pilot plant were 450 mm in diameter and 1500 mm in length. For Phenilon C2, the dimensions of the pilot plant are the same as for the laboratory one.

References

1. Мирзахонов, Ю. У., Хурсанов, Б. Ж., Ахроров, А. А., & Сулаймонов, А. (2019). Применение параметров натяжного ролика при теоретическом изучении динамики транспортирующих лент. In Энерго-ресурсосберегающие технологии и оборудование в дорожной и строительной отраслях (pp. 134-138).

2. Ergashev, N. A., Davronbekov, A. A., Khalilov, I. L. C., & Sulaymonov, A. M. (2021). Hydraulic resistance of dust collector with direct-vortex contact elements. Scientific progress, 2(8), 88-99.
3. Tojiev, R. J., & Sulaymonov, A. M. (2021). Comparative analysis of devices for wet cleaning of industrial gases. Scientific progress, 2(8), 100-108.
4. Rasuljon, T., Sulaymanov, A., Madaminova, G., & Agzamov, S. U. (2022). Grinding of materials: main characteristics. International Journal of Advance Scientific Research, 2(11), 25-34.
5. Тожиев, Р. Ж., Исомиддинов, А. С., Ахроров, А. А. У., & Сулаймонов, А. М. (2021). Выбор оптимального абсорбента для очистки водородно-фтористого газа в роторно-фильтровальном аппарате и исследование эффективности аппарата. Universum: технические науки, (3-4 (84)), 44-51.
6. Rasuljon, T., Azizbek, I., & Abdurakhmon, S. (2021). Research of the hydraulic resistance of the inertial scrubber. Universum: технические науки, (7-3 (88)), 44-51.
7. Тожиев, Р. Ж., Садуллаев, Х. М., Сулаймонов, А., & Герасимов, М. Д. (2019). Напряженное состояние вала с поперечным отверстием при совмесстном действии изгиба и кручения. In Энерго-ресурсосберегающие технологии и оборудование в дорожной и строительной отраслях (pp. 273-281).
8. Дусматов, А. Д., Хурсанов, Б. Ж., Ахроров, А. А., & Сулаймонов, А. (2019). Исследование напряженно деформированное состяание двухслойных пластин и оболочек с учетом поперечных сдвигов. In Энерго-ресурсосберегающие технологии и оборудование в дорожной и строительной отраслях (pp. 48-51).
9. Alizafarov, B., Madaminova, G., & Abdulazizov, A. (2022). Based on acceptable parameters of cleaning efficiency of a rotor-filter device equipped with a surface contact element. Journal of Integrated Education and Research, 1(2), 36-48.
10. Gulmiraxon, M., Muhammadqodir, Y., Ravshanbek, M., & Nikita, L. (2022). Analysis of the dispersion composition of dust particles. Yosh Tadqiqotchi Jurnali, 1(6), 70-79.
11. Ikromaliyevnab, M. G. (2022). New design of wet method wet cleaning blade-drum device. American Journal Of Applied Science And Technology, 2(05), 106-113.
12. Мадаминова, Г. И. (2022). Экспериментальные исследования по определению коэффициентов сопротивления барабанного аппарата мокрой пылеочистки. Universum: технические науки, (10-4 (103)), 46-52.
13. Мадаминова, Г. И. (2022). Исследования по определению контактных поверхностей пыли. Universum: технические науки, (5-7 (98)), 63-67.
14. Karimov, I., Tojiyev, R., Madaminova, G., Ibroximov, Q., & Xamdamov, O. T. (2021). Wet method dust remover black drum device. Barqarorlik va yetakchi tadqiqotlar onlayn ilmiy jurnali, 1(5), 57-63.
15. Karimov, I., Tojiyev, R., Madaminova, G., Ibroximov, Q., & Xamdamov, O. T. (2021). Hydrodynamics of wet dush powder black drum equipment. Barqarorlik va yetakchi tadqiqotlar onlayn ilmiy jurnali, 1(5), 49-56.

16. Isomidinov, A., Madaminova, G., Qodirov, D., & Ahmadaliyeva, M. (2021). Studying the Effect of Interior Scrubber Hydraulic Resistance on Cleaning Efficiency. International Journal of Innovative Analyses and Emerging Technology, 1(5), 87-93.
17. Isomidinov, A., Madaminova, G., & Zokirova, M. (2021). Analysis of modern industrial dust gas cleaning devices. Scientific progress, 2(8), 137-144.
18. Isomidinov, A., Madaminova, G., & Zokirova, M. (2021). Rationale of appropriate parameters of cleaning efficiency of rotor-filter device equipped with face contact element. Scientific progress, 2(8), 126-136.
19. Домуладжанов, И. Х., & Мадаминова, Г. И. (2021). Вредные вещества после сухой очистки в циклонах и фильтрах. Universum: технические науки, (6-1 (87)), 5-10.
20. Мадаминова, Г. И., Тожиев, Р. Ж., & Каримов, И. Т. (2021). Барабанное устройство для мокрой очистки запыленного газа и воздуха. Universum: технические науки, (5-4 (86)), 45-49.
21. Ализафаров, Б. М. (2020). Ecological drying of fine dispersed materials in a contact dryer. Экономика и социум, (11), 433-437.
22. Rasuljon, T., & Bekzod, A. (2022). Theoretical research of stress in rubber-fabric conveyor belts. Universum: технические науки, (4-12 (97)), 5-16.
23. Axunboev, A., Alizafarov, B., Musaev, A., & Karimov, A. (2021). Analysis of the state of the problem of ensuring the operation of the rotating units. Barqarorlik va yetakchi tadqiqotlar onlayn ilmiy jurnali, 1(5), 122-126.
24. Musajonovich, A. B. (2022). Methods Of Strength Calculation Of Multi-Layer Conveyor Belts. Eurasian Research Bulletin, 14, 154-162.
25. Tojiev, R., Alizafarov, B., & Muydinov, A. (2022). Theoretical analysis of increasing conveyor tape endurance. Innovative technologica: methodical research journal, 3(06), 167-171.
26. Tojiyev, R., Isomidinov, A., & Alizafarov, B. (2021). Strength and fatigue of multilayer conveyor belts under cyclic loads. Turkish Journal of Computer and Mathematics Education, 12(7), 2050-2068.
27. Ergashev, N., & Halilov, I. (2021). Experimental determination length of liquid film in dusty gas cleaner. Innovative Technologica: Methodical Research Journal, 2(10), 29-33.
28. Karimov, I., & Halilov, I. (2021). Modernization of the main working shovels of the construction mixing device.
29. Ikromali, K., & Ismoiljon, H. (2021). Hydrodynamics of Absorption Bubbling Apparatus. Бюллетень науки и практики, 7(11), 210-219.
30. Ergashev, N., Ismoil, K., & Baxtior, M. (2022). Experimental determination of hydraulic resistance of wet method dushanger and gas cleaner. American Journal Of Applied Science And Technology, 2(05), 45-50.
31. Karimov, I., Xalilov, I., Nurmatov, S., & Qodirov, A. (2021). Barbotage absorbation apparatus. Barqarorlik va yetakchi tadqiqotlar onlayn ilmiy jurnali, 1(5), 35-41.

32.Rasuljon, T., Voxidova, N., & Khalilov, I. (2022). Activation of the Grinding Process by Using the Adsorption Effect When Grinding Materials. Eurasian Research Bulletin, 14, 157-167.

33.Khoshimov, A., Abdulazizov, A., Alizafarov, B., Husanboyev, M., Xalilov, I., Mo'ydinov, A., & Ortiqaliyev, B. (2022). Extraction of caprolactam in two stages in a multiple-stage barbotation extractor. Conferencea, 53-62.

34.Ахунбаев, А. А., & Хусанбоев, М. А. (2022). Барабаннинг кўндаланг кесимида минерал ўғитларнинг тақсимланишини тадқиқ қилиш. Yosh Tadqiqotchi Jurnali, 1(5), 357-367.

35.Хусанбоев, М. (2022). Термическая обработка шихты стеколного производства. Yosh Tadqiqotchi Jurnali, 1(5), 351-356.

36.Kobilov, E. E., & Tukhtaev, M. K. (2022). Current treatment of acute bacterial destructive pneumonia in children. World Bulletin of Public Health, 17, 1-4.

37.Ахунбаев, А. А., & Хусанбоев, М. А. У. (2022). Влияние вращения сушильного барабана на распределение материала. Universum: технические науки, (4-2 (97)), 16-24.

38.Хусанбоев, А. М., Ботиров, А. А. У., & Абдуллаева, Д. Т. (2019). Развертка призматического колена. Проблемы современной науки и образования, (11-2 (144)), 21-23.

39.Хусанбоев, А. М., Тошкузиева, З. Э., & Нурматова, С. С. (2020). Приём деления острого угла на три равные части. Проблемы современной науки и образования, (1 (146)), 16-18.

40.Tojiyev, R., & Rajabova, N. (2021). Experimental study of the soil crust destruction mechanism. Scientific progress, 2(8), 153-163.

41.Kobilov, E. E., & Tukhtaev, M. K. (2022). Comparative Evaluation of the Results of Treatment of Acute Adhesive Intestinal Obstruction in Children. Eurasian Medical Research Periodical, 15, 1-3.

42.Rajabova, N. R., & Qodirov, A. B. (2022). Drying tonkodisperse materials in an unsuccessed rotary-druming machine. International Journal of Advance Scientific Research, 2(06), 35-39.

43.Rasuljon, T., & Nargizaxon, R. (2022). Impact on the internal structure of materials to drying process. Universum: технические науки, (10-6 (103)), 10-18.

44.Ахунбаев, А. А., & Ражабова, Н. Р. (2021). Высушивание дисперсных материалов в аппарате с быстро вращающимся ротором. Universum: технические науки, (7-1 (88)), 49-52.

45.Хусанбоев, А. М., Абдуллаева, Д. Т., & Рустамова, М. М. (2021). Деление Произвольного Тупого Угла На Три И На Шесть Равных Частей. Central asian journal of theoretical & applied sciences, 2(12), 52-55.

46.1Ахунбаев, А. А., & Ражабова, Н. Р. (2021). Высушивание дисперсных материалов в аппарате с быстро вращающимся ротором. Universum: технические науки, (7-1 (88)), 49-52.

47. Jumaboevich, T. R., & Rakhmonalievna, R. N. (2022). Installation for drying materials in a fluidized bed. Innovative Technologica: Methodical Research Journal, 3(11), 28-36.
48. Ахунбаев, А., Ражабова, Н., & Сиддиков, М. (2021). Математическая модель сушки дисперсных материалов с учётом температуры материала. Збірник наукових праць SCIENTIA.