ROTATION-PULSED FLUID BED SALT DRYER

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Abstract

Salt is one of the most popular spices in the food industry. It is usually produced from sea water by extracting, purifying and drying. In one of the technologies of its production the crystal sea salt is dried, ground into powder, packaged and distributed to the market.

Keywords: fluidized bed, crystal sea-salt, dryer

Introduction

The salt is a crystal material witch can be obtained by separation of the crystals from the solution, by means of machines using a centrifugal or gravitational force.

The sea-salt particles size varies from a few millimeters $2 \div 2{,}5$ mm up to $10 \div 15$ mm and more.

The residual moisture of the crystal sea-salt after its separation from the solution is usually from $2{,}5 \div 4{,}5$ %. At this moisture the product is unsuitable for grinding and therefore they should be dried up to a final moisture of $0{,}2 \div 0{,}25$ %.

The rotary dryers and fluid bed dryers have found the most widely application for crystal sea-salt drying.

With both types the heat required for moisture evaporation should be lead convectively. The rotary dryers have a comparatively simple construction, a little specific electric energy consumption, the most significant advantage being their reliable operation, even when processing polydisperse materials. Together with these advantages, these apparatuses have some significant disadvantages: a big metal cubic content per unit of produce, they are difficulty subjected to automatization and require great production sites.

The fluid bed dryers have a simpler construction, they are easily subjected to automatization, and they occupy smaller sites in comparison with the rotary dryers at one and the same output. A disadvantage of this type of dryers is the increased electric energy consumption for keeping the bed in fluidized state.

When the sea-salt moisture is within the maximum values cited above, particles fluidization is within becomes difficult because of the increased cohesion forces between the separate crystals that adhere to each other. In these cases, to be in fluidized state, to the bed vibrations, mechanical scattering or jet-pulsed moist particles fluidization should be applied. The apparatuses operating on the principle of jet-pulsed fluidization have a considerable simpler construction than those with a mechanical mixing or vibrations, but the efficiency of processing of high-moisture content adhering materials almost does not concede to vibration units.

The experience we have acquired on projection, investigation and operation of jet-pulsed fluidized bed apparatuses utilized for processing a great number of foods, chemical and biotechnological products (egg melange, boza, whey protein, Beauverin, Thrichodermin, Fuzarium, Cugoplex, coffee, nuts, etc.) have allowed us to successfully project, work out and implement into operation an installation for crystal sea-salt drying, with an output of 2500 ÷ 3000 kg/h of final product (Figure 1).

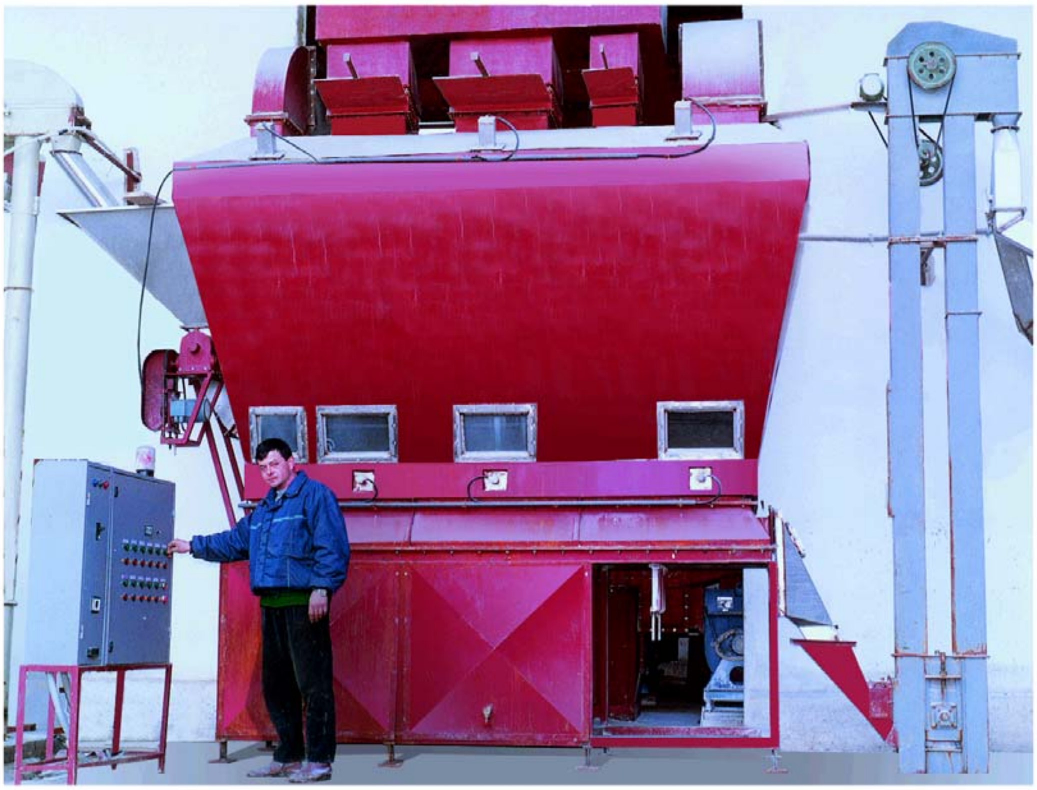

Figure 1. Rotation-pulsed fluid bed working chamber.

Dryer operation principle

This installation consists of a dryer (Figure 1), including a working chamber /5/ (Figure 2) and sub-grid chamber /38/ (Figure 3) separated by an immovable supporting grid /9/, moist product elevators /2/, dry product elevators /18/, roller grinder /1/, air heat-exchanger apparatus /36/, with a petroleum burner /33/, cyclones /24/ and /26/, fans /22/, /32/, /35/, and /42/, mixing chamber /14/, storage hopper /4/, rotational feeder /3/, thermometers, air-inlet ports, valves, etc.

The working chamber /5/ is divided by length into five sectors by means of transverse barriers. In the first three sectors drying of the material is done, while in the last two – the dried product is cooled down to approximately 35 ÷ 40 ^{0}C. The pipes /6/ and /16/ are positioned in the upper part of the drying chamber, as well as the mixing chamber /14/, that serves to lead out the waste drying agent from each one of the sectors. The mixing chamber /14/ takes out the air from IInd, IIIrd and IVth sectors. Sensors for measuring the exit air temperature in the above-bed space are mounted in the IInd, IIIrd and Vth sectors.

The sub-grid space /38/ is divided into three sectors. In the first two sectors gas distributing units are mounted for creation of a rotation-pulsed fluid bed with purpose of optimum fluidization of moist particles. In the last – third sector, the grid is split and is designed for creating a conventional fluid bed. This sector serves for cooling down the dried material which is fluidized without problems when a part of its moisture is led away.

The installation operates by following the principle, namely: the moist sea-salt passes through the roller grinder /1/ first, where the big bumps are broken into smaller particles, after which by means of the elevator /2/ it is lifted and is passed into the storage hopper /4/ of the dryer. The dosing of a definite quantity of material should be done by means of a volume rotor feeder /3/, after which the product enters first, by forming the fluidized bed upon the immovable supporting grid /9/. The crystals drying is done in the Ith, IInd, and IIIrd sectors of the dryer by means of blowing through the bed by drying agent heated up to 170 ÷ 200^{0}C. The air heating is done indirectly in air heat-exchanger apparatus /36/. The latter is supplied by a petroleum burner /33/, burning chamber and pipe heat-exchanger surface.

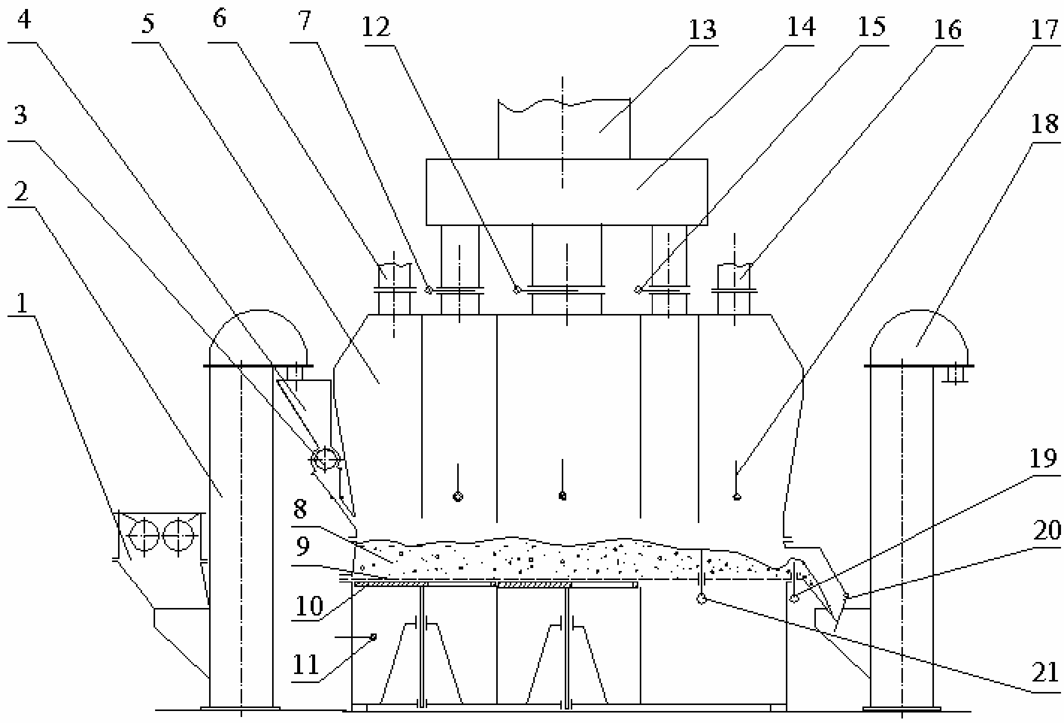

Figure 2. Working chamber scheme.

The passing of the material from sector into sector is free by means of the outlets formed for this purpose. At the end of sector IVth, a flat valve /21/ is mounted that serves for a varying height barrier, that regulates the fluid bed height in the first four sectors. In the last two sectors the dried crystals are cooled down by means of cool air sucked from the environment by means of the /42/. At the end of the last sector, the valve /19/ is positioned for adjusting the bed height in sector Vth, and immediately after it a valve-blinker /20/ is mounted serving for taking out the dried and cooled down material in batches and for drying chamber pressurization. Further on the crystal salt is taken by the elevator /18/ and is transported to a fine salt grinding grinder, after which the latter goes for prepacking, packaging and market distribution.

The cool air is sucked out from the workshop under the supporting grid /9/, which is situated in the cooling part of the apparatus, blows through the heated material and cools it down, heating itself regeneratively at the same time. After the bed the air is separated in each one of the cooling sectors into two parts – one of them is sucked from the fan /42/ through the pipe /16/, then it is dedusted into a cyclone and is thrown away into the atmosphere. The other part is included as fresh air into the drying agent recirculation cycle, passing through the drying part of the apparatus. The recirculating air is the sum total of the three streams – the fresh air from IVth sector and the exit drying agent from IInd and IIIrd sectors, these streams are mixing together into the mixing chamber /14/. The mixture formed is carried away along the pipe /13/ towards the fan /32/, together with which it is dedusted into cyclone /26/, then it is heated up in the air heat-exchanger apparatus /36/ to 170 ÷ 200^{o}C and along the pipes /39/ enters the first two gas-distributing sectors of the drying part of the apparatus. By means of the rotating gas-distributing disk /10/ the air is shaped as a flat jet surrounding the working chamber cross-section in the Ith, IInd, IIIrd sectors, blows through the bed of moist material and dries it up, intakes the evaporated moisture in itself and through the pipes /6/ goes out of the dryer. After that the moist air is sucked by means of the fan /22/ through the pipe /10/ then it is dedusted into the cyclone /24/ and is thrown away into the atmosphere.

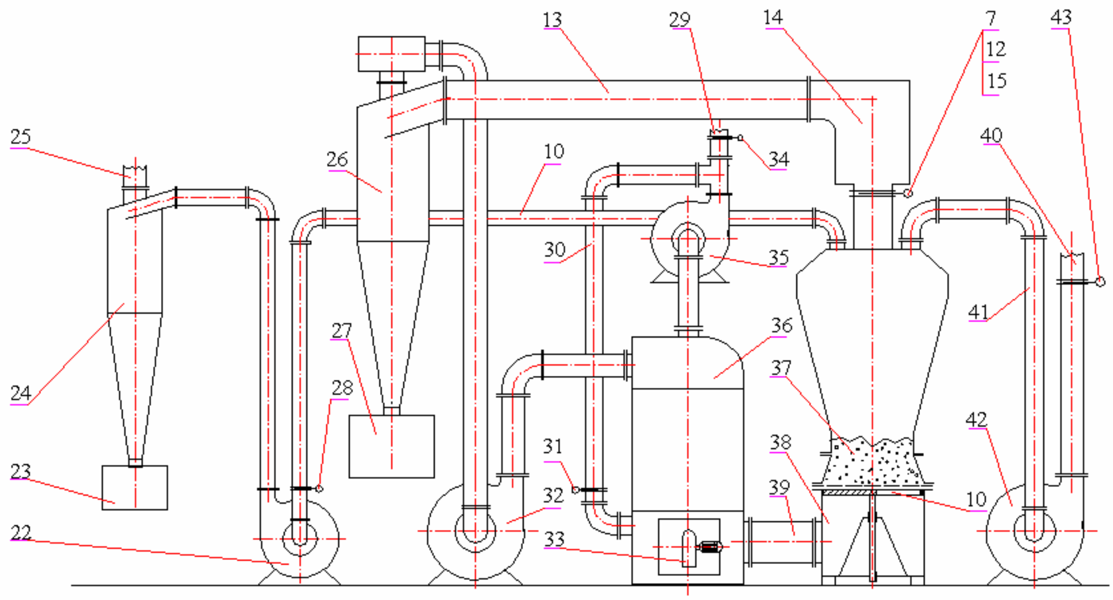

Figure 3. Dryer installation.

The remaining part of the exit drying agent is included into the recirculation cycle described above.

The described drying operation is realized in conditions of drying air particle recirculation through the working chamber, countercurrently to the wet material. The air saturation with evaporated water is gradual and the exit air quantity is as much as it is needed in order to lead away the evaporated water from the product. The remaining part of the air is recirculating consistently through the drying chamber and air heat-exchanger and is acting as heat-carrier for bringing the needed heat to the product.

When starting the installation after the established mode of operation has been reached, the following values have been measured: final product output of the dryer, drying agent temperature in the Ist, IInd and Vth sectors, drying agent flow rate in each one of the five sectors of the working chamber, exit drying agent temperatures in the IInd and IIIrd sectors.

The purpose of the measurements has been to find the optimum working mode of the installation.

Figure 4 gives the dependence of the dry product output of the installation on the material final moisture at different initial moisture.

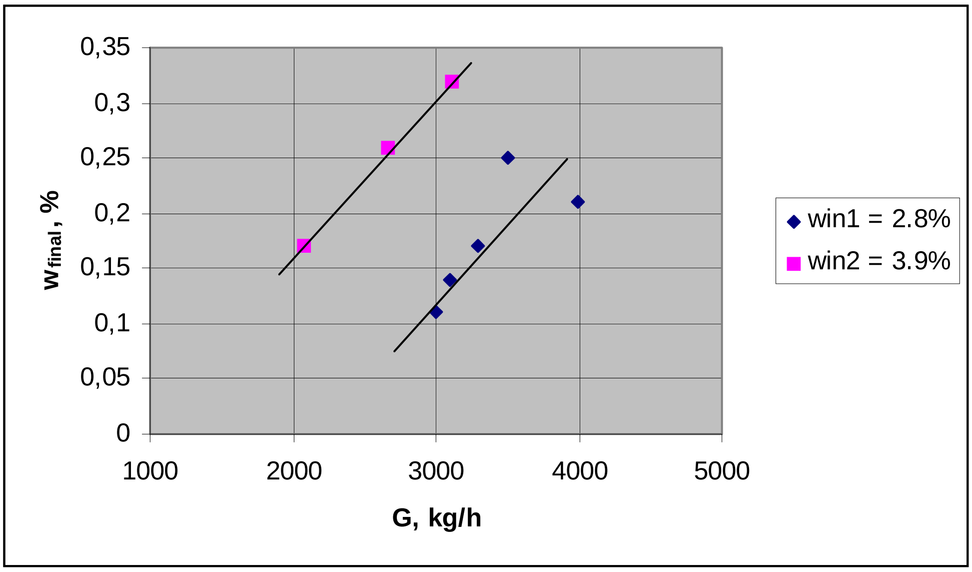

Figure 4. Drying capacity curves.

Conclusions

The application of rotation-pulsed fluidized bed dryers for salt drying is grounded.

The operation of an industrial rotation-pulsed fluidized bed installation for crystal sea-salt drying is described.

It is established that at the final moisture desired of 0,25 %, the dry product output is minimum 2500 kg/h, at maximum initial moisture of 3,9 %.

Nomenclature

w – moisture content, %
G – capacity, kg/h
in – initial

Literature

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