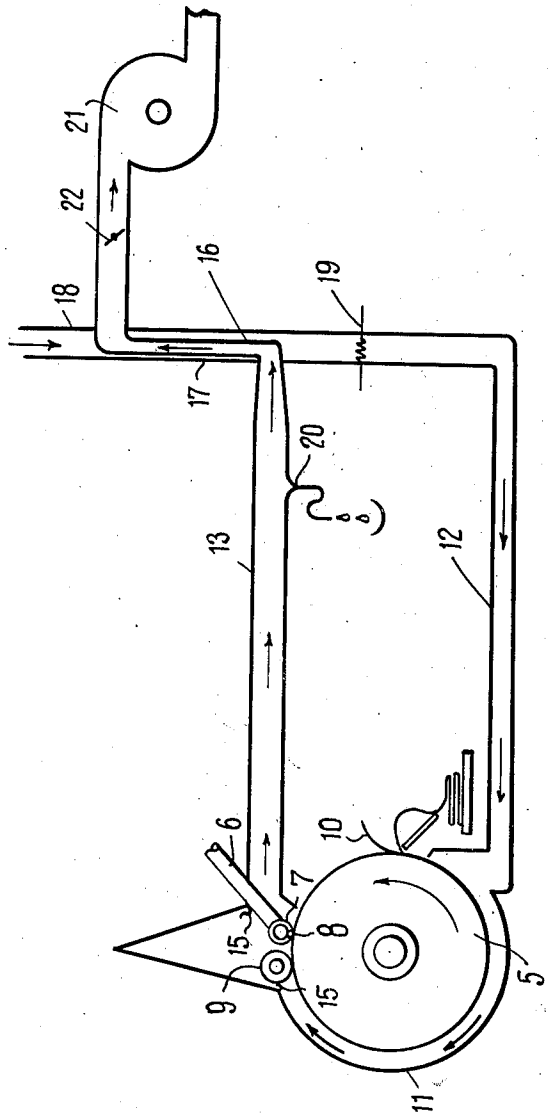
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TREATMENT OF FOOD MATERIALS

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TREATMENT OF FOOD MATERIALS

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This invention relates to the manufacture of food products and more particularly to an improvement in the method of reducing the moisture content of food materials set forth in the patent to Sartakoff Number 1,908,489, May 9, 1933, although it will be apparent to those skilled in the art that various features of the invention are equally well adapted to other methods of drying material by a contact with a drying surface.

An object of this invention is to provide a method of drying material in which the evaporation of moisture is so controlled and regulated as to insure protection of the material against overheating during the entire drying period, while subjecting it to the most effective drying temperature, thus improving the quality of the product and increasing the efficiency of the operation.

This and other objects which will be apparent to those skilled in this particular art are accomplished by means of the invention hereinafter set forth. The accompanying drawing comprises a diagrammatic view showing one arrangement of apparatus which may be employed for carrying out the method of the present invention.

In the present invention the drying surface may be of any desired type but is preferably provided by the outer face of a rotary, interiorly heated drying drum on which the material is carried through the drying zone. The fresh material is continuously delivered to the moving drum surface, dried thereon and then continuously removed therefrom, preferably in the form of a continuous film by a suitable scraper or blade.

Referring to the drawing, a rotary, interiorly heated drying drum 5 is supplied with material to be dried through a feed line 6 and a feeder head 7. The feeder head extends across the face of the drum and has a plurality of openings 8 through which material is deposited on the drum surface. Immediately adjacent to the feeder head is a heated distributor roll 9 or similar device which operates to disperse the material over the face of the drum as, for example, in the manner set forth in the Sartakoff patent, in which the particles of material are more or less separated so that each particle is subjected substantially directly to the drying heat. A scraper or blade 10 is pressed against the drum surface with sufficient pressure to maintain a constant contact across the entire extent of the drying surface during movement of the latter. The contact must be sufficiently close to remove all dried material so that the surface is perfectly clean and free of all particles of pulp and the like after passing the scraper. A flexible blade of steel, the edge of which is pressed against the drum surface with sufficient pressure to provide the necessary contact across the entire surface has proven to be entirely satisfactory. When the Sartakoff process of drying is followed, such a blade consolidates the particles and removes the dry material from the drum surface in the form of a continuous film, as described in the Sartakoff patent. However, it should be understood that the present invention while particularly effective when used in connection with the Sartakoff process, is equally well adapted to any form of surface drying operation, such as conventional drum drying or the like. The film, or the like, may be collected in any desired manner.

When drying any material upon a heated drying surface, care must be taken to avoid too elevated a surface temperature not only to prevent injury to the material itself, but in order to obtain the highest rate of evaporation. If too high a temperature is employed, a layer of steam forms between the material and the drying surface and this layer of steam insulates the material from the heat of the surface, in turn reducing the rate of evaporation. The most efficient temperature of a drying surface for most fruits and vegetables is approximately from 180° to 220° F. If the temperature is much above or below this range the rate of evaporation decreases. However, in drying some materials other considerations may render it advisable to employ a surface temperature outside of this specified range.

That portion of the face of the drying drum on which the drying operation is conducted, between the distributor roll and the scraper, is enclosed within a hood 11 extending from a point closely adjacent the scraper to and enclosing the point of application of the material such as the distributor roll 9 and the feeder head 7.

I have found that in the drying of fruit and vegetable materials, when fresh pulp having a high water content is first dispersed over a heated drying surface, the moisture evaporates with great freedom, in substantially the same manner as free water. However, as the percentage of moisture in the material is reduced, evaporation occurs less and less freely until when the moisture content is less than approximately 10% evaporation of all or part of the remaining moisture without injuring the material involves considerable difficulty. In order to safely accomplish evaporation of the lower percentages of

moisture, something more than mere heating or reduction in pressure is required.

Also, in drying such a material as fruit or vegetable pulp, evaporation of the liquid component absorbs sufficient latent heat to keep the temperature of the material down to a relatively low and safe point, but this is true only so long as the evaporation occurs rapidly enough to absorb the necessary amount of heat. When the evaporation of moisture from a heated fruit or vegetable particle is too slow to absorb sufficient latent heat the temperature of the material is raised to substantially the same temperature as the heating medium. Heretofore, this has resulted either in such overheating of the material as to injure the fresh fruit or vegetable, or it has required drying at a low temperature which in turn required a prolonged exposure of the material and corresponding damage.

In the present invention, in order to obtain the desired degree of drying in the shortest possible time without the use of dangerously elevated temperatures or subnormal pressures, provision is made for directing a stream of moisture-collecting air having certain predetermined characteristics along the drying surface in contact with the material being dried and in a direction counter to the direction of movement of such material. The moisture-collecting capacity of this air stream is so controlled and maintained as to turn the above mentioned evaporation factors to advantage in order to accomplish the purposes of the present invention.

The stream of moisture-absorbing air is first heated sufficiently to reduce its relative humidity to a low point, preferably to 10% or less. Inasmuch as the ordinary atmosphere is employed, it will be apparent that the actual amount of heating necessary to reduce its relative humidity to the desired point will vary with prevailing atmospheric conditions. For example, if the temperature of the atmosphere is 32° F. and its relative humidity 40%, in order to reduce its relative humidity to 10% it must be heated to about 72° F. If the temperature of the air is 32° F. and its relative humidity 90%, it must be heated to approximately 98° F. On the other hand, if the temperature of the air is 90° F. and its relative humidity 40% it must be heated to approximately 142° F. to bring the relative humidity down to 10%. If the temperature of the air is 90° F. and its relative humidity 90% it must be heated to approximately 178° F. The necessary amount of heating required on different days can be readily determined by known methods and varied in accordance with prevailing atmospheric conditions.

The heated air stream having a low relative humidity is conveyed through an inlet conduit 12 to the drying surface at a point closely adjacent the scraper where the evaporation of moisture from the material is substantially complete, except for a small remaining percentage which is ordinarily difficult to remove without injury to the material. However, the water-absorbing capacity of the air resulting from its low relative humidity is such as to rapidly absorb the small amount of moisture remaining in the material at that point and, in this way, maintain active evaporation until the instant when the material is removed from the heated surface. The material is removed from the heated surface as soon as it has lost the protection against overheating afforded by the evaporating moisture.

I have found that a hygroscopic material such, for example, as the fruit and vegetable product of the Sartakoff process the moisture content of which usually lies between 4% and 10%, absorbs moisture when in an atmosphere having a relative humidity above a certain critical point, while the same material will give up moisture to an atmosphere having a relative humidity below such point. Usually with such materials as the Sartakoff products, moisture is given up to an atmosphere having a relative humidity below approximately 40%, and taken up by the material if the relative humidity of the surrounding atmosphere is over 40%.

In the present invention, as above noted, during approximately the entire last half of the drying operation, as the partially dried material on the drying surface approaches the knife blade, the high rate of evaporation is maintained by contact with air at low relative humidity. The heat received by the counter flowing air stream from the heated drying surface prevents cooling of the stream and resulting condensation of the moisture collected thereby. In this way the relative humidity of the stream is kept below the critical point, approximately 40% in the case of Sartakoff products, until it comes in contact with material on the upper portions of the drum surface, where the material is predominantly liquid and has substantially the evaporation characteristics of free water. Here the relative humidity of the air stream can be increased above the critical point without too greatly reducing the rate of evaporation. As the air stream travels over this predominantly liquid material, although the temperature of the air stream is maintained against lowering by the heat from the drum, it rapidly becomes substantially saturated so that by the time it reaches the distributor roll and is in contact with the material freshly delivered to the drying surface its relative humidity is approximately 95%. This tends to reduce the rate of evaporation during the first part of the drying operation and aids in producing a more constant rate of evaporation of moisture from the material from the time it is first placed on the drying surface until it is removed therefrom. The moisture laden air is removed from the drying surface through a conduit 13.

In order to prevent moisture which may condense on the inner face of the hood 11 above the drum 5, from dripping on to the top of the drum, the hood is shaped at that point to provide steeply inclined surfaces 14 down which any condensed moisture will flow to gutters 15 which carry it away.

It will be apparent that in passing over the drying surface and absorbing moisture therefrom the air stream has accumulated a large number of B. t. u.'s and use is made thereof for raising the temperature of the incoming air stream to substantially the desired point. For this purpose, the heated, moisture laden air is conveyed by an outlet duct 16 through an economizer 17 through which an inlet duct 18 directs the incoming air to be thereby heated to the desired point for the purpose of reducing its relative humidity. If desired, the incoming air can have its temperature raised further by a suitable heating means such as a heating coil 19 or the like, to reduce its relative humidity still further. The large number of B. t. u.'s carried by the vaporized moisture in the moisture-laden air stream are ordinarily sufficient to raise the temperature of the relatively dry incoming air to the required degree, so that further heating thereof is optional. Means

such as the diagrammatically indicated trap and drain 20 are provided for removing moisture condensing in the outlet duct or economizer.

Any desired type of air pumping apparatus can be employed to maintain the proper volume of air flow at the necessary velocity, either by pressure or suction, or both. Such mechanism is indicated diagrammatically in the drawing by the exhaust fan 21 and damper 22.

Obviously, the invention can be variously modified and adapted within the scope of the appended claims.

I claim:

1. The method of reducing the moisture content of a material which when dry is hygroscopic in air having a relative humidity above a certain critical point, which consists in distributing the material to be dried over a drying surface, passing the material on said surface through a drying zone and removing substantially dry material from said surface, passing a stream of moisture removing air over the material in said zone and in a direction counter to the direction of movement of the material through said zone, maintaining the relative humidity of said air stream below said critical point until said stream is in contact with material still predominantly liquid, and maintaining said current of air in contact with liquid material until substantially saturated.

2. The method of reducing the moisture content of fruit and vegetable material which consists in forming a pulp of the original material, distributing said pulp over a heated drying surface, causing said material to move continuously through a drying zone at a temperature sufficient to reduce the moisture content to a predetermined point, passing a current of moisture removing air through said drying zone over said material in a direction counter to the direction of movement of said material, maintaining the relative humidity of said air stream below that at which the partially dry hygroscopic material will absorb moisture until said stream is in contact with material predominantly liquid, and then permitting said stream to become substantially saturated.

3. The method of reducing the moisture content of fresh fruit and vegetable material which consists in dispersing the particles of said material over a heated drying surface in substantially separated condition whereby each particle is subjected substantially directly to the heat thereof, progressively subjecting said particles on said surface to a drying temperature to reduce the moisture content of said particles to a predetermined point, removing the dried particles from the drying surface, simultaneously with the drying operation passing a stream of moisture collecting air having a low relative humidity first over the particles most nearly dry and then progressively over less dry particles and then over fresh material just dispersed on said surface, and maintaining the relative humidity of said air stream below that at which the partially dry hygroscopic material will absorb moisture until said stream is in contact with material predominantly liquid, and then permitting said stream to become substantially saturated.

4. The method of reducing the moisture content of fresh fruit and vegetable material which consists in dispersing the particles of said material over a heated drying surface in substantially separated condition whereby each particle is subjected substantially directly to the heat thereof, progressively subjecting said particles on said surface to a drying temperature to reduce the moisture content of said particles to a predetermined point, removing the dried particles from the surface, and simultaneously with the drying operation passing a stream of air having a low relative humidity first over the material having less than 10% moisture, maintaining the relative humidity of the air stream at less than 40% while in contact therewith, then passing said air stream progressively over less dry particles and then over fresh material just dispersed on said surface, until said air stream is substantially saturated.

5. The method of reducing the moisture content of fruit and vegetable material which consists of spreading the material over a moving heated drying surface, passing a stream of air having a low relative humidity first over the material having less than 10% moisture, maintaining the relative humidity of the air stream at less than 40% while in contact therewith, then passing said air stream over less dry material, and then over fresh material until said air stream is substantially saturated, and removing the dry material from said surface.

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