EXPLOSIVE PUFFING ENHANCES QUICK-COOK QUALITIES

Short-cycle procedure yields potato dice and slices with cooking properties superior to products dried conventionally. Commercial costs estimated

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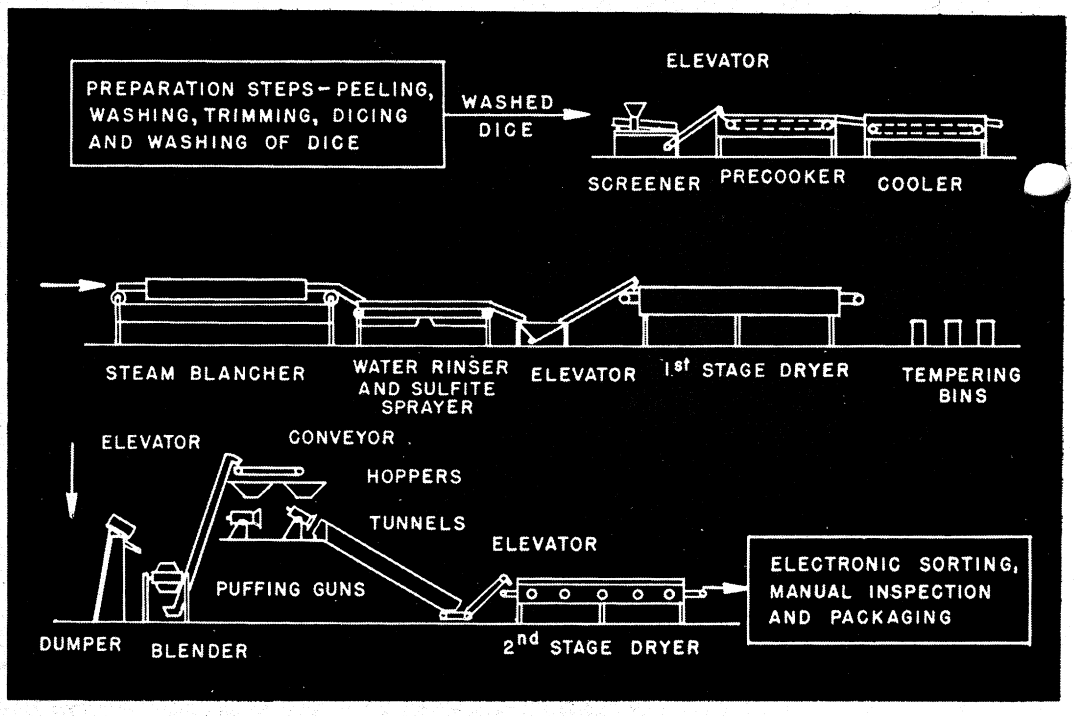

FIG. 1—FLOW SHEET depicts processing steps that differ from conventional manufacture of dehydrated potato dice. System features a puffing gun that uses superheated steam to supplement external gas heating. Capacity is 330 lb/hr.

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EXPLOSIVE PUFFING, which imparts quick-cooking properties to dehydrated pieces of fruits and vegetables, has been applied to white potatoes, carrots, beets, sweet potatoes, apples and blueberries.

Extensive research and pilot work indicated that for the process to be commercially feasible, a gun would have to be developed specifically for fruits and vegetables. Such a unit was designed, using injected superheated steam in addition to external gas heating.

Here we describe how the technique has been applied to Maine Katahdin and Idaho Russet potatoes with some idea of commercial costs.

Preparing Potatoes for Puffing

Fig. 1 depicts processing steps that differ from the conventional manufacture of dehydrated po-

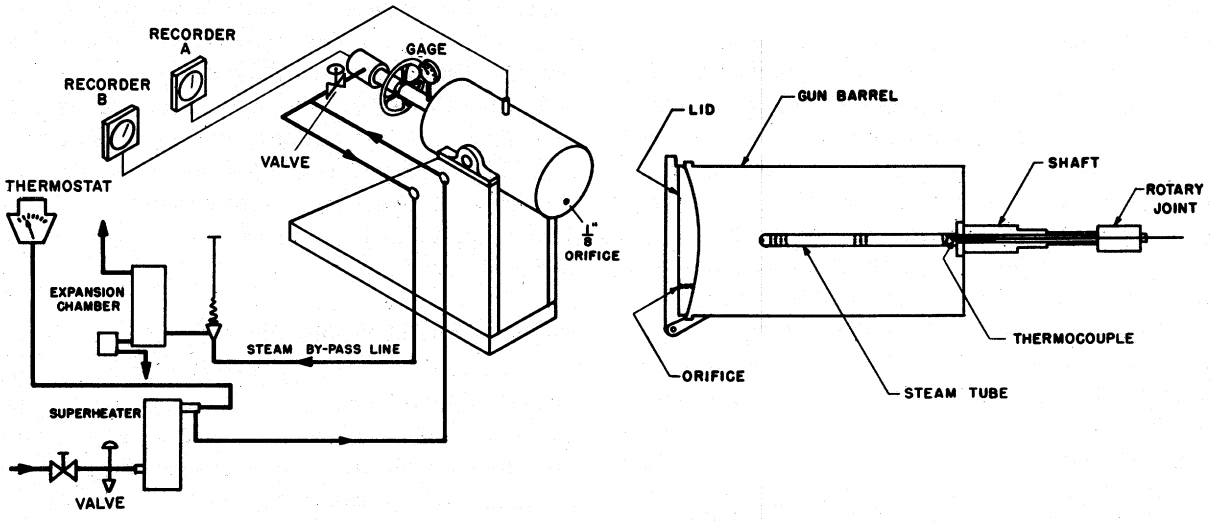

FIG. 2—SHOWS location of perforated steam tube within the gun barrel and the thermocouple that actuates Recorder A which monitors gun-surface temperature.

EXPLOSIVE PUFFING (CONTINUED)

tato dice. Peeling, washing, trimming, dicing and washing of the dice are done conventionally, as are electronic sorting, manual inspection and packaging.

Since dicing invariably results in the development of some fines which would contribute to nonuniformity of product, the dice are passed over a vibrating screen (Fig. 1) equipped with slots 2 in. long and 3/16 in. wide. Approximately 12% passes through the screen as fines which may be used in making other potato products such as flakes or patties.

The fraction passing over the screen is precooked for about 30 min at 160F and then cooled for about 10 min in water below 70F. Precooking and cooling eliminate pastiness in dehydrated mashed potato flakes, functioning similarly for reconstituted dice that are to be mashed.

Any residual enzyme is inactivated by blanching the dice for 8 min in atmospheric steam. In order to obtain the desired amount of sulfite in the finished product (200 to 500 ppm) the blanched dice are water rinsed and sprayed with a solution containing 0.5% each of sodium bisulfite and sodium sulfite.

Prior to explosion puffing, pieces must be dried to between 20-25% moisture on a wet basis. This can be done in a continuous through-circulation belt dryer in about 2 hr. An air temperature of 200F dry bulb is employed for the first hour and a temperature of 175F for the remaining time. An air velocity of 200 fpm and a bed depth of 3 in. are typical.

Treatment Before Puffing

Before puffing it is necessary to equilibrate the partially dried dice for uniform moisture distribution within and among the pieces. That requires holding the material at room temperature for approximately 16 hr. Although the equilibrated dice may be puffed at this stage, some clumping may occur as a result of gelatinization of surface starch. This condition is due to steam condensation and heating in the gun.

Therefore, it is recommended that the equilibrated dice be coated by tumbling for 5 min in contact with an anti-caking agent such as finely powdered hydrated sodium silico aluminate (equivalent to 0.75% of potato solids in dice).

The relatively slow operating cycles previously suggested for potatoes were the result of using external heat only. The cycle can be greatly shortened by injecting superheated steam while maintaining gun-wall temperature at the desired point with an external gas flame. The use of superheated steam, improved heating and surface coating eliminate the necessity for separating the pieces into two sizes and processing them separately.

Fig. 2 indicates the location of controls for gun operation and facilitates an understanding of the following sequential steps in gun operation.

First, steam is admitted to the superheaters by opening a valve. Electric power to the superheaters is turned on and the thermostat set (temporarily) to give 500-F steam. Gun lid is closed and rotation starts. Gas burners are lighted and steam enters gun through a quick-opening valve.

Gas rate is adjusted to give a gun-surface temperature of 330-340F, as indicated by recorder A. Latter is actuated by a sliding thermocouple on the barrel's exterior. Steam pressure is adjusted by a valve to 60 psi as indicated by a gage on gun shaft. Gas to gun is shut off and steam is directed to the bypass by closing the valve just outside the shaft.

Gun is now charged with potato pieces, for example 20 lb of ⅜-in. dice, and rotation is started. Gas is relighted, maintaining gun surface temperature between 330 and 340F. Now, the valve is reopened admitting steam to the gun. Temperature of superheated steam entering the gun should be checked on recorder B.

If necessary, the thermostat may be readjusted to maintain steam at 375-380F (which corresponds to 67 to 70-deg superheat) entering the gun. It may be necessary in starting operations to process several charges until the proper settings of valve and thermostat are achieved. Thereafter, the settings are left the same.

Having made these preparations, it is now possible to process charges in rapid succession as follows. Charge the gun with about 20 lb of dice containing between 20-25% moisture, close the lid, start rotation, light the gas burners keeping the gun surface temperature at 330-340F, and admit steam through valve.

When gage reads 60 psi (in about 1 min) hold this pressure for an additional 30 sec, then shut off the gas, tilt the gun, fire it, shut off the steam. The gun is now ready for reloading and continued operation.

With a properly designed loading hopper it should be possible to charge the gun, fire and reload in approximately 1½ min. This time added to the 1½ min heating cycle represents 20 charges per hr, theoretically equivalent to about 330 lb per hr of finished product.

On puffing, a small amount of moisture is removed, having been superheated in the gun above its atmospheric boiling point. However, some slight condensation takes place in the gun when the superheated steam contacts the relatively cool charge. Since there is excess condensation, the net result is a slight increase in moisture in the product discharged from the gun.

Further drying must be done to put the product in stable form. In a through-circulation belt dryer, a dry-bulb temperature of 150F and air velocity of 200 fpm will reduce the moisture to between 5 and 6% in approximately 1½ hr. This is with a bed depth of about 3 in.

Compression of Puffed Pieces

Previous work shows that the bulk density of explosion-puffed carrot dice can be greatly increased by compression after puffing and before final drying. Unfortunately, the same effect cannot be achieved with potato dice which tend to re-expand almost to the original size.

When passed between rolls set at the clearance of 1/32 in., bulk density of the dried product increased only by about 8½% (from 23.5 to 25.5 lb/cu ft). Moreover, unlike carrots, on reconstitution many of the compressed pieces contained hard uncooked centers; whereas the product dried without compression rehydrated uniformly in 5 min.

Explosive puffing of partially dehydrated potato slices is about the same as that for ⅜-in. dice. The slices will be cut about 3/16 in. thick. Tray loading during initial drying will be approximately 8.8 lb/sq ft for slices as compared with 10½ lb/sq ft for ⅜-in. dice. Moreover, the maximum charge to the gun will be 15 lb instead of 20 lb.

Cost of Going Commercial

Here is an estimate of the additional cost required to produce the new puffed quick-cooking product above the cost entailed in making the conventional dried unpuffed product.

A typical price for unpuffed ⅜-in. cubes is 21¢/lb, packed in multiwall paper bags of 50 lb net, in carload lots, FOB processing plant. Assuming typical sales expense and a 12% annual net profit on fixed capital investment, the "cost to make" the unpuffed product might reasonably be 15½¢/lb. The corresponding cost to make quick-cooking puffed potato dice would be about 18½¢/lb, similarly packed.

Detailed operating procedures and cost information beyond that given here may be obtained from the authors. (End)