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Concentrates, Strips Flavor in 1 Pass Without Vacuum

Simplified technique combines essence recovery with water removal from fruit juices at atmospheric pressure. Elimination of old steps cuts capital investment, saves labor and floor space.

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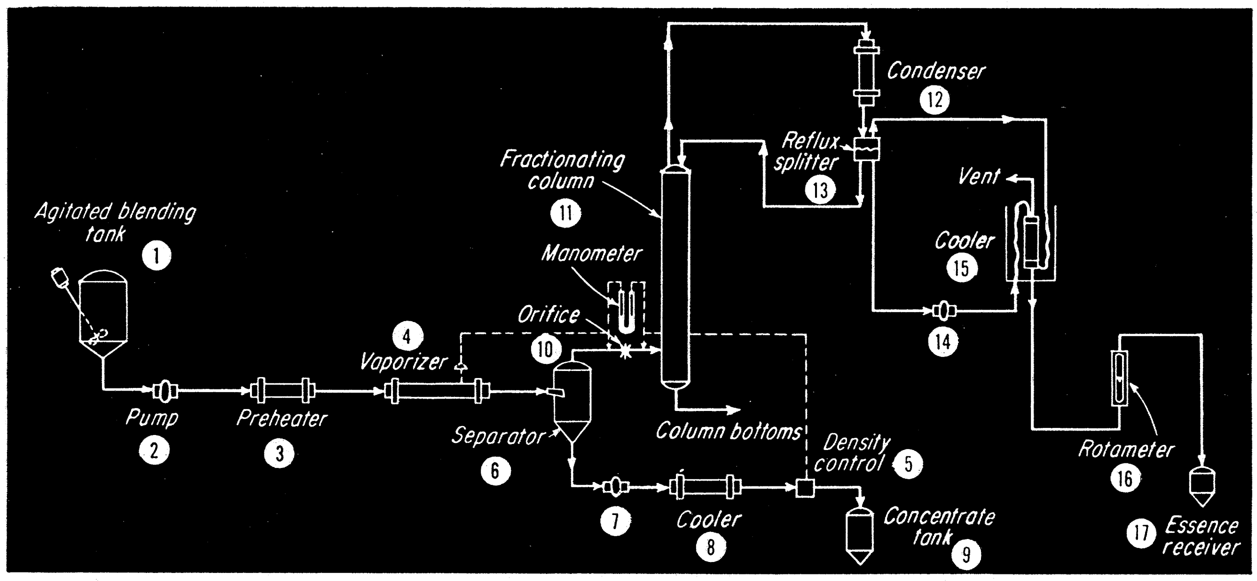

HOW SINGLE-ACTION SETUP OPERATES. Juice is pumped from blending tank (left) to vaporizer, where required amount of water is boiled off. Concentrate is separated, cooled, and stored in tank. At same time, flavor essence is recovered from vapor and accumulated in receiver (right). Sequence is detailed in text.

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A DOUBLE FUNCTION is achieved in a striking new fruit juice concentrating process.

—For, in addition to preparing a product of the desired Brix, the process recovers practically all of the flavor aroma contained in the vaporized water.

Featuring single-pass operation at atmospheric pressure, the EURDD technique eliminates expensive vacuum equipment previously required for concentrating the stripped juice. This—

1. **Reduces capital investment.**
2. **Conserves plant space.**
3. **Saves labor.**

No Fouling Problems

Basis of the improved process is very rapid heating, concentration, and cooling, with simultaneous essence[1] recovery. This permits heating to the required vaporization temperature without fouling of the preheater, or affecting flavor of the final concentrate.

In the operation, sweetened or unsweetened depectinized juice readied in the agitated blending tank—(1) in drawing above—is fed at a controlled rate by positive delivery pump (2) to preheater (3). It's to be noted that the blending tank should have sufficient capacity to eliminate rapid fluctuations in density of feed.

Since depectinized juice is being handled, fouling of the heating surfaces constitutes no problem. However, velocity should be high enough to create turbulent flow and thus avoid local overheating.

After being heated to a few degrees above its boiling point, the juice enters vaporizers (4), where water necessary to produce the final concentrate is removed in a single pass.

To make a 72 deg. Brix concentrate, for example, it would be necessary to vaporize 89.4% by volume of a 10 Brix juice, or 82.6% of a 16 Brix juice.

Degree of vaporization is controlled by an automatic steam-throttling valve on the jacket of the vaporizer. This is actuated by a density control located at (5). In contrast to previous assumptions[2,3] that steam pressures in preheater and vaporizer jackets should not exceed 15 psi., it has now been found possible to use up to 75-psi. steam without flavor damage to apple or grape juice if velocity is above 20 fps.

Vapor and liquid (concentrate) are separated in a conventional liquid vapor separator (6). Then concentrate is pumped (7) through tubular cooler (8) to tank (9). Cooler should be designed for rapid performance, since the product is subject to heat damage.

The vapors, which contain sub-

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TABLE I — RECOVERY OF METHYL ANTHRANILATE IS Not Greatly Influenced by Percent of Juice Vaporized

	Percent Methyl Anthranilate	
	With 30% Juice Vaporized	With 83% Juice Vaporized
Feed juice	100	100
Essence	19	42
Column bottoms	20	43
Stripped juice	61	15
Condensate	31	..
Concentrate	30	15
Concentrate + essence	49	57

TABLE II — HOW COLUMN HEIGHT and Rate of Reboiling Affects Recovery of Methyl Anthranilate

	Height of Stripping Column (in.)	
	7½	15
Rate of reboiling, (% feed rate to column)	21	31
Methyl anthranilate, (%)		
Fed to column	100	100
In essence	49	72
In column bottoms	51	28

1 Pass Without Vacuum

stantially all the aroma that was in the juice, are metered by orifice (10) and pass to fractionating column (11). Here, they are concentrated to produce essence of the desired fold. For example, a 150-fold essence has 150th the volume of the starting juice.

The fractionating column has an enriching section above the feed, a stripping section below it, and a reboiler at the bottom (where the rate of reboiling can be varied).

Aroma-enriched vapors from the column are condensed in unit (12) and cooled to about 190F. Essence is drawn off from reflux splitter (13) by positive delivery pump (14) through cooler (15) and via rotameter (16) to receiver (17).

In the cooler, the essence is used to scrub the volatile aroma fractions from the noncondensable gases. This is done by trickling the chilled essence down through a small packed tube while the chilled gases pass upward.

Mere chilling of the gases before venting condenses out little of these volatile components. The essence, however, is largely water, and when it is used as a scrubbing medium it can recover these valuable flavor components. When very high fold essences are being made, a column-bottoms scrubbing system[2] is desirable, entailing cooling of the condensed overhead vapors to about 90F. and reheating of the portion to be refluxed.

The rotameter (16) is required because the quantity of essence entering receiver (17) is the sum of essence withdrawn by pump (14) and essence recovered from the noncondensable gas. Since the latter will fluctuate appreciably with temperature of the condensate leaving unit (12), some method of metering the total from the two sources should be employed in order to obtain a product of uniform fold. That portion of the condensate not drawn off as essence is returned to top of column (11).

Advantages of single-pass atmospheric concentration (SPAC), lie in the simplicity of operation and elimination of a vacuum system.

In an operation where juice of 12 Brix is being converted at a rate of 400 gph. to a high-density concentrate of 72 Brix, and 150-fold essence is also being recovered, capital investment for the new system would run about $5,500 less than for one entailing essence recovery followed by vacuum concentration. There would also be savings in labor and space requirements.

Application to Various Juices

The SPAC process has been used successfully in concentrating the following juices: Grape, from 15.7 to 72.6 Brix; blackberry, from 8.5 to 72 Brix; blueberry, from 11.3 to 72 Brix; and peach, from 10 to 63 Brix; cherry, from 13.3 to 71 Brix; apple, from 12.5 to 72 Brix; and strawberry, from 8.5 to 52 Brix. In none of these cases was there any evidence of flavor damage.

Character of recovered essences, and of full-flavor concentrates made using them, was in every instance at least equal to that made by atmospheric essence stripping followed by vacuum concentration of the juice.

The process should also be suitable for other juices. Its application to Concord grape juice has some interesting aspects. Characteristic flavoring component of this juice is methyl anthranilate, which has a high boiling point at atmospheric pressure and is tenaciously retained. While the volatiles can be effectively stripped from most fruit juices by vaporizing small portions (i.e., apple juice requires 8-10% by volume; strawberry, about 20%; blackberry, 30%; and Montmorency cherry, 40%[4]) the odor of methyl anthranilate can be detected in grape juice from which 50% or more has been vaporized.

This led to the trial of a 2-stage process for more complete recovery[5].

Essence was made by stripping the juice as well as the condensate from the vacuum concentration of the stripped juice. Although effective, the extra steps were not considered justifiable.

The commercial process now in use is a compromise. It entails vaporizing about 30% by volume for aroma recovery and then depectinizing and vacuum-concentrating the stripped juice.

Here, the SPAC system would appear to be admirably suited for recovery of methyl anthranilate.

Indeed, the 83% vaporization

needed to concentrate a 15.7 Brix grape juice to 72.6 Brix effectively strips anthranilate (see Table I). Under these conditions, 85% of the methyl anthranilate in the feed juice was stripped, in contrast to 39% at 30% vaporization.

Unfortunately, the mere release of more aroma elements does not necessarily improve their recovery as essence. Further reference to Table I shows that, in spite of the high release of aroma at 83% vaporization, only 57% of the methyl anthranilate appeared in the full-flavor concentrate.

This is not much greater than the 49% recovered at 30% vaporization. In fact, the difference could not be detected by a trained taste panel.

Reason for this loss is the difficulty in driving the relatively non-volatile flavor to the top of the column where it can be recovered in the essence. The table shows that regardless of the vaporization used, the methyl anthranilate lost in the column bottoms was about equal to that recovered in the essence.

A significant improvement in aroma recovery from grape juice can be obtained by increasing the height of stripping section and the rate of boiling. Table II shows distribution of methyl anthranilate calculated on amount fed to the column. Doubling the height of the stripping section and increasing the boilup rate from 21% to 31% increased the recovery of the methyl anthranilate from 49% to 72% of that fed to the column.

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