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New Blanching Techniques

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NEW BLANCHING TECHNIQUES

The Environmental protection Agency (EPA) has established 1977 and 1983 effluent limitation guidelines for several industries. It can be anticipated that effluent limitations for the canning, freezing, and dehydrating industries will be established in the immediate future. The limits established for 1977 are described as BPCTCA (Best Practical Control Technology Available) and those for 1983 as BATEA(Best Available Technology Eeconomically Achievable).The law also requires those industries who discharge into the municipal systems to certain appropriate levels. Industry will be expected to pay for the proportionate capital cost and operational expenses of the municipal treatment facility that it uses. For these reasons, the cost of direct industrial discharge into municipal treament facilities can be expected to increase substantially in the years to come.

Blanching is an essential step in processing many vagetables. It softens the tissues of products such as spinch and other greens so that the product can be filled properly into the can. It removes gases form the tissues so that there is less air in the can to cause trouble. An example is mushrooms which contain large volumes of gas, sufficient at times to result in buckling of the containers during processing. It destroys enzymes that cause effects before canning. This is particularly important in vagetables for freezing.

Hot water blanching is one of the most effective washing operations possible. It gives not only a final cleansing but also washes away certain raw flavors. With many products it helps to preserve the color. Blanching increases the moisture content of a product such as soaked dry legumes.

Up to six or seven years ago most reserch work on the blanching process was concentrated on the problems associated with conventional hot water blanching such as leaching or loss of water-soluble constituents, including flavor, vitamins, and minelrals. Previously we had little economic or legislative motivation for pollution control. However during the last five years many in-plant modification projects for pollution control in the food industry have been activated.

Surveys of individual unit operations in the canning process indicate that blanching contributes significantly to overall plant effluent. In most cases over 50% of the plant biochemical oxygen demand (BOD) is due to blanching and cooling (Weckel et al. 1968). An example is shown in Table 1. Cosequently, many investigations have been undertaken recently to design blanching operations that would significantly reduce the generation of wastewarter.

In recent years the National Canners Association has investigated various means of reducing pollution caused by blanching. The characteristics of water, steam, microwave, and hot gas blanching have been studied (Ralls et al. 1972). The USDA's Western Regional Research Laboratory has conducted research on the individual quick blanch (IQB) process with the goal of reduceing effluent volumes and pollutants. I would like to describe these two techniques along

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with some other recent developments in this review.

1. Fluidized-bed Blanching

Fluidized-bed blanching was developed by Mitchell es al (1968) in Australia for use on green paes to achieve uniform short-time flanching at precisely controlled times and temperatures. Fluidization is a well established industrial process whereby a bed of particulate solids is subjected to an updraft of particulate solids is subjected to an updraft of gas of sufficient velocity to cause the material to behave as a fluid. The fluidizing medium used was a mixture of saturated steam and air. In the continuous-type fluidized-bed

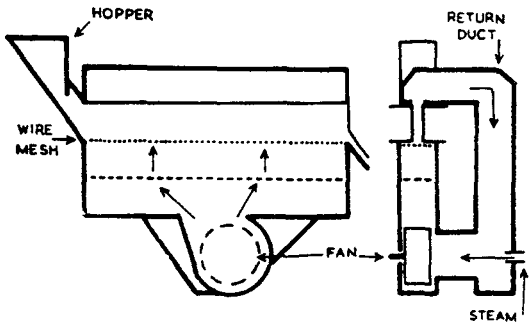

Figure 1. Continuous fluidized-bed blancher.

blancher (Flgure 1), the fluidizing mixture is pumped around a system of ducts by means of a fan and steam is injected continuously into the duct attached to the suction side of the fan. The fluidizing mixture is blown through a perforated gas-distributor plate and then through the bed and returned to the suction side of the fan. The slope of the bed is adjustable to contorol the depth of peas on the bed. They observed comparable results on peas blanched by fluidized bed blancher (195—200°) and water blancher (209—212°) as measured by maturometera and peroxidase activity. However, no information is available on the volume of water usage and other pertinent measurements.

2. In-can Blanching

This method replaces a traditional blancher with an overflow hot water (205°F) brining unit to bring green peas to blanching temperature. A jet of hot water directed into a can filled with peas stirs the contents and supplies sufficient heat to blanch the peas in 20 to 40 sec. A blanching head developed by Mitchell (1972) in Australia (Figure 2) is constructed to incorporate the open cylinder (A), locate the jet nozzle

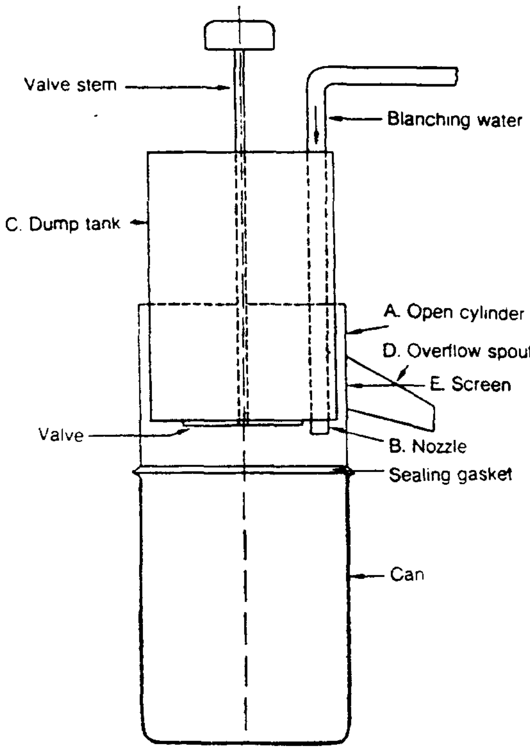

Figure 2. In-can blancher.

(B), carry a dump tank (C), fill the can rapidly with hot water at the start of blanching, and provide an overflow spout (D) and screen (E) to retain the peas while allowing discharge of water. A three-way valve controlled the flow of water to the jet or to a bypass, thus ensuring that the water coming from the nozzle is always at the specified temperature. The can, filled with peas to be blanched, is placed under the blanching head, and the dump tank is filled with hot water. The plug of the dump tank is removed and at the same time the hot water from the supply source is diverted to the nozzle. When blanching is completed (20-40 sec.) the flow of water to the can is stopped, the can head-space is adjusted, salt is added, and the can is closed. It is suggested that a series of about 100 blanching heads could be mounted on a turntable to give a machine suitable for inclusion in a commercial line. It is also suggestd that this method of blanching would reduce the incidence of damage since the peas could be placed in the cans immediately after washing, thus avoiding the need to transfer them after they have been softened by blanching process. This machine would fill and blanch peas at about 200 cans per minute and replace the standard water blancher and the filler. It is calculated that approximately 1600 gallons of hot water per ton of peas are required, therefore limiting the usage of in-can blanching as a pollution reducing system. However, it can be improved by recirculating the blanch water or recovering the heat in a heat exchanger.

3. Thermocycle Blancher(Venturi Effect)

This sytem was developed by Gabilan Iron & Machine Company, Salinas, California. According to the report of Havighorst (1973) in Food Engineering, venturi recycling of heat under a sealed blancher dome provides uniform temperature and increases

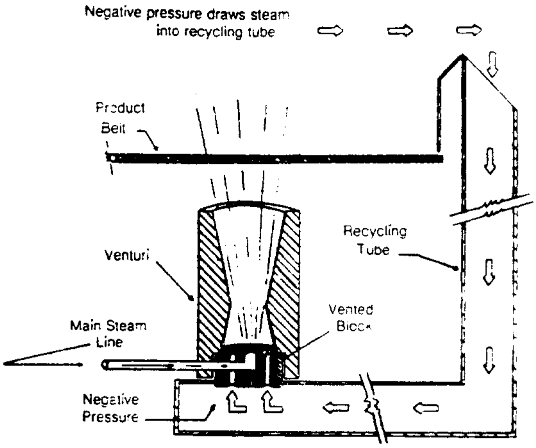

Figure 3. Cross section of venturi steam recycling system.

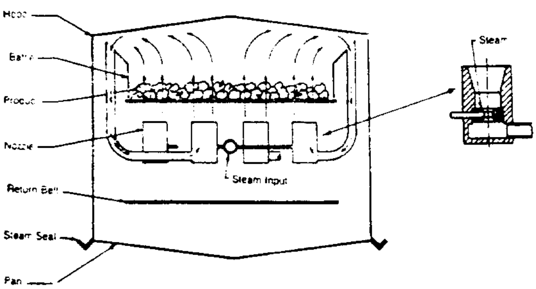

Figure 4. Steam flow through the venturi system.

efficiency and capacity (Figure 3). Incoming steam passes through the venturi to create a vacuum in the recycling tube. This draws available heat from the dome of the blancher's hood via the recycling tube (Figure 4). There are 53 recycling units in a 68-foot blancher. The interior of the blancher is isolated from the atmosphere (Figure 5). This is achieved by a

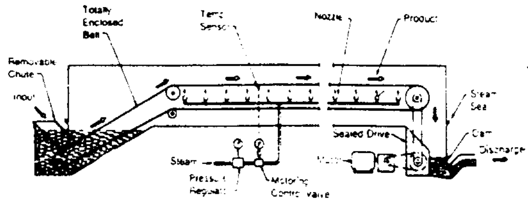

Figure 5. Thermocycle blanch or schematic

water steam seal loop around the lower periphery of the blancher hood and a water steam seal dam at each end of the unit. Compared with a conventional blancher, according to the report, this blancher:

a) maintains uniform temperature throughout the blanching area

b) provides greater production volume per square foot of blanching area (a model 86 ft long and 6 ft wide has a capacity of 25,000 lb/hr for spinach and other leafy vegetables.)

c) blanches more product per pound of steam

d) the enclosed all stainless steel system reduces probability of bacterial contamination

e) eliminates steam stack and provides vapor-free plant environment

f) improves product quality

Although there is no detailed scientific information available up to now, this steam recycle blancher

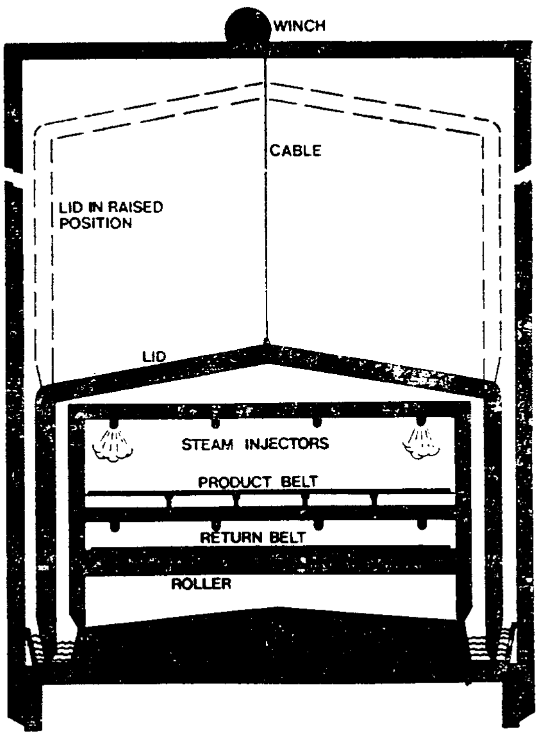

Figure 6. Hydrostatically sealed steam blancher.

appears to be promising for energy savings, lower liquid waste discharge volumes, and elimination of steam clouds in working area.

4. Hydrostatically Sealed Steam Blancher

This unit was designed to combine washing, blanching and cooling in a single unit (Figure 6). Only 45 ft long, the unit developed by Goodale Manufacturing Co., Watsonville, California (Ray, 1975) is about half the size of a standard steam blancher of the same width, but its blanching capacity is approximately twice as much. The efficiency is due to 1) an effective hydraulic seal-closing steam chamber area, 2) counterflow use of water which enters at the cooling section end, moves forward through seal area of the steam chamber and on through the washing section before discharge. The product remains on one continuous

Table 1. Properties of effluent waste flows during processing of peas[1]

	Effluent flow rate gal/hr	Suspended solids lb/hr	B.O.D. lb/hr
	(%)	(%)	(%)
Clipper mills & washers	8190(36.6)	63.1(79.3)	143.0(28.1
Washers	5020(22.4)	5.6(7.1)	46.1(9.2)
Blanching dewatering reels	4360(19.6)	10.8(13.6)	300.2(59.1
Size graders & fillers	4770(21.4)	0	18.2(3.6)
Total plant drain	22300(100)	79.5(100)	508(100)

1) Weckel et al (1968)

conveyor through the washing, blanching, and cooling sections. Because this unit is a hydrostatically sealed and closed system, steam consumptions is only about .077 lb of steam/lb of product—one half that of the conventional exhaust steam blancher (.155 lb steam lb product). Operating costs reported are about 0.7 c/lb of spinach and 1.4c/lb of broccoli. A 70—ft system for hadling spinach has a capacity of 30,000 lb/hr. Overall it is reported that this steam blancher uses 50% less energy, and 50% less water for cooling is normally required.

5. Individual Quick Blanch (IQB)

This process was developed as a modified steam blanch a few years ago at USAD's Western Regional Research Laboratory (Lazar et al. 1971). IQB is a two stage process: 1) each piece of product is exposed

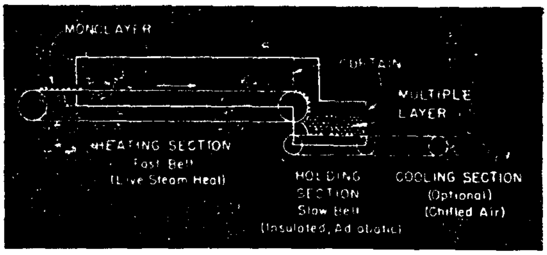

Figure 7. Schematic diagram the IQB system.

to a heat source for such duration that the mass-average temperature is in the range desired, and 2) the piece is held adiabatically until the temperature has equilibrated to the mass-average and the objectives of blanching have been accomplished. In this system, pieces of vagetable are spread in a single layer (Figure 7) on a mesh belt moving through a steam chest. Here, maximum heating rates result from complete exposure of each piece to live steam. After the relatively short exposure to live steam, and before the interior of the pieces become too hot, product is discharged as a deep bed onto another belt moving through an insulated chamber to equilibrate the product temperature at a mass-average temperature high enough to stop enzyme activity and to achieve a desired texture.

This method reduces leaching from the producted and thereby reduces effluent BOD because of the uniform heating inherent in a single layer as opposed to the deep bed used in conventional steam blanching. Further reduction in leaching and waste effluent was achieved by "preconditioning", i. e. partially warming and drying the food surface with air before the steam heating step (Lazar et al. 1971; Lund, 1973; Bomben et al. 1972) (Table 2).

Table 2. Comparison of IQB and conventional blanching[1]

Vagetables	Coventional blanch (sec)	IQB with preconditioning		% Reduction effluent solids IQB. convent. blanch
		Heating (sec)	Holding (set)	
carrots	180	30	90	73
Green	150	80	80	40
Lima beans	180	90	90	65
Brussel sprouts	270	180	120	——
Broccoli	210	90	180	——

1) Bomben et al (1972)

Brown et al (1974) have modified the orignal IQB system into a compact assembly of two stacked, circular vibratory trays and a vertical insulated tube for adiabatic holding (Figure 8). An electromagnetically driven variable amplitude Syntron circular conveyor is used in the heater. The conveyor operates with a motion that impels the vagetable pieces upward at 3600 strokes per minunte. The conveyor trays are stacked so that the product flows around one tray,

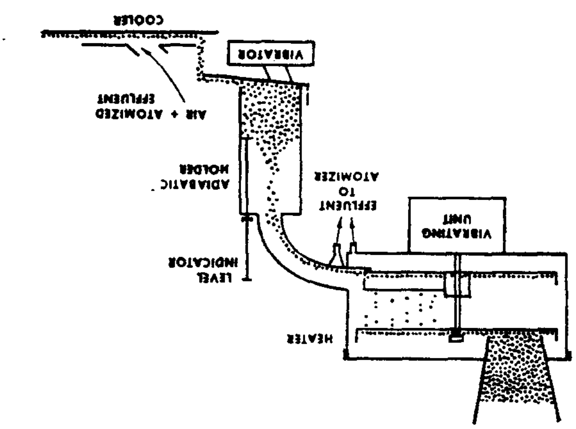

Figure 8. Vibratory conveyor blanch-cooling system.

drops through an opening, and flows around the other tray to the outlet. Steam is distributed above each tray through tubes with a series of orifices. The unit is completely insulated and the product is fed from a hopper attached to the steam chamber; thus steam loss is prevented. The holder section, attached to the heater chamber, is insulated. The produce leaving the heater passes over a screen to separate it from the heater condensate, and from there it drops into the holder. Blanched product, then, is cooled by spreading in a single layer on a conveyor belt. Air into which the blancher liquid is atomized is passed concurrently over the product. The liquid is screened after leaving the blancher, then fed to the atomizing nozzle.

Table 3. Comparison of effluent from green beans for combined blanching and cooling and conventional blanching and flume cooling[1]

	Effluent (lb/100 lb feed)	COD (lb/100 lb feed)
Combined vibratory blanch-cool	7.0	0.17
Conventional steam blanch flume cooling	500	0.35
Conventional water blanch flume cooling	520	0.32

1) Bomben et al (1974)

In experiments with green beans, the results (Table 3) show that while providing uniform heat treatment, a blancher using vibrating conveyors, product seals, and atomized blancher liquid for cooling gives significant reductions in effluent volume and solids loss as compared with other blanching and cooling methods (Bomben et al. 1972). Most of this volume (96%) is due to the flume cooling. Assuming a product temperature out of the blancher of 195°F and a cooling-water temderature of 60°F, it requires 5.8 lb of water per lb of procuct to obtain an 80°F product temperature. They found no significant difference in flavor, texture, or retention of certain vitamins or minerals in green beans when compared to those processed by conventional methods.

Brown et al (1974) reported that this system has the potential for significant reductions in effluent, steam use, and operating costs over conventional blanchers. However, calculated total cost of vibratory blanching is higher due to the loss in yield through evaporation. Bomben et al (1974) reported the approximate operating costs of the vibratory system compared to conventional steam and water blancher (Table 4).

Table 4
An estimate of water, steam, effluent, and electricity in blanching and cooling of green beans[1]

	Water, effluent & COD disposal (/ton)	Elct-ericity ($/ton)	Steam ($/ton)
Combined vibratory blanch cool	0.12	0.06	0.31
Conventional steam blanch flume cool	0.62	0.007	0.55
Conventional water blanch flume cool	0.63	0.007	0.80

(1) Bomben et al (1974)

6. Hot-gas Blanching

Hot-gas blanching was developed by the Berkeley Laboratory of the National Canners Association through pilot-plant and in-plant tests. Combusted gases from a natural gas furnace are blown down through the product, which is held and conveyed by belts (Figures 9 and 10). Steam is used to reduce dehydration losses and to increase heat transfer of the gas medium. Tests with green beans, corn, peas, and spinach show substantial reducton of wastewater volume and pollutants (Table 5). It has been shown

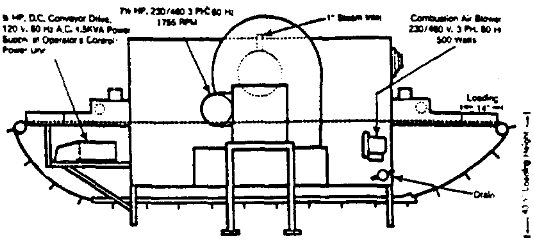

Figure 9. Side view of hot-air blancher.

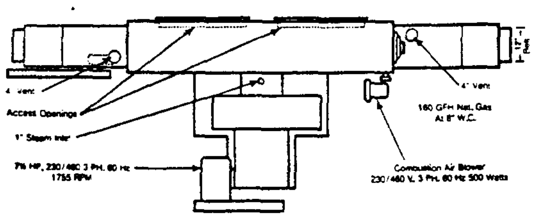

Figure 10. Top view of hot-air blancher.

Table 5
Percentage reduction of waste water volume, BOD, COD and suspended solids due to hot-gas blanching of vegetables, compared to commercial blanching[1]

Commodity	Percentage reduction due to hot-gas blanching			
	waste water value	BOD	COD	SS
Spinach	99.9	99.8	99.2	99.5
Green beans	99.9	99.9	69.9	99.9
Corn	33.3	28.3	22.2	18.7
Peas	84.2	91.4	90.0	93.0

(1) Ralls et al (1974)

that the retention of water-soluble vitamins is about the same for hot-gas blanching and commercial blanching of green beans (Table 6).

Table 6
Vitamin content of raw and blanched green beans[1]

Sample	Vitamin content, mg/100 g fresh wt.			
	B_1	B_2	C	Niacin
Raw	0.077	0.074	7.3	0.46
Commercially blanched	0.75	0.049	1.3	0.53
Hot-gas blanched	0.068	0.070	2.2	0.44

(1) Ralls etal (1973)

There is no significant difference in retention of calcium, magnesium, or phosphorus as a result of the blanching conditions used (Table 7). The overall quality

Table 7
Mineral cont of raw and blanched green beans[1]

Sample	Mineral content mg/100 g		
	Ca	Mg	P
Raw	31.7	18.9	19.7
Commercially blanched	35.7	23.6	21.6
Hot-gas blanched	37.0	20.2	21.5

1) Ralls et al (1973)

of hot-gas blanched vegetables, according to the report of Ralls et al (1963) is well within the range of commercial acceptability. However, hot-gas blanching produces less yield and is more expensive than conventional blanching. Recent studies of hot-gas blanching, conducted by Klinker (1975) at Libby's plant in Wisconsin, on peas, beans, and diced carrots showed that yield losses are higher than with conventional waterblanching procedures. In his blanching experiment with peas, the hot-gas blancher an 87.3% yield, while hot water drum blancher showed a 90.7% yield. Operating costs of experimental hot-gas blanching on green beans, corn, beets, spinach, and peas are substantially higher as compared to the commercial hot-water blancher (Tlale 8). Increased efficiency of

Table 8
Estimated cost[1] **of blanching vegetables ($/kkg blanched)**[2]

Commodity	Blanching system		
	Hot-gas	Steam	Hot-water
Gteen beans	2.94	—	2.40
Corn-on-cob	16.90	2.51	—
Beets	19.18	—	2.29
Spinach	10.56	—	2.89
Green peas	6.18	—	2.39

1) Fixed cost and operating cost
2) Ralls and Mereer (1974)

operation of a commercial scale unit could be expected to lower the costs of production and therefore give economic benefits. Clearly, further developmental studies are needed.

Although some of these new blanching techniques show an actual or potential value in drastically reducing waste from food processing, there is much research work that needs to be done to meet the upcoming regulations and to minimize their economic effect on the modification of unit operations.

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