

POTATO CHIP FRYING LINE

SLICE WASHING CONFIGURATION AND ITS EFFECTS ON PRODUCT QUALITY AND OPERATING COSTS



Slice washing takes place on a PC line between the slicers and the fryer. The type of equipment used for washing has a large effect on the product characteristics and quality. It can also have a large impact on the operating costs of the line. These considerations must be balanced against capital cost and floor space constraints in the factory.

When potatoes (and similar products) are sliced, cells are cut or ruptured and starch is released to the surface of the slices. Some of this starch will be washed off in the fryer and result in sediment that sticks to the bottom of the pan, requiring cleaning out periodically (“de-crumbling”) before it degrades the oil and disrupts the cooking process. It can also impact product quality by appearing on the finished product as black spots which are burnt starch that is carried out of the fryer on the product. A further impact on product quality is the starch that remains on the surface of the finished chip, giving it a rough look and texture and often a browner appearance. In most markets a white or yellow appearance is favoured on PC product.

Slicing also generates small fines or slivers, especially wavy or crinkle cuts. These are best removed prior to frying as they consume energy and will often be overcooked, impacting product quality and oil degradation.

Options for slice washing include:

- No washing
- Single stage (slicing into a wash tank that feeds the fryer)
- Two stage (slicing into a flume that is separated by a dewatering belt from a wash tank)
- Blanching (hot water washing to remove sugars that cause product browning in the fryer)
- Extended cold washing (using a rotary drum washer for longer retention time)
- Air Knife and Air Sweep (AKAS), single or dual, for removing surface water from the slices and belt. Typically used on the fryer infeed belt to reduce heat load on fryer and manage oil quality, can also be used at intermediate washing stages to reduce water carry-over. Fuel savings of up to five percent can be achieved for single and seven to eight percent for dual AK/AS
- Water clean-up system (to reduce fresh water consumption)

Nothing

No washing is used on batch or slow cooked style product. This product deliberately aims for a less processed look and feel, and the starch left on the surface also provides a glassier crunch and a slightly rough texture. Frying systems with no slice washing have a high loading of fines and require more frequent cleaning out of the fryer (typically three to five days). An Air Sweep is sometimes used under the slice-on-belt to help lay the slices flat and to remove small slivers. In general, having no slice washing does not produce a suitable quality of product for regular potato chips (as distinct from batch style).

Single Stage

Smaller PC lines often use a single stage washing system, where the slicer(s) are mounted directly over a wash tank (Potato Slice Speed Washer - PSSW) which then feeds directly into the fryer via a take-out belt. This system is suitable for smaller operators who might be happy to run five days between fryer clean outs and accept a lower quality product. As such it is generally only seen on up to 500 kg/hr lines. Washing performance can be improved by reducing water turnover time (i.e. adding much more fresh water and draining away starchy water) but in most cases this is unacceptable due to the cost of water and its disposal.

Two stage washing

Producers desiring a top quality product should be using at least two stage washing. The first stage of washing removes most of the fines and surface starch from the slices and



therefore loads the washing system the most. Transferring the slices to a second stage wash tank (PSSW typically) allows the slices to be much cleaner when entering the fryer. To approach this level of cleaning in a single stage would use a lot more water. Therefore the trade-off is between product quality and reduced operating costs (water consumption and cleaning time) vs initial investment and floor space requirements. Systems with two stage washing can often run up to ten days between fryer clean outs.

For lines 1000 kg/hr and above, two-stage washing will usually make the most sense for two reasons:

- To sell this much product will mean a good quality standard is needed
- Operating costs will be higher compared to capital costs than on a smaller line

Heat and Control's standard two-stage washing solution is to slice into a flume which discharges onto a dewatering belt (Potato Slice Pre Washer - PSPW) and then into a Potato Slice Speed Washer (PSSW). This has proven a very effective system and produces excellent quality product.

As lines get larger (2000 kg/hr and up) multiple slicers are required and the flume also provides a convenient and effective way to collect the slices and spread them across the width of the washer belts for presentation to the fryer.



Blanching

Blanching is washing for an extended time (three to six minutes) at elevated temperatures (around 80-85C). This ruptures and leaches sugars out of the potato cells. Potatoes with high sugar content turn brown during the cooking process (the Maillard reaction) which is normally undesirable. Properly blanched slices remain whiter and allow a consistent finished product quality to be made from varying fresh stocks. Potatoes that have been stored are generally higher in sugar than fresh crops, although it also varies by variety and season. Choosing only the most suitable varieties can minimise the need for blanching, but for smaller producers this can mean paying a premium. Therefore, it can be logical or even necessary, to purchase what is available and ensure they have the equipment to turn it into a good product.

Blanching results in some loss of starch to the wash water. As well as reducing yield, this starch gelatinises in the wash tank requiring extra cleaning effort compared to cold washers. While it is possible to discharge from the blancher directly to the fryer, it is preferable for better product quality to have a further cold wash stage (PSSW) between the blancher and fryer. This is because the blancher water is highly starch laden, and this will be carried into the fryer on the surface of the slices, increasing fines loading in the fryer and a rougher and possibly spotted finished product appearance (due to overcooked starch). Cleaning the slices more in the blancher increases fresh water input which also adds to the fuel consumption to heat the blancher.

Some producers choose to install a blancher beside the regular washers and only pass product through it when needing a 'slipstream' system. This is more expensive in terms of capital and floor space, as extra conveyors are needed, but can save

yield loss, water use and equipment clean up time for much of the year.

Experience has shown that best control of blanching retention time and agitation is provided by a drum blancher. Careful re-distribution of the slices across the width of the take-out belt is essential for further processing steps and is achieved in Heat and Control's blancher (Potato Slice Washer Conditioner - PSWC) by an adjustable water jet system.

An alternative to blanching is to use Pulsed Electric Field technology (Electroporation) in conjunction with an extended cold washer to remove sugars. Heat and Control's E-Flo can reduce or eliminate the need for blanching while adding other benefits such as increased yield.

Some regions without severe winters are able to manage without any blancher in the system.

Extended cold washing

This option is normally only used with Electroporated potatoes. It is necessary to perform extended cold washing (several minutes) and agitation of the slices to allow the sugars to leach out of the porated cells. The machine is essentially a PSWC (drum blancher) without the heating equipment.

Excessive washing of product that is sliced without being porated first will result in a loss of yield as the starch is washed from the ruptured cells more easily than from porated ones. Therefore, washing is a balance between product quality and yield. Our regular two-stage washers achieve a good balance on standard, non-porated product. On porated product, the extra washing will not result in yield loss because starch cannot be washed out of the porated cells.



Water Clean-up System

All Heat and Control washing systems include a Motorised Catch Box (MCB) to remove large particles and slivers from the wash water. Fresh water use can be minimised with the addition of a Water Clean-up System (WCS) - also known as starch removal or starch recovery systems. From the MCB, water flows over a hydrosieve (a specially curved static screen removing particles down to 0.75mm) and then to hydro-cyclones fed by a high pressure pump. The cyclones are effective at removing 90 percent of the starch from water and discharge a highly concentrated underflow for further processing or disposal. This system can reduce water consumption in washers by 20 percent or more which provides good payback in areas with high water costs.

Water clean-up systems can be applied to any cold washer stage. Typically they are used on the final stage to ensure the surface water carryover to the fryer is as clean as possible, although they can be applied to other washing stages as well to reduce total water consumption. It is not practical to remove gelatinised starch from hot water (blanchers) using this system.

A further possible step is to dry the removed starch which can then be sold for various uses. This requires a considerable amount of space and expensive equipment, so is not common. Generally the recovered starch is suitable for animal feed or industrial uses. This additional recovery equipment is mounted remote from the line.

Air Knife - Air Sweep

The Air Sweep (AS) consists of one or two plenums installed under the washer belt and connected to the suction of a large fan. This serves three functions:

1. Removing surface water from the slices
2. Settling the slices on the belt for good feed into fryer
3. Removing water and fines from the belt

A separating chamber is installed between the plenum and fan to remove the entrained water from the air stream and return it to the Washer (via the MCB).

The Air Knife (AK) is mounted above the conveyor to blow air down onto slices at high velocity.

This serves two functions:

1. Agitating the slices on the belt for good dewatering of both sides and to even out the spread across the belt
2. Removing surface water from the slices

The benefits of using AK/AS are:

- Reduced surface water carryover into the fryer
 - Reduced fuel usage per kg of product
 - Better oil quality
 - Less free starch and scrap in the fryer and finished product
- The fuel saving alone (five to seven percent) makes AK/AS a regular fitment on most PC lines; the payback period is normally less than two years with improved product quality as well.



Further Considerations

Good washing systems will present the product to the fryer in an even spread over 80-90 percent of the fryer cook width. This ensures even and consistent cooking in the fryer.

For regular slices we use an open belt made from ribbons of flat wire. These have openings 12 x 25mm or 12 x 12mm and do a good job of separating unwanted slivers from the good slices. They are also easy to clean and allow good dewatering with AK/AS.

For 'stick' products, typically 3x3mm in size, this kind of belt would not be suitable. Where this is not the main product,

we can supply a polyester mesh overlay which gets tied to the flat-wire belt and carries the sticks through the washer. Where a system will be processing sticks most of the time, we recommend using a balanced weave belt with opening size that will not pass the good product. This belt can also be used for regular slices but will carry slightly more water to the fryer and be harder to clean.

All washers are fitted with fresh water sprays on the discharge belt to rinse the slices and this also provides the make-up water to the system. A constant overflow of water is needed to carry starch away and maintain a reasonable concentration. This is also important to prevent microbial build-up.

Summary - Typical Washing Configurations

Single stage washing is common on small (<500kg/hr) lines where capital cost is a primary consideration and product quality is less critical. For all larger lines, two stage washing provides improved product quality, reduced water usage and better productivity (less frequent fryer cleanout). Heat and Control's combination of Flume into Pre-Washer followed by Speed Washer is a simple, proven and very effective step towards achieving top quality product.

Blanching is used where high sugar potatoes must be processed and product quality must be maintained. Electroporation can be a supplement or replacement to blanching. Blanchers are ideally installed between a Pre Washer and a Speed Washer to ensure best frying performance. Feeding the fryer directly from the blancher (eliminating the Speed Washer) is a compromise that can be tolerated where blanching is not required for much of the year. An optimum solution for lower operating costs at the expense of higher investment is a blancher that can be bypassed when not needed.

Air Knife - Air Sweep systems for removing surface water and scrap provide fuel savings and improved quality, and are almost universally fitted. Water Clean-Up Systems are becoming more common as water costs rise.

Second only to the fryer itself, the equipment chosen for slice washing is a major factor in product quality and operating costs of any PC line.

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