Kvaerner Pulping

Kvaerner Pulping AB
Fiberline Division

Kvaerner's continuous cooking systems - the flexible solution

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Abstract

This paper will describe the latest innovations in Kvaerner's continuous cooking systems. The focus will be on practical solutions rather than process theory. The paper will briefly show results from new installations as well as an overview of the technical solutions.

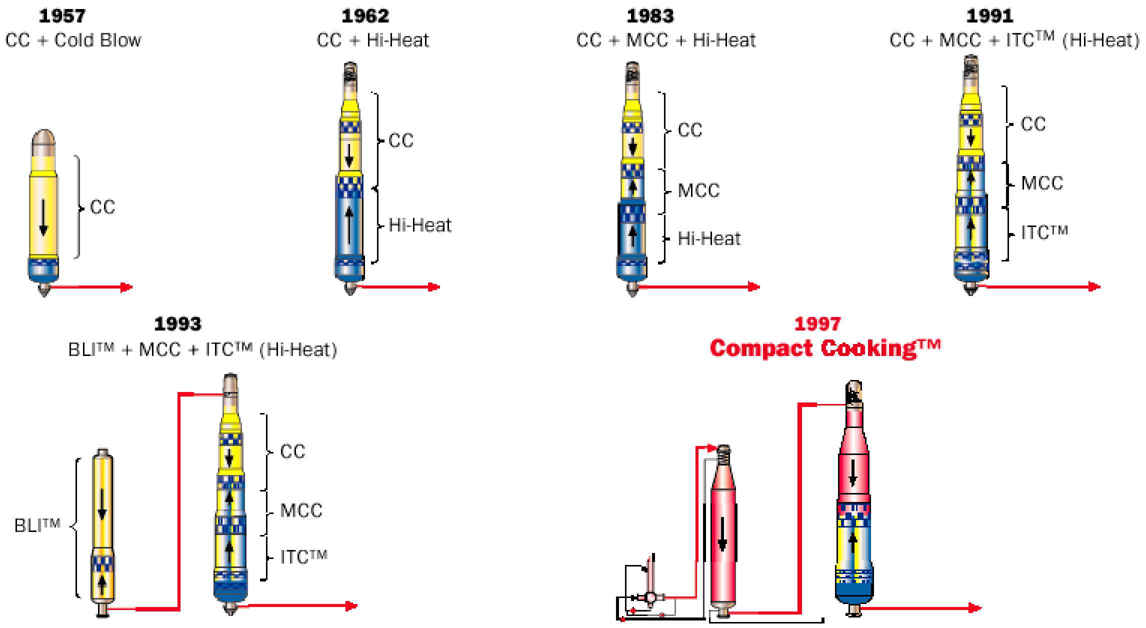
Background

The development of cooking has been very rapid during the past two decades. A number of new methods giving improved pulp quality, higher yield and better bleachability have been introduced to the market. The demands from the market have, in addition to the above mentioned improvements, also called for more flexible systems with a minimum of maintenance demand and easy operation.

A brief history

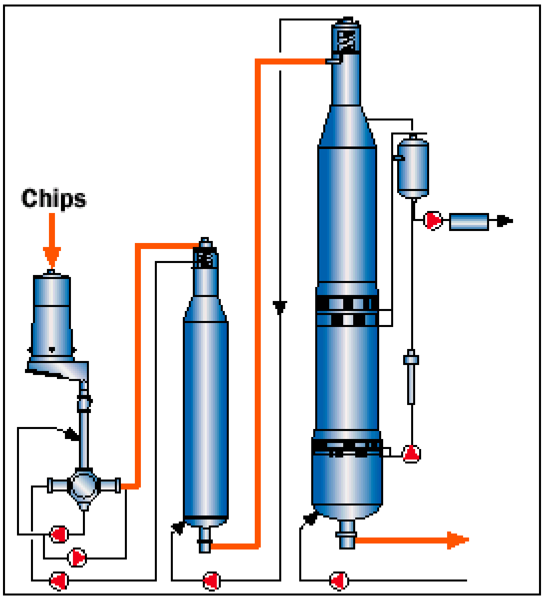
The history of continuous digesters started more than fifty years back in Karlsborg in the very North of Sweden with an experimental digester with a nominal capacity of only 5 tons/day.
The first commercial digester was installed 1948 in Fengersfors, also in Sweden, and the capacity was 50 tons /day. Today we are talking about digesters with a nominal capacity of more than 2000 tons/ day. Many of the old digesters were kept in operation for many years and there are a few installed during the 50's that are still running. In most of them the capacity has been increased by approximately 20 - 100 %, sometimes significantly more.

The continuous cooking technology was soon after the introduction of the cold blow in the 50's spread all over the world; in Australia, Japan, New Zealand, Canada, the U.S. digesters were started up, and of course also in many European countries.



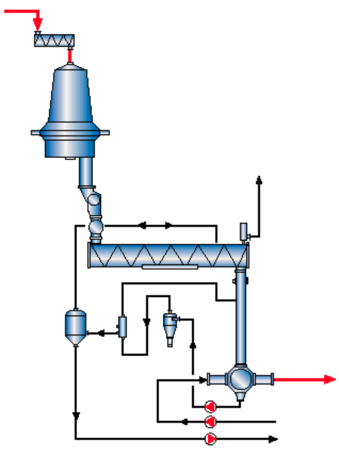
Some important milestones in the development of the continuous digester are Hi-Heat washing (1962), MCC (1983), ITC™ (1992) and BLI™ (1993). The latest step of development is the Compact Cooking™ system with its first trials performed in 1997.

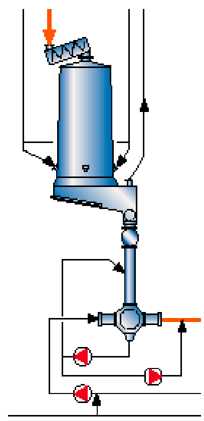
A brief description of a modern cooking system from Kvaerner is as follows: Presteaming in a DualSteam™ bin, feeding of chips with the Compact Feed™ system and efficient impregnation in a separate vessel. The digester itself is a Compact Cooking™ steam/liquor phase digester with ITC™ and a counter current wash zone at the bottom part of the digester. Thanks to its capability of producing pulp of excellent quality, Compact Cooking™ has become a standard feature in Kvaerner's deliveries.



Simplicity and flexibility

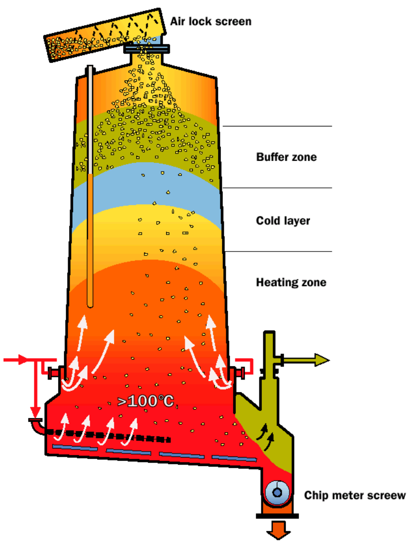
A common feature of Kvaerner's continuous cooking systems is flexibility, not only when it comes to an increase of production but also when it comes to process results. In some cases rebuilds have to be done to reach a certain production rate or to fulfil certain process criteria whereas in others no changes are needed. There may however be bottlenecks, especially in a traditional feeding line, restricting a desired capacity increase but in most cases such problems can easily be solved. Simple solutions giving the desired flexibility are described below.





Presteaming of chips

In the latest cooking systems there is no longer a steaming vessel in the feeding line. Instead all presteaming is carried out in a Dual Steam™ bin, efficient enough to make it possible to simplify the system. It is extremely important that the retention time in the chip bin under presteaming conditions is kept as exact as possible. In order to achieve that, the downward plug flow must be uniform with a minimised risk of channelling. Therefore, a mechanical outlet device with an easily maintained hydraulic drive system is installed in the bottom of the bin.



A proper plug flow ensures that there is no risk of steam blowing through as that may cause severe odour problems and abnormal steam consumption.
Also important is that the gases and the air in the chips are being removed after the presteaming. To achieve this a degassing system is part of the Dual Steam™ bin.

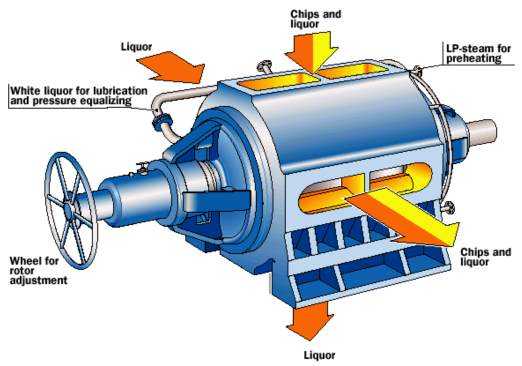
With properly presteamed chips, the subsequent impregnation will be efficient. The removal of air ensures that the movement of the chip column in both the impregnation vessel and the digester will be undisturbed. With a stable column's movement, the flexibility of the system can be maintained.

The following important parameters are being fulfilled in the Dual Steam™ bin:

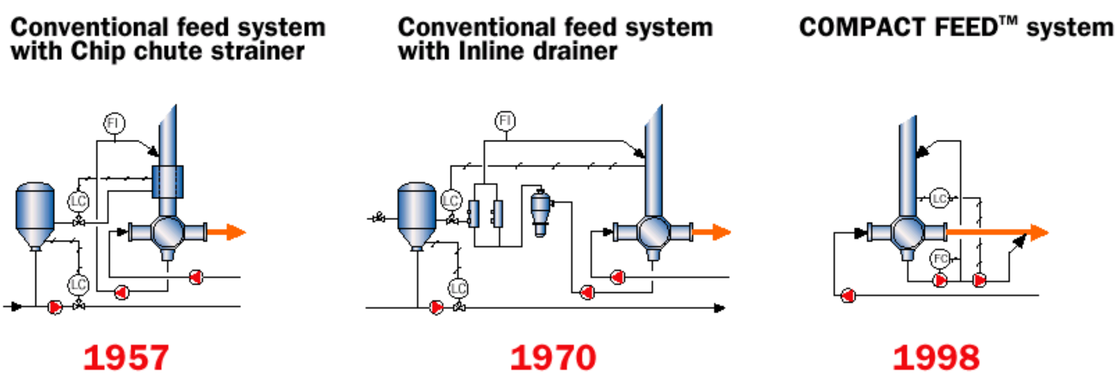
- Stable plug flow giving sufficient retention time.
- Minimised risk of gas and steam blowing through.
- Efficient degassing.
- Optimised steam consumption.

Simplifying the feeding line

The invention of the high pressure feeder was the key to continuous cooking. Functioning as the sluice between a low pressure and a medium pressure system the feeder normally, at nominal capacity, runs at a speed of 6- 12 rpm. In systems where a higher production rate has been chosen the high pressure feeder may run at up to 16 rpm. Above that speed, there may be problems with the pressure equalisation and hence the capacity may be hampered, so another solution must be chosen. It is also important to take the higher wearing of the feeder at high speed into consideration. The high pressure feeder is an expensive piece of equipment for which a replacement to a bigger unit is not easily justified.

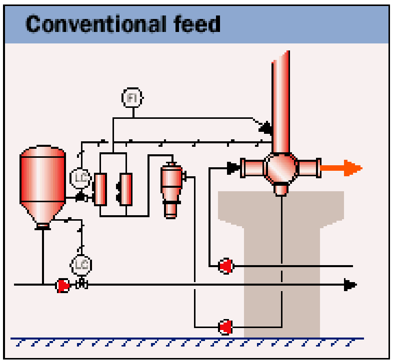


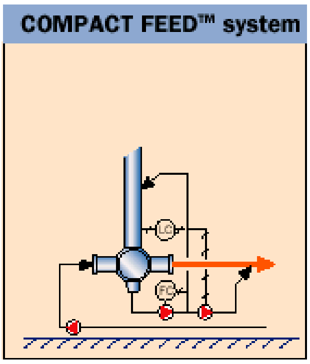
In most cooking systems, the feeding line is the most sensitive part to operate. The Compact Feed™ system has proved to give a high flexibility to overloaded feeding systems with easily introduced design changes. In fact, expensive replacements of high pressure feeders can be avoided at the same time as the maintenance of the traditional feeding equipment can be excluded from the annual outage agenda. Not to mention the disturbances that can be avoided. With fewer disturbances the safety is also improved.

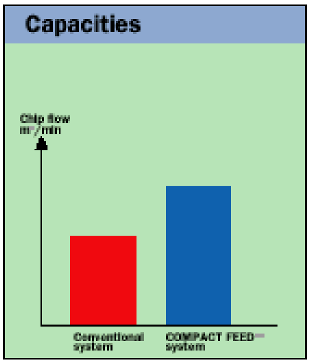


In the new feeding system it is possible to omit the sand separator, the inline drainers and the level tank. The level in the chip chute is controlled by an extraction of liquor from the chip chute circulation. The extracted liquor is then directly pumped into the top circulation line. The system is designed to minimise the risk of cavitation problems in the circulation.

The Compact Feed™ system enables a higher chip filling degree of the pockets of the high pressure feeder, up to ~70 % instead of the more traditional 55 %. That means that the production rate can be increased by ~25 % without increasing the speed of the feeder.







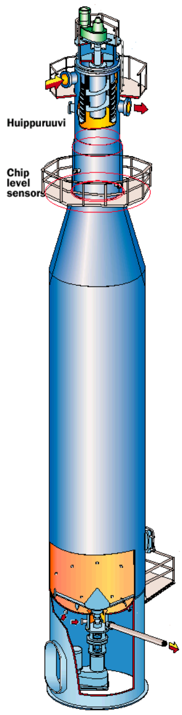
The advantages of the Compact Feed™ system compared to a conventional system are:

- A simpler system, easier to operate.
- Increased life time of the high pressure feeder.
- Easier maintenance.
- Improved safety.
- Cost effective system.

Impregnation

The importance of the impregnation of the raw material must not be underestimated. In order to achieve sufficient retention time for the impregnation and to obtain the very best flexibility the impregnation is best carried out in a separate vessel. This is however depending on the raw material and/or the desired production rate. In smaller systems it would be possible to impregnate the chips in the upper part of the digester.

In the impregnation vessel the liquor:wood ratio can be varied without affecting the digester and without the use of a strainer that may be plugged.
The temperature can be altered as well as the composition of the impregnating liquor. From this flexibility the fibres can be given certain properties and the treatment can be made very gentle.



A separate impregnation vessel also has the advantage of serving as a buffer in case a disturbance of the chip supply should occur. The process can then be kept running with acceptable results for a short while. Normally disturbances with the feeding of chips are solved within a few minutes. Therefore, a system with two vessels is more forgiving than most other systems.

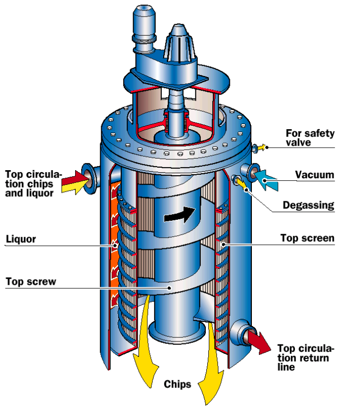
The impregnation vessel gives the following advantages:

- Excellent impregnation result.
- Possibilities to vary liquor:wood ratio.
- Possibilities to vary the impregnating liquor.
- More flexible operating conditions.

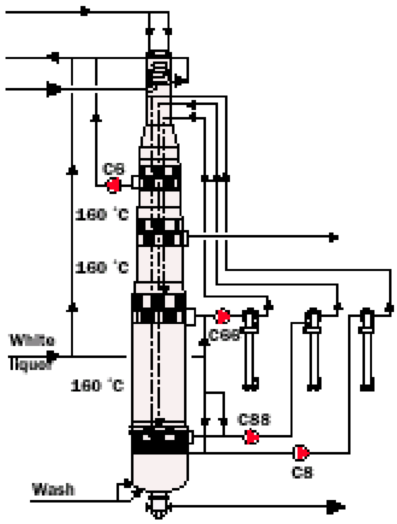
Flexibility in the digester

Kvaerner developed the Compact Cooking™ system in co-operation with a customer and a university in Sweden. The system fitted well with the aim of deleting as much equipment as possible, all in order to make the systems simpler and to reduce costs.

Not only has the process been made simpler but also some of the equipment. The top separator serves as a typical example having its most vital parts interchangeable between the two types of separators that are being used in the two vessels.



In the past, many different solutions for the cooking process have been tested, resulting in quite complicated systems. The most complicated digesters, with a comparatively large number of circulations in the digester vessel, have in many cases been fairly hard to operate. The problem is that the circulations, in order to provide the desired effect, have to be operated with rather big liquor flows. Taking into account that every counter current or cross flow through the chip column restricts its movement, one can easily conclude that the number of circulations should be minimised. This goes well along with the aim of simplifying the systems.

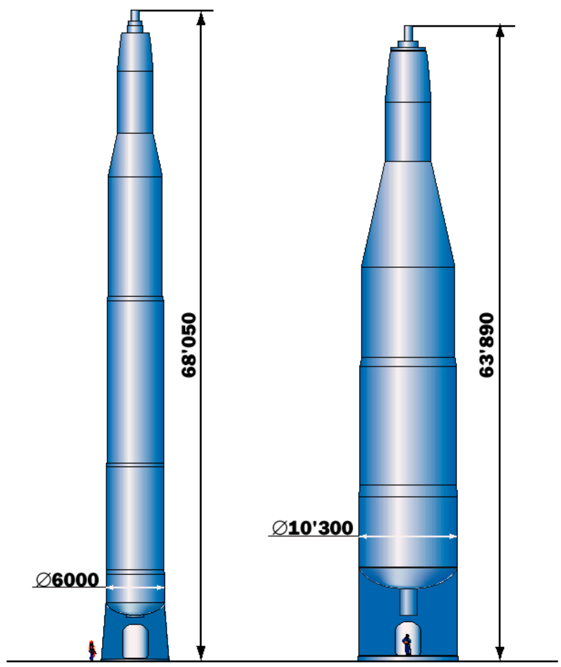


The cooking circulation in the upper part of the digester can without problems be omitted. In fact, the steam addition at the top of the steam/liquor phase digester is the best way to achieve uniform cooking conditions. In modern digesters there is no need for a MCC™ circulation either.

The basic principle for the flexibility of the Compact Cooking™ digesters is the possibility to achieve a more selective cooking result by varying the liquor:wood ratio, the alkali profile and a significantly reduced cooking temperature. A more selective cooking process means less degradation of carbohydrates which results in a better pulp quality and a higher pulp yield.

The cooking temperature has, with the development of the cooking process, been reduced significantly. From the first hardwood digesters running at 160ºC the process nowadays runs at well below 145ºC. The corresponding figures for softwood are 175ºC and 150ºC.

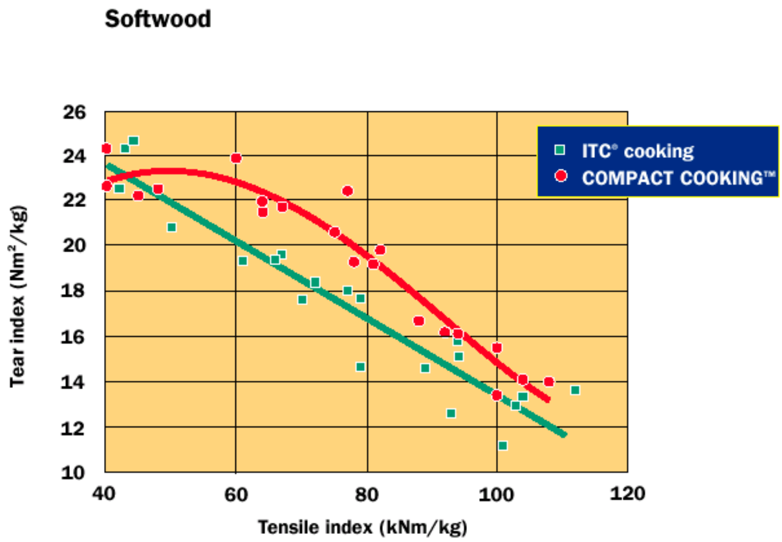
The extraction of liquor can take place either at the middle part of the digester or at the bottom part. In case the middle part is chosen for extraction, the lower screen unit is used for circulation. As there is a lot of "free" liquor present at the bottom, the circulation can be made efficient without plugging the screens. Hence the chip column's movement can go on undisturbed. The dilution factor, i.e. the upflow of liquor, would be the limiting factor but in general the conditions are the same as for conventional systems.



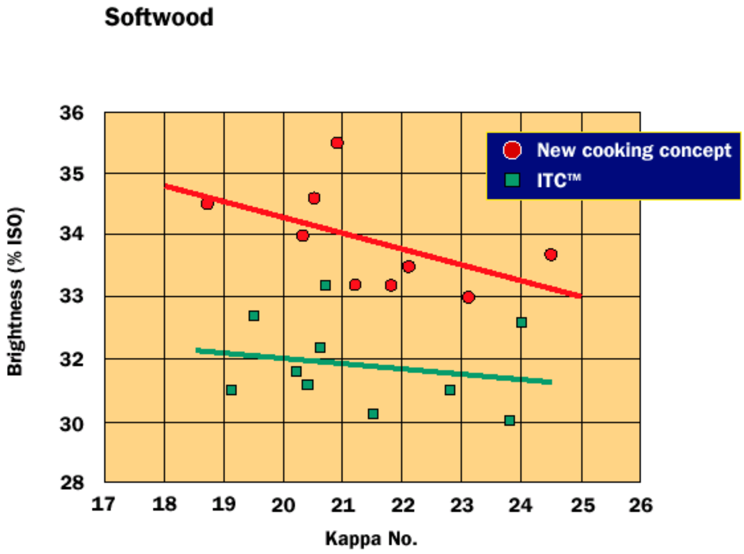
The size of continuous digesters has of course changed with the demands for higher production rates. They are today about the same height as they were some 20 - 30 years ago. The change is in the bottom diameter, which has increased from 5 - 6 meters up to more than 10 meters. It is in fact discussed to make digesters of a diameter of 12 m. Where the limit is, nobody knows.

Results from the simpler process

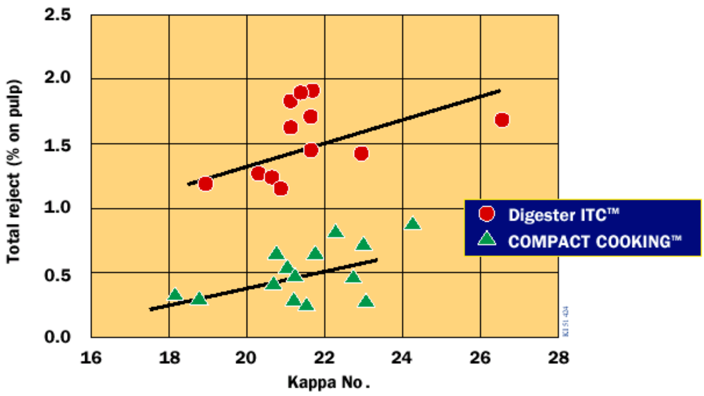
The tear index for the pulp from the Compact Cooking™ process increases significantly compared to the ITC™ produced pulp. It is then important to keep in mind that the ITC™ pulp was in the top range compared to other process solutions.



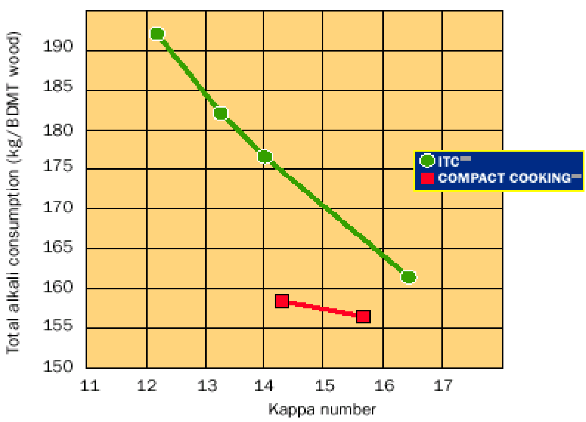
The pulp is brighter already after the digester with its subsequent washing and this is enhanced by the pulp's improved bleachability.



An important parameter to consider, with raw material being a significant part of the manufacturing costs, is the pulp yield. Subsequently the reject content must be kept as low as possible. A gentle but efficient delignification has proved to be the right way to achieve this. A very low reject content was achieved already with the ITC™ process but the positive effect has been further enhanced with Compact Cooking™.



Another positive result is the reduced consumption of alkali. To a great extent the reduction is due to the improved distribution in the new cooking system.



The advantages of Compact Cooking™ can be summarised:

- Improved pulp strength properties.
- Lower reject content.
- Higher brightness
- Improved bleachability.
- Reduced white liquor charge.

Conclusions

Although it may seem contradictory, simple systems are more flexible. With the knowledge of the process that we possess today, we know that it is important in a continuous cooking system to reduce the amount of possible disturbances of the chip column's movement. The chips have to move through the vessels completely undisturbed.
With less pieces of equipment to handle the process will fulfil all demands of simplicity and become reliable and cost effective.