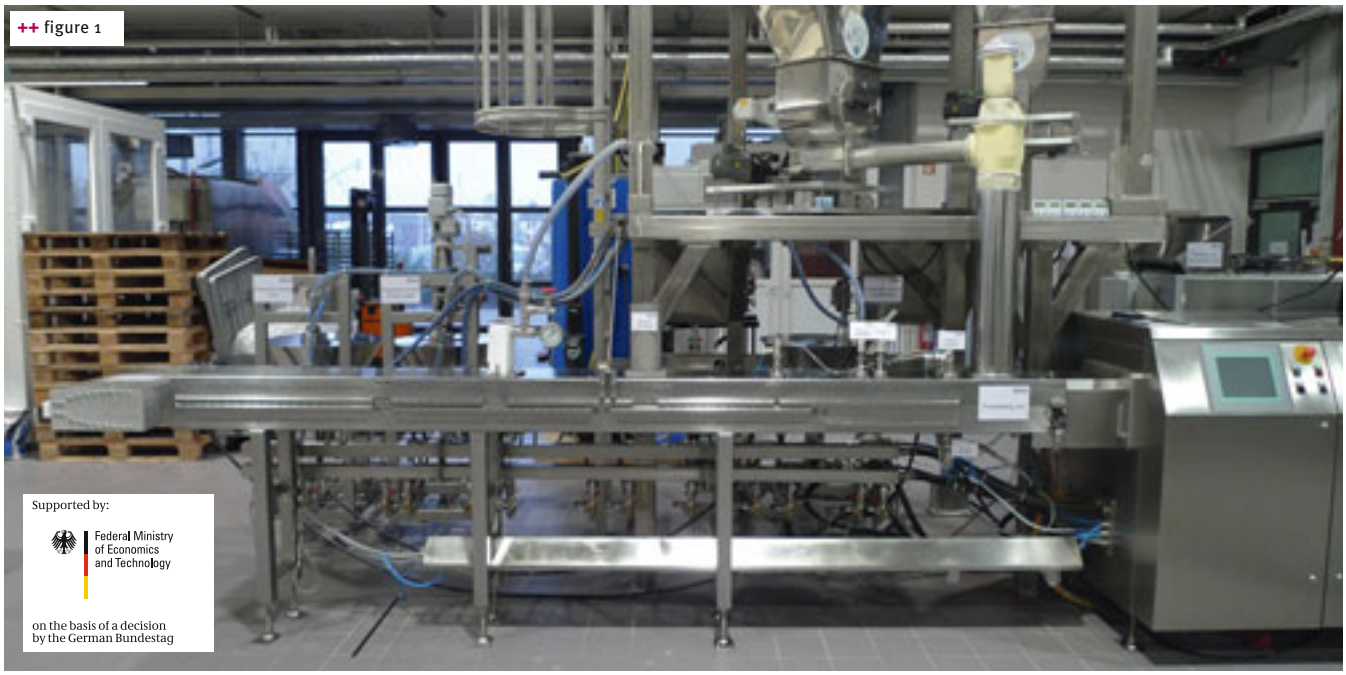
More than continuous mixing

THE CODEX BY RONDO GMBH, A COOPERATION BETWEEN RONDO AND HB FEINMECHANIK, PRESENTED AT THE BREMERHAVEN TTZ A DOUGH PREPARATION PROCESS THAT USES AN EXTRUDER AND A MOULDING NOZZLE TO PRODUCE A PLASTIC DOUGH WHICH DOES NOT SHRIVEL AND NEEDS NO DOUGH RESTING TIME BEFORE FURTHER PROCESSING



++ figure 1
The continuous extruder from Codex by Rondo in a trial version at the ttz Bremerhaven

In general the advantage of continuous mixing is uniformity and provided that the quality of the raw materials is consistent, a continuous mixer can be used to prepare dough that can be fed continuously into the downstream dough processing stage. This allows the production of large quantities, often reaching an output rate of several tons per hour.

A novel fully continuous dough preparation process has been developed under lead management by RONDO Burgdorf AG, Switzerland, and HB Feinmechanik GmbH & Co. KG, Metten, Germany, who are cooperating under the name CODEX by Rondo GmbH. All the research work has taken place at the Bremerhaven ttz (Technology Transfer Center). The result is a continuous double-jacketed extruder that mixes the ingredients, uses high pressure and vacuum to shape a plastic dough sheet, and then feeds this to the downstream laminating plant through a wide slit nozzle. Models with hourly processing capacities of 0.4–3.5 t are planned.

The process, set up in the Bremerhaven ttz, shows the manufacture of laminated products. This process is defined as the C1 Laminating Process. Other processes such as the C2 Sheeting Process for yeast doughs such as pizzas, donuts, spirals, flatbread, seeded rolls and baguettes, and the C3 Moulding Process for toastbread, sandwich bread and loaves are planned.

In the technical implementation of the experimental plant in Bremerhaven, the controller elements, all manufactured by HB Feinmechanik, are installed over a length of 2 m at the start of the plant. This is followed by various process zones to mix, transport and knead, across a kneader length of 4 m. Depending on the application, positive pressure and vacuum are applied in the zones relevant to the process. The sealing between the individual zones is actually carried out by the dough itself. The extruder jacket is equipped with five cooling zones. The dough temperature is controlled, and in the C1 Laminating Process it is maintained at approx. 15 °C without the addition of ice.

First of all flour and other solids are metered in and are still being pre-mixed. The mixture is wetted with water under high pressure from above and below. Test runs revealed that as a result of this intensive wetting and a water pressure of several bar, more added water is also actually bound, leading to a higher dough yield of up to 6 % in the final dough. The increased amount of bound water also remains in the product after baking. The use of flours with lower protein content is also possible, allowing significant savings to be made in material costs. In addition it has already been possible to meter in 5–50 % of pre-doughs (including dough slurries with a dough yield of 200) and to incorporate them completely without consistency inhomogeneities occurring. In the next step the mixture is conveyed into the kneading compartment. In contrast to other continuous mixers, the conveyor screws here operate as a counter-rotating extruder. Positively

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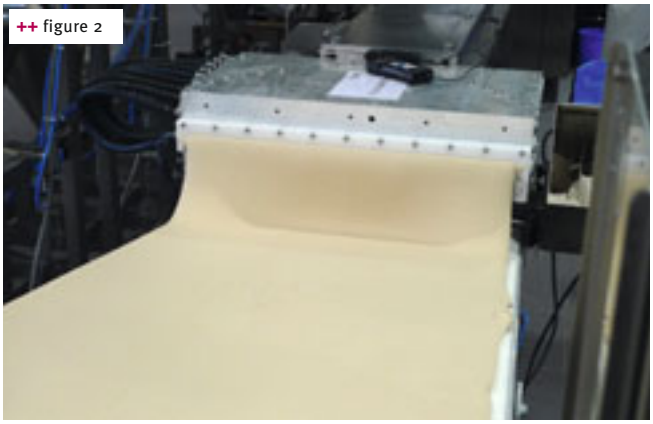

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++ figure 2
The vacuumed dough comes out of the wide slit nozzle smooth and with no cracks

++ figure 3

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++ figure 3
The produced dough is plastic, homogenous and doesn't tear apart

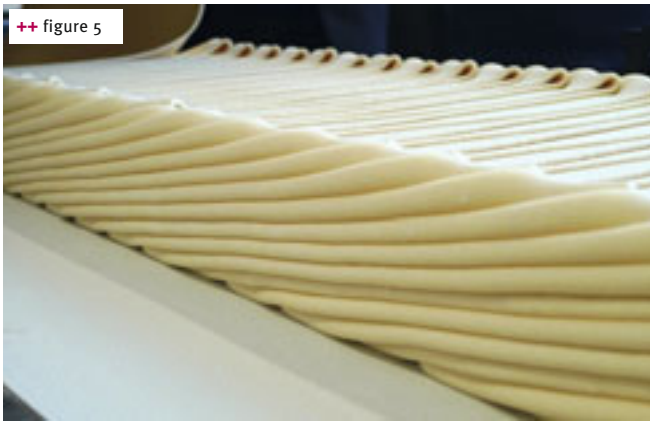
locking tools force-convey the dough forwards. In this process the attack angle of the screws defines the conveying of the dough through the feed chamber. Christian Becker-Sonnenschein, Managing Director at Codex by Rondo, explains that, "Due to the small diameter of the feed chamber, the energy input is greater and thus better than with previous mixer types." The dough is now kneaded under pressure in the kneading zone. In addition a vacuum of up to 200 mbar is used on 25 % of the kneading section. The dough seals the zones at the front and back, so each zone is self-contained. According to Becker-Sonnenschein this needs a minimum dough quantity of 400 kg/h at the ttz version; in this model the maximum amount of dough is currently up to 1.5 t/h.

The vacuum affects the dough plasticity, which the Bremerhaven ttz team were able to establish on the product. One reason for this is the gas bubbles in the dough, which are created under the pressure. Under vacuum these bubbles are expanded to become bigger. The continuous mixing divides the bubbles into an extremely large number of smaller bubbles, thus greatly increasing the surface area of the dough. The overall interaction between the pressure and vacuum phases controls the number and size of the gas bubbles in the dough. The extremely large number of thin cell walls are another reason for the plasticity and are part of the higher water binding. Dough resting time and dough cooling are eliminated by the low temperature of approx. 15 °C and the dough plasticity. Thus a butter croissant production line no longer needs a dough resting section. The addition of ice is eliminated. Becker-Sonnenschein says the dough and fat plasticities are at the same level during the processing period.

The small ingredients such as nuts and raisins can be metered in during the step after vacuuming, in order to avoid them being crushed. The dough strand is then conveyed forward and handed over to the laminating plant through a cooled wide slit nozzle as a uniform dough sheet 60 cm wide. The total dough preparation time from metering the ingredients to extruding the dough sheet from the nozzle is approx. 7 min. The vacuumed dough needs the compacting caused by passing through the nozzle, otherwise it would spread out. The result is a smooth sheet with no cracks, whose sides no longer need trimming. Becker Sonnenschein explains that, "No shear forces occur at the nozzle! That is important for ▶

++ figure 4

++ figure 5



++ figures 4+5
The laminated dough sheet can be produced in only 28 layers in one piece and through only a single folding channel

the dough, since only intact proteins can bind water." After emerging from the nozzle the dough becomes elastic again within 15-20 min, but remains dimensionally stable at the same time. Due to the wide nozzle, no portioning funnels and dough sheet shapers are needed upstream of the laminating station. In addition the layers, for croissants or Danish pastry dough for example, are manufactured in one single folding channel. This again shortens the line by one more folding section, and the whole process by more than half. If the kneading process ever needs to be stopped, an interruption of up to 30 min is possible without the dough properties changing. This eliminates the need for a buffer system. At the same time there is less reject production, because as a result of the controlled forced conveying, there is less waste in the event of a standstill.

The Codex by Rondo GmbH has also thought about easy cleaning: the entire process unit can be flooded in place automatically, and this can be done without opening the machine. However, if the lid ever needs to be opened, the kneading tools can be lifted out if necessary. The ttz confirms that all dough residues are stripped out by cleaning with an enzymatic and chemical solution for 20–30 min, and the continuous extruder has a low germ count.

In the initial stages, laminated doughs and dough sheets (i.e. puff pastry doughs, Danish and croissant doughs) were tested on the plant. In the next step, Codex is currently developing dough strands to manufacture (toast) bread and baguettes. The plan is that the toastbread will then no longer be produced by the 4-pieces method. Instead the plant will deposit it directly into the pans. Becker-Sonnenschein explains that trials of this will probably commence in March 2013. However, the results of the series of experiments up to the present are also very presentable:

Compared to doughs running through spiral mixers, the dough did not shrivel and had no tendency to crack. Overall the dough was very homogeneous, finely porous, dry and closed, and there were no adverse effects such as elastic shape recovery. The good water binding yielded a lower a_w value, which was compared in an experiment with that from a spiral mixer. Taking puff pastry dough as an example, the average a_w value with the spiral mixer was 0.7880 (ranging from 0.7813 to 0.7947), whereas the Codex average value was 0.7332 (ranging from 0.7258 to 0.7305). Markus von Bargen from the Bremerhaven ttz explained that the high water binding ability was in turn due to the intact protein chains, which are not damaged in this machine because of the gentle forward transport of the dough and the fact that hardly any shear forces are present. Another advantage is that when producing croissants, 28 layers can now be run in one piece and through only a single folding channel and one satellite head, which was previously impossible. This means the line is now only L-shaped and no longer looks U-shaped.

With puff pastry dough it is also possible to run with fewer layers, and the dough looks just the same with 120 folding units as with the usual 144 foldings. This allows a restriction to two folding processes, and it is no longer necessary to provide three folding stations. The coldest dough coming out of the extruder is at 12 °C, and can be used like that to fold butter into it. If margarine is used, the dough temperature is 20 °C. The aim is always to keep the plasticity of the dough and fat the same, and to have a dough that is not stubborn.

According to Becker-Sonnenschein, recipe adjustments should on the whole take place via the energy input, not by changing the mixing tools. The aim is also to develop a new nozzle for each product, the large energy input being helpful again here. The Codex extruder should be available at RONDO in Schio, Italy, for demonstrations from late May 2013 onwards. +++

++ figure 6

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The final products of the C1- Process Laminating: butter croissants

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