Sums make all the difference

THE PRICES FOR ENERGY ARE RISING AND THIS WILL NOT BE REVERSED. THE TIME IS NOW RIGHT TO CONSIDER THE ENERGY CONSUMPTION IN A COMPANY. EXPERTS **DR. ING. HEINER GERMAN**, MANAGING DIRECTOR OF GERMAN LEBENSMITTELTECHNOLOGIE GMBH, BERLIN; **UWE KESSELHUT**, MANAGING DIRECTOR CONSTRUCTION AND DEVELOPMENT AT WACHTEL GMBH & CO, HILDEN; **DR. MARTIN PITTROFF**, MANAGER PRE-DEVELOPMENT, MIWE MICHAEL WENZ GMBH, ARNSTEIN; **DIPL.-ING. RALF GEBHARDT**, GROUP MANAGER CONSTRUCTION INDUSTRIAL OVENS AND VACUUM COOLING, WP BAKERY GROUP, DINKELSBÜHL; **DR. GERD MEYER**, MANAGING DIRECTOR, DAUB GMBH, HAMBURG, DISCUSSED WITH **MS. HILDEGARD M. KEIL**, EDITOR-IN-CHIEF OF BAKING+BISCUIT INTERNATIONAL, WHAT CAN BE DONE IN THE FIELD OF OVEN TECHNOLOGY TODAY AND IN THE FUTURE.

+ **Keil:** Mr. German, companies are contacting you because they are unsatisfied either with the performance of their ovens or with the energy consumption. How important is energy management for companies now?

+ **German:** There are two situations that companies are at when they contact us: They either intend to optimize their equipment or they are planning new investments. GLT analyzes, proposes changes, which are partly implemented by us, and controls the results in an ongoing monitoring process. Of course, many ovens offer significant potential for energy savings but it is not only the ovens. When pursuing the subject from the beginning, the entire company must be looked at. With rising energy prices, the energy costs are becoming a factor to be taken into consideration when thinking about the profitability of new equipment.

++ **Dr. Ing. Heiner German**
Managing director of German Lebensmitteltechnologie GmbH

+ **Keil:** Let's pass this question on to the manufacturers of ovens. What do you do to reduce the energy consumption?
+ **Meyer:** This is not exclusively a matter of technology as we increasingly consider the process. More than 50% of the energy consumed during the baking process is used for the evaporation of water; 16 – 18% is released with the exhaust air. The remaining part is used to heat the product which could not be baked without heat. So, the less water evaporates, the more energy can be saved. The other consideration is a more intelligent management of exhaust air and steam by improved process controls. Process, water evaporation, and exhaust air – these are the three parameters that can and will have an influence.

+ **Keil:** What does this influence look like? Where do you reduce the consumption in practice?

+ **Meyer:** Daub is designing thermo-oil ovens and we are achieving a 2 – 3% lower baking loss throughout the process because we control temperature and process reasonably and operate with radiation. Furthermore, we apply intelligent sensors and controls in order to monitor the process and the amount of exhaust air, while ensuring the desired product quality.
+ **Kesselhut:** We pursue a different approach even though I do not disagree with Dr. Meyer. We have a heat recovery system which unfortunately for once has not turned out to be as successful as expected. We can use heat from the exhaust air and the flue gases to heat up water, but what do we do with the hot water in summer?
We therefore took a different approach. Today we use certain burners in our rack ovens which save about 11% of energy. In this context, in-store baking ovens are another subject. These ovens are used less in the late afternoon and evening. When the ovens are switched on again in the morning, a certain amount of heat is still in them. We programmed the control so that the customer has only to enter the time when he intends to start the baking process and not when the oven should start its heating up phase. From the remaining temperature in the individual hearths, the oven calculates independently when the hearths have to be heated up. The oven also "knows" whether it is summer or winter, and the environmental temperature in the store. The oven takes these parameters into consideration and turns itself on so that it is ready for baking precisely when the customer wants to load the oven. The advantage is not only that these ovens

need less heat but they also do not bake the first load with aggressive heat. Furthermore, our ovens are equipped with an "eco" push button. The sales person sets the time when he/she plans to use the oven again. The temperature in the oven drops but the oven turns itself on again exactly at the time when baking is required. In addition to that, the oven also compiles a table on its operating times. For example, the in-store baking oven is intensely used on Monday in the morning between 6 and 9 am, but after that its use decreases until it picks up again around noon. After that it decreases again with another peak around 4 pm. The oven memorizes these cycles and knows that next Monday the baking cycles will probably be similar and thus controls the hearths accordingly.
For industrial ovens, there are other possibilities. One example is to turn off certain groups because there the temperature decreases slowly and can be quickly heated-up again, upon request.

+ **Meyer:** So, this is an approach of not generating heat after all but to send it through the chimney and collect it from there in a heat exchanger to produce hot water. Of course, there are ways of using recovered heat, as for example when the hot exhaust air is used to pre-heat the infeed air of the burner.

+ **Keil:** It this applied?

+ **Meyer:** It has been applied and is another issue worth thinking about. But of course, this is a question of calculation. It requires a different burner which can cope with this temperature.

+ **Kesselhut:** This is done in condensing technology already. However, we cannot use condensing boilers in the oven because our burners cannot cope with the hot air. There are many plastic parts in that area which do not tolerate hot air.

+ **Meyer:** There are burners that do tolerate that. We used those 10 to 15 years ago, but they did not succeed. At that time we installed them in Switzerland because this was the only construction allowed there.

+ **Pittroff:** Currently the pre-heating of air as described here is failing because of technical requirements as provided by the manufacturer of the burner. In this field respective developments would be desirable.

+ **Gebhardt:** We have conducted trials with a manufacturer of burners. The problem is that the air fed into the burner must be pre-heated uniformly. If the air is too hot, plastic parts, as well as photocells will suffer. On the other hand, the exhaust air contains more energy than can be utilized for heating the burner air, so only parts of the energy would be reused. In my opinion it would be better to guide the exhaust air directly through a heat exchanger. This idea has potential if concepts are developed on how to use the recovered heat. The entire concept for the plant has to be taken into consideration. This is for example important for the design of the air conditioning. More and more bakeries today use air conditioning. For project design, it is important to get realistic values from all equipment suppliers, not only from oven manufacturers, in order to design the air conditioning unit appropriately.

+ **German:** Straight after the first energy crisis, a large bakery in Berlin thought about recovering the heat which was discharged through the chimney. As a result, a lot of hot water was produced and nobody knew what to do with it. The biggest problem was to guide the air with a fan to where it would be used. This fan had been placed on top of the oven. A graduate student discovered that the oven consumed more energy than ever before due to the fan. This was rather counterproductive. It certainly is the best option to first check all processes and optimize them by organizational or technical measures prior to thinking about the recovery of energy and how to utilize it.

+ **Gebhardt:** For large projects we increasingly compile energy considerations for different products. Today it is easy to determine the energy requirement needed for heating, steaming, pan warming, etc. The trend today is for par-baked products that are baked-off later in the store. Due to the reduced baking time the oven can handle more loads in the same time. This has the effect that more steam is generated per hour than would be needed for a complete baking process. In the store, the baking might also take place with steam and if an intermediate cooling process is also included, the energy consumption rises. The conclusion: the trend towards par-baked goods increases the energy requirement.

+ **Pittroff:** Potential energy savings can be categorized into three areas:

++ **Dr. Martin Pittroff**
Manager pre-development, MIWE Michael Wenz GmbH

1. The baking process has a certain requirement to which the consumption can basically be minimized. ▶

2. The energy requirements for constructional parts and equipment can be influenced by insulation, guiding of the heating gases, implementation of heat exchangers, etc.
3. Improvements in organization which can be achieved mainly by sensitizing the users, supported by advanced oven controls. With this view, the baking process is still at the beginning of its characterization. This is different from the automotive sector where the fuel consumption has to be stated in any sales folder. This is not common for baking ovens. In the past there have hardly been any requests for that kind of information except for direct requests by individual operators. To improve clarity in the future, a possible approach would be to analyze the entire process and to state the individual consumption parameters for e.g. pre-heating, holding, baking, waiting in energy saving mode, etc. However, this approach is connected with rather significant costs for data collection and data maintenance.

+ **Keil:** Do the users ask which energy a certain type of baked item might consume in a certain oven?

+ **Kesselhut:** Sometimes they do. However there is hardly any supplier who is willing to provide this information because it is never precise. This is just like with cars because nobody drives a car at a constant speed of 90 km/h without braking or acceleration. If a baker opens the door twice during the baking process, the energy consumption rises. The more steam the baker applies – no matter whether this is necessary or not – the more energy needed.

+ **Gebhardt:** I would recommend that in a company the steaming is reduced until changes are visible and then the amount of steam adjusted until the optimum parameter is approached. But this rarely takes place. The waste of energy through steaming is an issue that hardly any oven operator is aware of. Therefore, it is important to sensitize the operators and to make sure that the baking programs are optimized.

++ **Dipl.-Ing. Ralf Gebhardt**
Group manager construction industrial ovens and vacuum cooling, WP Bakery Group

+ **German:** This can be experienced in large companies. Even in a three-shift operation, one operator adjusts the oven differently from the previous shift operator, simply because of a need for more safety or because of different experiences. The oven parameters are changed at the beginning of the shift despite the fact that the product is discharged in its proper condition. The person on site often has a lack of knowledge on inter-relations and there is no incentive for optimization. The amount of steam the oven consumes is not important as long as the product comes out in its proper condition and on time. The sensitizing must come from third parties.

+ **Gebhardt:** We often have the request that the baking programs should be locked so that the oven operator cannot change them on his own. He can re-bake the product if needed, because there are always technological differences in dough make-up, but he cannot change the process.

+ **Keil:** Do I understand you correctly that you should be able to inform me as the operator on the energy a certain type of bread will consume during the course of a certain baking program?

+ **Gebhardt:** The influence which I have as a manufacturer of ovens is that the hearths are tight. If a hearth is not tight, it draws in air and steam escapes resulting in a quality problem. A leaky oven invisibly removes energy via the chimney.

+ **Meyer:** … and in particular in the region around the hearth flaps and sealings which have to be maintained...

+ **Gebhardt:** We recommend our customers check the seals once a week.

+ **Meyer:** But first of all they must be in place, which is not always the case. There are still ovens available which have no sealings at the flaps. Furthermore, the seals should have a long service life. It is hardly noticed that air is sucked in; instead the amount of steam is being increased. Of course there are possibilities we as suppliers can provide. One example is to design the temperature management in a way that ovens no longer have five zones but rather just as many as are needed. The same is valid for chimneys. We calculate the energy requirement per product. This is exactly as with driving a car. More speed, higher consumption.

+ **Keil:** That is fine because then I know that it is my way of driving that increases the consumption and not my car. In this field the sensitization you talked about is present, but if you expect the same sensitization from the oven operators, then you have to give a guide, a comparison figure.

+ **Meyer:** Maybe a consumption index on the monitor...

+ **Keil:** Maybe if it helps. ▸

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+ Kesselhut: But this is precisely the problem. Most bakers want to be on the safe side and apply more steam than is required. Together with IGV (Institute for Grain Processing, Nuthetal, Germany) we have conducted a project to assess how much steam is really required. We found that even a baker who applies less steam (in his opinion), still uses too much by a factor of 10. There are bakers who have additional steam generators connected to their rack ovens, as these bakers will apply even more steam than the norm which is far too much to begin with. However, the baker is successful.

++ Uwe Kesselhut
Managing director construction and development at Wachtel GmbH & Co

+ Gebhardt: Previously, the steam generators were time-controlled. The solenoid stayed open for a certain period of time and in which time as much water as possible could run in as allowed by the water pressure. Today the amount is precisely set. Of course, different products require different amounts of steam. It is the baker's art to determine the correct amount and to enter it into the software. In this way he determines to a certain extent the product quality.

+ Meyer: When I reduce my baking loss from 15% to 12%, I can save 1/5 of the energy used for the water loss. When calculated for the entire process, this totals 10%. Where do we gain 10% from steam if the entire energy consumption of the exhaust air amounts to only 15%?

+ Kesselhut: Currently nobody thinks about whether and how much steaming is required and how much energy could be saved by changing the operation accordingly.

+ Keil: This means in the long run: state definite values.

+ German: Now we have to take one more step forward and measure the amount of steam really reaching the baking chamber and what amount will be needed for proper quality. This is possible and we could learn from a Swiss baker. He adjusted the oven at the first measuring point to a dew point of 82°C because he knew that at this point the split would be optimal and the shine beautiful. We have to provide parameters for the bakers which allow them to reproduce the baking results. In another example we had to state that a baker had to add 40 kg more steam each day at precisely 10 am. If he did not, the bread would crack. We observed this phenomenon and took measurements to find out that the climate in the oven broke down at 10 am and that more steam was required to stabilize the climate. The reason: The program of the air conditioning unit opened a window in the roof each day at 10 am. Cold air dropped in and shifted the climate inside the oven horizontally thus reducing the amount of steam in the steaming section. Things like this are really expensive.

+ Gebhardt: Many bakers just accept that the amount of steam has to be increased at a certain time. They do not concern themselves with the reason.

+ Keil: This is an indication that the oven operators do not know the interrelation. As long as they do not have parameters for orientation, they are not able to combine the relationship between ventilation flaps or leaks and steam requirement. It is your task to provide respective indications in the controls to make it possible to react to significant deviations from the

German Lebensmitteltechnologie GmbH

Dr. Heiner German studied food technology at the Technical University, Berlin. His diploma thesis was on the collection of energy flows from the field to the finished baked good. His PhD thesis at Prof. Friedrich Meuser was titled "Development and use of a hygrometer for optimization of bread quality and energy efficiency during baking" and delivered the theoretical background for German's company. It quickly showed that he had addressed a topic rather neglected by the baking industry so far. The very first customer who ordered German to measure one baking oven only let him go after he had measured and optimized all other baking ovens in the company as well. The company GLT, founded in 1986, is available today for services such as energy measurements and analysis, energy and technology consultations as well as product and process development. Furthermore, the team of four people, together with partner companies will set up compete baking oven controls, baking chamber air conditioning units, as well as conditioning units for proofers, cooling chamber and clean rooms. Dr. German states that "our core competencies are technical innovations and their implementation within the baking industry." The team itself conducts the entire engineering work as well as the programming of controls and the design and construction of hygrometers. External specialists are responsible for the assembly work on site. Key features of GLT are the constant customer service from the planning stage, the implementation of the project to the optimization of the baked goods and energy efficiency. GLT customers are at home in the European food industry with focus on the baking industry. **+++**

nominal values. It is not possible to tell everybody to save energy without informing them why and how.

+ **Meyer:** There are two ways to make the operators aware of how they use energy – one is the collection of data and indication. The second way is to change the process accordingly with the goal to achieve a proper baking result with less baking loss. Radiation heat is the keyword. The baker then does not have to think about how much energy he used.

+ **Keil:** As a result, leaks or open flaps do not become irrelevant then.

+ **Meyer:** The next step would be sensor technology to find these faults.

+ **German:** I do not comprehend how it is possible to achieve the same baking result for bread with different baking losses. In general, the baking loss is closely linked to the strength of the crust and to the desired crust quality.

+ **Meyer:** Air carries less energy than a liquid medium. In a heating gas convection oven, the starting temperature is

++ **Dr. Gerd Meyer**
Managing director, Daub GmbH

higher. The temperature slope for a certain product is different. The crust dries out more easily, thus lacking elasticity. A continuous heating gas convection oven which has a higher start temperature than in the end zones has to be loaded with fully proofed products because they do not have sufficient time for development. This time is still available in a thermo-oil oven; the surface of the product will remain more elastic. A baker will load a thermo-oil radiation oven in a different way than a heating gas convection oven. You will get automatically a lower baking loss at the end of the process. When more heat is applied to the surface at the beginning of the baking process, more moisture escapes. However, the moisture is important for the heat transfer to the inside of the bread in order to reach the required core temperature.

+ **Kesselhut:** This is similar when baking in a STIR oven. The heat is transferred faster to the inside with the gelatinization inside the dough piece being accelerated. If there is no free water left, the heat cannot penetrate the products as easily and stays on the surface. From a baking comparison for rolls in a STIR and a conventional oven, it could be observed that the rolls start to brown in the conventional oven right from the beginning. In the STIR oven, the roll will only start browning after five or six minutes. The browning develops much faster and the roll is completely baked after 12 – 14 minutes. The baking loss is much lower because more moisture is bound.

+ **Keil:** Why don't all industrial ovens use STIR technology? Up until now only the J4 tunnel oven is using this method.

+ **Meyer:** If you use radiation ovens, the radiation can be limited to certain wavelengths. However, attention must be paid to the spectrum in which water vapor is being absorbed as this cannot get to the product. The STIR technology is very close to these wavelengths with only 3.5 µm apart. Therefore, steam clusters in the oven have to be removed otherwise the baking would be impaired. With the right coating, the right wavelength and the right surface in a radiation oven, the correct temperatures can be reached within four to five minutes. I would never use a STIR coating in a thermo-oil oven. I prefer different coatings.

+ **Kesselhut:** We have conducted trials with STIR tunnel ovens which have a coating in the first third of the baking chamber, the entrance section. After this section it is also possible to remove the rolls and bake them somewhere else. This would be just as fast. There are respective practical comparisons available: a 24m STIR oven and a conventional 36m oven next to each other. The baking time for the products in both ovens is the same.

+ **Gebhardt:** We have conducted trials with STIR. In this oven the core temperature is reached more quickly, but the temperature within the baking chamber has to be increased for proper browning. Apart from the time advantage, I do not see any other significant benefits. **... TO BE CONTINUED IN OUR NEXT ISSUE!**