Der Dialoggarer – ein Ofen mit Leistungshalbleiter-Kochtechnik

Tabea Mehnert

Kurzfassung

Mit dem Dialoggarer hat Miele auf der IFA 2017 eine Innovation im Küchenbereich vorgestellt. Dieser Ofen nutzt elektromagnetische Wellen zur Erwärmung von Lebensmitteln, die durch Leistungshalbleiter-Elemente erzeugt werden. Mit einem geschlossenen Kreislaufsystem passt der Dialoggarer eine Sendematrix eines elektromagnetischen Spektrums um 915 MHz kontinuierlich an den Garprozess der Lebensmittel an. Der Dialoggarer bietet neue Parameter und Programme für die Nutzung und stellt eine Alternative zur bislang genutzten Mikrowelle dar.

Schlüsselwörter: Dialoggarer, Miele, Kochen, elektromagnetische Wellen, Leistungshalbleiter

The dialog oven – an oven powered by solid-state cooking technology

Abstract

At the IFA 2017, Miele presented a new innovative oven, the dialog oven. This oven uses also electromagnetic waves, but these waves are produced by solid-state semiconductors. With a closed-loop system the dialog oven continuously adjusts a matrix of a frequency band around 915 MHz to the cooking process of the food. The dialog oven offers new operation parameter and programs for users, and provides a promisingly alternative to the previously used microwaves.

Keywords: Dialog oven, Miele, cooking, electromagnetic waves, solid-state semiconductors

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Innovation

Discovered in the last century and originally used for radar applications, the magnetron is also used for heating food (Wesson 2016). Until today, it is used as power source in microwave and combination ovens (van Roij and Huisman 2016, Wesson 2016). In the last years, the use of the magnetron was improved and perfected for cooking technologies. Today it delivers economical high power with good efficiency (Wesson 2016), but the control of frequency, amplitude and phase of the microwaves is not possible. The control is limited to switch on and off (Goji Food Solutions 2017, van Roij and Huisman 2016, Wesson 2016).

Intermediate power can only be achieved as an average value from the switch on and switch off ratio (van Roij and Huisman 2016). Thereby, the magnetron cannot deliver accuracy for high performance measurement systems (Wesson 2016). Due to the limited control there are spotty heating and variable results in the cooked food (Goji Food Solutions 2017). Once, it delivers a great cooked food and the next time the food will be overcooked or not completely cooked. Hence, for an accurate control of the power of electromagnetic waves and an even heating of the food a better solution is needed (Wesson 2016).

This solution is provided by radio frequency technology. This technology has been around for a long time, but the application as cooking technology is only recently used (Ampleon 2017). On the IFA 2017 (Internationale Funkausstellung - international radio exhibition) Miele presented a new innovative oven, the so called dialog oven (Miele 2017a). This new oven also uses electromagnetic waves, but here produced by solid-state semiconductors and not by magnetron. This solid-state cooking technology offers a promisingly alternative to magnetrons in different sectors such as catering, households and industry (Miele 2017b, van Roij and Huisman 2016).

Function and construction of the dialog oven

The name of the oven is given by his functionality. Through the so-called “M Chef” technology, the oven receives feedback from the food about the cooking state. The oven communicates with the food. In a manner of speaking, it is in a dialogue with the food (Miele n. d.).

Heating with electromagnetic waves

Electromagnetic waves such as microwaves and radio frequency are electromagnetic alternating fields, which change their polarity in a short time. The rapid changes cause polar molecules to rotate by repulsion or attraction. By this, the energy of the electromagnetic alternating field is transferred to the molecules and converted into heat. The power transmission and the amount of generated heat in the molecules are dependent on the dielectric properties of the molecules and the selected frequency (Kramer and Mühlbauer 2002). The electromagnetic waves penetrate in the interior of the food and generate the heat in the food itself (Miele 2017b). The penetration depth of the waves depends also on the electromagnetic properties of the food and the frequency of the waves. With increasing frequency, the penetration depth of the waves decreases and the energy conversion increases (Kramer and Mühlbauer 2002).

The use of radio frequency (RF)

Microwave ovens in Europe use only one defined and not controllable frequency of microwaves at 2.45 GHz (Wesson 2016). However, RF heating can operate at the frequency band of 13 MHz to 6 GHz (Goji Food Solutions 2017, Wesson 2016). The used frequency band in the dialog oven is about 915 MHz (902 MHz up to 928 MHz). Food mainly contains water. Because of the higher adsorption of water at 2.45 GHz than at 915 MHz, the wavelength of 915 MHz has a higher penetration depth. This leads to a gentle and more even cooking process (Miele 2018, Miele 2017b).

The used frequency in the dialog oven is also used in the German and European mobile network (Dettweiler 2017, Miele 2017b). Therefore, the cavity of the oven has to be good isolated, because the dialog oven could disturb the mobile network (Kremp 2017, Miele 2017b). For example, the hinged door of the oven has a specific construction, which makes it thick and radiopaque (Fig. 1) (Mansholt 2017, Miele 2017b).

Fig. 1: The hinged radiopaque door of the dialog oven (© Miele)

Fig. 2: The dialog oven (© Miele)

Solid-state amplifiers

The use of semiconductor devices like solid-state amplifiers instead of magnetrons eliminates bulky components such as transformer and rotary drive. The kitchen device is overall compacter and lighter, which can result in a new design and in a new construction of the device (van Roij and Huisman 2016). Nevertheless, from the external appearance there are no visible differences between a conventional oven and the dialog oven (Fig. 2) (Miele 2017a).

Usually every microwave oven has one magnetron. Through the commitment of more than one solid-state amplifier to multiple power sources, they offer more flexibility (Wesson 2016). Solid-state amplifiers control power, frequency, amplitude and phase of the emitted waves exactly (Goji Food Solutions 2017, van Roij and Huisman 2016). At each frequency, flexible solid-state amplifiers provide high performance (Wesson 2016). These properties make them more efficient and they can finely dose the electromagnetic waves (van Roij and Huisman 2016). Thus, the distribution of the waves in the cavity can be improved. For example, heating effects as hot spots can be reduced significantly (Wesson 2016).

Closed-loop system

Cooking is a dynamic process (Dettweiler 2017). During the cooking process the composition of foods changes (Miele 2017a, van Roij and Huisman 2016). The molecules in foods have a different formation, which is modified during heating (Miele 2017a). In addition, various foods have different behaviour during heating in the cavity (Wesson 2016). Therefore, the power has to be adapted at the different cooking states of the foods (Kremp 2017).

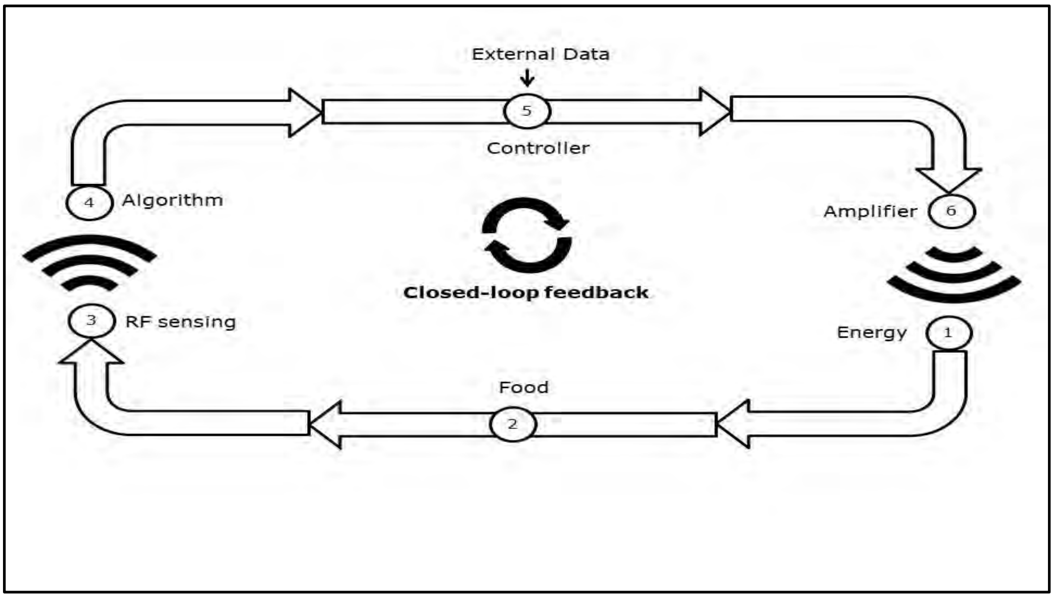

Fig. 3: Close-loop feedback algorithm system (modified according to: Goji Food Solutions 2017)

Fig. 3 shows the closed-loop system in which the power is adapted to the cooking process of the food in the cavity of the dialog oven (Kremp 2017, Wesson 2016). The solid-state amplifiers generate waves and transmit them into the cavity by two antennas (Fig. 4, Fig. 3 point 6 and 1) (Goji Food Solutions 2017). The electromagnetic waves penetrate into the food and heat it (point 2) (Miele 2017a). The food absorbs the waves dependent on their dielectric properties and the selected frequency (Wesson 2016). The part of the waves the food does not absorb will be reflected. The antennas measure this reflection continuously (point 3) (Miele 2017b). The programmed algorithm in the system uses the reflected waves to calculate how much energy the food really absorbs (point 4). Next, the algorithm calculates how much energy the food still requires to get done (point 5) (Goji Food Solutions 2017). This calculation bases on the given information about the required energy of the food at the beginning of the cooking process by the user or the preset program "Gourmet Assistant" in the dialog oven. The approximately velocity with which the energy should be absorbed is adjusted. With this preset, a matrix of frequency, amplitude and phase of the transmitted waves is generated and transmitted in the cavity. This matrix is adapted constantly during the cooking process (point 6) (Miele 2018). By this, the power can be exactly controlled (Wesson 2016). The process repeats continuously until the food is well cooked (Goji Food Solutions 2017, Wesson 2016).

Fig. 4: One of the two antennas in the cavity (© Miele)

The combination of this closed-loop system and the application of the frequency spectrum allow cooking various foods simultaneously (Dettweiler 2017). For example, complete menus including raw meat, raw potatoes and fresh vegetables can be together on the plate, and the cooking processes will finish at the same time (Miele 2017a).

Combination with conventional operation modes

By cooking with electromagnetic waves there is no browning reaction (Miele 2017a). Nevertheless, to receive crusts and toasted aromas the solid-state cooking is combined with conventional operation modes of ovens (Miele 2017b). The RF heating can be used with hot air, convection heat, top and bottom heat, backing, cooking and grill functions (Miele n. d.). The electromagnetic waves heat the interior of the food to the desired temperature. The conventional operation modes of ovens create the desired surface regarding heating, texture and taste (Wesson 2016).

Operation of the dialog oven

Not only the technology of the dialog oven is a new one, also the operation offers new parameters and programs to the users.

Gourmet Units and intensity

For the operation of the dialog oven two new parameters are necessary, the Gourmet Units and the intensity. The Gourmet Units are the amount of energy the food requires to be cooked. One Gourmet Unit corresponds to the energy of 1 kJ (Miele 2017a). The intensity regulates how fast the food will absorb the energy (Miele 2017b). Therefore, the adjustments “strong”, “medium” and “gentle” are used. Most of the food can be cooked with the adjustment “strong”. The setting “gentle” can be used for delicate foods such as Soufflé (Miele 2017a).

“Gourmet Profi” and “Gourmet Assistant”

For better handling of the dialog oven, there are programs like “Gourmet Profi” and “Gourmet Assistant”. The program “Gourmet Profi” is for users with cooking experience for experimentation. All parameters such as operating mode, Gourmet Units, intensity and duration can be set manually. For inexperienced cooks the “Gourmet Assistant” is used. This program suggests the right setting for the preparation depending on the type and quantity of the food (Miele 2017a). The automatic setting is based on an empirical database which was created by test trials with the dialog oven. Various foods were prepared in the oven, and time and energy were determined and saved in the database (Dettweiler 2017).

Comparison with present cooking technologies

The solid-state cooking is an efficient and gentle heating technology. Only with low-temperature processes like Sous Vide similar results can be achieved. However, the effort for this is much higher (Dettweiler 2017).

The solid-state cooking technology permits to prepare delicious meals (Ampleon 2017, Mansholt 2017). The penetration depth of the RF waves reaches the interior of the food. Therefore, the food is cooked "in volume" (Miele 2017b). This means, that the food is cooked simultaneously and evenly (Miele 2017a). However, the microwaves in the microwave ovens have a lower penetration depth and cannot reach the interior of the food. In the food hot-spots and cold-spots are created (Dettweiler 2017). During the heating process with electromagnetic waves moisture and weight loss of the food are avoided (Ampleon 2017). Moreover, the nutrient content and vitamins are preserved (Mansholt 2017, van Roij and Huisman 2016). In a conventional oven the heat transport takes place from the surface to the inner area. If the core is optimal cooked, the surface will be overcooked and dried out. The water in the food evaporates and the nutrients and vitamins will be lost, because mostly they are not heat stable (Miele 2017a, Wesson 2016).

In comparison to baking and cooking processes in a conventional oven, the dialog oven can require up to 70 percent less time dependent on the preparing meal (Miele 2017a). For example, the meal Pulled Pork requires only 2.5 hours instead of 8 to 16 hours. In addition, a marble cake and a potato gratin need 30 to 50 percent less time in the dialog oven than in a conventional oven (Mansholt 2017, Miele 2017b).

Furthermore, the solid-state cooking technology saves up to 60 percent of energy over conventional ovens (Ampleon 2017). In addition, solid-state cooking in combination with convection heat requires less energy. This consumption is dependent on the shorter cooking duration, the cooking method and the frequency (Goji Food Solutions 2017). Hence, the dialog oven offers a more sustainable cooking process than a conventional oven (Ampleon 2017).

Solid-state amplifiers have advantages, not only by the exact control of the power compared with magnetrons. During the operating time of three to four years, the power of a magnetron is normally reduced by 30 percent (van Roij and Huisman 2016). That's why magnetrons have a low reliability and a limited life cycle (van Roij and Huisman 2016, Wesson 2016). However, solid-state amplifiers can operate for years without interruption (Goji Food Solutions 2017). At the same operation rate as a magnetron they show no power reduction and have a life cycle of more than twenty years (van Roij and Huisman 2016).

Future prospects

Altogether, the dialog oven offers a new efficient and sustainable cooking technology with many advantages (Dettweiler 2017). However, the dialog oven is not the end of the present kitchen appliances. There will always be meals that will be cooked better with other technologies or devices (Mansholt 2017). Nevertheless, in future an establishment of the dialog oven in household kitchens for inexperienced cooks as well as in professional kitchens is possible. However, this takes time, due to the expensive acquisition costs of actually 7.990 € (Dettweiler 2017; Miele & Cie. KG 2017b). In addition, it is still necessary to explain the advantages of the dialog oven to the users particularly with regard to the cooking process and the food quality (Kremp 2017).

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