Microwave Energy Applications Management (MEAM) Test Center

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MEAM, founded in September 2011, is an all-in solution provider of microwave technology based industrial installations adapted to the need of the customer. The design is refined, based on the results of feasibility studies, using a set of proprietary instruments and technologies. The idea is to provide customers with a test center where they are trained in microwave technology. This gives them inside knowledge of the technology, and can also help the collaboration between the customer and MEAM to choose the best process-equipment combination. In the next step, customers can rent a machine before a lease or buy option is given. This process reflects the fundamentals of MEAM, which are knowledge, innovation and technology (represented in its logo in red, green and blue waves, respectively).

MEAM's focus lies today on the food industry, as well as industrial microwave processing of wood, glass and plastics, and water- and solvent-based paint, coating and drying in technical applications. MEAM is specialized in providing microwave technology ranging from test machines to industrial pilot installations (Figure 1). The main applications for its microwave-powered industrial drying, conditioning and heating installations are:

- Non-food applications: drying of technical slurry (e.g. gypsum or ceramic slurry), drying of plastics and powders, drying and conditioning of wood, granulates, rubber, water- and solvent-based paints, fiber and chip board, gypsum board and blocks, coated and painted glass, paper, textile, sintering of metals, re-engineering hot air processes into energy friendly hybrid systems (drying, melting, joining, etc.).
- Food industry: conditioning and heating of food, food processing and vending machines, tempering and thawing, sterilizing, etc.

Figure 1. Two industrial microwave systems: the MEAM Dry 32 (left) and the MEAM Dry S20 (right). The number reflects the maximum power of the machines.

MEAM believes in Green technology and all-electric systems with low or no CO_2 emission. The industrial solutions are based on unique proprietary expertise and technology. The installations deliver a robust technology; increased throughput (up to 80 %) and productivity leading to reduced capital cycles and agile production capability; controlled and directed heating and/or drying processes; safe and easy-to-use equipment; a low maintenance cost with easy to access equipment; compact solutions; and savings on investment cost.

Unseen and probably unknown possibilities of microwave drying are using the best of two worlds, namely by the combination with heat pump assisted convection drying. Microwave heating is a dielectric heating. The microwave energy converts into heat energy due to the polar structure of the molecules, atoms and ions. This heating is suitable for poor electrical conductors, while induction heating suits for good electrical conductors. The coupling vector for dielectric heating is the electric field, and for induction heating it is the magnetic field. The supply of energy effects occurs without intermediary heating elements and therefore the process has no inertia. The production of heat happens in the material itself and hence, almost without thermal dissipation: only the product heats, not its environment. The heating is direct and fast, and not bounded at all by the temperature level of the process if the loss factor of the product is temperature independent. The dissipation of the heat occurs within the product. The absorption of the energy takes place progressively with the penetration of the radiation into the mass of the product. This characteristic of microwave heating may enable good quality of the product and good working conditions of the operation.

To optimize the use of the energy involved in the drying or heating processes, heat recovery can be applied. This heat recovery will ensure a new destination for otherwise lost energy. The recovery can be done simultaneously with the drying or heating processes or afterwards on the hot product. In this way a valorisation of energy takes place increasing the efficiency of the total drying or heating processes.

For these reasons, MEAM has developed an adapted continuous system, i.e. MEAM DRY S48 HR, where the S stands for Sheet and HR for Heat Recovery, respectively. The maximum power of this system is 48 kW. Depending on the process, it is possible to recover the heat from the cooling water or exhaust air to defrost or preheat the product. At this moment, MEAM is constructing the MEAM Dry S48 HR (Figure 2), in which the recovered heat from the cooling water will be used to defrost the product, while the recovered heat from the exhaust air will preheat the product.

MEAM food test facilities

At MEAM test facilities, different microwave systems can be used for initial experiments and process optimisation. In all of the following processes, an energy optimisation/heat recovery analysis can be performed in order to make an economic analysis.

A first example, and maybe the best-known one, is microwave drying. This drying technique has proven its strengths not only on food products but also on many other products like technical slurry (i.e. gypsum or ceramic slurry), plastics and powders, wood, granulates, rubber, water and solvent based paints, fibre and chip board, gypsum board and blocks, coated and painted glass, paper, and textile. The main advantages stem from the volumetric heating, which leads to a high energy efficiency and fast drying processes. The robust technology results in several supplementary advantages, such as an increased throughput and productivity, the possibility of important energy savings and lower operating and maintenance costs, the safe and 'easy-to-use' equipment, and the option to work CO_2-neutral when renewable energy sources are applied.

Figure 2. The MEAM Dry S48 HR (the S stands for Sheet and HR for Heat Recovery) with a maximum power of 48 kW.

A second example is microwave sterilisation in a mono-mode heating cavity. This technique has been demonstrated by MEAM on fluids, i.e. milk. The sterilisation occurs at lower bulk temperatures of the fluids as compared to the micro-organisms. It was found that the sterilisation of the fluid took place at a bulk temperature of 68°C. This is the result of the selective heating of the micro-organisms due to the differences in the material properties. In this way, valuable and heat-sensitive substances, e.g. proteins and vitamins, are preserved. In addition, it is also possible to treat viscous products like yoghurt in a similar manner.

A third food application is the pasteurisation of ready meals using a continuous microwave machine. This study has been performed for Top's Foods NV, a company based in Belgium. The time needed to achieve pasteurisation is dependent on the total weight, the kind of product (e.g. meat, fish, vegetables), the number of different products in the ready meal, and the size of the components (large or small pieces). The fully-automated, patented technique is relatively fast, which leads to the reduction of thermal degradation of the nutrients to ensure that every ready meal is considered safe with prolonged shelf life, while conserving the authentic taste. The ready meals are packed before the pasteurisation and no vacuum needs to be applied during the cooling of the products, leading to less processing steps.

The following example concerns the tempering and defrosting of meat. This technique is very fast as compared to conventional methods. The process can be completed in only 9 minutes whereas conventional methods need one to several days. The required equipment is small, resulting in a more economically friendly set-up. Additionally, the production capacity of the system is flexible and throughputs as high as 2 to 2.5 tons of meat per hour can be accomplished with 60 to 80 kW of power. As an added bonus, the microbiology of the products can be controlled during the (short) process.

Another illustration of the use of microwave technology can be seen in microwave vacuum drying processes. This is a proven vacuum drying technique in the pharmaceutical industry, e.g. drying of the active components in drugs. The developed equipment for this purpose is called MEAM VP, which is presented in Figure 3. The test set-up at MEAM has a maximum power output of 1.2 kW. As a result of the vacuum, the actual drying can occur at very low temperatures, i.e. 17°C at 6 mbar. In this way, temperature shocks can be avoided which leads to a better preservation of the product and hence, in a higher product quality or a better nutrient conservation. Additionally, less product losses are obtained.

A final application is microwave pressure sterilisation. This new technique is a combination of two existing sterilisation techniques, i.e. microwave sterilisation and pressure sterilisation. This technique is a research topic at MEAM as it is expected to have lower process temperatures and the consequent advantages such as less product losses and higher quality.

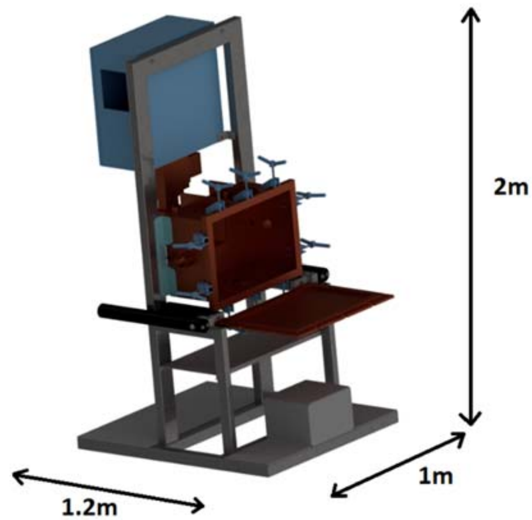

Figure 3. Drawing of the MEAM VP 1.2 (VP and 1.2 stand for vacuum/pressure and 1.2 kW power, respectively).

The presented experimental set-ups are those used in food applications. Since there is a large variety of non-food applications as well, MEAM is not restricted to these microwave systems and continues to investigate new products, applications, processes, and microwave systems.

About the Author

Carlo GROFFILS is the owner of Microwave Energy Applications Management (MEAM bvba). He received his electronic engineering degree (MSc) at the KU Leuven. After his studies, he started working at the assistant division TELEMIC at KU Leuven Research High power microwave applications. He was co-owner of the MEAC spin-off company KUL until 2007. During this time, he obtained many patents in the microwave field. Additionally, he wrote numerous scientific and technical publications in microwave energy engineering, and was honoured with the '*Industrie Technisch Management*' Award. Before founding MEAM, Carlo worked at Umicore as engineering manager, and at the KU Leuven as an interim lecturer. He was the Chairman of the International Microwave Conference with VITO and the KU Leuven.