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Microwaves step up to the plate

by Steve Ennen, Editor

You can forget about those days of crispy edges and frozen centers — at least in terms of industrial microwave technology. There are folks in the South, it appears, who have perfected microwave drying and heating for both solid and pumpable products. Now, they say the primary obstacles left in uniform microwave processing are the preconceived notions of past shortfalls.

Industrial Microwave Systems, (IMS), Morrisville North Carolina, a technology firm founded by two former Duke University professors, is working in concert with North Carolina State University and Raleigh, N.C.-based MicroThermics to harness microwaves and control them for fast and uniform use

for drying of solid foodstuffs and the pasteurization or sterilization of pumpable food products. IMS holds a host of patents for the process that is just now gaining respect in the food industry.

From a spark

Raytheon Corp. introduced microwaves after World War II. Though the technology has made it into millions of households, the industrial world has not been able to embrace the process largely because of a lack of uniform heating. Consumers deal with the crusty edges of the TV dinners, but food processors cannot be so forgiving. Standard microwaves, like those in your kitchen, can concentrate in non-uniform "hot spots." IMS has answered that issue and many more in two format options: planar, the flat surface drying for solid particulates; and cylindrical, an option best suited for processing pumpable products.

"Microwaves preferentially go for areas of high moisture and change the polarity of that moisture many times - that is what causes the heating," explains David Parrott, general manager of the IMS food and beverage group. Parrott has a doctorate degree in non-Newtonian heat transfer. "What we have done is get rid of the randomness and actually predict how the heating will occur." The theory is sound, and IMS *et al* feel they have a proven record of success. Now, says Parrott, the main hurdle is history. "The first thing we get is a lot of skeptics," says Parrott. "We are dealing with a lot of negative history."

He adds that IMS, in business since 1997, has logged early success in the textile and chemical indus-

This microwave unit, set up at North Carolina State University, dwarfs those in family kitchens. With advances in microwave technology, microwaves have overcome the uniformity challenges of the past.



tries, two groups that demand uniformity in drying. "We are leveraging that experience from textiles to the food industry," says Parrott.

Now the designers feel the technology is suited well for drying of low moisture grains, pet foods, agricultural waste products and much more.

"We had to be very specific about the markets we were going to address," Parrott adds. "Our planar technology is better for materials up to two inches thick."

Zap science

The key to controlling the heat is controlling the rather controllable, relatively large microwave frequency. Microwaves vibrate at a constant frequency, yet controlling their direction and flow has been the biggest hurdle in the technology. In the IMS method, the microwaves pass through a slotted waveguide that compensates for attenuation and aligns the hot spots in the natural power fluctuations of the waves. Essentially, this regulates power peaks by balancing them with the power dips. "This protects against thermal incidents," says Parrott. "We are compensating for attenuation and eliminating the hot spots." Because the microwaves vibrate at this constant frequency IMS can control their distribution across a plane or in the elliptical forms contained in the cylindrical method.

The planar system can function in a vertical or horizontal position and usually operates at a constant 915 megahertz that allows for better energy management. IMS can now offer a 95 to 99 percent energy conversion through its management of the waves. The frequency determines the size of the system.

"The higher the frequency the smaller the scale of



Josip Simunovic, research assistant professor at NCSU, displays a unit at work in the school of food science.

the equipment, with lower frequency, everything scales up," says Parrott. This relates directly to the drying speeds and footprint of the machines. For instance, a 25 to 50 percent increase in drying speeds can occur in a footprint of less than eight feet. "Ten years ago we could only max out at efficiencies about 25 percent," says Parrott.

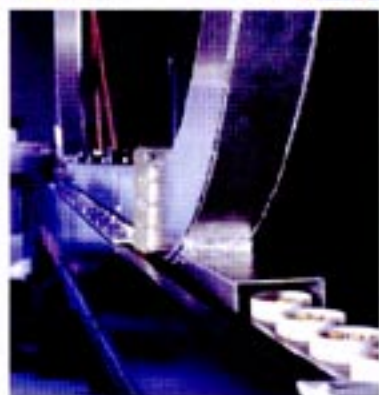
Improvements in components, such as circulators and magnetrons, have improved performance.

Optimal use of the system is as a pre-dryer or post-dryer. "The best use for these is as a hybrid team," Parrott says. "The microwave's role is ideal for post-drying after a gas-fired oven. It can take a biscuit with 20 percent moisture to less than 8 percent in 20 feet. Conventional drying is about 80 feet."

The machines are assembled in the 45,000-sq.-ft facility in North Carolina not far from the university. IMS and NCSU have signed a three-year research agreement and work closely on the development of both planar and cylindrical systems.

"The physical properties [of the materials] are not as important in this drying method as in conventional heating," says Josip Simunovic, the professor leading the research team at NCSU's Department of Food Science. "It is really an elegant system."

IMS and team have focused strongly on safety, ensuring its products prevent radiation leakage. "By virtually eliminating leakage we are probably conservative in our design," says Parrott.



This planar microwave system offers uniform and tightly-controlled heating.

IMS Expands

J. Michael Drozd founded IMS in July 1997 after he completed his Ph.D. in electrical engineering at Duke University and co-authored the patent applications that are the foundation of the Company's intellectual property portfolio. IMS converted to a privately held, Delaware "C" corporation in September 1998 after being originally formed as a North Carolina LLC. The Company has been headquartered at its Morrisville, N.C., facility since September 1999. Previously, IMS occupied a 3,000 square foot space in The North Carolina Technological Development Authority's First Flight Venture Center. In January 2001, IMS expanded from 15,000 to 45,000 square feet.

Cylindrical systems

The cylindrical process is used for pumpable products of any viscosity. An elliptical format controls the microwaves as they pulse through a fluid-carrying, FDA-approved plastic or ceramic tube. The material is never in direct contact with the heat, as is often the case in steam injection or other heating methods. The theory here is that flavors and nutrients that often succumb to direct heat or prolonged heating can lose their original complexion and potency. By avoiding contact and developing a tight control of the heating, ingredient integrity is maintained. With the microwave technology, the temperature can increase dramatically and food processors can control the temperature to the degree. The same

principle applies to the planar system.

MicroThermics enters the game in this cylindrical arena, manufacturing machinery that handles flow rates of up to two gallons per minute. "The elliptical applicator reflects the microwaves in a bow," explains David Miles, vice president of MicroThermics. "As you pump [product] through a tube, not all the particles move at the same rate. The 'wall side' molecules move slower. In the past, you were heating your slower moving product the most and the fastest the least.

"The elliptical form focuses the microwaves," Miles continues. "Once you have that under control you can control the temperature. This has phenomenal ramifications for delicate applications." Non-homogenous materials, such as

yogurt fillings with berries or sauces easily fall into this category.

"The penetration of the waves and the flow of the fluids is in a proportional relationship with frequency," adds Parrott.

The flow of microwaves, hence their temperature, are controlled with "tuning" dials located in the mechanism. "The wavelength stays the same," explains Miles, "it's how many times [each wave] bounces."

MicroThermics has perfected temperature control. The cylinder heats up in a matter of seconds and the temperature (to 305 degrees F maximum) is maintained with a minute variance in degrees for the a determined period. "Ninety-nine percent of the energy is going into heating the product." **FP**



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