

Microwave Curing of Rubber

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The Challenge: Leaving the Steam Age

Microwave curing modernized rubber production and opened new product lines for Pawling Corporation. Customer demands for reliable, seamless rubber gaskets, for continuous rubber strips that require no splicing, and for tight dimensional tolerances drove Pawling to seek an alternative handling and curing method for its products. The steam-cured rubber gaskets, moldings, and strips Pawling had supplied to the automotive and architectural industries since 1946 were limited to discrete lengths and simple shapes.

Pawling first investigated microwave curing as an alternative to its steam autoclaves in 1981. It had several requirements for a new system:

- Produce continuous rubber strips
- Reduce equipment and labor to handle product
- Eliminate the need for lubrication on shapes
- Tighten dimensional tolerances.

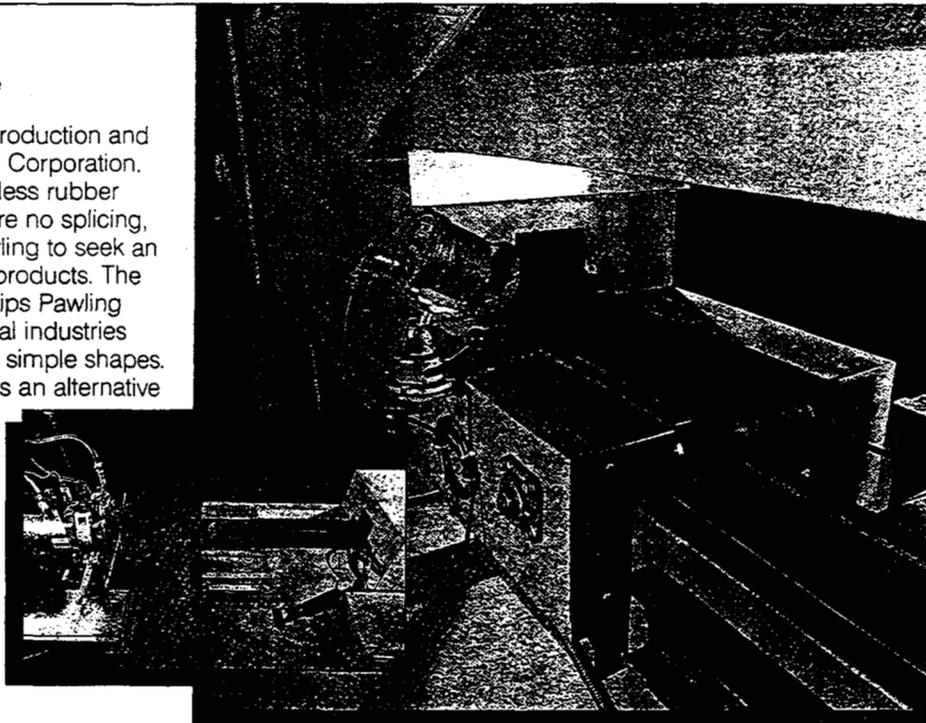
Curing rubber with a combination of microwaves and hot air proved so successful that Pawling has installed 2 new lines, the most recent in 1986.

The Old Way

Rubber must be heat cured to obtain final strength and resiliency and to reduce stickiness. Rubber conducts heat poorly, so any process that requires heat penetration, such as steam curing, is slow.

At Pawling, synthetic rubber was compounded and extruded through a die. The extrusion was sprayed with soapstone lubricant to control stickiness. Workers then cut the extrusions into 14-foot lengths, loaded the lengths into pans, and stacked the pans on racks in small rail cars. One loaded car was rolled into an autoclave 18 feet long and 5 feet high. The autoclave doors were closed, and the steam was turned on. The autoclave curing cycle averaged 30 minutes at 105 pounds per square inch and 307 F. After the lengths cooled for several hours, workers would cut them to customer specification, then pack and ship them.

The long steam curing cycle caused product quality problems. The rubber often slumped and lost its shape before completely curing, and cut ends often distorted. Both conditions contributed to the 5% scrap rate. In addition, excess lubrication could cause product contamination. The process had other drawbacks, too. Scheduling labor and extrusion equipment to feed the autoclaves at a constant rate was tricky. The 14-foot lengths were awkward for customers to handle: some customers spliced sections together, creating potential failure points; others cut the lengths further, wasting unusable ends.



A sensor mounted between the microwave and hot air ovens precisely monitors the temperature of the partially cured rubber. Inset: Rubber is extruded directly onto a conveyor and into the microwave unit, eliminating product handling.

The New Way: The 60-Second Cure

Pawling's need to produce continuous rubber strips with a minimum of handling mandated a continuous extruding and curing process. It investigated salt bath and hot air curing, but both had the same heat penetration problems as steam curing. Pawling was convinced that only a combination of microwaves and hot air could provide the fast cure a continuous process needs. Microwaves rapidly generate heat within the rubber itself; hot air maintains the temperature, efficiently completing the cure.

The new rubber curing line is only 115 feet long. The extruder occupies 15 feet, the microwave section 40 feet, and the hot air section 60 feet. Synthetic rubber is compounded and extruded by the same methods as before, although most formulations have been modified to more efficiently absorb microwaves. A temperature-resistant belt transports the extrusion from the die directly into the microwave/hot air curing unit at 70 to 100 feet per minute. Extrusion and curing requires approximately 1 minute, depending on line speed. Upon exiting the hot air section, the cured rubber plunges

into a water bath. According to customer demands, it is then either machine sliced or coiled into continuous lengths of up to 1000 feet, packed, and shipped.

The Results: Gains in Quality, Productivity, and Safety

A more desirable product. Pawling now supplies rubber to customer-specified lengths and tight tolerances. For instance, items like high-pressure gaskets are less likely to fail if they have not been spliced. The microwave/hot air process cures unusual shapes within a minute, before they have time to slump and distort.

Increased flexibility. Microwaves cure diverse shapes at a uniform rate, so Pawling manufactures a greater variety of products.

Elimination of steps. Lubrication and manual handling of the product are virtually eliminated. Workers no longer cut rubber and load and unload pans and autoclaves.

Reduced labor costs. Less labor is required to handle the product. Labor costs have decreased from 14% to 9½% of total unit product cost.

Material savings. Raw materials for the new formulations are slightly more expensive. But the fast cure cycle eliminated scrap from slumped or distorted product, resulting in material savings of 5%.

Less floor space. The straight 115-foot production line requires 20% to 35% of the space occupied by a conventional line.

Energy savings. The microwave units have a working efficiency of about 50% versus 10% for steam produced by an oil-fired boiler, more than offsetting the higher cost of electricity.

Safer work environment. The hazards associated with steam curing have been eliminated. Injuries, mainly due to workers cutting their hands during slicing operations, have decreased.

Microwave Curing for All Products?

Microwaves cure synthetic rubber products but do not heat nonpolar natural rubber molecules. Pawling still uses steam autoclaves to cure its small, but important, line of natural rubber products.

What Does It All Cost?

An 18-kW microwave/hot air rubber curing line costs \$250,000 to \$400,000. This price includes an extruder and a microwave/hot air curing unit. The higher cost would include additional power supplies and ventilation equipment, if needed.

The Bottom Line: Better Products, More Profit

Pawling now produces an improved product, one that meets customer demands for a variety of lengths and shapes and for tight tolerances. The value of these products to Pawling's customers is reflected in the premium price they command.

Other Applications of Microwave Heating

Microwave heating is efficient for heating many products besides rubber that are poor conductors of heat, including

- Ceramics such as catalytic converter components and china ware
- Chemicals and pharmaceuticals
- Investment casting waxes
- Food products.

Company Profile

Pawling Corporation
Pawling, New York

President—Roger Smith

Vice President—Lewis DeCarlo

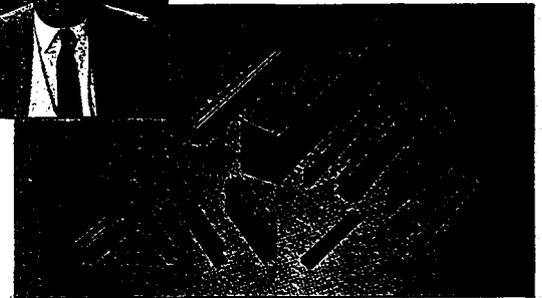
Approximately 400 employees

One of the country's leading producers of plastic, rubber, and silicone gaskets, moldings, and strips for the automotive, appliance, and architecture industries.

Company philosophy: Innovation distinguishes us, and our products are the proof!



Lewis DeCarlo, Vice President:
"You can bet we converted to microwave everywhere we could."



Pawling produces 52,000 different rubber shapes.

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