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One of the most important factors in the thermoforming process is to have the proper heat. In order to accomplish this, you must have an oven designed to be most efficient and most effective for your applications. Although there is no single heating element that is considered the best for every application, more and more research and actual trials are being done that help prove certain applications can be better accommodated with application-specific ovens, elements and their associated technology.

Second to having good sheet material, the next critical factor in the thermoforming process is heating the sheet correctly. The sheet must be heated uniformly to its processing temperature in order to avoid over heating or under heating the sheet. This is best accomplished by using an engineered, highly zoned oven with the latest oven controls.

## Heating Elements

In cut sheet thermoforming the use of electric heating is still by far the most popular method and also where the most industry technology exists. The electric heaters used today have much higher temperature capabilities than current gas heating elements, which link to creating faster cycle times. Electric heaters can be as simple as bare nichrome wires or metal tubular heaters (calrods). More popular today are the ceramic, quartz and halogen heaters. All of these heating elements have some advantages and disadvantages but the key is to understand these and equip your machine with the best suitable element.

◆ **Bare nichrome wire heaters:** Although rarely used in any of today's thermoforming machines these elements still exist mainly due to budget restraints. The very inexpensive costs of the initial purchase of these elements cannot be beat. In addition, they are simple to repair and replace. However, these elements are no longer being utilized because they limit your zoning capabilities, tend to heat non-uniformly and are very inefficient for the process. In the long run, the price you will pay for all the inefficiencies these cause are sure to exceed any other heating element costs.

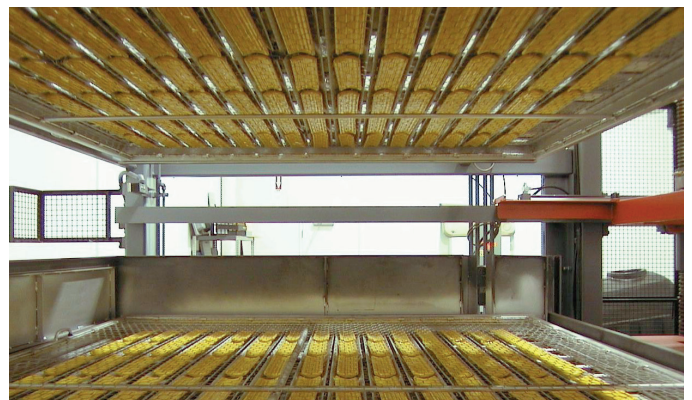
# Cut Sheet Thermoforming “Ovens”

— by Michael P. Alongi —

◆ **Metal tubular heaters (calrod):** The metal tubular heater has also had its day. Prior to the 1990's the calrod could have been claimed the most commonly used element. They last a very long time, and are somewhat inexpensive to build into an oven. However, the metal tubular heaters tend to

age and degrade quickly therefore creating many inefficiencies. They also require longer heat-up times, heat non-uniformly and limit the possibilities to highly zone an oven. The associated costs of building a good highly zoned calrod oven is almost as costly as manufacturing a ceramic oven, which just makes it harder to justify in today's market.

◆ **Ceramic:** The ceramic element may still be the most widely used in today's thermoforming machines. The rotary style machine is the largest consumer of this element. It is very versatile, long lasting, easily zoned, and very efficient in production. The ceramic element is typically favored when it is considered for longer production runs because it is durable and maintains excellent uniform heat. The only drawback to the ceramic element is typically related to the moderate heat up times and slower response times when being compared to quartz or halogen. Since ceramic elements have become so popular, pricing has become much more attractive.



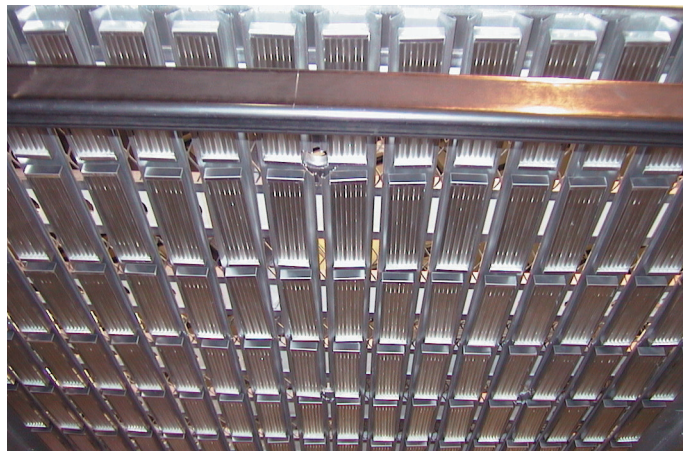
Ceramic heating elements.

◆ **Quartz and Halogen:** The quartz and halogen elements are continually gaining a larger share of new machinery being sold today. They tend to be best used in shuttle type machinery rather than rotaries due to their faster response times. These elements are also very versatile, have excellent temperature control and are easily zoned like the ceramic. An additional advantage with both quartz and halogen elements is the ability to incorporate heat levels or heat steps within a cycle. With the quick response times, different controllable heat levels are allowing thermoformers to decrease cycle times when applied. As the quartz element is becoming an industry standard in shuttle type machines, halogen seems to be most often used for more specific material applications rather than an “all-around” element. The only drawback to thermoformers today tends to be based on longevity. These elements are constructed of quartz glass tubes which make them much more fragile and easier to damage. Their life expectancy is slightly lower than the ceramic and they are typically more expensive.

### **Element Rating And Oven Design**

In addition to understanding the element types available and their characteristics, it is just as important to consider the elements watt rating and how it is designed into the oven's construction. The distance from the element to your material, the spacing between elements and, maybe even more important, what you control the elements with. There are formulas, calculations and application-specific fundamentals to bear in mind in order to design an oven. An oven designed with too little wattage can create very long cycle times, whereas an oven with too much wattage can degrade the sheet and/or drive day-to-day electricity costs up. Different types of oven enclosures can also affect the performance of your oven. A good oven design should restrict external drafts and isolate the sheet from the environment outside the oven station.

Although today's ovens and heating elements are much



*Quartz heating elements.*

more efficient and hold similar characteristics, they are becoming much more complex. Now thermoformers are taking this to the next level and the continued research is developing more answers. Which element is best to heat a High Density Polyethylene (HDPE) or Polycarbonate? What is better for thick gauge, highly engineered and/or multilayered materials? What about different color materials?

These questions are being asked more often due to the increase in competition and the determination to be most efficient. Answers to these questions are being tested and in some cases proven in the field today. Prior to considering a new thermoforming machine or rebuilding an oven that will keep you up to current technology, it is best to consult an industry professional and learn what can put you ahead of the pack.

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