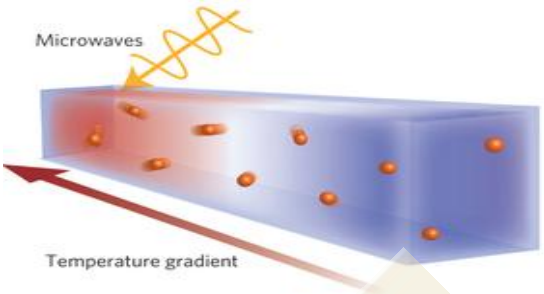
Infrared & Microwave Technology for Rubber Industry

Microwave Technology



Innovative concept of applying high frequency electromagnetic energy to substance which results in to generation of heat within material without applying heat from outside. When the material to be heat is subjected to high frequency electromagnetic field, the water molecules in the material reorient constantly to align with the changing field. This movement generates heat inside water molecules and makes entire mass of water to evaporate uniformly.

The new process is faster, consistent, controllable, productive, cost effective, efficient and uniform. The technology is highly guarded in the world market & is now available in India.

Conventional Rubber Vulcanization Vs Microwave Vulcanization

Conventional and traditional technology for applying heat to rubber during the vulcanization process has relied on labor intensive steam autoclaves (batch type), long and inefficient hot air tunnel oven and environment unfriendly high temperature liquid salt system. These are now being replaced by highly efficient, High speed microwave curing ovens automated with electronic sensors & controls, producing highest quality rubber products.

Microwave systems are widely used for the vulcanization or "curing" of rubber products, especially for the continuous vulcanization of rubber profiles and the pre-heating of large rubber products like bridge bearings etc.

Comparison of Performance of Conventional Continuous vulcanization Technique

Property	Hot Air	Fluid Bed	Salt Bath	Microwave
Heat Transfer	Poor	Fair	Good	Excellent
Distortion	Fair	Good	Good	Excellent
Energy Efficiency	Poor	Fair	Good	Excellent
Potential hazard	No	No	Fire	Radiation

Advantages of Microwave over the Other Existing Technologies

- Much faster & deeper heating of rubber items
- Much lower specific energy consumption (Watts/Kg of Rubber Processed)
- Superior working safety
- Absence of any environmental impact, risks & ecological issues
- Higher manufacturing Throughput Rate
- Minimized Plant maintenance cost
- Absence of rubber pigment or dye discoloration phenomena
- Negligible process start-up times (no time lags & minimum generation of rubber scraps to reach steady state conditions)

Definition of Rubber vulcanization

Vulcanization is the process of converting rubber and similar elastic polymers into durable products by cross-linking the polymer molecules, i.e. building additional bridges between them. While there are also types of cold vulcanization, microwave systems are always used for hot vulcanization, i.e. the rubber is first mixed with vulcanization agents, accelerators and other chemicals like fillers etc, then formed into the final shape and finally heated (170 - 220 °C) for a certain period of time, until the chemical reaction is finished and the part obtains is durable properties. While certain polar rubber types readily absorb microwave energy, e.g. Neoprene (CR) and Nitrile Rubber (NBR), other types like Natural Rubber (NR), Ethylene Propylene Diene Monomer (EPDM) and Styrene Butadiene Rubber (SBR) do not absorb microwave energy and therefore require certain fillers to make them suitable for microwave vulcanization. The most commonly used filler is carbon black, because it not only absorbs the microwave energy, but also increases the tensile strength and abrasion resistance of the final product. Where carbon black cannot be used, certain vulcanization agents, accelerators or other fillers serve as absorbers for the microwave energy. Microwave systems are mainly used for sulphur based vulcanization and cannot be used for some other types of vulcanization, e.g. peroxide based.

Infrared Pre-Vulcanization:

The Infrared System is highly efficient for the pre-vulcanization of rubber profiles and hoses. Arranged between the rubber extruder and the continuous vulcanization line the high power infrared radiation pre-cures the surface of the rubber products. This is related to a better dimension stability and an excellent surface quality. Through an optimized reflector design we reduced the energy consumption and improve the cleanness of the system. The infrared system is available in vertical and horizontal design in different lengths and heating capacities. This type of Infrared Pre vulcanization line is already very successful in many Rubber Industries of India.

Continuous microwave vulcanization of rubber profiles

The continuous vulcanization of rubber profiles is the main application of microwave vulcanization systems. Before the introduction of microwave systems, rubber profiles were usually heated by infrared radiation or hot air. However, rubber is a poor conductor for thermal energy, and especially in the case of profiles with a larger cross-section this did not only lead to unacceptable long vulcanization times, but also to other problems like "over-curing". Over-curing, also known as de-vulcanization, is the degrading of the material properties due to excessive exposure to heat. In order to completely vulcanize profiles with a large cross-section they had to be heated for an extended time, which caused the surface of the profiles to start degrading. Modern multi-mode microwave vulcanization systems, on the other side, work via volumetric heating, which, depending on the type of rubber processed, has distinctive advantages. This type of Continuous Microwave Vulcanization line is already successfully working in many Rubber Industries of India.

Continuous microwave vulcanization of solid rubber profiles

Because the microwave energy is capable of penetrating the rubber profile, energy transfer does not take place via the surface of the profile, but via volumetric heating. This means that the rubber profile is heated not only much more rapidly, but also much more evenly, especially in case of profiles with a large cross-section, **eliminating problems like over-curing**. Another advantage is that the profile leaves the microwave at vulcanization temperature, the infrared and hot air tunnels formerly used to heat up the profile are now only needed to maintain the vulcanization temperature for a certain time, making it possible to run them at much lower temperature, thus making the process **more energy efficient**. The **fast heating process** inside the microwave also permits to shorten infrared and hot-air tunnels, saving valuable work floor **space and saving additional energy**. Because of the fast and even heat-up of the profile, the final product is more evenly cured and has superior properties compared to traditionally vulcanized profiles.

Continuous microwave vulcanization of sponge rubber profiles

Sponge or "foam" rubber is a special type of rubber which contains a considerable amount of small cells or pores filled with gas, giving it superior thermal insulation properties. The final profiles are used for the thermal insulation of hot water pipes, in refrigeration plants, to protect people from contact with hot / cold surfaces etc.

For the production of sponge rubber a blowing or foaming agent is mixed into the rubber compound. During the initial heat-up, this blowing agent releases a certain amount of gas, which forms fine gas cells in the rubber profile and causes it to swell.

With traditional vulcanization systems, where heat energy was transferred through the surface of the profile, the outer part of the profile started to "blow" first. However, because sponge rubber is an excellent thermal insulator, the blowing of the outer layer insulated the inner part of the profile, not only stopping the blowing agent from releasing gas, but also causing the profile to be only partially vulcanized. Because the outer part already reached vulcanization temperature and hardened, even extended heating times could not lead to an acceptable cell formation.

In contrast, when heated in a microwave vulcanization system the rubber profile is heated up evenly over the cross-section, allowing the blowing agent to release gas almost simultaneously over the whole cross-section, resulting in gas pores of even size and distribution. Because the microwave energy is not absorbed by the newly formed gas pores, it continuous to penetrate the profile and heats it up to vulcanization temperature, resulting in an evenly blown and cured product with excellent mechanical and thermal properties.

Continuous microwave vulcanization of sponge rubber sheets

Due to the reasons mentioned above, microwave vulcanization systems are also the optimum solution for the production of sponge rubber sheets. However, due to the extremely large cross-section of these sheets even multi-mode microwave cavities might lead to an uneven heat-up and the problems related with it. Therefore we offer special plants for the production of these sheets, which are equipped with a tailor-made microwave energy distribution system. This distribution system not only ensures perfectly even heat-up even of thick and wide sheets, but also offers an extremely high efficiency and easy scalability, thus adapting perfectly to your production requirements.

Pre-heating of rubber parts using microwave (Batch Type)

Curing of large, solid rubber parts like bridge bearings, engine mounts etc usually takes place in heated moulds mounted into hydraulic presses. As the heat transfer only takes place through the surface of the product, the heating process is time consuming and can lead to negative effects like over-curing etc. In order to shorten down the vulcanization time and to avoid possible problems, these parts can be pre-heated using microwave ovens. Because of the large dimensions of the parts, pre-heating usually takes place in batch-style ovens ensuring that the parts are pre-heated within a reasonable time. Pre-heating using microwave systems leads to shorter production times, less energy consumption, and a more even vulcanization of the final product, improving the mechanical properties like compression set etc. This type of Microwave Rubber Preheater is already successfully working in all over world.

Rubber Bale Preheating using Microwave

The conventional method of pre-heating rubber is using a storage room heated to 80°C, where the material is stocked for days. Huge energy losses, significant floor space requirements, and difficult production planning are common characteristics of the method. To overcome these disadvantages, Microwave energy is used in the mixing room to rapidly pre-heat bales of natural rubber prior to mixing.

Microwave Booster in existing continuous Vulcanization Line

New application that is increasing in popularity is the insertion of a short, continuous microwave tunnel in an existing conventional & hot air, salt bath or ballotini line. The microwave boosts the temperature of the rubber when it comes out of extruder thereby permitting the line to run at speeds 25-40% higher with complete cure. In other words, you can increase your production capacity by just adding the 6 - 8m microwave Booster in your existing continuous vulcanization line.

Continuous Microwave heating of Hose

A significant challenge to the hose industry is to develop technology to build multi-layer hose on a continuous basis from start to finish. Microwave technology is ideal for this application since many hose structures have a tube made of microwave receptive material & a cover which is microwave transparent. The continuous microwave hose oven is a hybrid oven with Microwave & Hot air technology. The microwave energy penetrates through the non-receptive cover to heat the tube while the cover material directly sees the hot air, a very beneficial energy. Hot air assists not only in curing but in

achieving uniformity of heating & also in helping to keep the internal structures of the oven clean by burning off condensate.

Microwave Preheating of Rubber Tyre

Preheating of rubber parts by microwave is a very viable process. Preheating reduces the time of vulcanization; Increase though put by about 40% and also helps in achieving uniform cure.

In the case of Rubber Tyres, preheating increases green strength which is useful when the tyre components are assemble before vulcanization. Microwave Preheating of Large bus & Truck tyre reduces curing time by 25 to 30%. The Preheat time is very short in minutes as compared to long time required to cure these thick tyres. This reduction also helps in providing better flow, uniform cure, reduced scrap and lower tooling cost. It will also reduce the operating cost, improved product uniformity & improved process control. Depending upon the thickness of the product, Microwave energy can heat rubber up to a hundred times faster than with conventional heating methods.

Infrared Vulcanization Unit for Silicon Rubber

The Infrared vulcanization unit is suitable for the processing of peroxide and platinum cured silicone rubber. Important advantages of IR vulcanization are the cleanness of the process, which allows the production of biocompatible cabling in medical equipment and the fast and even cable curing through high performance circular emitters. It is also used in Shock vulcanization of silicon tubes & profiles with high dimensional accuracy, shape stability as well as smooth surface. The silicone IR vulcanizing process is a relatively clean and cost-effective process which can be tailored according to the customer requirements.

Combination of Infrared, Microwave & Hot air Line

Combination of Infrared Pre vulcanization with Microwave & Hot air Curing line will give tremendous change in your production. With the help of these, your production capacity will increase, reduce floor space requirement & improve product quality. Depending upon the thickness of the product, Microwave energy can heat rubber up to a hundred times faster than with conventional heating methods.

How to make Rubber to Microwavable?

Certain polar rubber types readily absorb microwave energy, e.g. Neoprene (CR) and Nitrile Rubber (NBR). Other Non Polar types like Natural Rubber (NR), Ethylene Propylene Diene Monomer (EPDM) and Styrene Butadiene Rubber (SBR) do not absorb microwave energy and therefore require certain fillers to make them suitable for microwave vulcanisation. The most commonly used filler is carbon black, because it not only absorbs the microwave energy, but also increases the tensile strength and abrasion resistance of the final product. In colorless compounds silica, Zinc Oxide, Stearic acids, accelerator and antioxidants, factice and chemical additives such as diethylene glycol and triethanolamine provide microwave absorption & heating capacity to non polar rubber compounds. Depending on your product requirement you can select fillers to make it microwavable.

For more information please contact our marketing division or visit our website www.electronicdrying.com

195, GIDC, Behind VCCI Complex,

Makarpura-Vadodara, Gujarat-INDIA-390010

Contact Person: Mr. Rajesh Deolalikar

Tele Fax: +91 265 2633894

Mbl : 09879606291

Mail : rajesh@electronicdrying.com