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Thermocol/Styrofoam – Correctly called, Expanded Polystyrene

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Some of the basic questions answered by this research:

1. What exactly is Thermocol? What is it made of?
2. How is it made of? Can it be made as a small scale industry?
3. Does its manufacturing cause any pollution?
4. How strong is Thermocol on its own? Is its fragility an issue when handling waste?
5. What is the situation in Indian waste regards Thermocol?
6. What have people done around the world to replace Thermocol? What can Thermocol be replaced by?

1. Forms of Polystyrene

Did you know?
*Thermocol and Styrofoam are both actually brand names of the foam version of a chemical compound called Polystyrene. So, the actual name to refer to this material by is Expanded Polystyrene or EPS. Also, EPS is basically a **PLASTIC**.*
For the sake of ease, uniformity and relevance of this research in India, the word Thermocol will be used to refer to any type of Polystyrene foam for most part of this research.

An introduction to Polystyrene

Polystyrene was discovered by Eduard Simon in Berlin in 1839.It has the numerical code 6 amongst all plastics. Polystyrene based products are classified as Plastic/Foam #6. Included in this category are Expanded Polystyrene (EPS) and Polystyrene Paper Foam (PSP Foam). In addition, packing peanuts are Plastic #6. Most foam #6 products can be identified by the resin identification code stamped on the material. Polystyrene is one of the most versatile plastics. Polystyrene is the fourth biggest polymer produced in the world after polyethylene, polyvinyl chloride and polypropylene.

Polystyrene – C_8H_8 – is a synthetic, thermoplastic, petroleum product. It is manufactured from a liquid hydrocarbon that is commercially manufactured from petroleum. Polystyrene is obtained by the polymerization[1] of Styrene or Phenylethene. The chemical properties of Phenylethene are identical to Polyethene, which is the most common plastic. Polystyrene can be solid or foamed.

[1] Polymerisation – a process in which individual molecules are linked to produce extremely large, multiple-unit molecules. In chemistry, it is defined as a process of combining several monomers to form a polymer.

Polystyrene (PS) can be divided into three varieties: General Purpose Polystyrene (GPPS), High-impact Polystyrene (HIPS) and Expanded polystyrene (EPS):

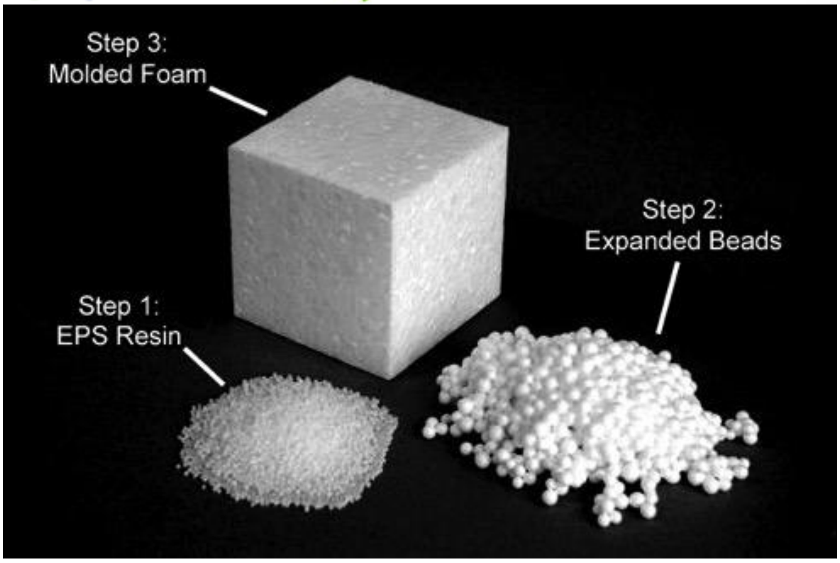
1) **General Purpose Polystyrene (GPPS)**
   GPPS is a transparent crystalloid with many specifications depending on its molecular weight. It is also known as Sheet or Molded Polystyrene. General purpose polystyrene is clear, hard, and rather brittle. Polystyrene is one of the most widely used plastics, the scale of its production being several billion kilograms per year.

2) **High Impact Polystyrene (HIPS)**
   General purpose polystyrene (GPPS) is a glasslike polymer with a high processability. When modified with rubber it results in a high impact polystyrene (HIPS) with a unique combination of characteristics, like toughness, gloss, durability and an excellent processability. Used in food service disposables and packaging, to name a few – Yogurt tubs, Salad bowls, Disposable knives, forks and spoons and in other displays and packaging - Refrigerator linings, CD Cases, Medical trays.

3) **Polystyrene Foam (EPS)**

Polystyrene foams are good thermal insulators and are therefore often used as building insulation materials, such as in insulating concrete forms and structural insulated panel building systems. Grey polystyrene foam, incorporating graphite has superior insulation properties. They are also used for non-weight-bearing architectural structures (such as ornamental pillars). PS foams also exhibit good damping properties, therefore used widely in packaging.

To make an EPS moulding product, first the PS resin is impregnated with a blowing agent (Pentane Gas) to allow pre-expansion to take place (Polymerization). It is then re-expanded using superheated steam in a batch pre-expander to the required expansion ratio (can be up to 50:1) before it is conditioned in the silos for aging. The aged pre-expanded material is next fed into a moulding machine with a dedicated tooling where steam is used to expand the material within the mould cavities into the desired shape. Finally the parts are dried in ovens before they are inspected and packed for delivery.



Polystyrene foam is the main form of Polystyrene that we are concerned with for our research and we will delve into it in detail from the next section onwards.

2. Polystyrene Foam – About the Material

In 1941, The Dow Chemical Company manufactured and trademarked a brand of closed-cell extruded polystyrene foam made for thermal insulation and craft applications. They called it Styrofoam.
In 1951, a German company, BASF successfully restructured the chemical bonding of polystyrene molecules and developed a substance named stretch polystyrene. This substance was named Thermocol. Its chemical formula is $(C_6H_5CHCH_2)_n$.
So essentially, Thermocol and Styrofoam are both generic names for the same product – expanded polystyrene.

Polystyrene foam can be further divided into two types

1) Extruded Polystyrene (Brand name: Styrofoam)
   Extruded polystyrene foam (XPS) consists of closed cells, offers improved surface roughness and higher stiffness and reduced thermal conductivity. Also called PSP Foam, it is also made from polystyrene resin (beads). The resin beads are put into an extruder that is heated, basically melting the beads. The extruded foam is then put into a "paper" roll and then molded into appropriate shape. Extruded polystyrene material is also used in crafts and model building, in particular architectural models. Because of the extrusion manufacturing process, XPS does not require facers to maintain its thermal or physical property performance. Thus, it makes a more uniform substitute for corrugated cardboard.
   The trademark 'Styrofoam' by Dow Chemical Company is informally used for all foamed polystyrene products, although strictly it should only be

used for 'extruded closed-cell' polystyrene foams made by Dow Chemicals.

2) Expanded Polystyrene or Thermocol

Expanded polystyrene (EPS) is a rigid and tough, closed-cell foam. It is usually white and made of pre-expanded polystyrene beads. EPS is used for many applications e.g. trays, plates, bowls and fish boxes. Other uses include molded sheets for building insulation and packing material ("peanuts") for cushioning fragile items inside boxes. Sheets are commonly packaged as rigid panels (size 4 by 8 or 2 by 8 feet in the United States), which are also known as "bead-board". EPS is made by combining the polystyrene and an physical foaming agent (usually pentane), and used to produce goblets, snack cases, insulated packaging, EPS is also made from polystyrene resin. In this case, the resin beads are expanded (due to steam) by 50 times in volume from PS resin size. Once the beads are expanded they are able to be molded into their intended shape.

Difference between EPS or PSP Foam?

The rule of thumb is if you can see the individual beads, then you have EPS. If the foam is smooth and you cannot see individual beads, then you most likely have PSP Foam. Usually, EPS is used for protective packaging, shipping containers (like coolers), and for construction products. PSP Foam (Styrofoam) is almost exclusively used for food products.

3. Manufacturing process of Thermocol

EPS is nowadays manufactured through a simple process. At room temperature, polystyrene is normally a solid thermoplastic, but can be melted at higher temperature for molding or extrusion, then resolidified. Styrene is an aromatic monomer, and polystyrene is an aromatic polymer. It is a rigid cellular plastic foam \material derived from petroleum and natural gas byproducts. The spherical beads of resin are subjected to steam, which causes the thermoplastic polystyrene to soften and expand up to 40 times its original volume. Each small bead of polystyrene is fully sealed.

Watch this video to see the manufacturing process.

An accidental discovery by American Chemist, Dr Baekeland:

Foaming plastics were discovered indirectly, because in the beginning no one could see their advantages. Dr. Leo H. Baekeland, the American chemist who developed the first completely synthetic plastic, bakelite, experimented with phenol (an acidic c\\ompound) and formaldehyde (a colorless gas) while trying to make a nonporous resin. When one of his mixtures unexpectedly began to foam, Baekeland tried to control the foam before realizing that it could have advantages. Following Baekeland's death in 1944, the first foamed phenolics were developed, soon followed by epoxy foam. A short time later, polystyrene was foamed.

Raw Materials for the production of Thermocol

- main component is styrene (C_8H_8)
- which is derived from petroleum or natural gas
- and formed by a reaction between ethylene (C_2H_4)
- and benzene (C_6H_6); benzene is produced from coal or synthesized from petroleum

The process (Summarized)

Styrene is polymerized either by heat or by an initiator such as benzoyl peroxide. Stopping the polymerization is difficult; however, inhibitors such as oxygen, sulfur, or quinol can be used. To form the low-density, loosely attached cells EPF is noted for, polystyrene must first be suspended in water to form droplets. A suspension agent, such as specially precipitated barium sulfate or copolymers of acrylic and methacrylic acid and their esters (organic product formed by the reaction between of an acid and an alcohol), is then added to the water. Numerous suspension agents are used commercially. All are similarly viscous and serve to hold up the droplets, preventing them from sticking together. The beads of polystyrene produced by suspension polymerization are tiny and hard. To make them expand, special blowing agents are used, including propane, pentane, methylene chloride, and the chlorofluorocarbons.

<u>The process (Detailed)</u>

First, styrene is made by combining ethylene and benzene. Next, the styrene is subjected to suspension polymerization and treated with a polymerization initiator, which together convert it into polystyrene. Once a polymer chain of the desired length has formed, technicians stop the reaction with terminating agents. The resulting polystyrene beads are then cleaned, and anomalous beads filtered out. To make small-cell EPF, workers then melt, add a blowing agent to, and extrude the beads. To produce smooth-skinned EPF, they pre-expand the beads, dramatically reducing their density. Next they heat and expand them before allowing them to sit for 24 hours so that they can cool and harden. The beads are then fed into a mold of the desired shape.

Making styrene

1 The basic unit of polystyrene is styrene, which is the product of a two-fold reaction. Ethylene and benzene, in the presence of a catalyst such as aluminum chloride, form ethylbenzene (C 8 H 8), which is then dehydrogenated (hydrogen is removed) at 1,112-1,202 degrees Fahrenheit (600-650 degrees Celsius) to form styrene (C 8 H 8).

Making polystyrene

2 Polystyrene is formed from styrene through suspension polymerization, a process by which tiny drops of the monomer (in this case, styrene) are completely surrounded by water and a mucilaginous substance. Supporting and surrounding the styrene globules, the suspension agent produces uniform droplets of polystyrene.

3 Next, a polymerization initiator is added to the droplets, which are suspended by heat radiation of about 212 degrees Fahrenheit (100 degrees Celsius). This results in free radicals, a group of atoms particularly likely to react with others because they contain unpaired electrons which are available for molecular bonding. Free radicals then combine at randomly to form chains of polystyrene.

4 Stopping the polymerization process is difficult. Terminators are introduced to the process to end it at the appropriate time. Though variable, chain length must fall within a certain range, because polystyrene with overly long chains won't melt readily, and polystyrene with short chains will be brittle.

Preparing the beads

5 After polymerization is complete, the mixture—consisting of beads made up of polystyrene chains—is cooled. These beads are then washed out and dried. Uniform

bead size is achieved by sorting the beads through meshes which filter out over- and undersized beads.

Making expanded polystyrene foam

6 First, the beads of polystyrene must be expanded to achieve the proper density. This process is known as pre-expansion, and involves heating the polystyrene either with steam (the most common method) or hot air (for high density foam, such as that used for a coffee cup); the heating is carried out in a vessel holding anywhere from 50 to 500 gallons (189 to 1,892 liters). During pre-expansion, an agitator is used to keep the beads from fusing together. Since expanded beads are lighter than unexpanded beads, they are forced to the top of the vessel's cavity and discharged. This process lowers the density of the beads to three percent of their original value and yields a smooth-skinned, closed cell EPF that is excellent for detailed molding.

7. Next, the pre-expanded beads are usually "aged" for at least 24 hours in mesh storage silos. This allows air to diffuse into the beads, cooling them and making them harder.

Molding

8. After aging, the beads are fed into a mold of the desired shape. Low-pressure steam is then injected into and between the beads, expanding them once more and fusing them together.

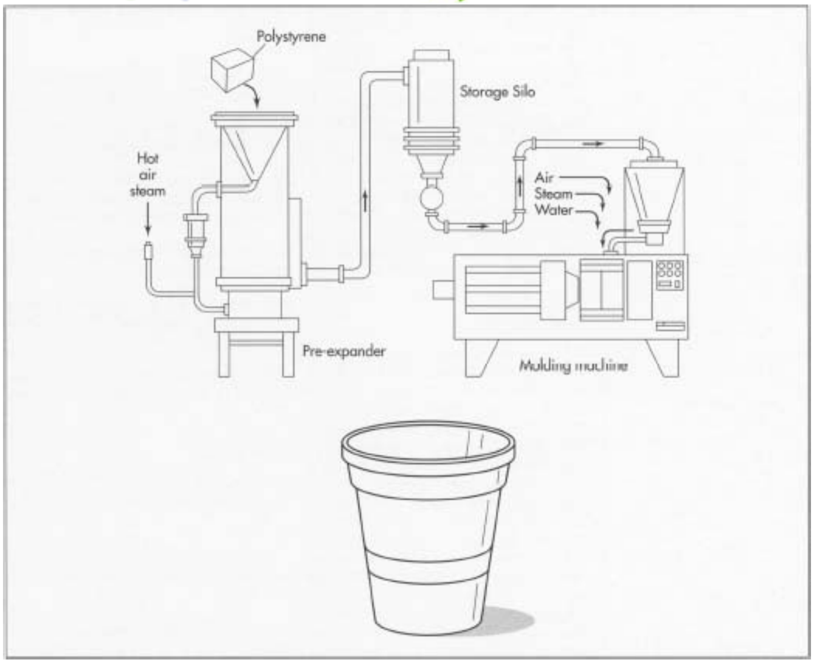
9. The mold is then cooled, either by circulating water through it or by spraying water on the outside. EPF is such a good insulator that it is hard to cool the mold down. Using small molds can reduce both the heating and cooling time and thereby speed up the process.

Making extruded, expanded polystyrene foam

10. This process yields EPF with small cell size that can be used to manufacture boards used for insulation. The beads are melted, and a blowing agent is added. The molten polystyrene is then extruded into the proper shape under conditions of high temperature and pressure.

Cutting, bonding, and coating

11. EPF is usually cut with common wood-I working tools, which must be kept very sharp at all times to cut smoothly. It can also be bonded with adhesives that do not destroy it. Water-based adhesives are good, as are phenolics, epoxies, resorcinols, and ureas. EPF is not resistant to weathering or sunlight, and it is flammable, so generally coatings such as epoxy, different kinds of paint, and nonflammable substances are applied to the surface.



Making EPF involves a number of steps. First, the polystyrene beads undergo pre-expansion, in which they are expanded to give them the proper density. After aging in a storage silo, the beads are fed into a mold and injected with steam, which expands the beads once again and fuses them together. After cooling, the molded EPF is cut to the proper shape and coated with protective epoxy or point.

4. Chemical properties

Chemical Properties of EPS

1) Density Range: 15 – 30 kg/m
2) Thermal Conductivity at 10 mean temperature: 0.028-0.031 Kcal m/hr. m c. For Styrofoam (EPF), Thermal *conductivity* varies between 0.029 and 0.039 W/(m·K) depending on bearing strength/density and the average value is ~0.035 W/(m·K).
3) Compressive strength: 0.8 – 1.6 kg/cm
4) Cross breaking strength: 1.4 to 2.0 kg/cm
5) Tensile Strength: 3-6 kg/cm
6) Application Range: -200 + 80 C
7) Water absorption by % volume for 7 days in water: 0.5% XPS is more suitable to wetter environments than EPS due to a Water vapour diffusion resistance (μ) of around 80–250
8) Self Ignition Point: 300 C
9) Melting Range: 100 – 200 C

5. General properties

General Properties of the material

1) It is non hydroscopic[2], odorless, rigid, closed cell.
2) Thermocol contains 98% by its volume still air entrapped in its cell and is the major reason for its excellent insulation properties.
3) Because of its closed cell structure, it offers a remarkable resistance to unwanted heat, chill and moisture to penetrate through it and also gives a rigid, structurally strong product to withstand various kind of loads and vibrations.
4) Thermocol can be high density Thermocol which is quite strong superior strength, commendable resistance to heat and high durability.
5) It does not decay or age with the time and gives permanent life long insulation without regular maintenance. Perfect, even and plain surface makes its suitable to opt it for false roofing and easy to install, carry and plaster on it.
6) It is moderately soluble in many organic solvents, acetone, gasoline, cyanoacrylate, and the propellants and solvents of spray paint.
7) It is fully resistant to all concentrated acid except HNO3 and H2SO4
8) It is non resistant to aliphatic hydrocarbons[3], ketones and chlorinated hydrocarbons and is affected by ultraviolet rays. It turns yellow and ultimate become brittle if left permanently exposed to sun.
9) Styrofoam is composed of ninety-eight percent air, making it lightweight and buoyant. Because of its insulating properties and buoyancy, it was adopted in 1942 by the United States Coast Guard for use in a six-person life raft.

6. Uses of Thermocol

Where is EPS currently used?

1) Food packaging industry

   Foam #6 food service containers include drink cups, food trays and clamshell containers. Food service foam containers must be in recyclable condition. Coffee and soda cups do not need to be rinsed; however, containers used for food need to be wiped or rinsed.

2) Shock absorbing/ Cushioning material in Packaging

   EPS packaging is often used to ship electronics, furniture and other fragile items – even fish. This rigid lightweight foam can be molded into any shape and offers excellent protection and insulation.

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[2] The fact that Thermocol is non-hydroscopic means that it does not absorb water easily.

[3] **Hydrocarbons** are organic molecules that consist exclusively, or primarily, of carbon and hydrogen atoms. They come in two flavors:**aliphatic hydrocarbons**, which consist of linear chains of carbon atoms; aromatic**hydrocarbons**, which consist of closed rings of carbon atoms.

3) For Insulation as it is a very good resistor of heat and cold
   EPS is used in medical coolers to keep vaccines and medicines at critical temperatures as they are shipped to hospitals, clinics and physicians' offices.

4) For craft applications
5) In Air conditioning
6) Sound proofing
7) False Ceiling
8) Pipe Insulation
9) Under roads and other structures to prevent soil disturbances due to freezing and thawing

Foam cups and food service products

Foam Packing Peanuts

Foam Packaging

Foam Coolers

7. Thermocol in India – Production and Wastage

In India, BASF India Limited was originally incorporated as R. A. Cole Private Limited. They started producing EPS in India at the same time when they started manufacturing it in Germany. With EPS, BASF took its first steps into India. Because of the increasing demand for the manufacture of plastics, they established their first production site in Asia in Thane in 1961.

There are hundreds of factories manufacturing EPS in India. Thermocol is used in large quantities for industrial and packing purposes, as well as in eateries in the form of thermocol plates and glasses. In fact, every day, nearly 1,000 kg Thermocol waste is disposed off in garbage bins, rivers or nallahs leading to pollution.

Environmental groups like the Earth Resource Foundation say styrofoam products make up approximately 25 to 30 per cent of space in landfills around the world.

8. Impact of Thermocol on the Environment

Environmental health concerns start with the elements used to make Styrofoam. Styrene, for example, is the foundational ingredient used to make polystyrene. It is broadly used in the manufacture of plastics, resins, and rubber. However this is not the only concern:

1) Styrene, the foundational/base ingredient of expanded polystyrene has been found to be a carcinogen. When thermocol containers are used for food, chemicals can leach into the food, affecting human health and the reproductive systems. This is accentuated if people reheat the food while still in the container.
2) It is manufactured using petroleum, a non-sustainable resource. Additionally, petroleum production creates heavy pollution.
3) Chokes up drains. The light, buoyant nature of polystyrene means it is easily washed or windblown into storm drains and waterways, where it contributes to marine pollution.
4) It is a petroleum-based, non-biodegradable plastic. It responds very slowly to bacterial decomposition in the soil, thus making the soil infertile. It is resistant to photolysis (the breaking down of materials by photons originating from a light source)
5) EPS is lightweight and therefore floats, means that over time a great deal of polystyrene has accumulated along coasts and waterways around the world. It is now considered the main component of marine debris.
6) While it stays in landfills, animals that scavenge food from there end up eating polystyrene scraps that clog their digestive systems and choke them to death.

7) Nobody has lived long enough to say how long it actually takes for polystyrene to biodegrade, but it is believed to be atleast 500 years. And when it does degrade, toxic chemicals are released into the environment, which could end up polluting the groundwater.
8) Though it can be recycled, the rising prices of oil has an impact on its recycling. While it can be recycled, the recycling market is diminishing. In many communities people are told that their recycling companies will not accept polystyrene products. Those that are recycled are remanufactured into things like cafeteria trays or packing filler.
9) Gaseous methane derivatives—chlorofluorocarbons (CFCs), are used to foam EPS. CFCs are inert, and harmless to humans and the environment upon their release but they result in depletion of the ozone layer. The ozone layer is a layer of the atmosphere that protects the earth against harmful ultraviolet rays from the sun.
10) Polystyrene manufacture is the 5th largest generator of hazardous waste. 57 different chemicals are emitted during the combustion of polystyrene foam.

9. Impact of Thermocol on Human Health

Polystyrene contains both styrene and benzene, which can leach out when the material comes into contact with hot or oily foods. The risk of the former is uncertain, but benzene is a known carcinogen. Think twice about the takeout Chinese and piping hot coffee, and definitely avoid microwaving containers made from polystyrene.

The EPA and the International Agency for Research on Cancer have established styrene as a possible human carcinogen. For those who are exposed regularly in the manufacture of products made with styrene, some of the acute health effects experienced include:

- Irritation of the skin
- Irritation of the eyes
- Irritation of the upper respiratory tract
- Gastrointestinal effects

The chemical also poses a serious health risk to workers exposed to it.. They can get a condition called “styrene sickness”. Chronic exposure to styrene leads to further complications, including effects on the nervous system. Symptoms of chronic exposure include:

- Depression
- Headache

- Fatigue
- Weakness
- Minor effects on kidney function

Why the 3 R's?

1. **Decrease our dependency on virgin resources**
   Recycling foam reduces our dependency on virgin resources and conserves them for future generations. Plus, when you use recycled foam #6 cups instead of alternative materials, you conserve additional natural resources such as timber and water – another bonus for the environment!

2. **Prevent Pollution**
   Recycling helps reduce the amount of pollution in our air which is generated by using virgin materials.

3. **Save energy**
   Recycling foam #6 allows us to conserve energy that would otherwise be expended on manufacturing new materials.

4. **Protect the Earth's atmosphere**
   By reducing the amount of energy and materials used to make new products, recycling helps cut down on greenhouse gas emissions that contribute to climate change.

5. **Demonstrate sustainability**
   Many citizens today look to their cities and municipalities to support sustainability by offering recycling programs. Cities that offer foam #6 recycling demonstrate environmental responsibility and set good examples for future generations.

10. Ways to Reduce Thermocol

Reduce – refers to the reduction of natural resources used. Sustainable packaging materials have increased relevance with the environmental problems plaguing the world today. The best way to reduce Thermocol would be to explore alternatives and delve deep into their feasibility.

Thermocol can be reduced by exploring alternative materials and other natural packaging which are more sustainable:

1) **Shola Pith**

It is also referred to as shola or Indian cork. It is a dried milky-white spongy plant matter which can be pressed and shaped into delicate and beautiful objects of art. Shola grows wild in marshy waterlogged areas. The biological name of shola is *Aeschynomene aspera* of the bean family. It is a herbaceous plant, which grows particularly in the marshy areas of Bengal, Assam, Orissa and the Deccan. The sholapith is the cortex or core of the plant and is about 1.5 inches across. Traditionally sholapith products were used in decorating Hindu idols and in creating the headgears of brides and grooms for a traditional Bengali wedding. In more recent times, shola pith handicrafts have found a wider application in home décor, as artistic objects. Almost similar to thermocol, which is artificially produced, sholapith is much superior to thermocol in terms of malleability, texture, lustre and sponginess.

2) **Coir and Textile Waste**

Pantheerankavu native P Muralidhar, a Kozhikode based inventor has developed an eco-friendly alternative to thermocol using only industrial waste, newspapers and organic gum. This substance does everything that thermocol does and is more resistant to heat and stress. It is of a unique design utilising only coir fibre powder which is a by-product of the coir industry, non-woven cotton, which is embroidery waste, old newspapers and gum which is obtained from certain wild vegetables. This invention is yet to be scrutinised by experts or showcased at technical events. The new product is also yet to be named. If more people could develop something like this, it could be a highly sustainable option.

3) **Honeycomb Mesh**

Honeycomb structures are natural or man-made structures that have the geometry of a honeycomb to allow the minimization of the amount of used material to reach minimal weight and minimal material cost. Man-made honeycomb structures are manufactured by using a variety of different materials, depending on the intended application and required characteristics, from paper, used for low strength and stiffness for low load applications, to high strength and stiffness for high performance applications, from aluminum or fiber reinforced plastics. Honeycomb made of paperboard is a sustainable packaging alternative to Thermocol.

4) **Corn Starch**

Polylactic acid – or PLA – is derived from cornstarch resin and that of other natural starches, which are wholly renewable and therefore a completely sustainable resource for packaging. PLA is light, but durable and is safe and non-toxic. Cornstarch packaging is 100% compostable and like a vegetable, will reduce down to carbon dioxide and water.

5) **Potato Starch**

The potato starch that we use comes from potato waste after food processing has taken place, not a crop grown expressly for their manufacture. The 100% compostable material contains no oil based materials, plastics or harmful toxins, and carries the EN13432 certification. It's durable, but will break down in just 12 weeks on a compost heap, making it the ideal material for multi-use retail carrier bags or hygienic domestic disposal bags.

6) **Palm**

Hailing from Northern India and naturally shed, the harvesting of palm leaf sheaths we use for our products provide valuable employment for small village communities, in their harvesting. Palm is a versatile and fully biodegradable and compostable material that requires no chemicals, resins or dyes. It's hygienic, lightweight, strong and water and heat resistant; so it's suitable for fridge/freezer storage and microwave and oven cooking (up to 220 degrees). If you're looking for something a bit different to package and present your products, especially food, palm is a perfect choice.

7) **Sugarcane**
It is a natural by-product of the sugar industry in South East Asia that would conventionally be disposed by incineration or dumping. Compliant with EN13432 (the European standard of compostability), our catering disposables made from this material can tolerate the freezer or microwave, and won't absorb oil or leak.

8) **Kapok**
Kapok is the fine, silkily lustrous fruit fibers from the fruit walls of the capsules, of the Ceiba tree. The fibres are 10 - 20 cm in length and 3 cm in thickness. These were used in packaging in South America. It is also known as the silk cotton tree or ceiba.

9) **Puffy Stuff**
Popular in Lebanon, It is a 100 percent biodegradable packing peanut made from grain protein. It has high density to protect whatever you're packing in it and won't shrink in humid conditions. But add a little water, and it will dissolve. It can be thrown away, put in a landfill or even hosed down in your garden.

10) **Fungi**
Research shows that Mushrooms might just be the new plastic. Just as nature makes ironwood trees, animals with armored shells such as lobsters, etc, nature is a great place to explore. A company, Ecovative uses fungal mycelium to digest farm waste such as corn stalks and grow amazing materials that today are replacing EPS (commonly called Thermocol) packaging. They are adapting millions of years of fungal evolution to literally grow materials that can compete with petrochemical-based plastics.

Thermocol can also be reduced by optimising pack design. Moulders can reduce EPS usage, thus reducing environmental burden and cost. EPS packaging can be utilized in many ways after its original intended use. As such, they contribute towards protecting valuable resources.

11. Ways to Reuse Thermocol

First of all, we need to stop purchasing Thermocol/Styrofoam – avoid buying products that come in EPS packaging and ask the seller to consider more sustainable packaging options. In cases where it is unavoidable, here's what you can do to reuse EPS:

1) When you receive Thermocol pellets in the form of packaging, reuse them in the next package you will be sending out. This way, you are not creating any more demand for Thermocol products. If you have no packaging use coming up soon, take your styrofoam peanuts to a nearby packaging store and donate them.
2) Tumble styrofoam peanuts or big chunks of styrofoam into a planter in place of heavy rocks for drainage. Also if you have huge planters it makes them that much lighter. If you don't have peanuts, just break up the formed packaging foam into your pot. Grind it and use it as soil conditioner to improve drainage and aeration.
3) Keep unneeded styrofoam in a trash bag until it is full, then take it to your local collection point (if there is one).They will usually accept free offers of your styrofoam and re-use it for packing.
4) Use styrofoam as the base for cake pops or candy or flower bouquets.
5) As mentioned above, EPS is highly flammable so it is unsafe to use this as makeshift insulation in residential buildings. But they're excellent for insulation of outbuildings like a dog house, tool shed, woodworking shop or pumping house within your property.

12. Ways to Recycle Thermocol

Recycling foam #6 reduces the amount of solid waste that goes to our landfills and incinerators. Even though foam makes up less than 1% of municipal solid waste based on both weight and volume, every bit counts.

1) Make Clay: Thermocol sheets can be sliced into smaller pieces and dissolved in a tray filled with acetone. This way the pieces get melted and are reduced to 5% of their original volume. After drying, it becomes like clay which can be reused for models.
2) Make Glue: Investigate solvents which can be used to safely break down your styrofoam. Pure orange rind oil, d-Limonene, is known to work.
3) Insulation Sheets
4) More Packaging

Expanded polystyrene (EPS) scrap can easily be added to products such as EPS insulation sheets and other EPS materials for construction applications. When it is not used to make more EPS, foam scrap can be turned into clothes hangers, park benches, flower pots, toys, rulers, stapler bodies, seedling containers, picture frames, and architectural molding from recycled PS.

How is EPS normally recycled?

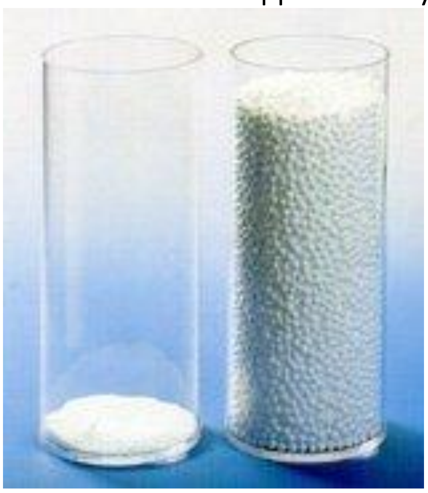
- Segregation: Ideally EPS should be separated before it enters the waste stream to minimise contamination and so as to not take up bin capacity for other recyclable materials. EPS scrap must be segregated from other materials in the waste stream before it can be recycled.
- Collection: Since EPS is lightweight, transportation cost is a major component of its recycling. The material handling requirements for EPS scrap are usually determined by the recycler. Most commonly EPS scrap is either bagged in loose form or baled prior to transport. In recent times, businesses that utilise a lot of EPS packaging have proactively worked with recyclers to assist with transportation and collection costs.

Here's how it is recycled:

- Foam products are collected for recycling.
- The foam is compacted into dense bricks.
- The compacted foam is converted into pellets.
- The pellets are used to create new plastic products.

13. Thermocol – Facts & Figures

1. Foam #6 is a thermoplastic that can be recycled over and over again.
2. Foam #6 is approximately 95% air, which makes it extremely light weight.



3. More than 127 million pounds of foam #6 were recycled in 2014, according to the latest EPS Recycling Report from the Alliance of Foam Packaging Recyclers.

4. Today EPF is easily the most recognized plastic
5. Extruded polystyrene is about as strong as an unalloyed aluminium, but much more flexible and much lighter
6. Foam #6 cups do not have to be rinsed before recycling. However, foam food containers should be rinsed or wiped clean.
7. Polystyrene can be recycled up to 20 times without losing its inherent properties
8. The environmental impacts of polystyrene production in the categories of energy consumption, greenhouse gas effect, and total environmental effect ranks second highest, behind aluminum.
9. Polystyrene takes up more space in landfills than paper, and will eventually re-enter the environment when water or mechanical forces breach landfills
10. The PMC is planning to set up a thermocol waste processing plant that will recycle around 3.65 lakh kgs of Thermocol every year

14. Laws, Policies, Regulations

Over 100 US and Canadian, as well as some European and Asian cities, have banned polystyrene food packaging as a result of the negative impacts to humans and the environment.

The PMC has tried to ban Thermocol in 2014 but to no avail.

End Notes and References

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