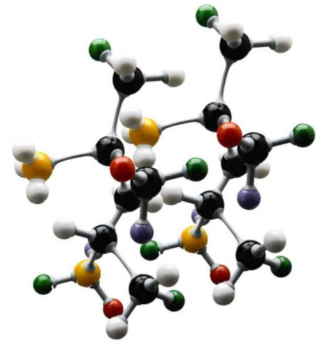
Technical Information Sheet

U-FOAM®

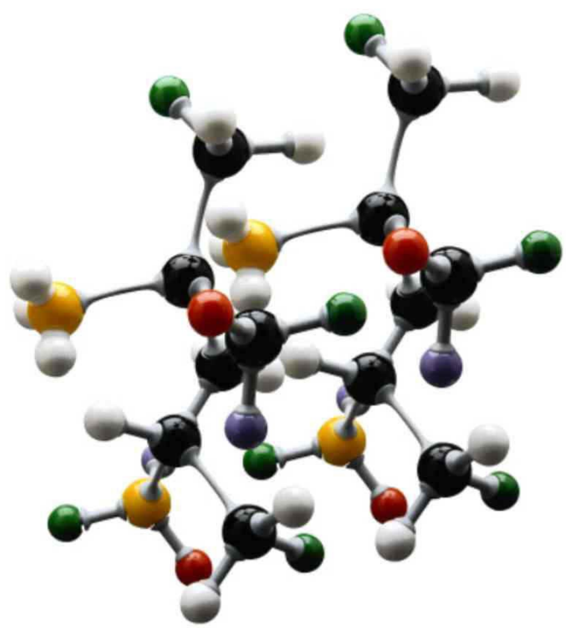


Cellular Plastics Polyurethanes, Polyurethane Foams, Plastic foams.

General Description

Polyurethanes can be a found in liquid coatings and paints, tough elastomers such as roller blade wheels, rigid insulation, soft flexible foam, elastic fiber, or as an integral skin. No matter how polyurethane is transformed, the underlying chemistry is the result of one man's genius, Prof. Dr. Otto Bayer (1902-1982), who is recognized as the "father" of the polyurethane industry for his invention of the basic diisocyanate polyaddition process

The origin of polyurethane dates back to the beginning of World War II where it is was first developed as a replacement for rubber. The versatility of this new organic polymer and its ability to substitute for scarce materials, spurred numerous applications.



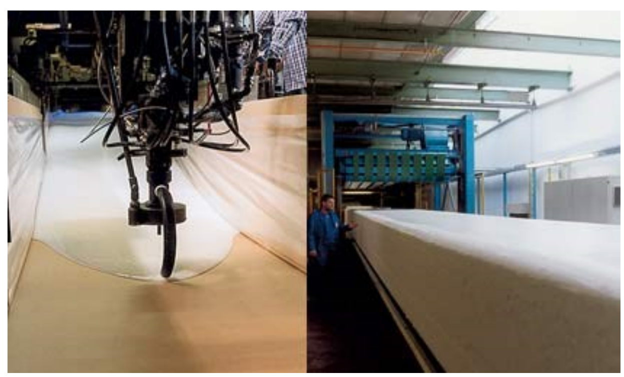
Molecular Structure of Polyurethanes

50 1959 - 2009

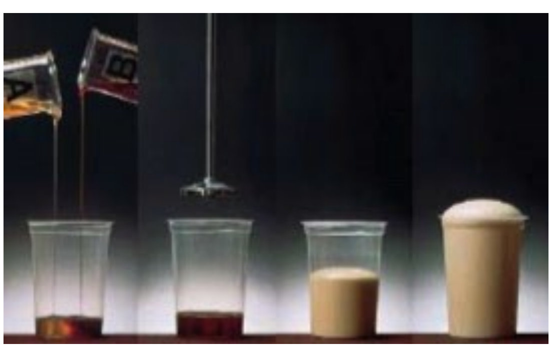
By the end of the war, polyurethane coatings were being manufactured and used on an industrial scale and could be custom formulated for specific applications. By the mid-50's, polyurethanes could be found in coatings and adhesives, elastomers and rigid foams. It wasn't until the late-50's, that comfortable cushioning flexible foams were commercially available. With the development of a low-cost polyether polyol, flexible foams opened the door to the upholstery and automotive applications we know today.

In 1959, Mr. M. Sarangapani, Chairman U-Foam Private Limited, the "Father of Polyurethane Foams in India" brought this wonder material to India.

Foams are light in weight and versatile, and are employed increasingly in a variety of applications that include thermal and acoustic insulation, fabrication of furniture and flotation materials.



Flexible Foam Manufacture



The Reaction of Polyurethane

U-FOAM®

What is Foam? How is it made?
Foam is a colloidal suspension of a gas in a liquid created by agitation. Foams are cushiony material formed by the creation of gas bubbles in a base material such as natural rubber, synthetic rubber or other elastomeric materials. They can be flexible or rigid depending on the type of cross-linking that exists between the molecules. Polyurethanes are one of the most versatile polymers known. They are synthesized by the reaction of a polyester polyol, or polyether polyol, with an aromatic or aliphatic isocyanate.

Reaction forming polyurethane foam

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                                                     O H     H O
                                                     ^ ^    ^  ^
                                                     ^         ^
HO-R-OH  +  O=C=N-R'-N=C=O   à  -- [ -O-R-O-C-N-R'-N-C-] --
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Polyols
There are two types of polyols: polyester and polyether. Ether containing polyols offer low temperature flexibility and viscosity to the polymer and are much more commonly used in the production of polyurethanes than polyesters. Many of them have low molecular weights, between 500 and 3000, and are made from propylene oxide and ethylene oxide. The functionality of the polyether polyol is determined by the number of active hydroxyl (-OH) groups per molecule. Normal elastomers contain 2 or 3. Flexible foams contain 3 and rigid foams contain 6. Ester containing polyols produce polyurethanes that are highly tensile, abrasion resistant, and oil resistant, they are much more expensive and much more difficult to work with because of their low resistance to hydrolysis.

Example of a Polyol:

HO -- R – OH   (R represents a carbon chain)

Isocyanates
Many isocyanates are aromatic, or cyclic, in nature. The functionality of the isocynate is extremely important to the production of polyurethanes and is determined by the number of isocyanate groups (-N=C=O) per molecule. Many polyurethanes, such as flexible foam, are made with toluene diisocyanate.

Example of an Isocyanate:

O=C=N – R'– N=C=O   (R' represents aromatic rings)

Blowing Agents
A blowing agent is a substance that is incorporated into a mixture for the purpose of producing foam. Blowing agents are classified as either organic or inorganic. Inorganic agents such as sodium bicarbonate, ammonium carbonate and sodium boron hydride generate gas slowly and the gas produced by these agents is generally difficult to control. Organic agents generate gas much more rapidly. Flexible polyurethanes are usually blown up using introduced carbon dioxide or carbon dioxide generated by the reaction between water and isocyanate. Prior to strict legislation banning CFC's, chlorofluorocarbons were also used as blowing

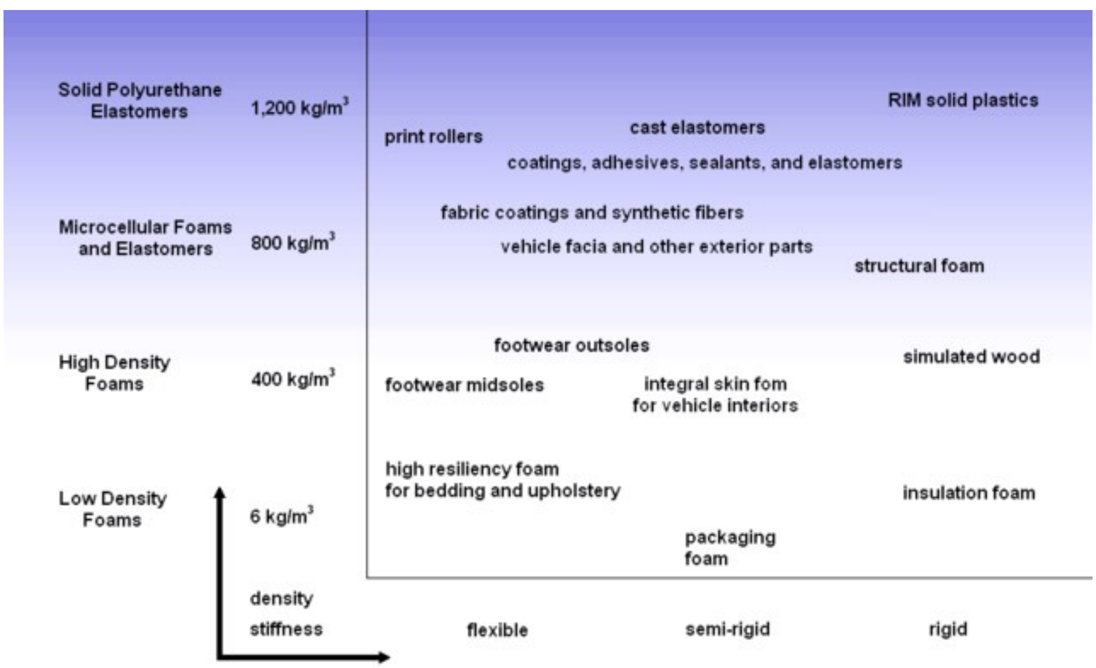
agents for the productions of flexible polyurethanes.

Silicone Surfactants

A surfactant, or a "surface acting agent," changes the properties of a liquid at its surface or interface. They are commonly used in cleansers and detergents. Their roles in cleansers and detergents include: modifying or controlling foam, modifying viscosity, and emulsification. These are used to reduce interfacial tension between monomers and the aqueous phase, prior to the onset of polymerization. The structure of a surfactant includes hydrophilic and hydrophobic portions. The hydrophilic portion is polar and the hydrophobic portion is water insoluble, containing long fatty or hydrocarbon chains. .

Catalyst

Polyester polyol acts as an organic catalyst in this reaction as well as in some other chemical reactions. A catalyst speeds up the rate of a reaction by lowering its activation energy. The catalyst is not consumed in the reaction.



Characteristics of Polyurethane materials

Cell Structure
Cell structure determines certain properties, thereby influencing the type of application of the foamed plastic. Open-cell foams offer little resistance to the passage of liquids and gases through them. A general principle is that flexible foams have open-cell structure and rigid foams closed cells. Generally, no foam has entirely one type of cell structure (open- or closed-cell structure implies that the number of cells in the foam is predominantly open or closed, respectively).

In an open-cell foam the gas phase is inevitably air. Open-cell foams have sound absorbing properties and when flexible, cushioning characteristics. This makes them suitable for use as sound absorbing materials and in cushioning applications (e.g.. flexible urethane foam).

In a closed-cell foam the resin membrane, which forms the cell walls, acts as a barrier to gases and liquids, although gases may pass through the membrane by the slow process of diffusion. Closed-cell foams, therefore, have lower water absorption and lower water vapour permeability than open-cell foams. If the gas phase has low thermal conductivity and is captive, closed-cell foams can usually provide higher thermal resistance than open-cell foams that are air filled. The cell size also influences thermal resistance.

Density
The ratio of gas to the solid plastic component determines density and greatly affects other physical properties of foam. In fact, many important properties including thermal resistance, mechanical strength and heat capacity are specifically related to density. This being so, density measurements are a routing part of any testing, permitting identification, in general terms, of the characteristics of foams.
The density of cellular plastics may vary from 1.6 to 960 Kg/m^3 or more, with most commercial foams having densities between 18 and 40 Kg/m^3. Generally, low-density (less than 60 Kg/m^3), rigid foams are used for thermal insulation, flotation, and protective packaging; high-density materials for structural applications including fabrication of furniture.

Fire Behaviour
Because cellular plastics have a relatively large surface area, the problem of flammability is more acute than with bulk plastics. Thermoplastic foams, like polystyrene, usually melt during a fire and may produce drops of burning molten plastic that increase the fire hazard. Attempts to reduce the flammability of plastic foams are similar to those applied to bulk plastics. Most of the commercial foams can be modified to improve their fire behaviour. The products of combustion of plastics should also be considered in their application.

Durability

The successful performance of any material in a construction application depends on its appropriateness to the function it must fulfill. It is generally good practice to follow the instructions of foam manufacturers (or suppliers) for correct applications and installation.

The weathering resistance of foamed plastics is usually comparable to that of the plastics used to make the foam. Exposure to solar radiation for long periods induces degradation of the base resin and results in deterioration of its structure and therefore of its performance. Plastic foams should be protected from exposure to direct sunlight or high intensity ultraviolet light. In most instances this can be accomplished by applying a coating that is opaque to ultraviolet radiation.

Because they are inert most plastic foams resist attack by bacteria and fungus. Many, however, contain a minimum of additives such as plasticizers, stabilizers, lubricants and colorants, and these may be susceptible to microbiological attack.

Forms Available

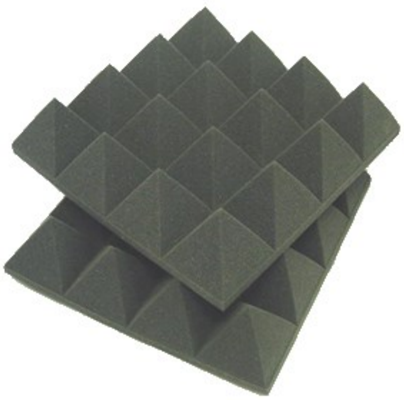
To be adaptable to a wide range of installation techniques, plastic foams have been made available in a variety of forms: rigid closed-cell, rigid open-cell, flexible open-cell, flexible closed-cell materials, or combinations of these, and in blocks, slabs, boards, sheets and numerous moulded shapes. In addition, some liquid prefoam mixtures (e.g., thermoset foaming compounds) are supplied as two- or three-part systems that can be foamed-in-place, poured-in-place, froth poured-in-place, sprayed-in-place or used for potting and encapsulating.

Dimensional stability can be a problem with all foams; some shrink, some expand. Generally, dimensional stability is affected by high temperature and high humidity or both. Designers should therefore be aware of the characteristics of the foam to be used. Plastic foam products are easily fabricated with woodworking tools.

Summary

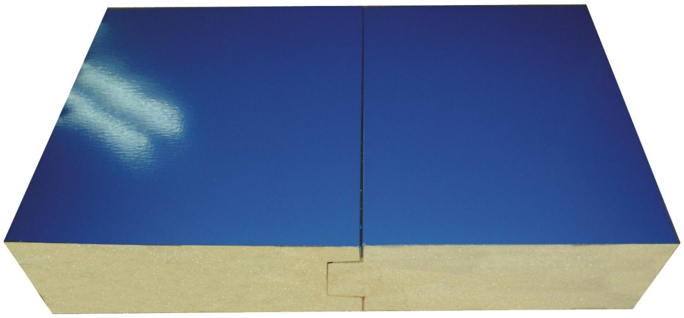
Foamed or cellular plastics are made up of a mass of fine gas bubbles (gas phase) dispersed in a solid plastic phase (matrix). According to the type of plastic used in the matrix, they are either thermoplastic or thermosetting. Plastic foams may be classified as open-cell or closed-cell foams, depending on which type of cell predominates. According to the degree of rigidity, plastic foams may be flexible, semi-flexible (or semi-rigid) and rigid. Rigid closed-cell foams can have good thermal insulation properties and buoyancy characteristics. Open-cell foams can have good cushioning characteristics (e.g., flexible) and sound absorbing properties.

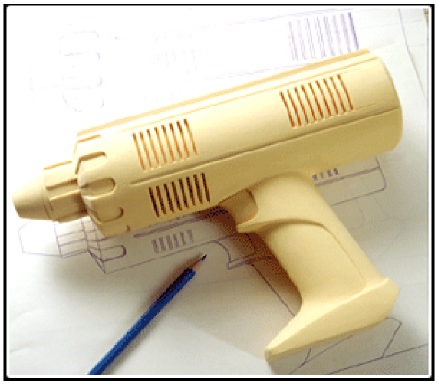
Product Gallery


Acoustic Foams


Rigid foams


Reticulated foams


Insulated Panels


Prototyping Foams

IMPORTANT NOTICE REGARDING FLAMMABILITY—All polyurethane foams including combustion modified foams will burn and generate smoke and gases. Performance conditions and corresponding data refer to typical performance in specific tests, such as UL-94 and MVSS-302, and should not be construed to imply the behavior of this or any other product under other fire conditions. All data regarding these products were obtained using specific test methods under controlled laboratory conditions intended to measure performance against specifications. Due to the great number and variety of applications for which U-Foam products are purchased, U-Foam does not recommend specific applications or assume any responsibility for use results obtained or suitability for specific applications. IN NO EVENT SHALL BE RESPONSIBLE FOR ANY CLAIM IN EXCESS OF U-FOAM'S SALE PRICE OF THE PRODUCT TO WHICH THE CLAIM RELATES.

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