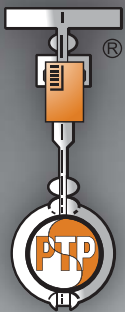


# TECHNICAL BULLETIN

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## SERVICES POLYURETHANE



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## Polyurethane

Polyurethanes are different from most plastic materials in that they can be tailored to meet the requirements of varying applications. Soft elastomers in flexible foams with low density are used in cushions and bedding. Tougher elastomers with higher densities are used for soles of shoes and boots. Rigid foams are used in construction, automobiles, furniture, boating, and many other applications.

## Polyurethane: History

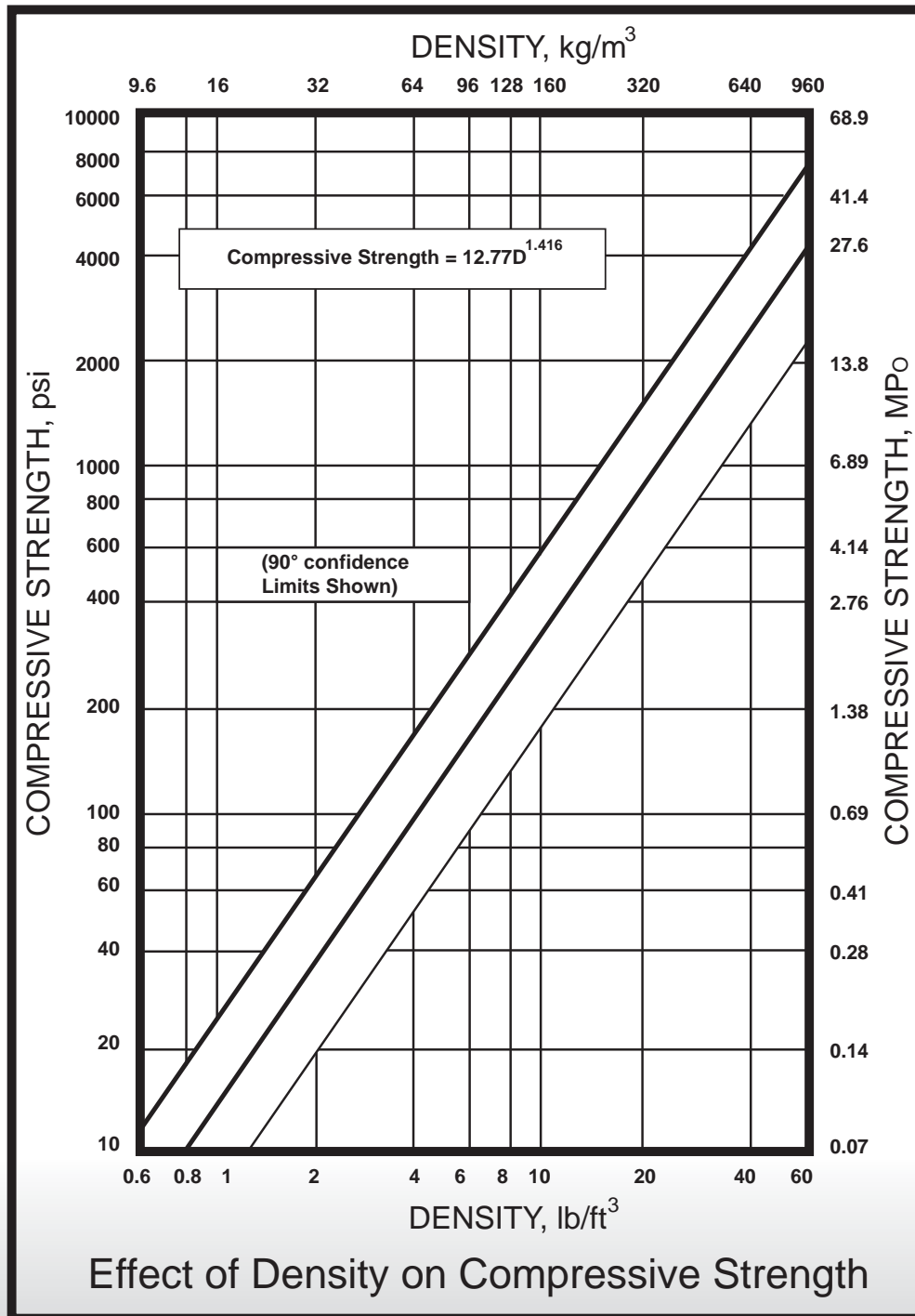


The commercial potential of polyurethane chemistry was first recognized in the late 1930's. I.G. Farben (Germany), ICI (U.K.), and du Pont (U.S.A.) developed a variety of applications. ICI introduced rigid foams in 1957. Production line insulation for refrigerators was introduced in 1963. In 1968 General Motors started making polyurethane bumpers for the Pontiac G.T.O. The combination of strength to support loads and thermal insulation made rigid polyurethane foam an attractive material for the cryogenic pipe supports required

for major LNG facilities constructed in the 1970's.

## Polyurethane Components: Pipe Supports

The primary design parameter for the polyurethane component of a pipe support is density because this determines the compressive strength. As shown in Figure 1, on a log-log scale the relation between compressive strength and density is linear. Tensile strength also has a linear log-log relation to density. Because the loads on supports for larger diameter pipes are larger than those on polyurethane components in many other industrial applications, we require higher density materials. For components used in pipe supports with densities from 10 to 40 pounds/cubic foot (160 to 640 kg/cubic meter), particularly those produced in molds, the compressive strength is essentially the same in all directions. Thermal conductivity is another design parameter of concern for the pipe support designer. For rigid foam polyurethanes, thermal conductivity increases with density. Fortunately, the 10 to 40 pound-density materials are less sensitive to the choice of blowing agent and aging, two concerns for industries which use low density foams to achieve very low thermal conductivity.



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## Laboratory Testing

Laboratory tests have been developed to characterize the important physical properties of plastics to help guide design and production. The table below shows the ISO and equivalent ASTM tests which are widely applied to rigid polyurethane foams.

Standard Tests of Rigid Polyurethane Foams		
ISO Number	ASTM Number	Physical Properties Measured
844	D 1621	Compressive stress-strain
2581	C 518	Thermal conductivity Flow meter
2582	C 177	Thermal conductivity Hot plate
5490	D 2856	Closed-cell Content

## Rigid Foam Production for Pipe Supports



Rigid polyurethane components are produced by mixing two liquids; polyisocyanates and a mixture of polyol, catalysts, water and/or a blowing agent, pigments and other additives. Companies with experience in blending these chemicals can tailor them to the specific application. When the chemicals are combined under controlled conditions, an exothermic reaction begins and the foam begins to expand. With proper control of conditions the reaction continues to completion and a solid product is obtained.

The primary factors which manufacturers must control are temperature, accurate metering of the liquids, mixing, curing time and freedom from contaminants. Many machines have been developed for manufacturers to use for both control and efficient production. At Piping Technology we use RIM (Reaction Injection Molding) machines which provide excellent mixing, temperature control and metering of the chemicals. Our large inventory of molds give us the ability to provide proper geometry with a minimum of waste, reproducible results and maximum productivity of the workforce. Assembly line techniques can be applied when quantities justify this approach. The cure time before de-molding depends on the size of the components.

## Chemistry

Rigid polyurethane foams have a relatively large amount of cross-linking as the foams expand. Suppliers of the chemicals control the degree of cross-linking by functionality (higher functionality produces more cross-links) and molecular weight of the components in the blend. Figure 2 shows a photomicrograph image of a cut piece of rigid foam. The closed cells formed during cross-linking can be seen. These rigid cells provide the strength and the interior space provides low thermal conductivity. Water can be used as the blowing agent for foam in this 10 to 40 pound-density range. This avoids the need to use chlorofluorocarbons which were so important in the production of 1 to 2 pound-density insulation prior to modern environmental regulation.

## Permeability

The water vapor permeability of rigid polyurethane foam is low but pipe support applications often have a very large temperature differential between the cryogenic fluid inside the pipe and the climate outside the insulating system. For this reason, pipe support designers use impermeable facings (galvanized, rolled shields), with low-permeable coatings and linings to separate the moisture-laden air outside from the polyurethane component which is in contact with the cold pipe. An effective moisture barrier on the warm side is particularly important for this type of application.

## PT&P: Polyurethane Production Capabilities

Piping Technology and Products has a complete manufacturing facility for production of polyurethane components required for pipe supports. We invite our customers to visit our facility and observe the fabrication of insulated pipe supports of all types. Our engineers will be happy to discuss the use of rigid foam polyurethane for cryogenic supports.



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