



THOMBERT

Polyurethane and Rubber Tires: A Comparative Overview

In the material handling business original equipment manufacturers, lift truck dealers and distributors find themselves marketing polyurethane and rubber tires simultaneously. To achieve optimum performance one needs to better understand the attributes of each product. In this article, both products will be broadly compared along with their proper application, with an emphasis on polyurethane tires. Some of the areas that will be discussed are:

Rolling Resistance
Cushioning
Traction
Load Capacity
Wear and Abrasion Resistance
Cutting / Tearing / Chunking
High Speed Operation
Floor Marking
Wet Floor Conditions
Chemical Resistance
Price
Attribute Chart

A Brief History

Rubber has been used in tires for over 100 years. Polyurethanes have been used extensively for only 50 years. Since that time rubber and polyurethane have evolved into a highly specialized group of compounds. Polyurethanes were discovered in Germany during WWII while scientists searched for a synthetic rubber compound. The availability of natural rubber was becoming scarce for Germany as the Americans were putting pressure on their supply lines. As a result, Germany looked for a solution to this problem. It was during their efforts to find a synthetic rubber that the German scientist, Otto Bayer, discovered a material called polyurethane that would later become the workhorse of the material handling industry.

To better understand each material, one needs to understand that rubber and polyurethane tires each have strengths and weaknesses specific to their unique properties. As a general rule, rubber tires are used more extensively on propane and internal combustion types of lift trucks. These trucks often operate both inside and out. In that type of application, rubber is preferred for a softer ride and better traction.

Conversely, polyurethane is limited to electric lift trucks of various types that are used primarily indoors where the floors are made of smooth concrete. Because the load capacity of polyurethane greatly exceeds that of rubber, it is preferred in this application.

Rolling Resistance

Polyurethane's chemical makeup allows it to have lower rolling resistance than rubber. This may not sound like an important attribute, but the higher rolling resistance reduces the efficiency of any

electric lift truck. The more often a battery has to be charged the less productive it is and the direct labor associated with handling the battery increases. As a general rule, it is always best to use a polyurethane tire on an electric lift truck to keep rolling resistance to a minimum.

Rubber tire manufactures do have rubber tire products available that are categorized as electric rubber compounds specifically for electric trucks. These products are designed for lower rolling resistance to improve battery life.

Cushioning

The cushioning ability of a tire is directly related to its durometer or hardness. The higher the durometer number, the harder the tire. Rubber tires will typically be in the range of 67-75 durometer while polyurethane tires will fall between 83 and 95 durometer. Simply put, the softer the tire, the more impact it can absorb. Since polyurethane is typically harder, it is known for giving a rougher ride to the lift truck operator than rubber. One must remember that on average, rubber is about 15 durometer points softer than the softest polyurethane compound. If a soft ride is important to a lift truck operator, then a rubber tire can be used efficiently and effectively as long as the truck is not electric. If the truck is electric, then an 83 durometer polyurethane tire will be the softest compound recommended to maximize load capacity while minimizing rolling resistance. Polyurethane tires are not widely available in compounds softer than 83 durometer. Softer polyurethane durometers also quickly lose their overall toughness and load capacity. As loads have increased over the years polyurethane manufactures have developed compounds as hard as 95 durometer to increase performance. While these compounds can carry significantly more load, they offer little in the way of cushion to the operator. Many times the maintenance manager is faced with the difficult decision to sacrifice operator comfort for increased productivity that can be attained with the higher durometer polyurethane tire. As a general rule, the 95 durometer polyurethane tire will offer about 15% additional load capacity than an 83 durometer. The additional load capacity may not sound like much, however it can mean getting the tonnage through a warehouse without the downtime from failing tires.

Traction

Another difference between rubber and polyurethane can be found in each material's ability to grip the surface on which it operates. Rubber tires will always have a softer tread surface, while polyurethane tires will be harder. Since rubber is softer, it will provide a broader foot print on the surface than polyurethane. As a result, rubber will always provide the customer with better traction than even the softest polyurethane. However, polyurethane manufacturers have developed a process called "siping" or "routing" where various tread styles are machined onto the surface of the tire. After this process, polyurethane tires have significantly better traction without sacrificing load capacity.

Load capacity

From a capacity standpoint, a polyurethane tire will carry twice the load of a rubber tire. For this reason alone, lift truck manufacturers have utilized polyurethane for load wheels and tires. Tires made of polyurethane will be much more resistant to splitting, tearing, or chunking out under load as rubber tires have a tendency to do. The exact polyurethane chemistry that is behind such an amazing feat would consume far too much space in this article. We will save the chemistry discussion for another day.

Since loads and speeds carried by all types of lift trucks seem to be constantly increasing in recent years, premature failure caused by continuous overloading seems to be the main cause of failure for both rubber and polyurethane. Overload=Heat=Failure. It's just that simple whether you are using rubber or polyurethane.

Wear and Abrasion Resistance

While rubber will offer a softer ride, it will not wear as well as polyurethane. In fact, as a general rule polyurethane tires will outlast rubber tires by about four times. As the rubber tire is used, it loses fragments of its tread because of surface conditions and general abrasion. On the other hand, polyurethane does not experience similar wear due to its overall toughness. Polyurethanes tend to excel under sliding abrasion while rubber performs less effectively.

Cutting and Tearing Resistance

Due to its overall toughness, the polyurethane tire will withstand rough floor conditions and debris much better than rubber. Rubber does not exhibit high cut / tear strengths. Once torn or cut, a rubber tire will see the cut or tear area propagate. Polyurethane is resistant to both cutting and tearing. In fact, the items that would normally cut and tear a rubber tire will become imbedded in the polyurethane tread without causing it to cut or tear. However, it should be noted that the cutting and tearing of both rubber and polyurethane, ultimately reduces the life of each compound.

High Speed Operation

Polyurethane tires do not dissipate internal heat well. If polyurethane has an Achilles heel it is heat. As the speed of the truck is increased, the polyurethane tire becomes less desirable. Internal combustion and propane lift trucks generally travel too fast for polyurethane tires and operate outside, so a rubber tire is the preferred choice in this application. Most electric lift trucks travel at speeds of 6-8 miles per hour. Within this speed range, polyurethanes excel. Rubber dissipates heat well and will hold up in the higher speed applications.

Floor Marking

Polyurethane tires do not mark the floor of a warehouse. Even though polyurethane tires come in a wide array of colors, the basic chemistry used will not allow any colorant to mark floors. A polyurethane tire can pick up dirt off the floor and lay it back down on the coated surface. This can leave one with the impression that the polyurethane tire is marking the floor. Dirt that has impregnated the coated surface does look like particles from the tire.

Rubber on the other hand does mark floors if one is using a standard rubber compound. Carbon black used in rubber is the primary culprit. There are non-marking rubber products on the market that generally do not mark the floor. These tires are typically grey in color as they lack the carbon black additive.

Wet Floor Conditions

Most produce areas have wet floors because the warehouse must keep the produce cool and damp during storage. This application poses some problems for electric lift trucks. A large piece of machinery on a slippery floor is not a good combination. Traction quickly becomes very important to the warehouse manager and the lift truck operator.

One would automatically think that rubber should be used since it will offer better traction. However, there are some polyurethane products available that will offer almost equal traction in this environment. If a polyurethane tire is siped (small cuts across the face of the tread at an angle) it will offer increased traction without sacrificing load capacity. A rubber tire could offer traction in the application but load capacity will be sacrificed.

Chemical Resistance

Another comparison between rubber and polyurethane tires can be made in the area of chemical resistance. As an example, a rubber tire exposed to solvents may tend to lose its ability to have good tear strength and chunk resistance while the polyurethane is unaffected after long term exposure.

However, it should be noted that harsh solvents like methyl ethyl ketone, methylene chloride or acids can destroy polyurethanes as well.

Price

From a pricing stand point it is difficult to precisely compare a polyurethane and rubber tire. One can always be sure of one thing; the polyurethane tire will be more expensive due to raw material costs. Conversely, rubber raw materials are much less expensive. Depending on the compounds, a rubber tire can cost 25-50% less than a polyurethane tire. Since rubber tires can be used in a wider array of applications and will always cost less, rubber will always be the most prevalent product used in the material handling industry. However, if the lift truck is an electric and the load requirements are high, then a polyurethane tire will be used in spite of the additional costs! But remember, while a polyurethane tire can cost twice as much as a rubber tire, the polyurethane tire can last up to four times longer.

To summarize, rubber tires have their place on lift trucks just as polyurethane tires do, but the choice is dependant upon which material is best suited for the customer and the application. As a general rule, if a warehouse operator is utilizing a fleet of electric lift trucks, the better product will be a polyurethane tire. The use of polyurethane will help the operator increase throughput by having each truck capable of carrying more load during a given shift. With lower rolling resistance, polyurethane tires will offer increased battery life. With increased overall toughness, the polyurethane tire will outlast the rubber by four times, thus reducing change outs and labor costs. If a warehouse operator has a fleet of propane or internal combustion lift trucks, then rubber will be the obvious choice.

One must also realize that there are many formulations available in both polyurethane and rubber tires to maximize performance of each material. Each material will function effectively as long as it is applied correctly. Properly applied, each material will do the job it is designed to do for the customer.

Attributes of Polyurethane and Rubber		
	<i>Rubber</i>	<i>Polyurethane</i>
Load Capacity	Good	Excellent
Chunk / Tear Resistance	Fair	Excellent
Abrasion Resistance	Fair	Excellent
Traction	Excellent	Good*
Cushioning	Excellent	Fair
Rolling Resistance	Good**	Excellent
Floor Marking	Fair	Excellent
High Speed Operation	Excellent	Good
Outside operation	Excellent	Fair
Inside operation	Good	Excellent
Wet Floors	Excellent	Good*
* Sipe tire will improve performance in wet applications		
** Electric rubber compound		