

How Stuff Works: Asphalt

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Asphalt is one of those things, like electricity, that few Americans could live without. Most American roads (96 percent) are paved in asphalt, meaning that our commutes and our shopping trips depend on it. Everything we buy at the store comes in via truck on those same roads, so without asphalt there would be nothing to buy. Millions of tons of the stuff is made and laid every year in the U.S. Yet we tend to take asphalt completely for granted. Let's give asphalt its due and take a look at how this essential material works.

An asphalt road starts with crude oil pumped out of the ground. The crude oil ends up at an oil refinery and there it gets boiled. The refinery takes the crude oil vapor and captures it in at different temperatures to separate the molecules in the oil into groups. There are very short, lightweight molecules like propane and butane with 3 or 4 carbons in the carbon chain. Gasoline molecules typically have 10 carbons. Motor oil has 20 to 50 carbon atoms. The very longest chains — typically 150 carbon atoms or more — are asphalt. These are the heaviest molecules in crude oil — the sludge at the bottom of the barrel.

Asphalt is black and solid at room temperature. You have to apply heat to turn it into a liquid. To make the hot mix asphalt (HMA) found on most roads, you start with a big rotating, heated drum. Into it you put gravel and sand and raise the temperature to 300 degrees or so. Then you add 5 percent to 6 percent asphalt from the refinery and mix until all the gravel is thoroughly coated. The drum dumps this hot mixture into the back of a dump truck, and it gets laid by an asphalt spreading machine to make a road. After several hours the mixture cools off, the asphalt solidifies and you have a hard surface that will last for years.

An interstate highway that handles thousands of cars and trucks a day uses a lot of asphalt. The layer of asphalt might be a foot thick, sitting on top of a gravel base up to two feet thick. A normal road through your neighborhood has only a few inches of asphalt in two layers. The base layer uses chunkier gravel. The surface layer uses smaller pieces of gravel to provide a smoother surface that cuts down on noise and tends to repel water better.

One interesting thing about asphalt is that it is recyclable. In fact, asphalt is the most recycled material, by weight, in the United States. Old asphalt roads can be ground up, reheated and remixed to make new asphalt in a process that is very efficient.

So what's not to like? Asphalt is relatively inexpensive, easy to make, easy to lay and it lasts a long time. About the only problem is the fact that it does wear out eventually. One obvious sign of this is the infamous pothole. Potholes more often appear in the winter for two reasons. First, cold asphalt is more brittle than warm asphalt, so the road is more likely to crack in the winter. A hot asphalt road in the summer sun has some tendency to be self-healing, but that is definitely not the case on a cold, dark winter night. So a small crack forms and lets water in. If that water freezes, it expands and widens the crack.

Since the asphalt layer is simply sitting on top of the gravel layer below, eventually a chunk of asphalt several inches thick pops out when a heavy car or truck passes by. Immediately you have a four or five inch deep hole in the road.

Cars driving over the hole quickly crush the edges and make the hole bigger, and they scour out the gravel beneath the asphalt. Suddenly, in just a day or two, you have a hole that is two feet around and a foot deep. It is a full blown pothole that can eat your tires and wreck your fancy rims. The only solution is an asphalt patch. By the time potholes start forming, it is probably time to resurface the road.

So what does the future hold? There is some discussion of replacing asphalt with glass roads. The road would have a glass surface that protects banks of solar cells and LEDs. The LEDs could display stripes and messages, and the solar cells could generate enough electricity to power the entire country. It will be interesting to see if this idea ever appears on a real road.