



# PEX Water Pipe:

**No soldering required.**

Rolls of plastic tubing are far easier to snake through joist and stud bays than are lengths of rigid copper pipe. For this reason, PEX is an excellent choice for remodeling and retrofit situations, allowing you to snake plumbing lines almost as easily as you can snake wire. PEX has a much better resistance to bursting when frozen than copper, and is far less expensive, about 50¢ per ft. vs. 85¢ per ft. for copper, with far fewer fittings to buy.

Cross-linked polyethylene tubing is cheaper to buy,  
is faster to install, and won't corrode or explode,  
but some old-timers still don't trust plastics

# is Copper on the Way Out?

BY ANDY ENGEL

**M**ost of us grew up in homes with copper pipes, and they were reliable enough that we gave them little thought.

Joining them takes soldering skills so simple that my father taught me when I was about 10. But a relative newcomer, PEX, is mounting a serious challenge to copper plumbing, despite the latter's long history of reliability.

PEX is a clumsy acronym for cross-linked polyethylene, meaning that it's a strong plastic suitable for potable water. Popularized as the go-to product for radiant-floor heating, PEX has seen its use for potable water grow by about 40% annually. This isn't happening on a lark. The scuttlebutt among plumbers is that PEX is every bit as reliable as copper, yet costs less and is faster to install.

My own experience with PEX involves two underfloor heating systems. The plastic pulls through holes in joists and studs with slightly more difficulty than Romex. Fittings for PEX are expensive, but you don't use many.

## What is PEX anyway?

Polyethylene is a common plastic whose inert nature makes it valuable for food containers (or in this case, potable-water pipes). You likely poured milk into your morning coffee from a polyethylene jug. PEX differs from your milk jug in that it's cross-linked—its molecules are rearranged to resemble a

Copper tubing appeared in the early 1920s, was tested and standardized by the American Society of Testing and Materials (ASTM Standard B88) in 1932, and owned a significant market share by the 1940s. Copper was the newcomer taking on industry giants lead pipe, which appeared in 79 A.D., and

## PEX isn't copper's first plastic challenger

galvanized-steel pipe, which appeared toward the end of the 19th

century. By 1994, more than a billion feet of copper pipe was being used in houses every year. That's eight times around the earth, or about 80% of the market.

The other 20% comprised a new generation of challengers: plastics. Plastic water pipes called chlorinated polyvinyl chloride (CPVC), cross-linked polyethylene (PEX), and polybutylene (PB) were introduced to the European and North American markets beginning in the 1960s. Of these pipes, polybutylene gained ground the quickest. After its introduction in 1978, PB pipe was installed in about 6 million houses, but after 10 to 15 years, it began to fail and disappeared from the mainstream housing market around 1995.

CPVC is a reasonable alternative with a 40-year track record but few compelling reasons to switch from copper. It costs about the same, and after the PB debacle, plumbers have been gun-shy of plastics. CPVC has 10% to 15% of the residential plumbing market, but with copper's price skyrocketing, CPVC could gobble up a larger share—if not for the less-expensive and easier-to-install PEX.



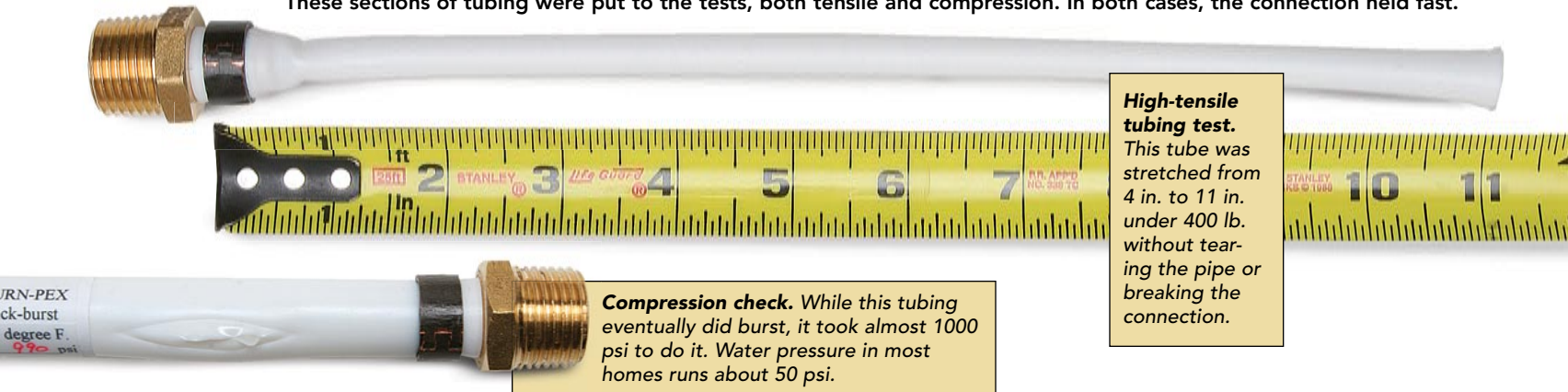
**You don't have to use red for hot.** But you can. The different colors make it easier to keep track of which tubes are hot and cold. That can be handy for homeowners.

A CPVC 4120 HI TEMP 100 PSI @ 180°F -630 F

**CPVC is reliable but rigid.** This plastic pipe is less expensive than PEX but more time-consuming to install.

## TOUGH TUBING, TOUGHER CONNECTION

These sections of tubing were put to the tests, both tensile and compression. In both cases, the connection held fast.



### High-tensile tubing test.

This tube was stretched from 4 in. to 11 in. under 400 lb. without tearing the pipe or breaking the connection.

**Compression check.** While this tubing eventually did burst, it took almost 1000 psi to do it. Water pressure in most homes runs about 50 psi.

chain-link fence—which greatly increases the plastic’s strength.

Although the polyethylene PEX is made of comes from oil, it is one of the more environmentally friendly plastics. No pipe is without environmental cost. Although much of the copper used for pipe is recycled, all of it originally came from mines. And the manufacture of another plastic pipe, CPVC (chlorinated polyvinyl chloride), is said to release dioxin, a potent carcinogen.

Cross-linked polyethylene, although chemically the same as the milk jug, is much tougher and has a “shape memory,” allowing it to be stretched or kinked and return to its original shape with time or heat. PEX’s shape memory is so strong that at least two manufacturers, Rehau and Uponor, rely on it to create leakproof joints, rather than on crimped metal fittings.

Three different processes are used for cross-linking this plastic, and the resulting products are called PEXa, PEXb, and PEXc. The original, PEXa, dates from the 1950s and has been sold in Europe for radiant-floor heating since 1971. Rehau’s Lance MacNevin says PEXa is more forgiving than either PEXb or PEXc, claiming that it can be stretched to about 400% of its manufactured length before

failure. But even PEXb and PEXc can stretch substantially. Because of PEXc’s cross-linking process (cross-linked with a laser beam while lying flat), it tends to stay flat when rolled out. If you’ve ever found yourself being followed by a coil of pipe when installing an underground plastic water line, you’ll appreciate this seemingly small advantage. PEXb and PEXc are somewhat less expensive than PEXa.

### Copper has a long track record and few drawbacks

The American Society of Testing and Materials (ASTM) standard governing copper pipe and fitting sizes was implemented in 1932. That means you can buy a fitting at the hardware store today that will slide right onto a 75-year-old copper pipe.

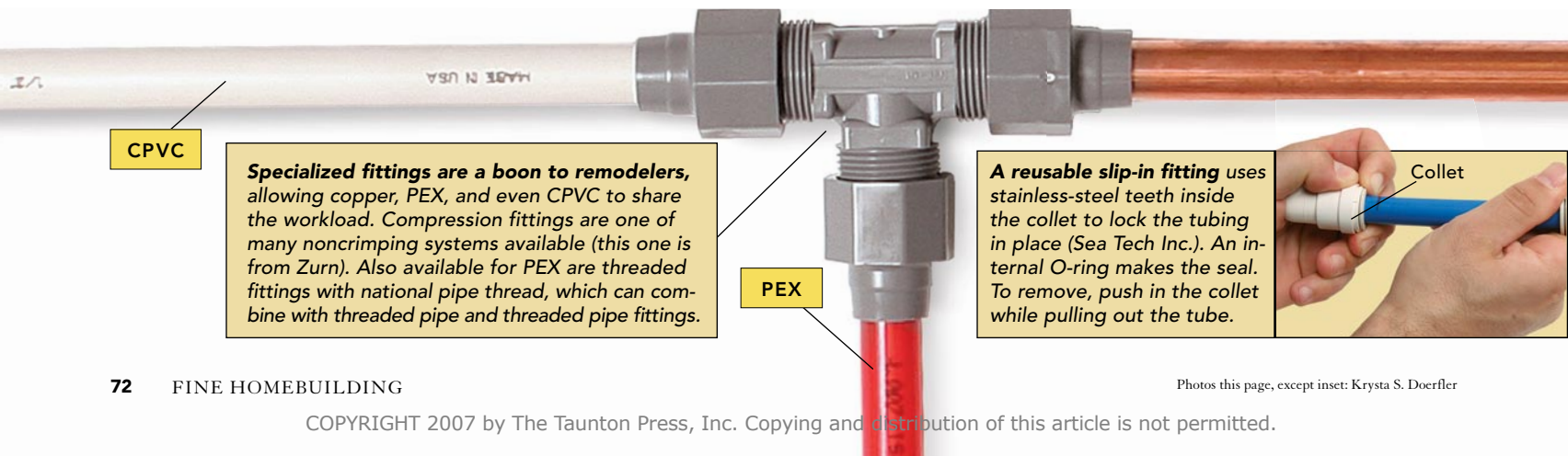
Studies have shown that copper has antimicrobial properties, perhaps helping to keep your water safe to drink. About the only functional downside to copper is that it is susceptible to developing pinholes in areas with corrosive acidic well water. Andy Kireta Jr. of the Copper Development Association agrees that corrosion can happen, but he notes that “because we have historical data that indicate the areas prone to acidic water, we know to recommend conditioning

to neutralize the water’s pH in these places.” Kireta also points out that “copper tube is one of only a handful of materials that can be recycled and maintain the same level of purity as the original product. That is, you can melt down old copper pipe and use it to make new copper pipe. Most recycled materials, such as steel, paper, and plastics, drop a notch in quality each time they’re recycled.”

The last plastic pipe to make serious inroads into copper’s market dominance was polybutylene, a flexible gray tubing that had problems with leaky fittings. Blame and lawsuits flew like snow in a New England blizzard, and polybutylene disappeared from the market in the mid-1990s. CPVC is approved for domestic potable water, but it doesn’t have a huge market share.

### If copper worked and plastic failed, then why risk using PEX?

With many plumbers gun-shy of plastic pipe after the polybutylene debacle, why take a chance on the PEX generation? First, PEX isn’t polybutylene. Polybutylene failed for a number of reasons, one of which was that the fittings were made of a type of plastic that didn’t react well with the chlorine used by many municipal water-treatment facilities.



CPVC

**Specialized fittings are a boon to remodelers,** allowing copper, PEX, and even CPVC to share the workload. Compression fittings are one of many noncrimping systems available (this one is from Zurn). Also available for PEX are threaded fittings with national pipe thread, which can combine with threaded pipe and threaded pipe fittings.

PEX

**A reusable slip-in fitting uses stainless-steel teeth inside the collet to lock the tubing in place** (Sea Tech Inc.). An internal O-ring makes the seal. To remove, push in the collet while pulling out the tube.

Collet

# A LEAKPROOF JOINT MADE FASTER THAN SOLDERING



There are many systems for crimping PEX joints. Some are available only to licensed plumbers, but online stores (sources below) will sell to anyone. The Zurn system (shown here) is fast and easy.



**Cut the tubing** squarely with a sharp blade in a special PEX-cutting tool.



**Slip a steel collar** over the tube, then insert a barbed brass connector into the tube.



**Squeeze the collar** with the proprietary crimping tool, and you're done.

All approved PEX tubing meets ASTM standards. Pipe intended for potable water must meet additional National Sanitation Foundation (NSF) and American National Standards Institute (ANSI) rules. To ensure compliance, samples are tested annually, and unannounced audits of PEX manufacturing plants are made three times a year.

Second, PEX often performs better than copper: It isn't susceptible to pinhole leaks because it's chemically inert; it won't clog with mineral scale because its inner surface is smoother; and it has superior resistance to bursting from frozen water. Jim Bolduck, a Cumberland, Maine, plumber, told me about a PEX-plumbed house he'd seen that had lost its heat in the dead of winter. "That house froze so solid that the boiler split open," said Bolduck. "All the PEX survived, though."

Dana Bres, a research engineer with HUD's Partnership for Advanced Technology in Housing (PATH), points out another asset: "Quality control for all types of plumbing tube (PEX, copper, and CPVC) is excellent, so the pipes themselves rarely leak. Leaks happen at joints, and copper plumbing is loaded with joints. PEX comes in rolls hundreds of feet long, which minimizes the number of joints and the potential for leaks."

In 2004, PATH listed PEX plumbing systems using plastic distribution manifolds as one of the top-10 emerging technologies.

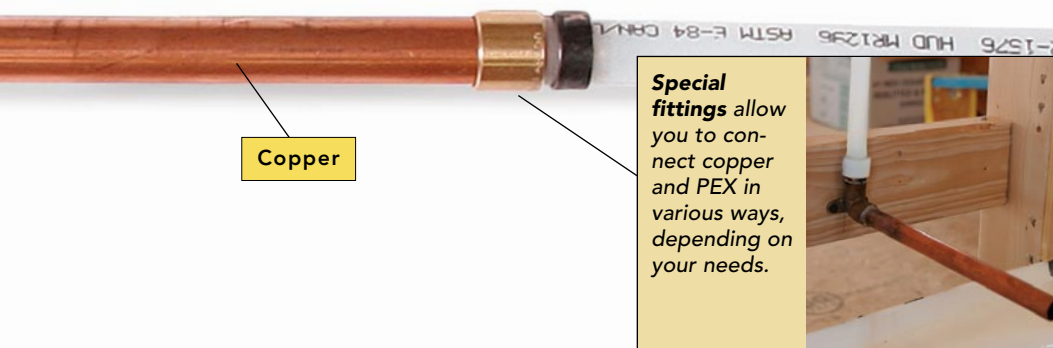
## PEX and copper can combine for remodeling

Like CPVC, PEX comes in the same outside diameters as rigid copper pipe (nominal diameter plus 1/8 in.). At least one manufacturer, Watts Radiant, makes compression fittings that work with all three types of pipe. In fact, in my own house, I needed an emergency repair fitting after drilling a hole through a PEX heating line. The old-time plumbing store I went to didn't carry PEX fittings, but they did sell me a compression coupling for copper pipe. That was five years ago, and although it's not a code- or manufacturer-approved joint, it doesn't leak, either.

For blended systems, PEX manufacturers have fittings that join to PEX at one end and either solder to copper or glue to CPVC on the other. Additional fittings allow PEX to terminate and stub out of the wall or floor.

## PEX can be run like copper, but that won't maximize its potential

You can configure PEX plumbing systems several ways, and it's possible to do so in ways



**Special fittings** allow you to connect copper and PEX in various ways, depending on your needs.

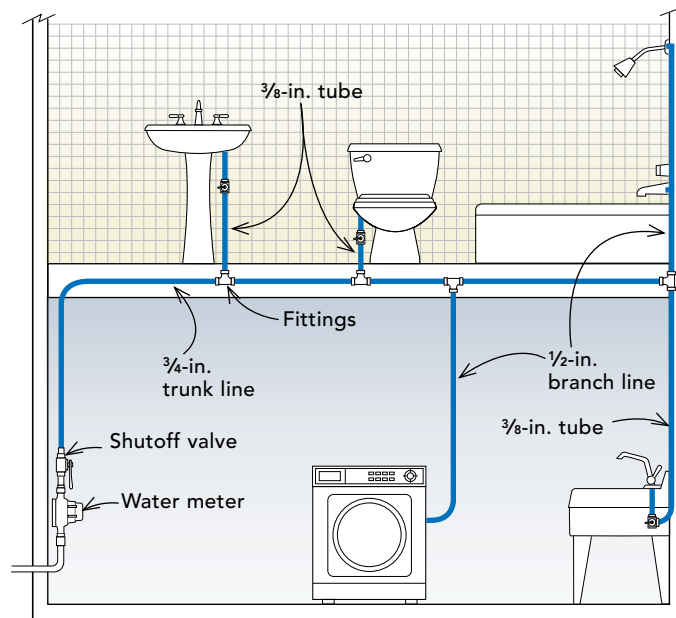
## BUYING PEX ONLINE

Many manufacturers deal only with licensed plumbers, but online stores sell to anyone. Among "Breaktime" readers' favorite sites:

- [www.mvsupply.biz](http://www.mvsupply.biz)
- [www.houseneeds.com](http://www.houseneeds.com)
- [www.pexsupply.com](http://www.pexsupply.com)
- [www.blueridgecompany.com](http://www.blueridgecompany.com)
- [www.pexconnection.com](http://www.pexconnection.com)

## FLEXIBLE PIPE ALSO OFFERS DESIGN FLEXIBILITY

Incorporating manifolds into the layout can save water and energy because you eliminate most of the pipe between the water heater and the faucet. Although blue (cold water) lines are shown in these layout examples, hot-water layout would be similar.



### Trunk-and-branch systems

**Easy, but waste a lot of water**

Traditional systems consist of large-diameter (usually 3/4 in.) trunk lines to distribute water throughout a house. Smaller branch lines (1/2 in. and 3/8 in.) tee off to feed individual fixtures. Trunk-and-branch systems have several disadvantages, notably a large number of fittings, which are costlier, slower to install, and more likely to leak than a single run of pipe. Also, a lot of water goes down the drain before hot water reaches the faucet.

that save water. PEX can be configured like a traditional copper system, with larger-diameter trunk lines teeing off to smaller branch lines that feed individual fixtures. Doing so will eliminate some elbows and their potential leaks, but it doesn't take best advantage of PEX's properties.

The PEX industry pushes several other configurations, all of which start out at a plastic or copper manifold, where the hot and cold mains split off to various parts of the house (photo below). With manifold systems, each branch has its own shutoff valve, analo-

gous to an electrical system's circuit-breaker panel. Using PEX with manifolds can save water and energy because hot water reaches remote sinks more quickly.

### National plumbing codes treat copper and PEX equally

Because PEX and copper are the same outside diameter, one might wonder how the inside diameters compare. After all, inside diameter determines flow rate. The walls of PEX pipe are thicker, so the inside diameter is smaller. For several reasons, however, all

U.S. plumbing codes treat copper and PEX interchangeably when considering adequate water flow. The inside of PEX is smoother than copper, and PEX offers fewer flow restrictions because it is bent into sweeping curves instead of turning with sharp elbows the way copper and CPVC do.

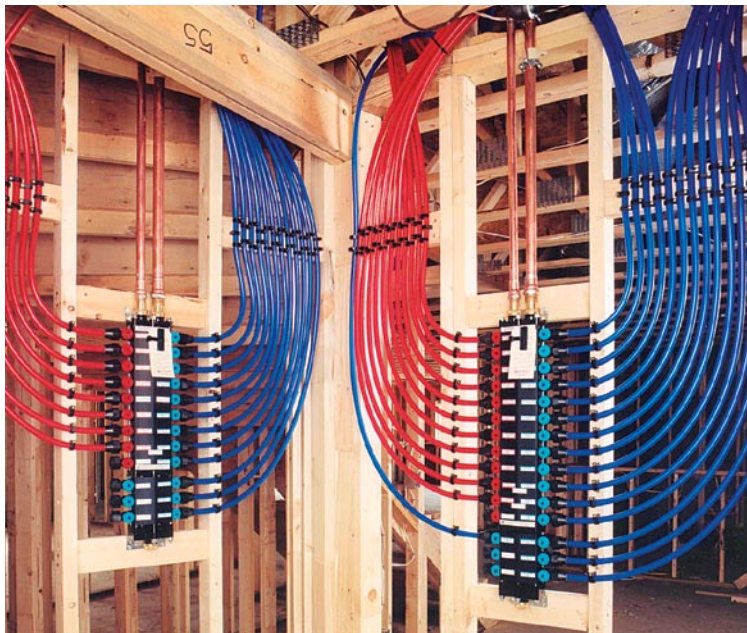
Although PEX has been part of national plumbing codes since the early 1990s, not every jurisdiction has adopted those codes. Before using PEX for potable water, check with your local building inspector.

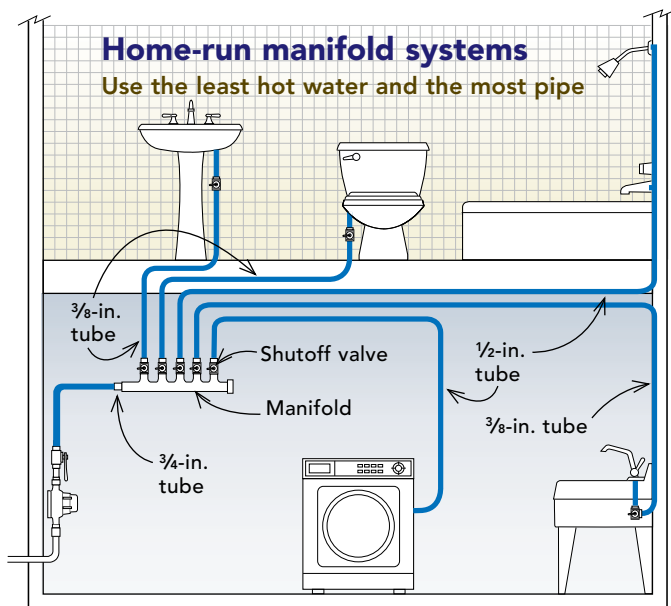
### Normal PEX isn't UV-tolerant

One major shortcoming is that left unprotected, PEX deteriorates when exposed to the sun's UV-rays. Copper doesn't have this problem. Most PEX is warranted for only 30 days of direct sun exposure, but some premium lines coated with a UV-inhibitor are good outside for a year. Even the best PEX can't be left exposed outside, so copper must be used for pipe that's to be exposed to the elements. If you're using PEX under a slab, either cover the pipe where it stubs out of the concrete, or spend more for PEX with a UV-inhibitor.

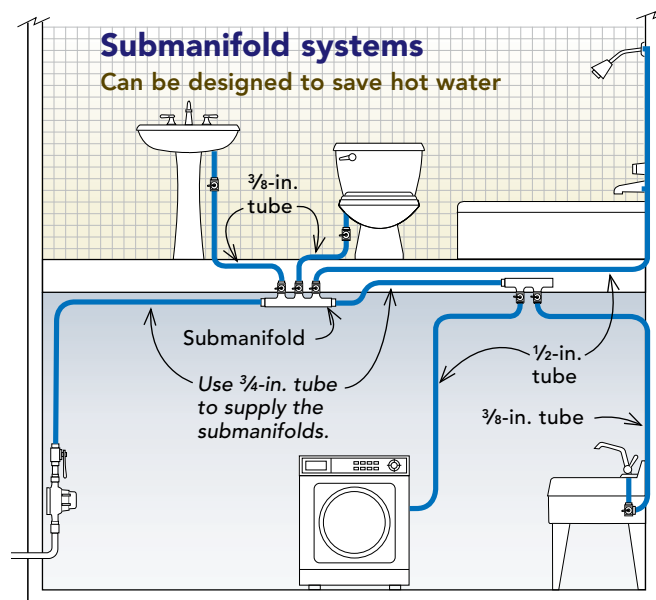
PEX also is susceptible to damage from certain oil- or solvent-based compounds, and can allow these compounds to pass through the pipe and into the water. Never bury PEX (even if coated with a UV-inhibitor) in contaminated soil, and avoid oils and greases when working with PEX.

**PEX doesn't have to be messy.** Although some plumbers complain that PEX installations are messy, others enjoy the drama of the final hookup to the manifolds. Red (hot) and blue (cold) tubing can make a confusing mass of pipe understandable.





A large-diameter ( $\frac{3}{4}$  in.) main water line feeds the manifold; smaller lines run from the manifold to each fixture. Any fixture in the house can be shut off at the manifold. And because home-run systems don't rely on a large pipe for distribution, you save both water and energy. Simply put, you don't have to leave the faucet running as long before hot water reaches the sink. This design flexibility has a cost, however. Because a dedicated line is going to each fixture, you use a lot of PEX and drill a lot of holes.



There are many ways to design submanifold systems, which require far less pipe and drilling than a home-run system. Rather than one main manifold, each bathroom, laundry, and kitchen gets its own submanifold. The simplest system, pictured here, won't save any water over a trunk-and-branch system, but other submanifold systems can be configured as water and energy savers by incorporating a main manifold and a recirculating pump.

## How do I persuade my plumber to use PEX?

I've spoken to a number of plumbers about PEX and didn't find one who flat out refused to use it. Most plumbers who've used it were enthusiastic. Those who were reluctant fell into two camps. A common concern was voiced by Dave Trone, a plumber in Columbia, N.J.: "Plastic and brass expand at different rates, and I think that leaks where PEX pipe joins to brass fittings are simply a matter of time." The other concern I heard surprised me. "It just doesn't look as neat as copper," said one Nebraska plumber.

Although it's true that joints between PEX and brass don't have copper's 75-year track record and that leaking polybutylene fittings are still a sore spot with some plumbers, a representative from Zurn Industries addressed Trone's concerns: "PEX is the most engineered and tested plumbing material out there. Its shape memory allows it to expand and return to size repeatedly, so we're confident of the long-term viability of the joints." Then he showed me a PEX-brass connection that had been subjected to 990 lb. per sq. in. (psi) pressure. The joint had held tight, but the PEX tube burst. Residential water systems generally run at less than 50 psi.

When I brought up the Nebraska plumber's complaint about neatness with Rehaus MacNevin, he replied, "We hear that occasionally. That's why we also make PEX in 20-ft. rigid lengths that can be used in visible locations like a basement."

Manufacturers seem concerned that leaks caused by poor workmanship could undermine the acceptance of PEX, so many offer on-site training and certification to licensed plumbers. In fact, many of the biggest players, such as Rehaus and Uponor, won't sell their product to uncertified installers. But because PEX and its fittings are sold through plumbing-supply houses, enforcement of this mandate is spotty. Other manufacturers, however, believe their systems are so simple to use that they're sold at Lowe's and The Home Depot. PEX and its fittings are also readily available online (sources p. 73).

If your plumber still isn't buying into PEX, bring up labor savings. Says Bres: "In a recent PATH field evaluation of otherwise identical homes, it appears that using PEX shaves a day off the plumbing installation, reducing the install time from three days to two."

When I plumbed my new house in 1999, I ran PEX for the radiant-floor heat. For the potable-water system, though, I reflexively

used copper because conventionally, that's how you plumb a house. I had a good time soldering the joints and figuring out the system. Being a competent but slow do-it-yourself plumber, I needed about a month's worth of weekends to do the job.

If I had my house to plumb over again, I'd configure PEX in a submanifold system. I think that approach offers the best bang for the buck, and it makes good use of PEX's advantages. Because I'd want to do the work myself, several of the best systems on the market that require pro installation immediately would be out of contention. So my choices would be limited to materials I could buy online or locally. Given that, I wouldn't shop for a particular brand. All the PEX manufacturers I spoke with left me feeling comfortable with their products. I'd look for a supplier of a system; that is, I'd want the fittings and the pipe to come from one manufacturer. I'd look for a supplier happy to provide advice and support. And I'd expect the job to take about half the time. □

Andy Engel is a carpenter, writer, and home-energy consultant in Roxbury, Conn. Photos by Daniel S. Morrison, except where noted.