Heating System Tuneups

by Richard Trethewey

Nearly 11% of all heat loss in forced-air systems comes from leaky ducts. Replace duct tape at joints and seams with a high-quality mastic.

Regular maintenance, equipment upgrades, and new high-tech controls can revive most existing furnaces and boilers

Heating systems more than three to five years old can usually be improved through add-ons, modifications, or improved maintenance. Most combustion units are oversized, for instance — particularly if the house has had insulation added since the unit was installed — and most have unsophisticated control systems. In addition, heat distribution systems can usually be improved through adjustment, new products, or in the case of air systems, tightening of the ductwork.

The options presented here are among the most promising and practical, and should apply to the 65% of our nation's homes that are heated by forced hot air and the 10% heated by forced hot water. Remodeling contractors who educate themselves about these options have an opportunity to give clients a valuable service. These modifications may well result in fuel savings that will help pay for more remodeling work; in many cases, an upgrade will give you the extra heating capacity you need to heat any space you add.

All Systems

We'll consider forced-air and hydronic systems separately, but there are some steps you can take that apply to both types of heating systems.

Cleaning and tuneups. Routine maintenance is the homeowner's job, but it won't hurt for you to point out the importance of regular tuneups (yearly for oil-fired systems, every two years for

Figure 1. *A programmable thermostat, such as the Set 'n Save II Plus (Hunter Fan Co., 2500 Frisco Ave., Memphis, TN 38114; 800/971-3267), saves on fuel by automatically lowering the temperature setting when the house is unoccupied.*

gas). These should include combustion and flame checks, draining hot water systems of sediment and bleeding them of air, checking air ducts for leaks, and so on. Table A lists routine maintenance for forced hot air and forced hot water or steam systems; these steps alone will promote better performance and longer life in nine out of ten systems.

Upgrade thermostats. Another way to quickly improve virtually any hvac system is to upgrade its brain — the thermostat. Compared with "clock" thermostats first introduced in the 1970s, today's microprocessor-controlled setback thermostats are more sophisticated but easier to install and use (see Figure 1). An investment of $30 to $100 will buy a computerized thermostat that can improve system efficiency from 7% to 10%.

Some setback thermostats have two cycles, one for weekdays and one for the weekend; the better ones have seven-day cycles, for people who want to be able to program each day of the week individually. Almost any unit allows a user to temporarily override the programmed settings. If you avoid the bottom of the line, you'll usually get a unit that's easier to program. I've found that the more buttons a thermostat has the simpler it is to use, since you don't have to figure out how to make buttons serve multiple tasks.

Hot Air Systems

These modifications apply primarily to forced hot air systems — those with a fan that drives the air through the house. But many (particularly those concerning ductwork) also apply to passive, or "gravity-fed," hot air systems.

Focus first on flow. Assuming the basic layout of the air distribution system is sound (see "Duct Design Basics," 12/95), you need to check the condition of the ductwork itself. Unfortunately, loose ductwork is the rule: One study found that the average home with forced hot air heat lost 11% of its heat through leaky ductwork. The cost of fixing these leaks can run anywhere from the price of a few hours of labor and some mastic to hundreds of dollars for a ductwork overhaul. But any repairs *should* bring immediate returns in comfort, and most will provide a payback of no more than two to five years.

The three most common leak sites are in the return air plenum, at joints between branch ducts and the main trunk line, and where ducts attach to room outlets (Figure 2). Ideally, you

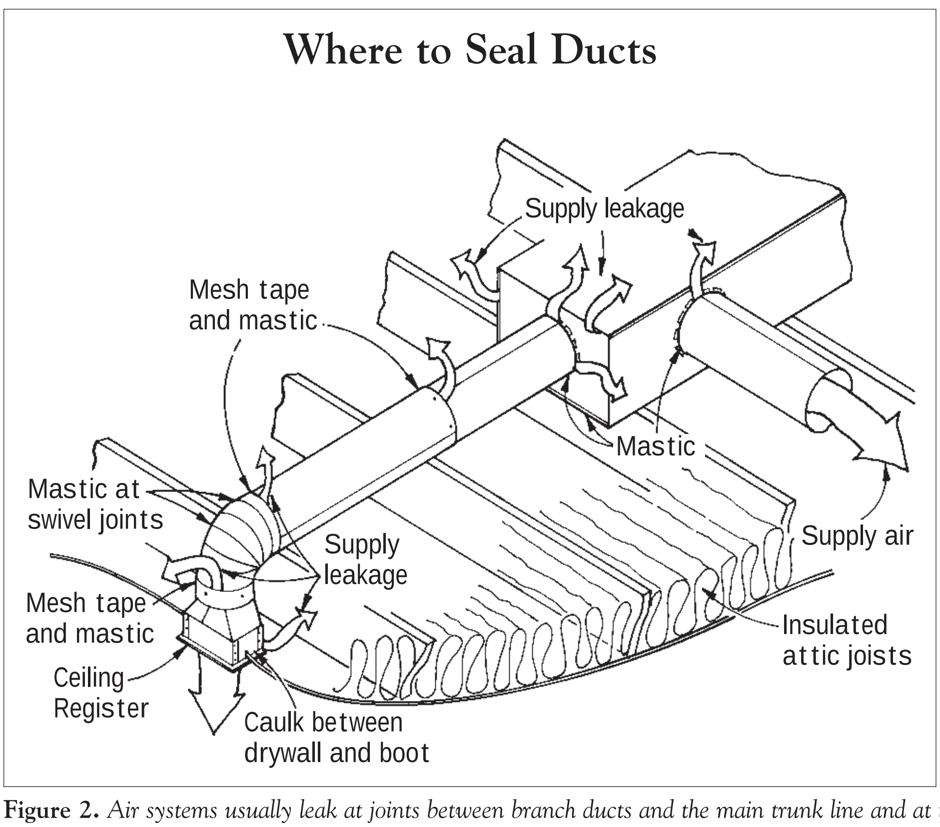

Figure 2. *Air systems usually leak at joints between branch ducts and the main trunk line and at the connections between supply ducts and registers (left). Replace all duct tape with mesh tape and a high-quality mastic. Pay close attention to sealing cracks where ductwork penetrates unconditioned spaces such as attics or basements (right).*

should seal all seams and joints that appear loose or that are sealed with duct tape, which will degrade within a few years. Tear off the duct tape (even the stuff that looks okay) and seal the seams and cracks with mesh tape and a high-quality mastic, such as Uni-Mastic or Seal-N-Save (United McGill Corp., P.O. Box 820, Columbus, OH 43216; 800/624-5535). Use a flexible caulk to seal penetrations where the ductwork passes through to the exterior or to unconditioned spaces such as attics or basements. Make sure ducts are clean near their terminal ends and that the registers aren't covered or blocked by furniture or rugs and such. Finally, insulate any ductwork running through unconditioned spaces with R-11 fiberglass blankets.

Do the balancing act. One potential drawback of forced-air systems is that they can cause pressure differences throughout a house. If the system isn't properly designed or if someone messes with the control dampers, some rooms will be pressurized and some depressurized, leading to unwanted temperature discrepancies within zones. Pressurized rooms are poorly heated because new air can't get in. In depressurized areas, infiltration of outside air causes drafts and dryness, and raises fuel consumption. This is more than an occasional problem: The Electric Power Research Institute found that, on average, household infiltration rates are 15% to 36% higher in forced hot air homes than in others.

The way to avoid pressure differentials — to "balance" the system — is to match supply and return air capacity and, just as important, to provide low-resistance return air paths between every room and the return air register or registers. Giving every room its own ducted return register solves this challenge but is expensive. Instead, most homes have one or two centrally located return registers to which return air must flow. The problem comes when something — usually a closed door — blocks the free flow of air to this central return register from individual rooms.

It takes a sharp hvac contractor with a blower-door test kit to evaluate and fix a system where the supply and return capacities are badly out of balance. But there are some simple things a GC can do to improve return airflow. You can undercut the doors to bedrooms and other isolated rooms 1 1/2 to 2 inches, or you can install transom grilles. Unfortunately, both of these easy solutions badly compromise privacy. A more discreet solution is to install "transfer" grills high on one side of a stud bay and low on the other side, connecting an airway to rooms on both sides of the wall. For yet more privacy, create a "jumper duct" by putting a ceiling grille in the isolated room and connecting it via a short run of duct to the open space nearest the main return register.

Keep in mind, however, that you shouldn't make these modifications unless you have good reason (such as a blower-door test) to believe you've got blocked return air paths.

Consider adding zones. In houses so badly out of balance or so spread out that the above steps won't work, extra ductwork may be required to balance the system. If that's the case, consider having an hvac contractor create some zones in the existing system. This usually involves installing a thermostat for each new zone, new ductwork or modifications to existing ductwork to create the new zones, and a few tweaks and add-ons to the furnace (a good control electrician or manufacturer's tech consultant can help here). A new zone can often be

Table A. Recommended Maintenance for Gas and Oil-Fired Systems

All Furnaces and Boilers
Clean burner and combustion chamber.
Run combustion test to check furnace or boiler efficiency and preclude any danger of backdraft.
Check for fuel-line leaks.
Check and calibrate thermostat.
Change oil filter.*

Forced-Air Systems
Test airflow.
Check for duct leaks and make needed repairs.
Check fan belts for snugness and wear.
Clean or replace air filter.
Clean fan.
Lubricate fan motors.
Adjust fan switch.
Make sure registers are properly oriented and free of obstructions.
Vacuum ducts.
Check, repair, and improve duct insulation.
Clean humidifier (if present).

Hot Water or Steam Systems
Clean or replace fuel nozzle.
Insulate pipes with compressed fiberglass.
Keep radiators clean and free of obstructions.
Manually adjust aquastat.
Bleed air out of system.
Lubricate motor and pumps.
Drain expansion tank.
Drain sediment from boiler.
Clean or replace clogged radiator vents.**
Replace bad steam trap.***
Check system for proper amount of water.

* Oil-fired systems only.
** One-pipe steam system only.
*** Two-pipe steam system only.

Note: *The maintenance steps listed here should be performed yearly for oil-fired systems and every two years for gas systems.*

Table B. Efficiency Upgrades

Upgrade	Cost	Estimated Fuel Savings	Comments
FORCED-AIR FURNACE			
Replace fuel nozzle with a smaller one	Up to $60	2% to 10%	More expensive with gas furnaces; may be free with oil furnace tuneup.
Flame-retention head oil burner	$250-$600	10% to 25%	Oil furnaces only; may require downsizing the combustion chamber.
Replace pilot light with electric ignition	$150-$300	5% to 10%	Gas furnaces only.
Install automatic vent damper	$250-$400	3% to 15%	Closes flue to reduce standby heat loss up chimney. Savings usually greater with oil furnace than with gas.
Install a setback thermostat	$40-$280	7% to 10%	Lowers the temperature setting automatically while occupants are sleeping or away from home.
Install power burner	$400-$600	10% to 20%	Converts old oil and coal systems to gas.
BOILER			
Install thermostatic radiator valve (TRV)	$200 per unit	10% to 15%	Do-it-yourself project on one-pipe steam system will cost $35 to $75 per radiator.
Weather-responsive control (outdoor reset control)	$300-$1,000	5% to 25%	Hot water boilers only. Adjusts boiler water temperature according to outdoor temperature. Savings highest when used with setback thermostat and TRVs.
Replace fuel nozzle with a smaller one	Up to $60	2% to 10%	Hot water systems only. More expensive with gas boilers; may be free with oil boiler tuneups.
Flame-retention head oil burner	$250-$600	10% to 25%	Oil-fired boilers only. A better but more expensive option than downsizing the nozzle.
Replace pilot light with electric ignition	$150-$300	5% to 10%	Gas boilers only.
Install automatic vent damper	$250-$400	3% to 15%	Closes flue to reduce standby heat loss up chimney. Savings usually greater with oil than with gas.
Install setback thermostat	$40-$280	10% to 20%	Lowers temperature setting automatically while occupants are sleeping or away from home.
Install gas power burner	$400-$600	10% to 20%	Converts old oil and coal systems to gas.
Radiator reflectors	$10-$100	Varies	Galvanized sheet metal, aluminum foil, foil-faced insulation, or metalized film mounted to the walls behind radiators reduce heat loss through walls.

Note: *Most furnaces five years old or older will benefit from one or more of these upgrades. Estimated savings are not cumulative, however. On older furnaces, consult with your hvac sub or energy auditor about the cost effectiveness of modifying the furnace versus installing a new one.*

Figure 3. *Weather-responsive boiler controls like this one from Tekmar adjust the temperature of boiler water to match changes in outdoor temperature. This increases system efficiency because the boiler never heats the water more than is necessary to keep the house at the desired temperature.*

created by putting in "variable air volume" or "flow control" dampers in existing duct runs. These dampers, which include some innovative products such as pneumatically-controlled dampers, respond to the thermostat setting by automatically opening or closing to allow more or less treated air into the zone.

It can run from $1,200 to $1,500 to add a second zone to a one-zone system; installing a variable air volume system could cost twice that. Again, this should be done only by hvac contractors with lots of experience in FHA design and with training from the system's designers, because it's easy to mess up. But if it's done right, zoning will deliver a huge increase in the flexibility, comfort, and efficiency you can get out of an existing forced hot air system.

Tweak the furnace. Table B lists several modifications you can make to forced hot air furnaces. All bring real savings quickly, and most pay for themselves in one or two heating seasons. While these changes won't get a standard five- to ten-year-old system up into the 85% efficiency range of today's new units, they can take a furnace that is running at about 55% or 60% efficiency and bring it up to 70% or 75%.

One furnace modification not listed in the table is a variable speed blower, which kicks on and off gradually to reduce noise and also varies its speed depending on the heating or cooling load. These blowers are a nice improvement found in many new systems, and in theory they should make a sensible retrofit. But putting one into an existing furnace and blower unit is tricky and likely to lead to problems and expense, so I don't recommend them as a retrofit option.

Hydronic Systems

I like hydronic systems because they're less finicky than forced hot air systems and because they offer many options for increasing control of where, when, and how much heat is delivered. Many of the patches and modifications I will mention have been developed in just the last few years, offering new opportunities to improve even old steam radiator systems. And most of these modifications are fairly easy to make.

Table A shows the routine maintenance every hydronic system needs; as with forced hot air systems, these should be the first line of attack in any evaluation or overhaul. Table B also shows options for upgrading or modifying hydronic systems, with rough estimates for both costs and benefits of each upgrade.

Most of these options are straightforward, but a few, particularly the newer ones, are worth describing in some detail.

TRVs. Thermostatic radiator valves (TRVs) have been used for decades in Europe, but have become more readily available in the U.S. over the past ten years or so. TRVs mounted on individual steam or hot-water radiators control the flow of hot water (or venting air in steam radiators), acting as thermostats for those individual radiators. TRVs allow the occupant to tailor the amount of heat delivered to different radiators within a single zone. On a second floor, for instance, an infant's bedroom can be kept at a toasty 70°F degrees all night, the parents' at 60°F, and the spare bedroom at 55°F. Depending on the household, the increased convenience and comfort comes with considerable energy savings.

Weather-responsive controls. A fairly recent development for hot water (but not steam) systems is the weather-responsive boiler control (also known as "modulating aquastats," or "reset controls"). A weather-responsive boiler control works by constantly sensing the outdoor temperature and adjusting the boiler water temperature accordingly via the aquastat (Figure 3). Thus, when it's 0°F out, the boiler will heat the water to maximum temperature (usually around 180°F); if it's around 30°F degrees outside, the boiler might heat the hot water to only 135°F. The system never heats the water any more than necessary to keep the house at the desired temperature. For every 3°F that you can lower the boiler water temperature and still heat the building, you save 1% in fuel. This increased efficiency can cut a home's heating bill by 15% to 25%. Good models include those from Honeywell (1985 Douglas Dr. North, Golden Valley, MN 55422; 800/328-5111), Stadler (3 Alfred Circle, Bedford, MA 01730; 800/370-3122, and Tekmar Control (4611 23rd St., Vernon, BC V1T 4K7, Canada; 604/545-7749).

Weather-responsive controls aren't cheap — the control itself runs about $300 and takes an hvac contractor a half day or so to install. These controls also can't be used with a tankless boiler system unless you install a four-way mixing valve, which gets a bit more complicated and pricey. These aren't reasons to avoid weather-responsive controls; they're simply factors that an experienced hvac or plumbing-heating contractor should evaluate before going ahead. ■

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