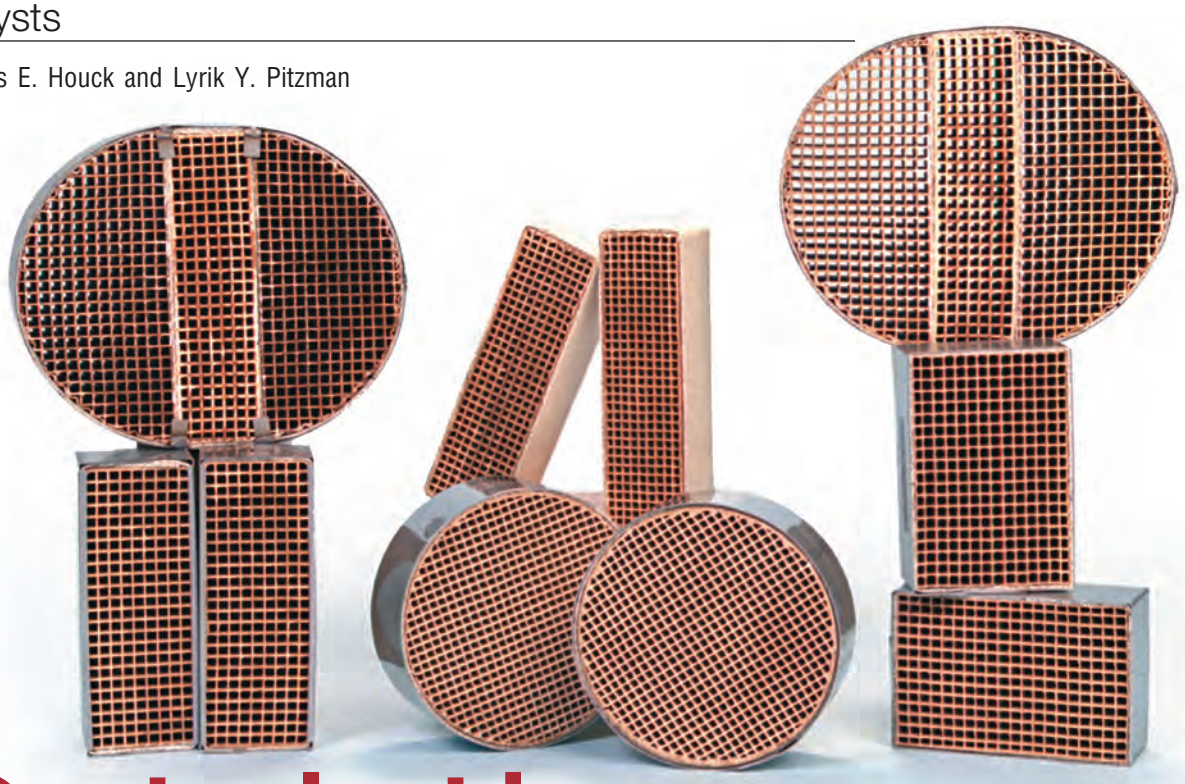
By James E. Houck and Lyrik Y. Pitzman



Catalytic Comeback?

New research shows today's wood stove combustors not only produce longer burn times with fewer emissions, but also function efficiently for much longer than previously thought.

More heat, less air pollution and less creosote. This is the trinity for environmentally sound, safe and desirable wood heaters. Catalytic technology offers some very real benefits in each of these areas. The concern over short catalyst life and the need for replacement that plagued the technology early on, and still flavors the perception of catalytic heaters, appears to have been mitigated by well-designed heaters specifically engineered to accommodate catalysts. Additionally, catalysts themselves have evolved since the late 1970s when they first came on the wood heater scene.

Lower Emissions

As many readers may be aware, the U.S. EPA is in the process of developing a New Source Performance Standard (NSPS) for residential wood heaters. The NSPS will set new limits on particulate emissions. The conventional wisdom is that the new limits will be much lower than the current ones.

On average, catalytic heaters have lower particulate emissions than non-catalytic heaters and, in fact, the wood heater model with the lowest certified particulate emission rate (0.6 g/h) is a catalytic unit. Also, with the focus on wood heater certification, many forget that, in addition to particulate emissions, residential wood combustion emits volatile organic compounds (VOC) and carbon monoxide gases. Catalysts oxidize these materials along with particles producing water and carbon dioxide from them.

As a class, VOC's contain health injurious compounds, some of which are on the EPA's Hazardous Air Pollutant (HAP) list. Methane is also a VOC and is a potent greenhouse gas. While a few companies dominate catalytic heater manufacturing, a total of 48 companies (although some are no longer active) have one or more catalytic models listed as certified with the EPA. In addition to traditional freestanding cordwood stoves and fireplace inserts, there is a potential to interface catalysts with hydronic heaters and cookstoves, which may be included in the new NSPS as well.

Bigger May Be Better – at Least for Some Market Segments

Not everyone wants a big stove reminiscent of their old Fisher Grandpa Bear, but many do. While there are exceptions, in general most modern certified non-catalytic stoves have smaller fireboxes because it is more difficult to reduce particulate emissions low enough to be EPA certified if the firebox becomes too large.

Anecdotally, we have heard consumers say over and over, "I don't like these new stoves – they're too small." This is

Catalytic Combustors from Sand Hill Wholesale.

not the issue with catalytic technology; these are heaters with larger fireboxes that can be certified more easily. Catalytic stoves can be sized similarly to their non-catalytic counterparts or they can be designed to be larger.

Higher Efficiency Means More Heat

To put it bluntly, efficiency claims for many wood heaters still originate from the marketing department not from the engineering department, or are the product of "gamesmanship" with laboratory testing. Everyone wants a more efficient wood heater that produces more heat from the same amount of fuel. What is not just a marketing claim, and generally accepted, is that, as a group, catalytic wood heaters are more efficient than non-catalytic wood heaters. For example, the default efficiency currently listed for catalytic heaters in the EPA's NSPS is 72 percent in contrast to 63 percent for non-catalytic heaters (40 CFR §60.536 (i)(3)).

Catalyst Longevity

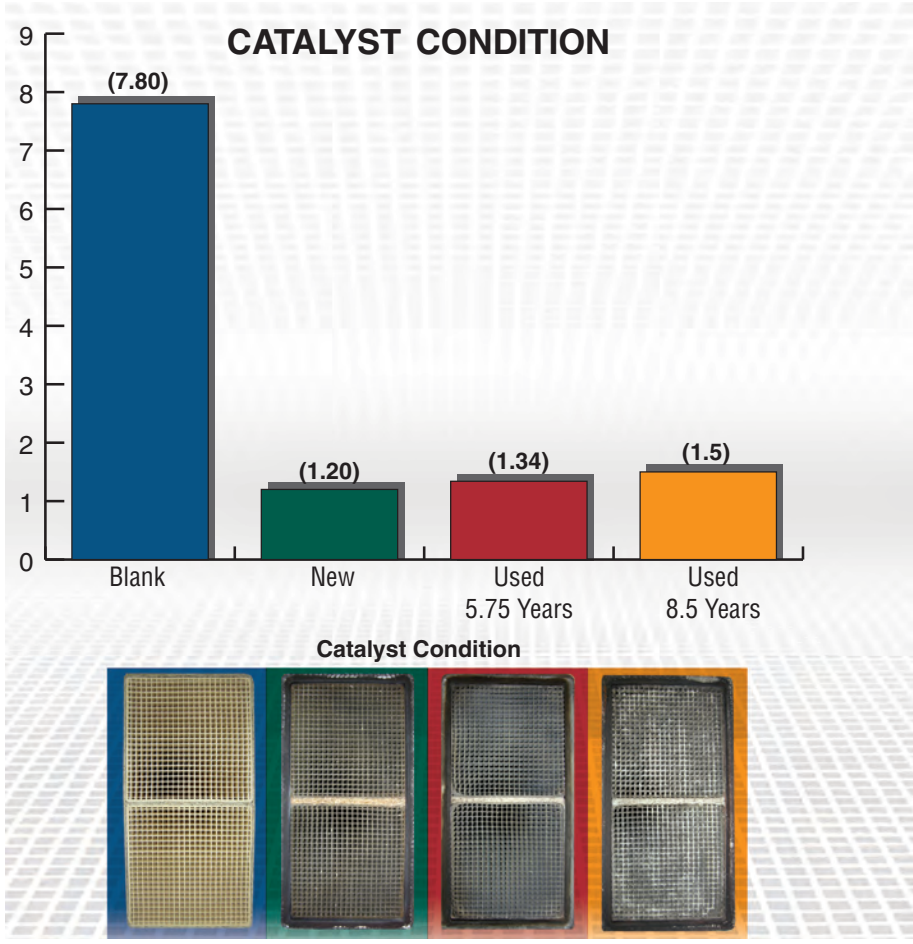
Catalyst longevity in the earliest wood heater models was believed to be short (on the order of five years) and was the basis for the EPA promulgating a lower particulate standard (4.1 g/h) for catalytic stoves compared to that for non-catalytic stoves (7.5 g/h) as part of the NSPS. The rationale for the lower catalytic stove standard was that, as the catalyst degraded with time, the emissions would increase and, on average over the lifetime of the appliance, the emissions would be similar between catalytic and non-catalytic wood stoves.

It is the contention of the Catalyst Hearth Coalition (CHC) that well-designed, modern catalytic wood stoves "protect" the catalyst from thermal stress and direct flame impingement, and that catalyst longevity is not an issue. On behalf of the CHC, OMNI Environmental Services (OMNI) measured particulate emissions from two wood stove models with used catalysts removed from residences. Only a very modest deterioration in particulate emissions was seen in the older catalysts (five-and-a-half to nine years old using two stove models) as compared to new catalysts. While limited in number, OMNI's tests suggest that catalyst degradation in a well-designed stove is not an issue.

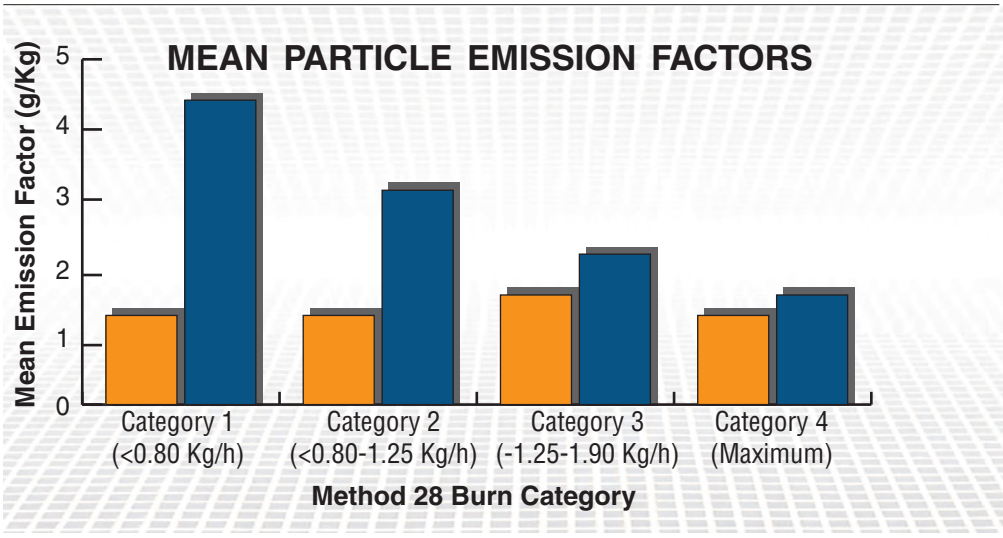
Low Burn Rate Performance

Ferguson, Andors & Company, working with the Hearth, Patio & Barbecue Association (HPBA), attempted to obtain individual burn rate and corresponding emission rate data for all currently manufactured certified wood heaters. Data for many stove models were successfully obtained. OMNI calculated emission factors (g/kg) from these data, as emission factors are a better indicator of the completeness of combustion than emission rates.

While not a definitive indicator,



Particulate emissions are nearly as low in older catalysts as new ones when used in a well-designed stove. Two to three cords per year were burned in the used catalytic stoves.



Mean particulate emission factors for certified catalytic heaters are less than for non-catalytic heaters at all burn rates. (Data after Ferguson, Andors & Company 2010 report to HPBA.) Most dramatic is the difference at low-burn rates which would be more prevalent in milder climates and at the margins (Spring and Autumn) of the heating season.

lower emission factors would tend to correlate with higher combustion efficiencies. Overall thermal efficiency is the product of combustion efficiency multiplied by thermal efficiency. Consequently, if all else were equal, stoves with lower emission factors would tend to have higher efficiencies.

As expected, the mean emission factors for catalytic stoves were lower than for non-catalytic stoves at all burn-rate categories specified by the Method 28 test procedure. Notably, the mean emission factors for catalytic stoves were much lower than for non-catalytic stoves at the lower burn-rate categories, suggesting a disproportionately better performance of catalytic stoves than non-catalytic stoves at lower burn rates.

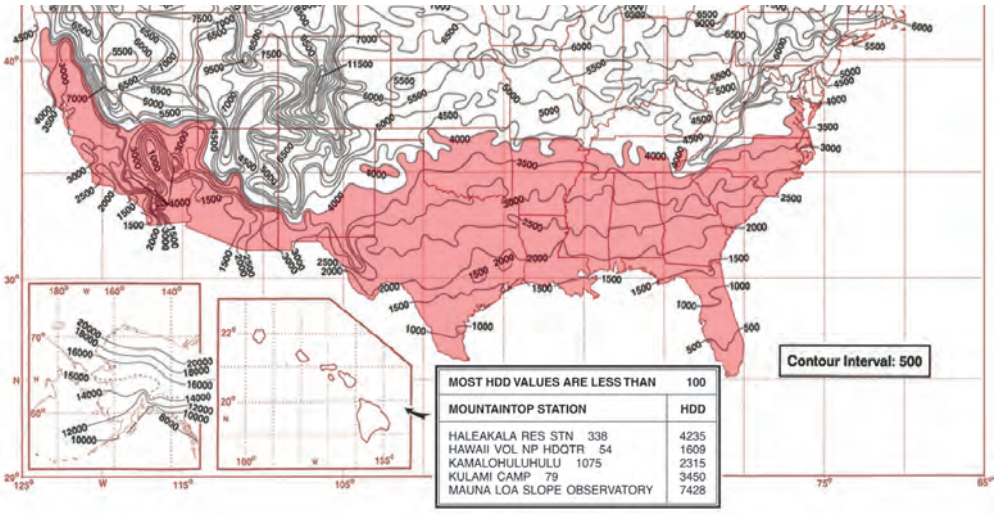
The Reality of Low Burn Rates and Cold Starts

As noted, catalytic stoves appear to operate disproportionately better at lower burn rates than non-catalytic stoves. Review of surveys conducted by the Energy Information Administration (EIA), American Housing Survey (AHS), Simmons Marketing Research and the HPBA reveals that: (1) 22 percent of housing units with occupants reporting using a wood stove are in the lowest heating degree day category (<4,000 HDD). (2) 24 to 32 percent (depending on the survey) of housing units with occupants reporting owning or using a wood stove are in the South census region. (3) 45 percent of wood stove fires are reported as occurring during non-winter months (spring, summer or fall).

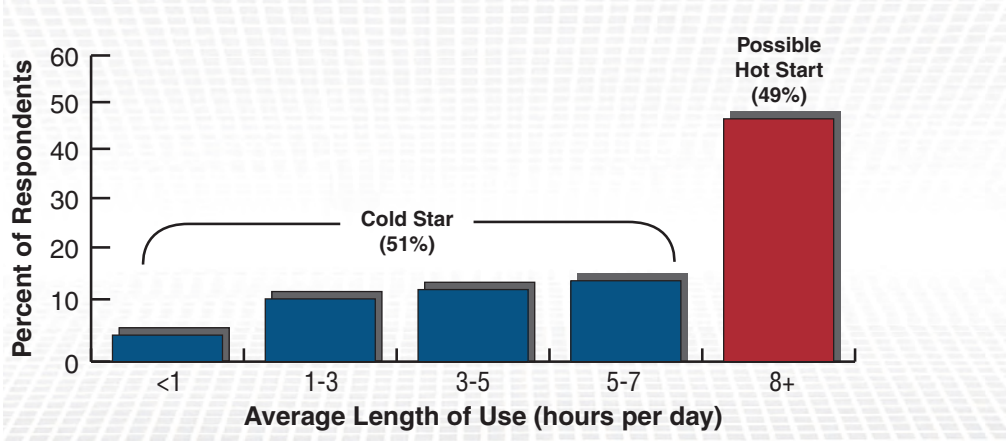
While burn rates in the lowest category are not the most common scenario, they are likely to occur a significant fraction of the time, particularly in milder climates and during the margins of the heating season. The burn rate distribution developed for the current NSPS does not take milder climates or the margins of the heating season into consideration.

It is believed that catalytic stoves achieve their emission reduction potential sooner than non-catalytic stoves after the start of a fire because only the catalyst needs to be brought up to temperature, not a large mass of metal and firebrick in the area of secondary combustion needed for emission reduction and high efficiency with a non-catalytic stove. Review of EIA and HPBA surveys reveals that, at a minimum, 42 to 51 percent of wood stove fires begin with a cold start. The current NSPS testing procedure (Method 28) uses a hot start only.

It also is believed that catalytic stoves do proportionately better with hardwoods than softwoods; hardwoods generally burn slower than softwoods as they are usually wetter, denser and have less resin. It is estimated that about 60 percent of cordwood burned in residential heaters in the U.S. is hardwoods (See *Hearth & Home*, January 2007.) The current NSPS testing procedure (Method 28) only uses a softwood (Douglas fir).



Twenty-two percent of housing units that reported using a wood heater are in a climate with less than 4,000 heating degree days (U.S. DOE). It is reasonable to expect that lower burn rates, with which catalysts perform well, are more prevalent in milder climates.



Catalysts in wood heaters reach operational temperature (approximately 550°F) within 10 to 20 minutes of start of fire in contrast to longer times needed for secondary combustion to control air emissions from non-catalytic heaters. An HPBA consumer survey showed that more than half of home wood heater events probably began with cold starts from the fact that 51 percent had an average use period of less than seven hours (plenty of time for the heater to cool down).

A U.S. Department of Energy survey also confirmed these results as it documented that 42 percent of wood heater use events were less than four hours in duration. Interestingly, EPA's wood heater certification method (Method 28) does not include cold start scenarios – only hot starts.

The Catalytic Hearth Coalition

The Catalytic Hearth Coalition (CHC) was founded in 2008 by catalytic combustor and catalytic wood heater manufacturers. The CHC platform is to promote catalytic wood heater technology, work closely with regulators and support research and development of catalytic wood heater technologies. The CHC is brand-neutral and open to the entire hearth and catalyst industries for membership. One objective of the CHC is to develop an endorsement/labeling process for members that have products that meet or exceed specific performance standards.