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Project Summary

Field Performance of Woodburning Stoves in Crested Butte During the 1991-1992 Heating Season

Dennis R. Jaasma, Curtis H. Stern, and Mark Champion

The 1991-92 field performance of 11 woodburning stoves in and around Crested Butte, CO, were evaluated. Measurements included particulate matter (PM), carbon monoxide (CO), total unburned hydrocarbons (THCs), and weekly average burn rates. The monitored stoves included EPA-certified catalytic and noncatalytic stoves. The main emphasis of this continuing study is to characterize the emissions of EPA-certified stoves as they age with normal use.

Emissions from a previously monitored Phase II (stoves certified to EPA's 1990 standard) noncatalytic stove appeared to be unchanged when variations in fuel moisture content and burn rate were taken into account. A second Phase II noncatalytic stove also performed with emissions at levels which had been observed for noncatalytic stoves in previous monitoring.

On average, the catalytic stoves had PM emission factors about 50% greater than those measured during the 1989-90 study, when most of the monitored catalytic stoves had fresh catalysts. This increase is likely due to catalyst degradation. An average emission increase of 147% was measured for two Phase I (stoves certified to EPA's 1988 standard) catalytic stoves, both of which were monitored in previous years. Two Phase II catalytic stoves, both of which were new this season, performed at the same emission level observed during the 1989-90 study of stoves with fresh catalysts.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The town of Crested Butte contracted with Virginia Polytechnic Institute and State University (VPI) for the field measurements of woodstove emissions in Crested Butte during the winters of 1988-89 and 1989-90. These measurements were intended to determine the effect of a town-wide changeover from conventional to EPA-certified woodstoves. Both particulate matter (PM) and carbon monoxide (CO) emissions were measured during these studies. The current (1991-92) study was intended to monitor the performance of Phase II stoves in Crested Butte as they age.

The previous studies created a large database of emissions from conventional and Phase I stoves, giving baseline data for comparison to Phase II models. Because some certified stoves were monitored during more than one study, the current study enables some comparisons between current performance and performance 2 or 3 years ago. Any one season of study will not tell the whole story of long-term woodstove performance. The results of this study, therefore, can best be used in comparison with results from previous and future studies.

The hardware used for the measurements is known as the "VPI sampler." This sampler has been compared to an EPA reference method for woodstove PM

(Method 5G) and has been found to be accurate.

During this study hydrocarbon emissions were measured for the first time using this sampler. Collected gas samples were pumped into Tedlar® bags and sent to VPI for analysis. Both total and nonmethane hydrocarbons were measured. Problems with sample storage procedures resulted in data which are interpreted as approximate lower estimates for volatile hydrocarbon emissions.

Summary and Conclusions

The primary thrust of the 1991-92 monitoring was quantification of degradation of emissions control performance. Degradation can be quantified by comparing results from individual stoves monitored during different heating seasons, and in this study there were three stoves (two catalytic, one noncatalytic) which can be evaluated this way. The previously monitored Phase I catalytic stoves (CAT05 and CAT07) showed respective emissions increases of 105% and 189% for PM emission factors relative to their performance two seasons ago. Structural failure (CAT07) and catalyst degradation (both stoves) are the probable causes. One noncatalytic Phase I stove (NCAT09) was monitored two seasons ago and can be compared to its previous performance. When burn rate is taken into account its performance appears unchanged from the earlier data.

Based on comparison of 1989-90 catalytic stove data obtained with fresh catalysts, there was evidence of emission degradation (or unusually poor performance for other reasons) in 67% of the catalytic stoves monitored. Most of these were Phase I stoves, and catalyst deterioration is the suspected cause in most cases.

Two Phase II noncatalytic stoves performed at about the same emission levels observed 2 years ago for Phase I noncatalytic stoves. The emissions from noncatalytic stoves are more sensitive to wood moisture and burn rate than are catalytic stoves. This sensitivity complicates the comparison of year-to-year data. After correcting for variations in these variables, the data showed no evidence of degradation.

The Phase II catalytic stove was in its first heating season. Its performance was approximately the same as that of the Phase I catalytic stoves of the 1989-90 study, where care was taken to ensure that stoves and catalysts were in good condition. However, its PM emission factor was about twice that of one of the Phase I stoves when new.

Tedlar® bags were used to store gas samples for later hydrocarbon analysis, but problems with sample integrity reduced the accuracy of the data. The total hydrocarbon emission factors for catalytic and noncatalytic stoves were estimated at 16.8 and 14.0 g/kg, respectively, using the average of two exponential sample decay calculations. Based on some highly preliminary measurements, these numbers are probably 20% low due to the adsorption of hydrocarbons by the desiccant which was part of the sample train.

The Method 25 analyses of the samples indicate that approximately 56% of the hydrocarbons were methane. This corresponds to methane emission factors of 10 and 8 g/kg for catalytic and noncatalytic stoves, respectively.

Further monitoring would help to develop a statistically sound database which can give definitive answers about stove degradation. This year's work indicates that catalyst durability is a problem. In-stove catalyst evaluations and bench tests would also be of help in future work.

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D. Jaasma, C. Stern, and M. Champion are with Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0238.
Robert C. McCrillis is the EPA Project Officer (see below).
The complete report, entitled "Field Performance of Woodburning Stoves in Crested Butte During the 1991-1992 Heating Season," (Order No. PB94-161270; Cost: $27.00; subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
Air and Energy Engineering Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

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