New York State Premium Low-Sulfur Heating Fuel Marketplace Demonstration

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Abstract

Fuel oil now used in homes in the US has an average sulfur content of about 0.25 percent. This produces sulfur oxide emissions and contributes to fouling of the heat transfer surfaces in oil powered heating equipment. The fouling from sulfate deposits decreases efficiency and increases the need for and frequency of equipment cleaning. Fuel oil with a lower sulfur content (0.05%) is available that can reduce air emissions and lower the operating costs for home oil burners.

The objective of this program is to demonstrate the advantages of reduced sulfur fuel oil through field-testing in a collaborative project between the New York State Energy Research and Development Authority (NYSERDA), Energy Research Center, Inc, Brookhaven National Laboratory, the Empire State Petroleum Association, and participating fuel oil dealers. This study will accurately evaluate actual changes in heating equipment performance with the lower sulfur fuel compared to conventional fuel oil by measuring differences in heating unit deposits, changes in stack temperature, and other measures that are applicable to this field investigation.

The expected environmental and cost benefits to New York State and the US by using lower sulfur fuel oil are substantial and will be fully evaluated and quantified during this study. Sulfur Oxide emissions in New York State can be lowered by more than **30,000 tons a year**, with an estimated "environmental cost" benefit of **$137 million a year**. New York state homeowners can lower fuel costs by approximately **$11 million a year** through improved annual efficiency. In addition, annual service costs by switching to low sulfur oil can potentially be reduced **by $65 million a year**.

New York State is the largest consumer of home heating oil in the US, and can benefit the most from a voluntary low sulfur fuel oil program. This project will demonstrate important benefits. It will also investigate potential obstacles to expanded use of low sulfur oil in homes including fuel availability, added sales tax for low sulfur oil, and equipment compatibility concerns.

Introduction/Background

In normal service, the efficiency of oil-fired boilers and furnaces degrades over time as heat exchanger surfaces become fouled. The rate of this efficiency degradation has been estimated at 2% per year. Annual cleaning of the heat exchanger is required to maintain equipment performance. The sulfur content of typical No. 2 heating fuel is about 0.25%. This sulfur contributes significantly to the process of heat exchanger fouling as will be discussed. The sulfur in any fuel results in sulfur dioxide being released into the atmosphere when it is burned. Changing to low sulfur content fuel (0.05 %) could **eliminate 80 percent** of the sulfur dioxide generated by residential oil heating systems. In volunteering to market a lower sulfur fuel, heating oil dealers can make a substantial contribution to helping preserve the clean air that we all breathe and, at the same time, providing better maintenance and service to their customers.

The mechanisms of heat exchanger fouling have been studied at Brookhaven National Laboratory (BNL) as part of the Combustion Equipment Technology program funded by the US Department of Energy. This work has included the use of uncooled fouling probes, controlled temperature test sections with cast iron and steel exposed surfaces, side-by-side four-month boiler studies, and field tests. Studies on fouling and the effects of sulfur on fouling rate have also been conducted by the CANMET Energy Technology Center (CETC) in Ottawa under sponsorship of the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE). BNL participated in the planning and monitoring of this ASHRAE study. In all tests, a dominant conclusion has been the very important role that fuel sulfur plays in the rate of fouling.

During combustion, about **99%** of the sulfur in the fuel is oxidized to **sulfur dioxide (SO_2)** and emitted from the stack. This combustion product contributes to air pollution but does not directly affect the heat exchanger. The remaining **1%** of the fuel sulfur converts to **sulfur trioxide (SO_3)** in the flame. This then reacts to form **sulfuric acid**, which condenses on any boiler or furnace surfaces below the dewpoint of the acid/water system - about 220 F. The acid reacts with iron from the wall to form iron sulfate scale on heat exchanger surfaces. *Over 50% of the mass of the fouling deposit typically removed from heat exchanger surfaces is iron sulfate scale (corrosion product).* Studies at BNL and CETC with controlled surface test sections showed a direct correlation between fuel sulfur content and the rate of heat exchanger fouling. Side-by-side boiler tests at BNL showed a dramatic reduction in the rate of fouling and efficiency decline when normal fuel was replaced by low sulfur fuel.

Currently in the U.S., heating oil for residential use has an average sulfur content of about **0.25%**. The ASTM limit for No. 2 heating oil is **0.5% sulfur** by weight. Considerably higher levels have been allowed, however, and regulations vary by state and area. Low sulfur fuel, **0.05%** by weight, is now mandated for use in highway diesel engines as an emissions control measure. There is interest in the voluntary use of such low sulfur fuels in residential heating systems to reduce boiler fouling rates, extend boiler life, and reduce air pollutant emissions.