

Firing Miniature Steam Locomotives

by Dick Thomas

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Technical Program for May 2003

Dick Thomas once again gave one of his very informative talks. This month the subject was firing miniature steam locomotives, which is part of the ongoing Boiler Series. Dick started by observing that fuels for locomotive boilers can be categorized into the following three groups:

1. Solid
 - Soft Coal
 - Hard Coal
 - Coke
 - Petroleum coke
 - Wood
2. Liquid
 - Oil
 - Gasoline
 - Alcohol
3. Gas
 - Propane
 - Butane

SOLID FUELS

In the past, coal was definitely the fuel of choice following full size practice. As a locomotive engineer at one of the rail fairs at Sacramento was overheard to say. "You ain't steam railroadin' unless you're burnin' dirt!" For model work, the gold standard for coal was the Welsh type. In the US, Pocahontas coal from the eastern states and in the west, coal from Utah and Wyoming was reputed to be good. However, Dick pointed out that one must be careful when using large geographic regions to define a coal. There can be quite large variations in coal properties for small location changes within a large coal region. Other important variables in coal firing are the boiler and firing technique. Differences in these two parameters will have one operator claim wonderful results for a given coal, while another will condemn it. Finally, only by actually firing will one know what coal works well in a particular boiler. Soft coal is fine if you like a heavy, sulfurous exhaust. Also, it tends to clinker in the firebox and needs careful cleaning and firing. Hard coal is harder to start, but burns cleaner. What railroad used Phoebe Snow to advertise how clean its passengers stayed because it used hard coal? Coke, petroleum coke, and wood have also been used as fuels, but they are not often seen today compared to soft and hard coal. Dick advised storing coal under water to prevent the loss of volatile components.

An important advantage of coal firing is the relative simplicity of the equipment needed. A grate, shovel, poker and ashpan will do it. Of course some attention to the front end will go a long way to ensure success. Once ignited, the coal bed is a very stable source of heat. The recommended starting point for grate design is a ratio of 60% air to 40% grate.

Disadvantages of coal firing include:

- Necessity for some sort of device to arrest sparks and cinders,
- Needs a starter fire bed to ignite the coal,
- Regular cleaning of fire tubes and smokebox
- Potential smoke inhalation hazard to the operator and environmental pollution
- Irregular availability and cost of good coal
- Necessity to empty ashpan regularly

LIQUID FUELS

Liquid fuel almost always implies fuel oil. Gasoline has been used and sometimes mixed with fuel oil. But since gasoline is so dangerous, it is not seen very often. Alcohol was a popular fuel for the smaller gauges, but has been supplanted today by butane.

Spraying the oil into the firebox by a steam atomizer is the most popular method of oil firing. The advantage of this system is simplicity. Another scheme is to pass the liquid oil through a regenerative vaporizing tube then controlling the resultant vapor via an orifice and needle valve. The flame is similar to that obtained with a gas burner and is very quiet. The disadvantage is the necessity of maintaining air pressure in the oil tank to force the oil through the burner. Also, there are the usual problems keeping small orifices open.

A disadvantage of fuel oil is the rather disagreeable odor that seems to permeate everything in sight forever. Continuity of ignition is another problem, and if the fire goes out, care must be taken to clear out any unburned vapor before re-igniting. Usually, the flame is arranged to impinge on some firebrick to enable automatic re-ignition. In place of an ashpan, an oil pan with refractory lining is used. Sometimes a fire arch is used to lengthen the flame path in order to get more complete combustion.

GAS FUELS

The easy availability of bottled propane and its clean burning characteristics makes it a very popular fuel. Of course, first you have to get over the realization that full sized steam locomotives were not fired with propane.

Like liquid fuel, no grate is needed and the pan is rather like that for an oil burner. The burner may consist of a number of small burners, similar to those found on hand held torches, mounted on a manifold or one or two large diameter burners. Another burner type is similar to that found on a gas range. The orifices may be holes or slots cut in a tube. The last type is usually much quieter in operation than the first two. Ignition and re-ignition is readily done.

Propane is heavier than air and therein lies its potential danger. Even though a "stinkum" additive is used help detect a leak, there remains a danger of propane pooling in a depression then igniting. This is no idle threat; hobbyists have lost their lives in a propane fire. Further, a very strict plumbing protocol must be observed to ensure a safe fuel delivery system from tender to burner. It's very important to have an emergency flow control valve to shut off the gas flow if the fuel breaks. A minor disadvantage is the potential for plugging of the fuel line with ice or the regulator freezing if the gas delivery rate is large enough to reduce the bottle temperature below the freezing point of water. The remedy is to use several smaller bottles to increase the surface area, lengthen the fuel line by adding a coil, or submerge the bottle in the feedwater.

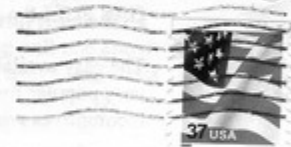
Dick concluded his talk by strongly urging boiler operators to carefully consider the following characteristics of fuel before making a decision.

- Heating Value
- Residue and Ashes
- Firing Methods
- Accessory equipment needed
- Availability
- Cost
- Safety
- Ease of an emergency shut-down
- Operator's Health Concerns
- Environmental Concerns

If possible hedge your bets by designing flexibility in the firing method in case a switch in fuels sometime in the future has to be made. As always, Dick recommended builders consult the model engineering textbooks and review the model engineering periodical literature to ensure an adequate technical background before cutting metal. Thanks to Dick for a great talk as evidenced by the many questions and discussion points raised after the presentation.

Technical Talk summary by Stephen Vitkovits

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