From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Friday, December 23, 2011 5:39 PM
Subject: RE: Everything (?) I know about Propane Firing

> Sent: Tuesday, December 20, 2011 8:51 AM
> To: Chuck Hackett
> Subject: Propane Burner etc.
>
>
> Chuck,
>
> I have built a propane burner for my Pacfic in preparation for Train
> Mountain. It is similar in style to yours. Yesterday I did a quick trial holding
> it in the vise on the workbench. There was enough heat to melt the diffuser
> on a fluorescent fixture several feet away!
>
> I am using a nozzle size #45 drill. I think I will try a smaller one. At less than
> 4 psi there was a large flame - nice and blue though. I have a small regulator
> that I had hoped to use for a control after the main regulator at the tank. So
> far that is not working but it is early days in the trial.

How is the regulator "not working"? Broken? If it's working I can't imagine how it's not working …

> Questions:
>
> What pressure do you regulate to at the tanks?

In the fuel car I regulate it down to about 25-30 psi

> Do you have a second regulator at the front of your tender or is that just
> some type of valve? Possibly a needle valve?

I have a second regulator at the front of the tender (drops pressure to 8-11 psi) before the line goes to the cab but I don't think it's really needed.

> Do you know what type of valve or regulator you have under the cab floor? I
> was very impressed with the control handle system you have in the cab
> itself. It was very convenient to operate.

Just prior to the burner there is a final 90-degree valve for controlling the fire level. This is what the "firing" valve handle on the left floor of the cab (looks like a second brake stand) is connected to.

There is also a "burner control valve" under the cab floor. This has a thermocouple connected to it and shuts off the gas if the burner and pilot light go out. This was from an old RV appliance.

> Do you know what size nozzle is in your mixer?

Lots of people ask this … I don't remember what size mine is but bottom line, pretty much any size you want, keeping in mind the following:

1) The amount of heat produced is proportional to the CFM of gas consumed.
2) Better mixing of the gas and primary air (in through the venture) improves combustion.
3) The higher the gas velocity, the better the mixing.
4) The smaller the orifice the higher the velocity of a given CFM of gas.
5) The same CFM of gas can be provided by a large orifice at a low pressure or a smaller orifice at a higher pressure (until the velocity reaches the speed of sound at which point no further increase occurs).

So, in general, you want a smaller orifice fed by a higher pressure …

… but … If the volume of gas/air mixture coming from the venture is too great for the total area of holes in the burner tubes the flame will lift from the tubes and blow out …

> Do you use an arch in the firebox? Stainless steel? Height? Etc

Yes, see: http://whitetrout.net/Chuck/844/newboiler/Part3/Part3.htm

> Any help on the above questions and other suggestions you can provide will
> be appreciated.

Below is a message I sent to Rich Kruger (and copied to Dan) back in July of 2010. It contains several emails describing various aspects of propane burners and firing. You will also find below a description of each of the three documents attached to this email.

After you digest it all (it'll take a couple of minutes ☺), let me know if you need clarification or additional info.

Regards,

Chuck

From: Bob Pappa
Sent: Friday, October 07, 2011 9:03 AM
To: cdh844@gmail.com
Subject: Loco propane burner design pdf.

Chuck:

Hopefully the travel back from the fall meet was uneventful. Was good to see you again. It's been busy since the meet, including another run out to North Dakota for some final brush clearing and perliminary survey work for the shop location.

You stated at the meet that you have a pdf of the propane burner you are using in the northern and that you could send it. I would appreciate if you could do so. Time to start preparing for TM next June.

Thanks.

Bob

From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Thursday, July 22, 2010 11:39 AM
To: 'Richard'
Cc: Dan Bissonnette
Subject: Everything (?) I know about Propane Firing

From: Richard
Sent: Sunday, July 18, 2010 7:45 PM
To: cdh844@gmail.com
Subject: Propane Burner

Propane Burners

Chuck, Dan and I will be converting our engine to propane and we are in the process of building or purchasing a burner. We have located a propane burner assembly by Jan-Eric Nystrom which will provide 54 kilowatts or 178,200 BTU's which I believe is sufficient for our engine. Each additional burner added to the assembly will increase the KW by 9. The problem is that I lack the experience to machine the parts and time is also a contributing factor.

We have located a preassembled burner from loco Parts and are considering this option. We need to add a baffle above the air intake of each burner. You have been using propane for many years and will appreciate any recommendations you have.

Rich

Hi Richard,

Below is a bunch of stuff I have sent in emails to various folks which should cover most of it.

It's a little confusing because there are multiple emails (I have separated them with double horizontal lines), each with replies within them.

This is a conglomeration of emails that I have sent to people over the years and there is a lot of duplication – sorry. I hope there are no contradictions. If you find any, please let me know.

The first 5 messages are messages from my latest conversation with Russ Kepler. They are in order with the ***oldest*** first.

After these messages there are three double-line separators in a row and then a bunch of older messages in order by date with the ***newest*** ones first.

Sorry it's not more organized. As I say in one of the emails "I really need to get this info onto my web site". Alas, all I need is time ☺

The attached documents (also mentioned in the emails) are:

- ModelTec_Article.doc – Article describing the original burner design
- Dennis Riches Drawings.doc – Drawings made by Dennis Riches when he built the burner in my Northern
- Burner Photo Document Rev. 10-07.doc – Photos I took when I rebuilt the Northern in 1999-2000

After you digest it, let me know if you have more questions.

Best Regards,

Chuck

From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Monday, January 19, 2009 12:28 PM
To: Russ Kepler
Subject: Propane Firing

Hi Russ,

(I have REALLY got to get all this stuff on my web site … yet another project!)

Below is a message (docs mentioned below are also attached to this message) I sent out some time ago to someone that was asking about my burner.

As to the plumbing on my locomotive: I draw from two standard Manchester #30 tanks simultaneously. The tanks are in the fuel car (reefer) behind the tender. In the fuel car the lines from the tanks go to two separate 90 degree shutoff valves (so I can change tanks without losing the fire) then (via propane rated rubber hose) to a manifold, to a standard acetylene regulator which takes the pressure down to about 30 psi. From there to another shut-off valve and then (via copper) to a hose w/QD fitting that connects to the back of the tender. From there it goes (via copper line) to the front of the tender to a gauge (shows pressure from the fuel car) and a second regulator (this one is an inexpensive pneumatic version that does not vent) which drops the pressure down to about 15 psi. Then to another gauge that shows the line pressure going to the locomotive. It then travels via copper and a second hose w/QD connector to a thermocouple auto-cutoff valve located under the floor of the locomotive cab.

This valve is a standard valve found on lots of propane devices, the trick is to find one small enough to fit in the space available. I don't know what it went to originally but it's more or less cylindrical in shape with the pilot button on one end. The pilot button sticks up through the cab floor. The pilot light gas tube also comes from this up to a pilot light on the burner.

As far as I know, my locomotive is the only one I've seen with a pilot light and auto-cutoff valve. As difficult as it is to find and fit, I think the valve is a good idea in case the burner goes out without notice (sudden opening of the throttle, wind when the burner is at a low setting, etc.). Not good to have propane gas floating around when a coal fired locomotive goes by …

From the cutoff valve the flow goes to a firing valve to control the level of fire. Mine is made from a 90 degree valve with the shaft extended up through the cab floor and looks like a brake stand on the left of the cab. From there the gas goes to a gauge that shows the pressure going to the burner (usually between 1 and 12 psi) and then (finally) to the burner.

When I get back to Tampa in about a week or so I can send you photos of all this.

> From: Russ Kepler
>
> Photo attached. It's Schroeder's design, and I'm told that it works
> pretty well. The burner has 54 slots of .028 width and 1/2" length for
> a total open area of .75". The orifices are currently drilled to a #60
> and can be adjusted for the best mix. I was expecting to run with a
> Goss regulator as they can run fairly high pressure, I wanted the
> pressure and small orifice to help the mixing. I have a regulator and
> torch and was playing with the idea of testing with that setup.

I don't know what you mean by "high pressure" – as I said above, I run about 1-12 psi to my (single) orifice.

Increased jet velocity will indeed promote mixing but I think you'll want a way to control the primary air flow going in where the jets are so you can adjust the mixture (keep in mind that the burner will probably act differently in open air than it does in the firebox).

The gas velocity through the slots is a tricky thing. The propane flame front has a characteristic velocity. If you exceed this velocity the flame will lift from the burner and in the worst case blow out. If the gas flow is too slow, and the slots too wide, the flame will flash back into the mixing tube – which can get exciting.

One of the challenges is to create a design that can pump as much fire as possible into the firebox and yet be turned down low and not go out. I have "drawings in my head" for a multi-section burner where sections come on as needed so I can have fairly large gas flow in on section at low fire to put the boiler on 'simmer'.

> From: Russ Kepler
>
> ….
> I also forgot to ask about regulating the air through the burner - do
> you have
> an ashpan under the burners, a grate, or is it completely open?

In the attached photos you will see that MOST of the grate area under my burner is closed off and I still net too much air through the firebox when climbing a long hill (I'll forward a message I sent to someone that discusses this).

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It turns out that a fixed airflow restriction must be a compromise and what is
really needed is a device that controls the smokebox vacuum in response to the
burner gas flow.  In an ideal case the control would turn on the blower if the
vacuum is too low (e.g.: loco not moving) and open a smokebox damper if the
vacuum is too high (a micro-controller would be good at this but I'm SURE I'd get
flack on that <vbg>).  Any smokebox vacuum in excess of that required to support
full combustion at a given burner level is only cooling the boiler.
```

- QD fittings – covered this in my last message. I'll try to remember to call Linweld and see who makes the QDs I have.
- Safety: Be sure to use thread sealer, etc. and check all joints with soapy water. You don't want ANY leaks.
- Blower: Unlike coal, you need air flow whenever the burner is lit and it's unlikely that stack 'chimney effect' will provide enough except at the very lowest settings. The worst case is when you're happily running along and you have to stop for a derailment, etc. and forget to turn on the blower. Gas still flows into the firebox but the flames have no place to go except out the bottom of the firebox and up the sides of your locomotive which is not good for your reputation as an engineer or the paint job on your locomotive (don't ask how I know this <g>). For this reason I always leave my blower on enough to support full fire (it's not a lot) even when running up a hill even though it wastes some energy (excess air flow).
- Arch: I am a firm believer in using an arch in a propane-fired locomotive. Propane is a relatively slow burning fuel. If the gasses get sucked into the flues before combustion the relatively cool flues will quench the flame before combustion is finished. This is one of the causes of people saying that the exhaust gives them a headache. See: http://whitetrout.net/Chuck/844/newboiler/Part3/Part3.htm
- Flame hitting firebox: One might think that the flame directly on the firebox walls (water legs) would be a good thing but this is another case of the flame being quenched before combustion is complete. One thing I have thought of to try is to place a band of stainless steel about 1/8" away from the firebox walls where the burner flame hits them. My thinking is that the SS would heat up to glowing red and not quench the flame and transfer its energy to the firebox by radiation. Another project for someday …
- Auto control valve: You can make a burner regulator that uses the boiler pressure to control the burner. Just set the pressure you want to maintain and have fun riding. It will keep the pressure up against the pops while running and shut down the burner when you stop. My plan is to have the current 'firing valve' connected to this regulator. At its lowest setting it would automatically keep the boiler on 'simmer' while you go to lunch, etc. Although if I was going to be away for long I wouldn't do this as it's probably dangerous (running out of water – pressure drops, burner goes up - oops, something going wrong, etc.)
- Turbulators: I want to try this someday. These are twisted ribbons of SS in the flues. They cause turbulence which slows down the gasses and allows more heat to be absorbed by the flues. Very doable on a propane locomotive – not so on a coal or even oil-fired locomotive.
- Lots of other issues but that should give you enough to chew on for awhile ☺

After this message I'm forwarding several messages to you that cover some of the same items a little more and some things I have not discussed here.

Getting a propane fired locomotive running well is a challenge and a trip down many engineering paths. Many people give up before they get satisfactory running (i.e.: "it smells bad and gives me a headache" – this is due to incomplete combustion), I consider it an engineering challenge ☺

Feel free to call me on my cell phone (402-681-5033) any time if I can help or expand on some aspect …

I really MUST get all this on a web page … oops, I think I'm repeating myself …

Best Regards,

Chuck
- - - - - - - - - - - - - -
Hi Charles,

The answer to your question can get a little complex involving things like load being pulled, speed, type of burner, burner efficiency, cylinder bore & stroke (i.e.: volume of steam per unit distance), etc.

As a starting point I can tell you that, in an average day running at Train Mountain I would probably go through about 9 pounds of propane per hour (not including firing up). This is running at various speeds pulling a total train weight of around 5,500 pounds. IIRC my cylinder bore & stroke are 2.5" x 3.5". You asked about gallons per hour but, at the retail level, propane is usually sold by the pound. Propane weighs about 4.2 pounds per gallon so 9 pounds per hour equates to about 2.1 gallons per hour.

Burner: Here the issue gets even more complicated. My Northern has what I would call a "furnace" type burner. My Northern was originally built by Dennis Riches (now deceased) and was first run in 1969. I have attached three documents to this email:

ModelTec_Article.doc – Article describing the original burner design
Dennis Riches Drawings.doc – Drawings made by Dennis Riches when he built the burner in my Northern
Burner Photo Document Rev. 10-07.doc – Photos I took when I rebuilt the Northern in 1999-2000

I have done very little in the way of modifications to the burner itself. Pressure to the burner ranges from about 1-2 psi up to a max of about 10-11 psi but this is VERY dependent on the design of the jet(s) you are using (number, total effective area, velocity, etc.). I pull gas from two standard Manchester horizontal 30 pound tanks simultaneously and I do not have trouble with them freezing.

ALL propane fired locomotives that I have seen (including mine) have too much draft. Any draft in excess of what is required to support complete combustion is anti-productive because all it's doing is cooling down the boiler. A coal fired locomotive increases steam generation when working hard up a hill because of increased draft, and thus, increased heat of the fire. A propane fired locomotive decreases steam generation when working up a hill due to increased draft which, without special dampers, etc., causes excess draft (over and above that needed to support a full fire) to pass through the boiler. This excess air flow cools the boiler.

I know that lots of people like the 'rosebud' type of burners but I much prefer the furnace type because, among other things, they let in less 'excess' draft than other types, are quieter and fill the firebox better.

There is a LOT more to discuss about running with propane but that's a start. Let me know if you have other specific questions.

Also:

1. Always be on the lookout for even the smallest propane leak
2. Never use an air regulator for propane. Only use a regulator designed for propane or acetylene (i.e.: a fuel gas). The seals on air regulators are not designed for fuel gases and many times they have vents.

Regards,

Chuck Hackett

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From: Charles D. Field III
Sent: Monday, June 30, 2008 1:24 AM
To: cdh844@gmail.com
Subject: Propane powered locomotive

Dick Morris recommended I talk to you about operating a locomotive on propane. I'm working on a Little Engines new Northern and would like to talk to you about how your locomotive runs on propane. How much gallons of fuel does it burn per hour, how long can you run the engine on 5 gallons of fuel.

Thanks for any information.

Charles D. Field III, AIA
Principal
Field Brothers Architecture, Inc.
3355 Mission Ave. #211, Oceanside, CA 92058
Office: (760) 450-1202 Fax: (760) 450-1204 Cell: (858) 243-5223

From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Monday, January 19, 2009 12:29 PM
To: Russ Kepler
Subject: Propane Firing (forwarded message 1 of 3)

> From: Jim Leggett
> Sent: Friday, March 17, 2006 12:45 PM
> To: Chuck Hackett
> Cc: Don and/or Wanda Orr
> Subject: Some locomotive and propane questions
>
> Hello Chuck (and Don),
>
> We have a loco in our club that burns propane. It is a freelanced CN
> 4-8-4 and the builder has added his own burner which is fully
> automatic. The safeties lift at 120 and 125. The burner (1 large and
> 3 secondary nozzles) throttles back to 50% at 115 and opens to full

> at 100 psi. He runs this with 42 psi at the burners to get enough of
> a flame (flamethrower more like it). To have this pressure at the
> burners he needs 85 psi in the tank, a tank from a forklift.

I don't claim to be an expert, but I'll be glad to offer thoughts from my experiences.

I've wanted to add a burner control to my engine for a long time but that project just hasn't "bubbled to the top" yet.

My plan is to have a "run" setting similar to what you describe above and a second "idle" setting which would let the boiler pressure drop down to about 40-50 psi which is enough for a reasonably fast restart on her blower. This will save fuel while I'm eating lunch, etc.

My one hesitation I have is that one must be conscious of the fact that you might get called away for an extended period of time which might, without proper planning (i.e.: boiler having enough water) cause the boiler to get low on water.

Does he have a "low water cutoff"? I've wanted to build one of these also - mostly as an engineering challenge.

His propane pressure of 42 psi seems very high to me but this depends greatly on the burner design and orifice size. It would make it all that much important to have good strong hoses where the line passes between cars. It also makes leaks more likely but that's manageable with care and good quality fittings.

Is his flame all blue or does it have a lot of yellow? If it has a lot of yellow, the burner is not running efficiently.

Also, you say "flamethrower more likely"; a large flame is not necessarily a good thing. The reason is two-fold, if the flame is contacting the firebox sides, that portion of the flame is being 'quenched' and will cease to burn causing loss of efficiency as well as cause soot to accumulate on the firebox sides. Secondly, propane is a 'slow burning' fuel - in other words it needs time to burn completely. In fact, it is still 'burning' even after it leaves the visible 'flame zone'. If the 'gas path' is too short, allowing the flame to enter the flue tubes before combustion is complete the flame is again quenched causing soot and loss of efficiency (you will get an acidic smell out the stack). For this reason, it is desirable to have an arch that runs from below the lower row of tubes almost all the way to the rear of the firebox, just below the crown sheet. Mine is shown at:

http://whitetrout.net/Chuck/844/newboiler/Part3/Part3.htm

How much propane does he go through in a day? I can run all day pulling my 12 car passenger train (almost 6,000 pounds, including locomotive) using about 40-50 pounds of propane depending on how fast I'm running and the grades involved.

I have a regulator in the fuel car that drops the tank pressure down to about 25-30 psi to the tender. On the front of the tender there is another regulator that drops the pressure to about 11-15 psi. The gas then goes to the burner control valve in the cab and then to the single venture located below the cab floor that then feeds the burner shown here (this page is incomplete because it's currently under construction):

http://whitetrout.net/Chuck/844/Burner/Images/Pic00029a.jpg

this burner burns with an almost totally blue flame.

> Sometimes he adds compressed air to the mix...

Added to the gas prior to going to the burner? I've never heard of doing this. Sounds like he doesn't have the 'primary air' mixture set correctly at the burner but not seeing the burner design, it's hard to tell.

BTW: I regularly run my tanks down to less than 5 psi in the tank ...

> He has had some problems with the tank freezing so he added a water
> bath which is heated with a steam line (5 psi) which is controlled
> automatically with a pressure switch... it is quite the locomotive!
>
> We are inexperienced with propane in our club, one other member has
> built two 0-4-0s. We don't like the idea of heating propane tanks and
> I have read about two incidents when tanks overheated and dumped
> liquid propane at other clubs.

I am DEFINITELY against any kind of heating of the tank!!!! Sure, 99% of the time it will work great but all it takes is for the steam control valve to stick open once and you have a real serious problem on your hands. This can cause the burst disk to rupture causing the release of high pressure propane gas - or worse direct release of liquid propane - which can not be shut off. Imagine if this were to happen in a station loading area ... sever injuries, possibly death ... end of club ... end of story ...

I would never do this and I would not allow this at our club. I would stay WAY away from the engine if I found myself at the same track facility.

Imagine if the engine is purchased by someone less knowing about the intricacies of the system's operation or isn't "shop smart" enough to perform the required maintenance and operational checks - an accident waiting to happen. Propane is a dangerous enough fuel without asking for trouble.

Have I been forceful enough? Probably not ... read the three paragraphs above again to be sure it sinks in ...

Another no-no that people think about is to draw liquid from the tank and run it thru a heated 'evaporator' - again, unless the evaporator is designed by NASA and human spaceflight rated I wouldn't trust it, the consequences of a .00000001% chance of failure is too great, especially when other, safer approaches work fine.

I run two 30 pound tanks in the horizontal position. These tanks are standard tanks designed and built by Manchester Tank to be used in either the vertical or horizontal position (vertical fill only). I draw gas from both tanks simultaneously. This provides enough evaporative surface area to prevent freezing except on a cold day.

These two tanks fit nicely in a reefer with enough room left over for a large car battery along with an air compressor and reservoir.

The tanks are manifolded together with valves that allow the tanks to be changed one at a time without loosing the burner or pilot light.

Another word of warning: I have seen a propane regulator freeze open due to gas being drawn so fast that droplets of liquid froze in the regulator preventing it from closing. This caused the pressure at the burner to go out of sight. Luckily the condition was noticed quickly and they were able to close the tank valve.

> I mentioned that you had a similarly sized engine and pull 14 or so
> heavy cars around TM. I also mentioned that I recalled that Don Orr's
> burners weren't the flamethrower type.
>
> I don't know if there is an arch or not but don't think so. It is a
> steel boiler with copper flues and a copper firebox. The fellow built
> the entire loco and boiler and burners himself with no plans. He
> copied most basic dimensions from another CN Northern that has since
> left our club.

See my comments on arches above ...

> She has steel tires

As does mine, only way to go in my opinion ...

>, automatic air compressor,

I have castings for two cross-compound pumps to replace the (inoperative) simplex pumps on mine - alas, no time for that project yet. When they are done I plan on having the electric compressor as backup and only come on if the main reservoir drops below a set level.

I also have two working compressor governors (patterned after the prototype) that I purchased when I was in New Zealand.

> bell ringer,

Had one on my previous engine, finicky as heck ...

> generator

I have an original Mosley (sp?) that I don't run (too valuable and it can't support all the lights I have anyway). I'll be selling it as soon as I get a decent dummy unit.

> and more. The builder is nearing 90 yrs-old ....

I hope I'm still vertical at 90 !

> .... Any advice you can share would be appreciated.

Well, you have what I can offer at the moment - it's probably worth what you paid for it :-)

Again, I would advise him to switch to a two tank system and discard the tank heater. If he is going through significantly more propane than I he should re-evaluate his burner and get its efficiency up. This will also reduce the propane flow and reduce the tendency to freeze up.

BTW: I am NOT against having a water bath and changing the water when required. I'm just against having any kind of heater.

Take care, and play safe,

Cheers,

Chuck Hackett
"Good judgment comes from experience, experience comes from bad judgment"
7.5" gauge Union Pacific Northern (4-8-4) 844
http://www.whitetrout.net/Chuck

-----Original Message-----
From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Monday, January 19, 2009 12:31 PM
To: Russ Kepler
Subject: Propane Firing (forwarded message 2 of 3)

Hi Dan,

Sorry not to have gotten back to you sooner but I've been buried here and a decent reply to you query takes a bit of time and it's been hard to get a decent chunk lately ...

Interspersed below is the short version. I'd be happy to discuss it more with you to fill in the gaps. I'm on the road this weekend but you can email me or give me a call at home (402-332-4460) some evening next week if you like.

Be warned: Contrary to what some think, it's not as easy as dropping in a burner. It takes time to get things operating at peek efficiency.

> -----Original Message-----
> Chuck
> This is Dan Bissonnette from the SCRR up in Hudson Wisconsin. Tommy Cebula
> and I are looking into the possibility of converting our heavy pacific,

> (1280) which currently burns kerosene , into a propane burner.After
> considerable conversation we need are looking for advise on the feasibility
> of this idea. Your name came up and if I may presume upon your time I was
> wondering if you could offer us a little mental assistance
>
> 1280 was originally configured as a propane burner, but the former engineers
> were never able to get it to work(see history below). Your FEF3 very well
> on propane and is a large engine , can you give us some insight into the
> design and configuration of your set up. I have looked at the Marty burner
> and a few other designs, but how do you address a couple outstanding issues.

A couple of thoughts right off the bat:

1) I'm not a fan of the "Marty" style (also called SolarFlow I think). My feeling is that it does not provide a solid 'bed' of flame and burns with significant noise due to high gas velocity ... others think differently :-)

2) Every propane engine I've seen (including mine, which I'm still working on) allows too much draft through the firebox for a propane burner. Keep in mind: At all times you only need enough draft to support complete combustion - any excess airflow is just cooling off the firebox and carrying the hot gasses out of the firebox/tubes before they have transferred their heat. The challenge is to have enough draft with the blower when stopped but not get too much draft when working hard uphill. The first thing is to close off most of the bottom of the firebox. I have heard someone say that the sum of the open area below the firebox should be about twice the throat area of the stack but this differs from engine to engine depending on stack/exhaust nozzle design.

3) The base of the burner FLAME should not be much higher than the level of the bottom of the water in the water leg. Many burners I've seem (particularly the 'Marty' style) have the flame too high which reduces the exposure of the firebox.

4) The flame should always be blue. Yellow indicates incomplete burning.

5) You MUST have the blower on when stopped - otherwise the flame will come out the bottom of the firebox and burn paint, feet, etc. Easiest is to leave the blower on all the time but, of course, this adds to excess draft while running.

> 1)Any modifications you had to make to the Fire Box

Propane is a relatively slow burning fuel. An arch is a must to make the gas/flame path as long as possible. See 'Flue Failure' on my website

http://whitetrout.net/Chuck/844/newboiler/Part3/Part3.htm

> 2) Ignition

I have an auto-igniter for the pilot light that senses the absence of flame and automatically re-lights it. I found it while browsing an appliance parts store. I think it's intended for use on RV furnaces, etc. This isn't strictly required. Properly designed, the burner should not blow out even when working hard.

My burner also has a thermocouple controlled gas valve (like a domestic hot water heater) that cuts off the main gas if the burner & pilot light go out. I think that this is a very desirable device but I haven't seen other engines with this.

> 3) How do you keep the propane from freezing

In the fuel car there are two horizontal 30-pound tanks (standard vertical/horizontal Manchester tanks) that are connected together by a manifold. Gas is drawn from both during operation. The key is to have a large tank surface area in relation to the amount of gas you're drawing off. DO NOT BE TEMPTED TO WARM/HEAT THE TANKS TO KEEP THEM FTROM FREEZING! This is VERY dangerous! An unheated water bath is ok but isn't required if you have enough tank surface area.

I go through about 9 pounds of propane per hour of running.

> 4) Boiler size and BTU generation
> 5) Manifold design

Here is a web page about my burner that I've started:

http://whitetrout.net/Chuck/844/Burner/Images/Pic00029a.jpg

The air inlets are below each burner tube.

The venturi shown on the right feeds a mixing tube that feeds the manifold mentioned that's on the left of the burner.

I don't remember the orifice size at the moment. I run a gas pressure of from 2 to 11 psi.

The object is to create a 'bed' of flame that covers as much of the bottom of the firebox as possible.

I have a drawing of the burner somewhere ...

> 6) Significant issues when you did this that we might be able to plan for

Treat propane with care and make sure that all connections are designed for fuel gas. Do not use regulators not designed for air - some have vents which is dangerous with fuel gas. The quick disconnects I used are auto-shutoff designed for use with acetylene (get at welding supply store).

Many people object to the acrid smell of propane burners. An acrid smell indicates incomplete combustion. If the exhaust smells acrid, the burner needs attention.

Well, that's the basics. Gota go pack the truck for the drive back to Omaha from our place in Tampa.

Regards,

Chuck Hackett

-----Original Message-----
From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Monday, January 19, 2009 12:31 PM
To: Russ Kepler
Subject: Propane Firing (forwarded message 3 of 3)

> From: Tim Kirby
> ....
> I'm surprised Chuck Hackett hasn't chimed in - perhaps he's on the road.

Nope, I've been catching up on some shop work (making steel inserts for six more worn out aluminum frogs).

> His
> 844 Northern has always been the premiere example of a propane burner in
> my experience. IIRC he runs with three tanks.

I draw from two standard 30# Manchester Horizontal/Vertical tanks (I think they are #1175TC shown here: http://www.mantank.com/products/steel_propane/30-40.htm (hmmm - link now appears to be broken). The two others you saw are stored in the second reefer 'till they are needed.

> A propane flame that is burning correctly should give of little or no odor
> as I understand it. If it's smelly then you're probably not burning the
> fuel properly. Inefficient and spendy =8^O

(I REALLY do have to find time to put all this on my website so I don't have to keep typing this when we discuss propane <vbg>)

My experience is that the proper air/fuel mixture AND proper firebox configuration results in very little odor.

Air/fuel mixture #1: Primary mixing, this happens where the gas jet is. The jet draws in air and the resulting mixture exits from the burner supporting a flame at that location. If the mixture is correct you'll get a blue flame, any yellow (mostly incandescent carbon) indicates incomplete combustion. If the velocity of the fuel/air mixture is faster than the "flame front velocity" (rate of burning) for the particular fuel/air ratio the flame will lift from the burner and (most likely) be blown out (like when you turn up an OX/Acet torch too high).

Air/fuel mixture #2: Secondary mixing is what happens in/around the flame after it has left the immediate area of the burner.

Propane is a relatively slow burning fuel and requires a long flame path to allow complete combustion (it's still burning even though you can't see it). If the flame encounters anything that "quenches" it below the temperature required to support combustion it will stop burning. The two major causes of this are the flame contacting the sides of the firebox and the gasses entering the flues before combustion has completed. An arch is highly recommended to lengthen the gas path to allow as much time as possible before the gasses enter the flues. The arch in my Northern (12" x 18" firebox) extends from the front flue sheet to within about 2" of the back of the firebox.

Too little secondary air (drawn into the firebox by the smokebox draft) will not support complete combustion and the exhaust will have an acrid smell due to the unburned hydrocarbons.

Too much secondary air (too much draft) will cause (at least) two things: the excess air will actually cool the boiler and the higher air velocity through the firebox and flues reduces the time that the propane has to finish its combustion process. Thus, unless special precautions are taken, a propane locomotive is at a disadvantage compared to a coal fired locomotive on a long uphill run.

When a coal fired locomotive works harder it generates more draft which makes the fire burn hotter (good when working uphill!). In a propane locomotive a given burner design can only put out so much heat (the BTU rating of the burner). If you attempt to force it too hard the flame lifts from the burner and blows out (not good on the hill <vbg>). The excess draft caused by working hard does nothing to support combustion (a given gas rate only requires a given amount of air). So, on the long hill pull the propane locomotive is actually performing worse than in a light/moderate pull because the excess draft is cooling the boiler and not allowing the propane to burn completely. The coal fired locomotive works BETTER when working harder but a propane locomotive works WORSE when working harder (not good).

Possible approaches to curing the "working uphill" draft problem:

1) Cover the bottom of the firebox and add a damper to allow adjusting of the airflow. I feel this is impractical because it would be difficult to make it self regulating and thus would be another item to distract the engineer from paying attention to the track ahead.

2) Use a larger exhaust nozzle or raise it in the stack to reduce the draft developed. This has the disadvantage of changing the "bark" of the locomotive and not being self regulating, reducing the draft at all times, not just when there would be too much draft.

3) Add a computer controlled damper ... ok, we won't go there for what I hope are obvious reasons <vbg>.

4) Add a damper in the smokebox. This is what I'm going to do to my Northern the next time I have the smokebox off the engine. This consists of a large port (maybe 2"x4" in my case) in the bottom of the smokebox covered by a light hinged "door". The door is held closed by a light spring adjusted so that the door opens when the smokebox vacuum reaches the level required to support complete combustion (2" of water in my case) at the highest burner setting. The nice thing is that (AFAICT) this method is inherently self regulating.

Now, back to freezing:

> From: Mark
>
> Fellow forklift fuel burners,

I prefer to think of it as that fuel which I can find anywhere and does not require me to brush the flues <vbg>

> Early this morning, as I was firing my LE Modern Mogul, and oiling around,
> I was shocked to find the rubber hose from my regulator frozen stiff and
> covered with frost. There was frost on the regulator, and the hose, all
> the way up to the valve at the cab to the firebox. The hose between the
> tender and Propane tank car was so stiff, I'm sure it would have snapped
> in two if I took a tight curve. I blew the whistle, shut it down, and
> stared at the thing for a long time.

Lots of bad stuff here. You do not mention frost on the tank, nor did you mention that the burner pressure was low or the tank pressure was going down due to the liquid propane becoming colder in the tank. This leads me to believe that you are drawing liquid from the tank and into the regulator where it was changing to a gas causing rapid cooling due to low thermal mass. If the evaporation was occurring in the tank (where it's supposed to) the tank would be frosting first.

Other problems with allowing liquid through the regulator:

1) The regulator can freeze (stick) causing you to loose control of the liquid/gas flow to the burner
2) If there is any moisture in the area of the tank valve it might prevent you from being able to shut off the tank (not good).
3) If liquid travels past the regulator you can get uncontrollable gas rate at the burner, possibly blowing out the burner and allowing propane gas to travel (it's heavier than air) to other flame sources in the area (locomotives, etc.) and cause really bad stuff ...

Bottom line, you need to ensure that no liquid exits the tank under any circumstances.

Other than checking to be sure that the tank is properly configured and positioned to deliver vapor in the horizontal position I can think of at least one other cause: How was the tank last filled? Does it have an OPD valve? If the tank was overfilled (more than 80% of its volume) the liquid level might have been above the "riser" which is intended to collect vapor from the high point in the tank.

> I have a horizontal, 8 gallon tank, and I've heard of mounting tanks on
> steam heated saddles, I've read about warm water baths for the tanks, and
> I've thought about an insulated jacket, with steam lines built into it, to
> wrap the tank to help keep it warm.
>
> It might even be a good idea to run a lap or two of copper steam line
> around the regulator itself, but the point of this post is to ask other

> Propane users what THEY do to address the problem of frozen components.
> Any hints, tips, suggestions or caveats out there? I sure would like to
> hear what others have done.

If you provide ANY form of heating to the tank please do not operate the locomotive anywhere near me or my family! This is VERY dangerous!

All propane tanks have a pressure relief port or burst disk. If you were to (inadvertently for sure) overheat the tank there would be an uncontrollable release of propane gas/liquid in close proximity to the open flame of the firebox. I'll leave the results to your imagination. Some in the past have suggested avoiding this by using a thermostatically controlled steam line but a failure of the mechanism would still have disastrous results. It's not worth it, and it's not needed. In addition, during the initial firing you have no steam heat ...

I can fire up my northern (the burner fills the entire 12" x 18" firebox, 14 gallons of water in the boiler) from a single 30# cylinder in the steaming bay with no trouble except that on a cold day the liquid in the tank gets cold, lowering the tank pressure and possibly the (15 psi) pressure to the burner control valve. No frost on the regulator, hoses, etc. This is another reason that I suspect you were getting liquid from the tank.

As I said to Tim K's post above, when running, I draw from two horizontal 30# tanks at the same time. This provides twice the tank surface area to absorb ambient heat ("radiate cold" if you like but it would drive thermodynamics people crazy <g>) so that the tank temp, and thus pressure, remains high enough except in the coldest weather.

My tanks are mounted in a reefer behind the tender with no floor under them which allows air to circulate and prevents propane vapors from collecting (remember, propane is heavier than air).

So, please, no heating! It IS permissible to set the tank in an UNHEATED water bath to increase the "thermal mass" but, judging from the size of your tank (8 gallons -> 40# tank?) it's large enough for your size locomotive ant I wouldn't think that you would have a big problem. (BTW: I burn about 9# of propane per hour of heavy running).

> From: Mark
> ....
> Thanks for the interesting input. Glenn's offering belongs in Wikipedia!
>
> After reading and digesting most of that, I get that:
>
> Warming the tank would be good, to mitigate the cold caused by
> evaporation, but;

I guess you know where I stand on that one <g>

> .... It would seem,

> if the problem is eliminated at the source (warm the tank), the plumbing
> will take care of itself, and would be better off left alone. Does that
> make sense?

Yup

> That 'wrapper' I mentioned was less about insulation, and more about
> physically warming the tank all around it's circumference, and THEN
> insulating, to keep the heat on the tank. I pictured something like a
> flexible clamshell jacket, with a copper or rubber coil snaking back and
> forth, through which steam would pass, thus heating the tank.

I hope I've convinced you to not go down that path ... sorry if I sound harsh on this one but I'd hate to have you make the 6 o'clock news ...

> I had the pros install the proper fittings to convert this tank into a
> horizontal mode, so that part is fine.

Have another pro check it, mistakes happen ...

> The part that ISN'T so fine is
> that I've forgotten whether the round hole in the handle is supposed to be
> up or down!

After you find out, paint "This Side Up" on the tank.

> From: Richard Finlayson
>
> A friend that visits Train Mountain saw my propane setup on my 4 3/4" OS
> Super 6 (one tank, regulator at tank, then control valve at the engine)
> and
> mentioned that a common setup for running there is to draw off of several
> (3?) tanks simultaneously. I presume the slower draw down on each tank
> allows for ambient heat to keep up with the cooling effect as the liquid
> vaporizes, while several tanks provides enough fuel to keep things fired
> nicely. ....

The more surface area you have for a given amount of gas flow (evaporation rate within the tanks) the better off you are as it allows more heat to be absorbed from the surroundings to make up for the heat consumed by the evaporation process.

Interestingly: The evaporation rate from each tank is somewhat self regulating because, if one tank is delivering more gas than the other, it gets colder, thus lowering its tank pressure, which causes more gas to flow from the other tank.

> From: Mark
> ....
> Doug: Though I wasn't able to find Ed at the Propane shop today, I have a
> sinking feeling I may have had the tank upside-down. ....

Ooops ...

> ....
> I only recently built the burner for my loco, which was originally an oil
> burner. Someone told me to install a plate, which would act as a floor to
> the firebox, and mount it with the burners sticking up through individual
> holes, letting the air mixture holes in the burners remain under the
> plate, to supply air to the burners.

Mine is a "furnace" type: with one venturi feeding a mixing tube that, in turn, feeds a manifold supplying 7 (or 9, I forget) 3/4" burner tubes running the full length of the firebox. Each burner tube has two rows of holes to support flames.

> I carefully built that plate, lit the fire and, as soon as I closed the
> firebox door, and turned up the pressure, the fire went out. Oops, not
> enough air.

I assume you had the blower on?

> I drilled a few 5/8" holes in the plate, to let in more air, and it fired
> much better, but would howl and roar when full on. Cracking the firebox
> door stopped the howl.
>
> I drilled more holes, and now it only howls on but very rare occasions.

Mine never howls. At max fire it's more like a low rumble.

There's lot more to this subject but I think that's enough for now, besides it's 3:00 AM!

Cheers,

Chuck Hackett
"Good judgment comes from experience, experience comes from bad judgment"
7.5" gauge Union Pacific Northern (4-8-4) 844 http://www.whitetrout.net/Chuck

-----Original Message-----
From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Monday, January 19, 2009 3:13 PM
To: 'Russ Kepler'
Subject: RE: Propane Firing

> From: Russ Kepler
>
> Looks like a ton of material to go through. I did a quick pass and
> have one

> question - did you ever install that automatic damper? That sounded
> pretty handy to me.

I kick myself for not thinking of the damper when I took the boiler off for the rebuild in 1999/2000 - at least I could have machined out the opening in the bottom of the smokebox. My thought is to machine a rectangular opening about 2"x4" in the bottom of the smokebox and mount a rectangular frame on the inside to accept a door opening towards the inside. By adding weight or a light spring I figure I could set it such that, if the smokebox vacuum rises above 2" of water (what my burner needs for full fire) it would start to open to maintain the vacuum at 2" of water.

> Also, I saw a pressure controlled valve for automatic boiler
> pressure in Live Steam a couple of years ago, did you see anyone have
> luck with that? I saw part of a discussion...

That may have been the one I saw also. I have drawings for one I'd be glad to scan and send your way if you like.

Alas, this project is on the "when I can get to it" list along with the damper, turbulators, and who knows how many other projects ...

Best Regards,

Chuck

-----Original Message-----
From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Friday, December 14, 2007 8:14 PM
To: 'Michael Guy'
Subject: RE: Propane burner design

> From: Michael Guy
>
> ....
> Hi Chuck,
> It is a temp conversion of my Romulus loco (now owned by a friend), the
> firebox is 7" x 7" inside. I have a price from Don Orr of $425 for him
> to make a burner using his standard nozzles, this feels like the right
> approach but I an genetically opposed to paying someone else to do what
> I know I can do!!

Here is a web site that describes how to make burners of this type:

http://www.ggls.org/MartyBurners/index.html (hmmm - link now appears broken)

I have never been a real fan of this type of burner, mostly due to:

1) Too much of the flame hits the firebox sides and hence gets "quenched" causing combustion to cease in this portion of the flame causing reduced efficiency and an "acrid" exhaust caused by the products of incomplete combustion.

2) They give off more noise than a "furnace" type burner (like mine) due to the higher gas velocities involved.

3) They are fairly high in profile and most people mount them too high in the firebox (so that they are not visible below) which causes the flame to be substantially above the mud ring reducing the firebox area directly exposed to the flame.

4) Most installations I've seen have way too much open area under the firebox causing way too much secondary air into the firebox which just cools the gas temp and lowers efficiency.

Due to #1, 2 & 3 above, I think they consume more propane (and this cause more tank freezing) than would be the case with a more efficient burner. That said, there are many people who like them.

In your case they might make more sense because you might be able to construct a burner that is easier to get in and out of the firebox.

I would put the burners in a staggered row configuration for a denser "packing" of the burners in the firebox opening.

> Romulus has a very effective Lempor exhaust and over-fire firebox air
> holes and I do expect to have to de-tune the lempor substantially.

If you don't plug the over-fire I fear you will have too much secondary airflow causing reduced flue gas temp.

For comparison, my Northern goes through about 9 pounds of propane per hour of steady running (a little over 6,000 pounds of locomotive and train).

> ....
> For legal reasons I will have to run from tanks no more than 10lb. I
> expect frosting to occur but we will have at least three tanks standing
> by and can swap them out as needed.

If you are allowed to manifold several of these tanks together you could reduce/eliminate the freezing. The idea is to have as large a tank surface area as possible for a given rate of gas draw.

> The other approach would be to use a
> fork lift truck tank as then there would be no hassles about size and it
> is horizontal to start with.

I thought you couldn't go above 10lb. for legal reasons?

Cheers,

Chuck Hackett
"Good judgment comes from experience, experience comes from bad judgment"
7.5" gauge Union Pacific Northern (4-8-4) 844 http://www.whitetrout.net/Chuck

-----Original Message-----
From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Friday, December 14, 2007 10:49 AM
To: 'Michael Guy'
Subject: RE: Propane burner design

> From: Michael Guy
> Sent: Friday, December 14, 2007 8:16 AM
> ....
> it seems to me I recall that you do use the
> three-tank propane supply, is this correct and do you have any issues
> with the tanks frosting too much?

I draw propane from two horizontal #30 tanks carried in a reefer behind the tender and I have not had any trouble with the tanks freezing. They are not in a water bath, etc. but the bottom of the car is open to allow air circulation. Keep in mind that I have a 12" x 18" firebox, one substantially smaller would get by with one #30 tank or two #20's.

I think you said that this was for a temporary conversion of a coal-fired engine? Keep in mind that a propane fire does not need near as much draft as a coal fire (and too much draft is counterproductive as it just cools the boiler). You will probably need a nozzle change.

Also remember that a propane fire always needs air. If you stop in a coal-fired locomotive the fire just goes down, in a propane fired locomotive the fire comes out the bottom of the firebox if there is no draft - and it tends to ruin paint! For this reason I always leave the blower on.

It takes a bit of time to "tune" a propane-fired locomotive so be prepared to tinker for a bit ...

What size firebox are we talking about?

Let me know if I can be of any help.

Cheers,

Chuck Hackett
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7.5" gauge Union Pacific Northern (4-8-4) 844 http://www.whitetrout.net/Chuck

-----Original Message-----
From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Tuesday, October 09, 2007 2:58 AM
To: 'Live Steam Railroading and Model Engineering'
Subject: Propane firing, more than you wanted to know (was: Frozen Propane hoses...)

> From: Tim Kirby
> ....
> I'm surprised Chuck Hackett hasn't chimed in - perhaps he's on the road.

Nope, I've been catching up on some shop work (making steel inserts for six more worn out aluminum frogs).

> His
> 844 Northern has always been the premiere example of a propane burner in
> my experience. IIRC he runs with three tanks.

I draw from two standard 30# Manchester Horizontal/Vertical tanks (I think they are #1175TC shown here: http://www.mantank.com/products/steel_propane/30-40.htm. The two others you saw are stored in the second reefer 'till they are needed.

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> as I understand it. If it's smelly then you're probably not burning the
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(I REALLY do have to find time to put all this on my website so I don't have to keep typing this when we discuss propane <vbg>)

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1) Cover the bottom of the firebox and add a damper to allow adjusting of the airflow. I feel this is impractical because it would be difficult to make it self regulating and thus would be another item to distract the engineer from paying attention to the track ahead.

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Now, back to freezing:

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> Fellow forklift fuel burners,

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require me to brush the flues <vbg>

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> covered with frost. There was frost on the regulator, and the hose, all
> the way up to the valve at the cab to the firebox. The hose between the
> tender and Propane tank car was so stiff, I'm sure it would have snapped
> in two if I took a tight curve. I blew the whistle, shut it down, and
> stared at the thing for a long time.

Lots of bad stuff here. You do not mention frost on the tank, nor did you
mention that the burner pressure was low or the tank pressure was going down due
to the liquid propane becoming colder in the tank. This leads me to believe that
you are drawing liquid from the tank and into the regulator where it was changing
to a gas causing rapid cooling due to low thermal mass. If the evaporation was
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circumstances.

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one other cause: How was the tank last filled? Does it have an OPD valve? If
the tank was overfilled (more than 80% of its volume) the liquid level might have
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> will take care of itself, and would be better off left alone. Does that

> make sense?

Yup

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> physically warming the tank all around it's circumference, and THEN
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> that I've forgotten whether the round hole in the handle is supposed to be
> up or down!

After you find out, paint "This Side Up" on the tank.

> From: Richard Finlayson
>
> A friend that visits Train Mountain saw my propane setup on my 4 3/4" OS
> Super 6 (one tank, regulator at tank, then control valve at the engine)
> and
> mentioned that a common setup for running there is to draw off of several
> (3?) tanks simultaneously. I presume the slower draw down on each tank
> allows for ambient heat to keep up with the cooling effect as the liquid
> vaporizes, while several tanks provides enough fuel to keep things fired
> nicely. ....

The more surface area you have for a given amount of gas flow (evaporation rate within the tanks) the better off you are as it allows more heat to be absorbed from the surroundings to make up for the heat consumed by the evaporation process.

Interestingly: The evaporation rate from each tank is somewhat self regulating because, if one tank is delivering more gas than the other, it gets colder, thus lowering its tank pressure, which causes more gas to flow from the other tank.

> From: Mark
> ....
> Doug: Though I wasn't able to find Ed at the Propane shop today, I have a
> sinking feeling I may have had the tank upside-down. ....

Ooops ...

> ....
> I only recently built the burner for my loco, which was originally an oil
> burner. Someone told me to install a plate, which would act as a floor to
> the firebox, and mount it with the burners sticking up through individual
> holes, letting the air mixture holes in the burners remain under the
> plate, to supply air to the burners.

Mine is a "furnace" type: with one venturi feeding a mixing tube that, in turn, feeds a manifold supplying 7 (or 9, I forget) 3/4" burner tubes running the full length of the firebox. Each burner tube has two rows of holes to support flames.

> I carefully built that plate, lit the fire and, as soon as I closed the
> firebox door, and turned up the pressure, the fire went out. Oops, not
> enough air.

I assume you had the blower on?

> I drilled a few 5/8" holes in the plate, to let in more air, and it fired
> much better, but would howl and roar when full on. Cracking the firebox
> door stopped the howl.
>
> I drilled more holes, and now it only howls on but very rare occasions.

Mine never howls. At max fire it's more like a low rumble.

There's lot more to this subject but I think that's enough for now, besides it's 3:00 AM!

Cheers,

Chuck Hackett
"Good judgment comes from experience, experience comes from bad judgment"
7.5" gauge Union Pacific Northern (4-8-4) 844 http://www.whitetrout.net/Chuck

-----Original Message-----
From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Thursday, March 08, 2007 11:59 PM
Subject: RE: [ml] Propane Heater

> From: T M Smith
>
> I am constructing a small loco and hope to fire it using liquid
> propane/gas stored in the tender.
> I am intending to use an 1/2 deep pan 2-1/4 x 2-1/2inch surface with
> the gas burning at the upper surface of a thin ceramic tile set in the
> top of the pan.

>
> I have made a test burner, 1/3 of above size which is only partially
> successful.

So we're talking 0.75" x 13/16"? That's a small burner, tricky to get a good uniform gas/air mix and uniform pressure distribution.

> The gas enters the rear face of the pan through a nozzle approx 0.050
> diam passes air holes and enters the pan drawing air in to obtain a
> mixture. The mixture then passes up through the holes in the tile to
> burn at the surface.

Is the gas orifice 0.050" or is the primary air hole 0.050" and a smaller gas orifice is injecting the gas in the center of this hole?

If the gas orifice is 0.050" this sounds huge for this size burner.

> The problem with the test burner was that the flame could only be
> maintained at one setting of the gas valve when I had hoped for a
> range of settings to give me control of the steam raised in the
> boiler.

Part of the difficulty in the design of the gas/air mixing jet is getting it to provide the ideal gas/air mixture over a range of operating pressures.

> The individual flame jets were smaller around the edges of the
> burner making control more difficult and leading to flame lift-off in
> the centre.

Can you describe the flame? Was it totally blue (near perfection), blue with white/yellow tips, or totally yellow (bad)?

I have never dealt with this type of burner but a couple of things occur to me:

- I think you need some kind of mixing tube - i.e.: the gas/air mixture is injected into one end of the tube and allowed to mix thoroughly as it travels to the other end before it enters the burner. This might account for the mixture perhaps not being uniform across the burner. To promote complete mixing within a shorter length you can insert cross bars, twisted strips, etc. within the mixing tube.

- What is the gas path within the burner box? Is it straight into the middle from the side? Is the 'rear face' you mention in the middle of the bottom face of the 'pan' and aimed at the bottom surface of the ceramic? Keep in mind that the gas/air mixture has a mass and, injected into the open 'pan' area it will tend to form high and low pressure areas within the 'pan'. Think of blowing into a box, the pressure will be higher in front of where you're blowing and lower at the sides of the gas stream you are creating. One way to investigate this is to attach small tubes in the bottom of the pan at various locations and use an inclined water manometer (more sensitive than a vertical manometer) to check pressure differences within the pan. If the inlet is in the bottom face of the pan, pointed upwards to the ceramic tile I think this explains why the flame is stronger in the center of the ceramic - where the 'stream' of gas/air is being directed.

As others have said, the flame will 'lift' from the burner surface when the gas velocity exceeds the 'flame front velocity' (speed of burn) of the gas/air mixture (fast for the ideal mixture, slower if rich). As far as I know, the only way around this is to lower the gas velocity (more 'holes' to achieve the same overall gas flow) or some kind of 'flame holder' that causes turbulence/velocity slowdown within the flame path.

> I am interested in knowing the size of bore of the gas jet, the size
> and position of the air inlet holes,

From my experience this is a matter of trial-and-error (but I'm not a combustion engineer). Keep in mind that a smaller gas orifice will produce a higher velocity gas jet at a given pressure which will 1) bring in primary air more efficiently and 2) cause more complete mixing in a shorter distance due to the turbulence created.

Many times people ask me what pressure I use to the burner (12" x 18") in my locomotive. I explain that this is not a simple answer because you can get the same amount of gas per second through a 0.010 orifice at a high pressure as you can through a 0.100" orifice at a lower pressure (assuming you don't approach the speed of sound in the smaller orifice). However, the smaller orifice will do a much better job of creating a good air/fuel mix.

For your trial-and-error make up a nozzle assembly that will allow you to screw in different size gas orifices and an 'air shutter' (ring that slides over the air holes) that will allow you to vary the air getting in.

Also keep in mind that the burner may burn very differently in the open air on the bench than it does within the confines of a firebox due to altered secondary airflow and 'quenching' of the flame (cooling of the combustion gasses below the temperature required to sustain combustion). Quenching happens when the flame contacts the firebox sides and when the gasses enter the flues. Many times this is where the 'acrid' smell comes from that many complain about with propane fired locomotives. The acrid smell is from the unburned hydrocarbons contained in the flue gasses.

> the size and disposion of the
> holes in the tile surface.

I thought you were using a ceramic tile as the burner surface? If so, you are stuck with the size and distribution of the 'holes' inherent in the ceramic you are using - or did I miss something?

A given ceramic tile surface will only support a certain maximum gas flow before the velocity exceeds the 'flame front' speed of even the ideal gas/air mixture.

Hope this is of some help - I've run propane for years and I'm still trying to improve it ...

Someone please correct me if I have some 'facts' above wrong ...

Cheers,

Chuck Hackett
"Good judgment comes from experience, experience comes from bad judgment"
7.5" gauge Union Pacific Northern (4-8-4) 844
http://www.whitetrout.net/Chuck

-----Original Message-----
From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Friday, November 10, 2006 7:29 AM
To: 'daniel bissonnette'
Cc: 'Tommy Cebulla'
Subject: RE: Propane Burner conversion

Hi Dan,

Sorry not to have gotten back to you sooner but I've been buried here and a decent reply to you query takes a bit of time and it's been hard to get a decent chunk lately ...

Interspersed below is the short version. I'd be happy to discuss it more with you to fill in the gaps. I'm on the road this weekend but you can email me or give me a call at home (402-332-4460) some evening next week if you like.

Be warned: Contrary to what some think, it's not as easy as dropping in a burner. It takes time to get things operating at peek efficiency.

> -----Original Message-----
> Chuck
> This is Dan Bissonnette from the SCRR up in Hudson Wisconsin. Tommy Cebula
> and I are looking into the possibility of converting our heavy pacific,
> (1280) which currently burns kerosene , into a propane burner.After
> considerable conversation we need are looking for advise on the feasibility
> of this idea. Your name came up and if I may presume upon your time I was
> wondering if you could offer us a little mental assistance
>
> 1280 was originally configured as a propane burner, but the former engineers
> were never able to get it to work(see history below). Your FEF3 very well
> on propane and is a large engine , can you give us some insight into the
> design and configuration of your set up. I have looked at the Marty burner
> and a few other designs, but how do you address a couple outstanding issues.

A couple of thoughts right off the bat:

1) I'm not a fan of the "Marty" style (also called SolarFlow I think). My feeling is that it does not provide a solid 'bed' of flame and burns with significant noise due to high gas velocity ... others think differently :-)

2) Every propane engine I've seen (including mine, which I'm still working on) allows too much draft through the firebox for a propane burner. Keep in mind: At all times you only need enough draft to support complete combustion - any excess airflow is just cooling off the firebox and carrying the hot gasses out of the firebox/tubes before they have transferred their heat. The challenge is to have enough draft with the blower when stopped but not get too much draft when working hard uphill. The first thing is to close off most of the bottom of the firebox. I have heard someone say that the sum of the open area below the firebox should be about twice the throat area of the stack but this differs from engine to engine depending on stack/exhaust nozzle design.

3) The base of the burner FLAME should not be much higher than the level of the bottom of the water in the water leg. Many burners I've seem (particularly the 'Marty' style) have the flame too high which reduces the exposure of the firebox.

4) The flame should always be blue. Yellow indicates incomplete burning.

5) You MUST have the blower on when stopped - otherwise the flame will come out the bottom of the firebox and burn paint, feet, etc. Easiest is to leave the blower on all the time but, of course, this adds to excess draft while running.

> 1)Any modifications you had to make to the Fire Box

Propane is a relatively slow burning fuel. An arch is a must to make the gas/flame path as long as possible. See 'Flue Failure' on my website

http://whitetrout.net/Chuck/844/newboiler/Part3/Part3.htm

> 2) Ignition

I have an auto-ignighter for the pilot light that senses the absence of flame and automatically re-lights it. I found it while browsing an appliance parts store. I think it's intended for use on RV furnaces, etc. This isn't strictly required. Properly designed, the burner should not blow out even when working hard.

My burner also has a thermocouple controlled gas valve (like a domestic hot water heater) that cuts off the main gas if the burner & pilot light go out. I think that this is a very desirable device but I haven't seen other engines with this.

> 3) How do you keep the propane from freezing

In the fuel car there are two horizontal 30-pound tanks (standard vertical/horizontal Manchester tanks) that are connected together by a manifold. Gas is drawn from both during operation. The key is to have a large tank surface area in relation to the amount of gas you're drawing off. DO NOT BE TEMPTED TO WARM/HEAT THE TANKS TO KEEP THEM FTROM FREEZING! This is VERY dangerous! An unheated water bath is ok but isn't required if you have enough tank surface area.

I go through about 9 pounds of propane per hour of running.

> 4) Boiler size and BTU generation
> 5) Manifold design

Here is a web page about my burner that I've started:

http://whitetrout.net/Chuck/844/Burner/Images/Pic00029a.jpg

The air inlets are below each burner tube.

The venturi shown on the right feeds a mixing tube that feeds the manifold mentioned that's on the left of the burner.

I don't remember the orifice size at the moment. I run a gas pressure of from 2 to 11 psi.

The object is to create a 'bed' of flame that covers as much of the bottom of the firebox as possible.

I have a drawing of the burner somewhere ...

> 6) Significant issues when you did this that we might be able to plan for

Treat propane with care and make sure that all connections are designed for fuel gas. Do not use regulators not designed for air - some have vents which is dangerous with fuel gas. The quick disconnects I used are auto-shutoff designed for use with acetylene (get at welding supply store).

Many people object to the acrid smell of propane burners. An acrid smell indicates incomplete combustion. If the exhaust smells acrid, the burner needs attention.

Well, that's the basics. Gota go pack the truck for the drive back to Omaha from our place in Tampa.

Regards,

Chuck Hackett

-----Original Message-----
From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Tuesday, September 19, 2006 8:29 PM
To: ; 'Live Steam Railroading and Model Engineering'
Subject: RE: [Livesteamers] Propane valve

> From: Christopher P Mahony

>
> Question for all propane users out there:
>
> What kind of valve do you use after the regulator but before the burner to
> control
> the flow of propane? I have a 90 degree ball valve, but would like something
> with a
> finer control.

On my Northern (7.5" gauge, 12"x18" firebox) I use a 90 degree ball valve between the gas supply and the burner.

Note: The pressure supplied to the ball valve is ~10 psi. The gas pressure is dropped from tank pressure to about 20 psi by a regulator in the fuel car. It gets dropped again at a small regulator on the front of the tender to set the 'full fire' operating pressure, usually between 10 and 13 psi depending on the type of running I'm doing.

So wide open flow is controlled by the regulator on the tender and the 90 degree valve in the cab is used to cut the flow back from that. The useful range of handle positions is much less than 90 degrees however. Someday (yea, another project I'll probably not get to <g>) I'd like to build a regulator that is controlled by a cam so that I can cut the cam profile such that it expands the useful range of handle positions but I'd still like to keep the full range to somewhere between 90 and 180 degrees.

Cheers,

Chuck Hackett
"Good judgment comes from experience, experience comes from bad judgment"
7.5" gauge Union Pacific Northern (4-8-4) 844
http://www.whitetrout.net/Chuck

-----Original Message-----
From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Tuesday, July 11, 2006 2:03 PM
To: 'Live Steam Railroading and Model Engineering'
Subject: RE: [Livesteamers] Propane 'Box' Burners

Added to my previous post:

I have been told one parameter that someone uses in burner design: the total area of the burner jets (i.e.: the holes/slots/etc. supporting the actual flame) should be about 5 times the area of the venturi throat where the gas/air mixture is formed ...

Cheers,

Chuck Hackett

"Good judgment comes from experience, experience comes from bad judgment"
7.5" gauge Union Pacific Northern (4-8-4) 844
http://www.whitetrout.net/Chuck

-----Original Message-----
From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Tuesday, July 11, 2006 2:00 PM
To: 'Live Steam Railroading and Model Engineering'
Subject: RE: [Livesteamers] Propane 'Box' Burners

> From: Wayne Davis
> ....
> Berry Solomon that you were next to in the group photo runs this type burner
> on a 3/4" and 1" gauge that I know of. He was at our Iowa club years ago
> and explained this burner to a few of us. Then a few years latter he sent
> an email to one of the 1" group at Gohoner Nebraska. I have a paper copy of
> the data on how to build this 1" scale burner I could scan, if that would
> help any.
>
> This burner worked great in the 3/4" engine I saw him run, and I didn't
> smell the un-burnt gas like you do on some propane engines.

Hi Wayne,

I know Barry and I spoke to him about his burner while I was at
TM. Unfortunately, the dimensions he used were mostly 'trial and error'.

> From: Art.Gibson
> ....
>   Sorry I can't provide the requested information,(not that smart)but
> there was a design for a similar burner although round 4-3/4 in.dia.
> included in an article by George Hill in Live Steam magazine for August
> 1977.
>   It may be possible to use some of the dimensions shown as a starting
> point for your design. If you are unable to find the article I can provide a
> copy of it to you.

Hi Art,

List member Dave Johnson emailed me a copy of an article that gives me some info
but it appears that, other than consulting a combustion engineer, what I have is
basic concepts that I'm familiar with and some other information that I will have
to use to build some test setups and just adjust things until I get the greatest
output.

I assume that "greatest output" will be reached by:

1) Burning as much propane as possible (total gas flow per minute) as completely as possible within the boiler - i.e.: eliminate quenching of the flame by contact with the firebox walls and/or flue tubes - this may require SS 'shields' between the flame and the lower firebox sides. The shields are heated to glowing read by the flame and they, in turn, radiate the heat to the lower firebox sides. As I see it at the moment "as completely as possible" requires attention to proper gas/air mixture and promoting turbulence to get a uniform gas/air mixture.

2) Getting maximum heat transfer from the flame/combustion products as possible (this mostly means maximizing radiant heat transfer). One thing that is suggested to help this is a grid of SS bars above the fire to be heated by the flame and radiate heat to the firebox.

3) Minimizing excess draft (causing boiler cooling and excess heat loss up the stack). This is challenging to do under varying running conditions (i.e.: lightly loaded and notched up - vs. - 'in the corner' and heavily loaded.

Since it's easy to machine I'd like to make the test burners out of aluminum but I'm not sure it will stand up to having an open flame just above its surface ...

To test heat output I'm currently thinking of either making a 'test boiler' that would be a box-within-a-box affair (much like a firebox inside a boiler) made from light (16 gauge?) steel that would surround the burner. This would closely duplicate a boiler environment and allow controlling draft. The 'water space' between the boxes would be filled with water but open to the atmosphere (i.e.: no pressure buildup) and one could either measure the temperature rise in the water over time or provide a steady inflow of water at a known temperature at one corner and measure the temperature of the water at an outflow affixed to the opposite corner. Knowing the temperature rise and the flow rate would give you the amount of heat being absorbed.

Another option would be to use the boiler I have for my Mason Bogie in the same manner since I'll need a burner for it anyway (and I'm not anywhere near far enough along to need it in its intended application!). This would also allow for the possibility of measuring gas temps at the flue ends which people have wondered about in the past.

I'll let you know when this goes from the 'mind engineering/napkin design' stage to the 'cutting metal' stage :-)

Cheers,

Chuck Hackett
"Good judgment comes from experience, experience comes from bad judgment"
7.5" gauge Union Pacific Northern (4-8-4) 844
http://www.whitetrout.net/Chuck

-----Original Message-----
From: Chuck Hackett [mailto:cdh844@gmail.com]

Sent: Thursday, July 07, 2005 9:23 PM
To: 'Live Steam Railroading and Model Engineering'
Subject: RE: [Livesteamers] Re: psi for a LE 0-6-0 propane burner

> From: Christopher Mahony
>
> Anybody out there know at what PSI I should have the propane set for a
> LE burner. I do have a regulator that has a gauge 0-60#s. One of the
> other members has a vertical boiler in 1 1/2" and runs that at 8 psi.

Christopher, I get asked a lot what pressure I use on my burner but there isn't one pressure that fits all. It depends on the burner design, specifically the orifice size used. I assume that there is a formula but I don't know it.

My burner has one orifice that feeds a mixing tube and then a manifold to the burner tubes in an 18" x 12" firebox. I run from 2 psi to 8 or 9 psi. If you purchased your burner(s) I'd check with the supplier or just test it yourself.

Remember, a burner sometimes acts differently in the firebox as opposed to open air. It will probably take some fiddling to get the gas pressure, primary air and secondary air adjusted for best running. Don't expect it to run great first time.

Pressure - you'll only be able to turn the gas pressure up so far before the flame is blown right off the burner. Each burner has a designed max BTU. If you attempt to exceed this flow rate the gas is traveling faster than the flame front velocity and the flame just blows off the burner.

Cheers,

Chuck Hackett
"Good judgment comes from experience, experience comes from bad judgment"
7.5" gauge Union Pacific Northern (4-8-4) 844
http://www.whitetrout.net/Chuck

-----Original Message-----
From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Tuesday, September 28, 2004 8:35 PM
To: 'Larry Simoneau'
Subject: RE: propane firing

> Oops, I didn't make it clear, I will buy smaller bits to cut
> down the orifice size.

Oh, ok, that's different :-)

> I built the burners from plans on the

> GGLS web site http://www.ggls.org/MartyBurners/ (hmmm - link now appears broken).

Oh, I thought you were using the 'Solar Flow' nozzles (which is what I think these were modeled after)

> ....
> I meant to ask you about an arch. I'll have to make one from
> stainless steel, how much space do you leave around the top and sides?

The arch is shown here:
http://www.whitetrout.net/Chuck/844/newboiler/Part3/Part3.htm

It's closely fitted to the sides and, IIRC, there is about 2" from the arch to the crown sheet.

If you haven't seen them, the full story of replacing my boiler is at:

http://www.whitetrout.net/Chuck/844/newboiler/Index.htm

... And some tests on boiler lagging:

http://www.whitetrout.net/Chuck/844/Tests/Lagging/Index.htm

Cheers,

Chuck Hackett
"Good judgment comes from experience, experience comes from bad judgment"
7.5" gauge Union Pacific Northern (4-8-4) 844
http://www.whitetrout.net/Chuck

-----Original Message-----
From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Tuesday, September 28, 2004 12:25 PM
To: 'Larry Simoneau'
Subject: RE: propane firing

> From: Larry Simoneau
>
> I'll buy some smaller drill bits and make new orifices for
> the burners. Hopefully, this will get the flame to all blue.

I have seen but never worked with the nozzles you have. You might want to first check with the supplier on recommended solutions.

I believe the yellow flame indicates that you have too little primary air flow for the gas coming from the jets. Making the orifice bigger would probably make the problem worse.

You need two sources of air:

Primary Air: This is the air that is drawn in by the flow from the orifice. This air is used to create the appropriate air/fuel mixture to support the initial flame.

Secondary Air: This is the air around the flame created by the orifice/nozzle. It's function is to support the complete combustion of the propane. Propane takes a relatively long time to totally burn.

By the way, do you have an arch? An arch is required to allow the propane to completely burn before it enters the flues and cooled to the point where combustion stops. My arch goes about 3/4 of the way to the rear of the firebox.

If your stack smells exhaust 'acidic' then there is a problem with primary/secondary air or the combustion is not being allowed to complete before getting extinguished by being cooled by the firebox walls or the flues (the arch helps this).

Be aware that the burner will act differently inside the firebox as opposed to outside in free air.

Cheers,

Chuck Hackett
"Good judgment comes from experience, experience comes from bad judgment"
7.5" gauge Union Pacific Northern (4-8-4) 844
http://www.whitetrout.net/Chuck

-----Original Message-----
From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Tuesday, September 28, 2004 10:15 AM
To: 'Larry Simoneau'
Subject: RE: propane firing

> From: Larry Simoneau
>
> Hi Chuck-
>
> If you don't mind, I'd like to ask you a few questions about
> propane firing. I know your Northern is propane fired and
> you pull quite a load with it.
>
> 1) What are you using for propane tanks? How are they
> arranged, manifolded, etc?

Hi Larry,

In my old fuel car there were three vertical #20 tanks connected directly to a rubber hose manifold. In my new fuel car (reefer) I have two horizontal #30 tanks (made by Manchester Tank www.ManchesterTank.com). Each tank is connected through a ball valve and a flexible rubber hose to a brass pipe manifold (all 1/4" fittings). The ball valve at the tank allows me to change one tank at a time without loosing the fire or pilot light.

The manifold then feeds an acetylene regulator which reduces the pressure to about 25 PSI which is then fed to the tender.

>
> 2) Have you experienced freeze-up and non-delivery of propane?

I only get frost (and reduced pressure) when it's very cold outside or the tanks are getting low. Keep in mind that I'm feeding a 12" x 18" firebox so I draw a lot of propane at full fire. The #60 of propane lasts me all day+ of running.

I would recommend NOT artificially heating a propane tank with steam/hot water from the boiler, etc. because this can cause the tank's pressure relief to open spraying raw propane - not good around a firebox!

Make sure the tank can have air circulation around it (in my reefer fuel car the bottom is open). The trick is to have enough tank surface area in relation to the rate that you're drawing propane. In your case you might be able to find a long thin horizontal tank or just manifold multiple #20 tanks together.

>
> 3) What style of propane burner are you using? Rosette,
> barbeque, etc.

More like a furnace burner. Here is a web page I'm working on (not yet finished) with a photo taken when I was rebuilding the engine. The orifice at the right feeds mixing tube that feeds the manifold on the left.

http://whitetrout.net/Chuck/844/Burner/Images/Pic00029a.jpg

>
> 4) What propane pressure are you running the system at?

I hear lots of people ask this question but it all depends on the number of orifices, their size, etc. I forget the size of my orifice. The 25 PSI propane from the fuel car is dropped to about 10 PSI by a regulator on the tender which feeds the fire control valve in the cab. This valve feeds the burner at a pressure of 1 to 9 PSI.

>
> 5) Do you run the steam blower continuously, if so, at what
> approximate pressure?

It's very important to have the blower on whenever the throttle is closed to prevent the fire from coming out the bottom of the burner and damaging paint, etc. I always run with the blower set to 10 PSI (I have a gauge on it) so that if a derailment distracts me and I close the throttle I don't have to remember to turn on the blower.

Again, the appropriate pressure for you depends on the blower characteristics. My 10 PSI supports the fire even on the high setting.

>
> Last week I converted my 1-1/2" scale Mogul to burn propane
> using the "Marty Burner" design on the GGLS website. I have
> 11 burners in the 5-3/4"
> by 8" firebox. As a first try I mounted a 20 lb barbeque
> tank on a flatcar and ran a hose forward to a control valve
> (just a ball valve) and then to the burner. The burners run
> a little rich (yellow tip flames) but I do get a lot of
> flame.

You need to get it to blue.

> On a long grade pulling four cars the burners are not
> able to keep up with steam consumption. I can make the
> grade, but I go from 120 PSI at the bottom to 80 PSI at the
> top. After a bit of running the tank develops 1/4" of frost
> around the bottom of the tank.
>
> I have also experienced the flame being sucked out of the
> burners and dying when the engine is pulling hard.

Sounds like you have too much draft. A coal fire burns hotter with more air but, on a propane fired engine, if you have more draft than what's required to support complete combustion all you're doing with the excess draft is cooling down the firebox, etc. This effect is most pronounced on hard pulls up a long grade.

You could change nozzles but this also changes her bark ..

One thing you could try is making an extension for the exhaust that moves the nozzle higher in the stack so that it produces less draft.

I have the same problem at times. My long-term solution will be to machine an opening in the bottom of the smokebox with a door held closed by a light spring such that the door opens when the smokebox vacuum reaches 2" of water which is what my burner needs.

>
> Hope I haven't overwhelmed you with questions. We really
> like the 10 minute steamup with propane

You might not want to steamup that fast as it can be hard on the boiler, tubes, etc. I can go from cold to pops in 18 minutes but I usually take about 45 minutes because I'm busy cleaning, lubing, etc. anyway ...

> and my wife really
> likes the fact that my son and I are not all dirty at the end
> of the day. I'd like to make this system work well.

I like the control it gives you over the fire and the fact that the engine is easier to clean.

If you want, you can also build an automatic burner control that keeps the pressure just below the pops at all times.

Like any firing method, it takes time to get things working at their peek.

>
> Any help would be greatly appreciated,
> Larry

Hope I filled in some of the blanks :-)

Cheers,

Chuck Hackett
"Good judgment comes from experience, experience comes from bad judgment"
7.5" gauge Union Pacific Northern (4-8-4) 844
http://www.whitetrout.net/Chuck

-----Original Message-----
From: Chuck Hackett [mailto:cdh844@gmail.com]
Sent: Sunday, February 15, 2004 2:54 PM
To: 'Live Steam Railroading and Model Engineering'
Subject: RE: [Livesteamers] propane tanks

Larry Davis wrote:

> I am converting my engine from coal to propane and have been looking
> around for just what will make the best propane tank.
> Do I want steel, or Aluminum? Horizontal or vertical? What size? Do
> I need a regulator and gage set up? Do I want a quick disconnect
> system to it? Do I want to have it removable for filling? Do I want
> it painted black to absorb heat? Should it be in water? What other
> safety concerns should I be aware of?

Warning ... long message :-)

Hi Larry,

I have run propane in two large locomotives (7.5" gauge Hudson 4-6-4 and, currently, a 4-8-4 Northern, http://www.whitetrout.net/chuck/844). Here are my observations/suggestions:

SAFETY FIRST: Like any fuel gas, propane is dangerous if proper precautions are not taken. In the case of propane, since it is heavier than air, special care must be take to not let it pool in low places (bottom of a fuel car, etc.).

While running hard I think I burn approx. 9 lbs of propane per hour (14 gallon boiler, 2.5" x 3.5" pistons).

I have two horizontal 30 gallon propane tanks which ride in cradles at each end of an open bottom boxcar with a removable top. The open bottom prevents propane from accumulating and reduces freezing. I have a second set of tanks to swap in when the first set runs out. The tanks were purchased from Manchester Tank:

http://www.manchestertank.com/

I think mine are model #1175TC.0 shown at:

http://www.manchestertank.com/products/dot_propane/30_40_gas.htm

I used to have three 20 pound tanks (BBQ style) in an old fuel car but my new fuel car was not high enough to enclose them in the vertical position. I like the 30 pound tanks in that I only have to deal with 4 tanks instead of six but the downside is that they are heavier. For me, the added cost of aluminum tanks wasn't worth the added cost but that's something you'd have to decide for yourself. Horizontal or vertical is your choice. Use whatever fits into your setup the best but only use the tank in the position it's designed for. You need vapor (unless you have a burner designed for liquid which I've never seen) and if you operate the tank in the wrong position you might get liquid. I would definitely make the tank removable so that you can swap tanks when it's empty. It's also easier to take a tank to the filling point as opposed to a piece of rolling stock. I have only been to one track with on-site propane filling facilities - St. Croix RR in Hudson, Wisconsin.

Use as large a tank as you can comfortably handle and will fit in your chosen location. No sense having to change tanks more often than needed and it will reduce freezing.

Do not paint the tanks - especially a dark color which might cause them to overheat in the sun causing the relief valve to open.

The fork lift tanks I've seen have both liquid and vapor connections on them. Be sure to use the vapor connection. Unless you can get them cheaper I don't see the advantage of a fork lift tank (and I think that they are heavier for a given capacity).

Tank gauge: My tanks have quantity gauges on them but I have not seen a quantity gauge yet that was worth a hoot, I know mine aren't. I always have full tanks handy and I drain the tanks to the last drop so I haven't found a need for the gauges. Oddly enough, in my case, the tank with the gauge (Manchester Tank) was cheaper than one from another manufacturer without a gauge! If you really want to be able to tell how much gas is in the tank purchase a cheap bathroom scale. Subtract the empty weight of the tank and you have how many pounds of gas you have remaining.

My (subjective) observation has also been that the two horizontal tanks do not freeze up as fast as the three verticals did. I'm not sure exactly why this is. It may be due to a) larger liquid surface where evaporation is taking place,

b) larger 'wetted' tank surface exposed to the surrounding air, c) my powers of observation are all screwed up and they are no better :-)

Now to plumbing details: From each tank there is an OPD coupling (tightened by hand, no wrench required) followed by a 1/4 turn valve followed by an 18" flexible hose to a brass pipe manifold fastened to the floor of the car. (note: all fittings are 1/4 pipe and all hose is propane rated). The manifold is connected to an acetylene regulator set to about 25 PSI. I draw from both tanks at the same time. The outlet from this regulator runs through another 1/4 turn valve to a hose connection at the front of the car which has an acetylene quick disconnect coupling (available at welding supply houses) to the tender. The quick disconnect is the type that shuts off when disconnected to prevent escaping gas.

The 1/4 turn valves on the tank ends of my hoses allow me to change tanks without the burner going out - a nice convenience when passengers are waiting :-)

DO NOT use regulators designed for air! Many have vent holes which can allow propane to escape. True story: My Hudson used one 30 pound tank laying down in the tender. I was at the old Northeast Ohio Livesteamers track in Copley (sp?) one year. I was sitting in the station and I heard a low 'whoosh' sound, I checked things out and all seemed ok. Awhile later I heard another low 'whoosh'. I took the top off the tender and was greeted by a 4 foot flame shooting up from near the tank valve. A four foot flame near 30 pounds of propane is NOT a good idea - and it was near the station platform too. I reached in (very close to the flame) and shut off the valve on the tank and things got back under control. I lost the hair on my forearm and suffered some minor burns but nothing too serious. What I discovered was that the previous owner had used an air regulator with a vent. The regulator (which connected directly to the tank) had frozen up and propane was gushing from the vent hole. Being heavier than air, the propane had 'flowed' down the track until it reached the locomotive firebox and then flashed back to the tank (the 'whoosh' I heard). I guess that the first time it happened it had extinguished itself. I replaced the regulator with one designed for fuel gas and had no more troubles.

I should mention here that in my new fuel car the OPD hose connector contains an 'excess flow preventer'. This consists of a spring loaded ball designed to seat and shut off the flow if the flow exceeds a certain value or if liquid were to somehow try to escape through the line. I know of at least two types. On one, the handle is green, and on the other the handle is black. The color denotes the level of flow that will cause the valve to close. I have the green ones and I think that they are the higher of the two. These excess flow preventers are a good idea in that they will shut off the flow if a hose were to break, obviously bad, or if liquid were to try to exit the tank - a bad idea to a burner not designed for it.

Safety chains: Always have safety chains between any two cars that have a propane hose between them: fuel car - tender and tender - locomotive in my case. Get in the habit of connecting the chains first before connecting the gas and disconnecting them after disconnecting the gas line.

Plumbing continued: From the connector at the rear of the tender the gas flows to another regulator at the front of the tender. There are gauges showing the pressure from the tender (so you can see that the tanks are nearly empty) and the pressure to the locomotive burner. The regulator reduces the pressure to about 10 to 12 PSI. The gas then flows from the tender to the locomotive through another set of acetylene quick disconnects. The gas then flows to a 'thermocouple' valve under the cab. This valve is like those found on gas furnaces, water heaters, etc. It supplies gas to the burner and the pilot light. The pilot light has a thermocouple that tells the valve that the pilot light is lit. The valve has a plunger that must be pressed to light the pilot light. In the event that the flame were to go out for some reason the valve shuts off all the gas (burner and pilot). The gas then flows to the firing valve on the cab floor, a gauge showing gas pressure to the burner and then to the burner.

Tanks Freezing: With my current setup I don't have problems with the tanks freezing unless they are just about out of gas or the ambient air temperature is low (but I rarely run in the winter). As Tim O. has mentioned, I too have poured hot water over the tanks on a cold day or to get the last bit of gas out. I have heard of people that have placed the tanks in a water bath with a steam heat coil or wound a steam heat coil around the tank(s). I think that this is a bad idea because of the danger of overheating the tanks and causing their pressure relief valve to open. One idea Tim and I have discussed conceptually is having the tank in a water bath with a steam coil controlled by a thermostatic valve such that it keeps the water at some set temperature. I have not found freezing to be a big problem for me even at Train Mountain running up the serpentine or running hard at places like St. Croix and Largo (Florida) pulling the public. So, if freezing is a problem for you, I'd add another tank and draw off in parallel before getting more exotic.

I can take some photos of the fuel car, etc. if they would be of use to you ...

Things I'd like to add: Someday I'd like to add a burner control valve controlled by the boiler pressure such that it turns down the burner at a given pressure. I'd like to have two set points: 1) normal running, 125 PSI boiler pressure and 2) 'idle' of about 60 PSI for times when the locomotive is sitting for awhile.

Burner: My burner is what I would call a 'furnace' type. Single venturi, manifold and multiple burner tubes (http://www.whitetrout.net/chuck/844/Burner/Images/Pic00029a.jpg). This photo is from a web page I've started but haven't finished yet.

> From: Jerry Kimberlin
>
> .... The tank valve is always on the top of the tank so
> that gas is delivered, not liquid.

It's not the valve that needs to be at the top to draw off vapor - there is a 'dip tube' from the valve that reaches to the 'top' of the tank - where 'top' here is the 'top' when the tank is in its designed operating position. My horizontal tanks have the valves and fittings on the end when it's in the horizontal position. There are others where the valve & connections are on the long side of the tank.

Sorry this was so long. I hope this wasn't more than you wanted to know! :-)

Cheers,

Chuck Hackett
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