March 2010

Plain Facts About Freezing Regulators

Although most people don't realize it, the LP-gas regulator has to do a difficult job. Many think all the regulator does is reduce a given high pressure to a given low pressure. They're right but this is just the beginning.

Your regulator must compensate immediately for any gradual or drastic changes you or the weather may make on the inlet pressure. It must also compensate immediately for gradual or drastic changes your customers make in the gas load.

Your regulator has to be able to shutoff flow completely when the load goes down. Your regulator must be gentle enough to pamper the pilot light on Mrs. Jones' stove and flexible enough to satisfy the appetite of a boiler—a turn-down that can be as high as 1000 to one.

To accomplish all this, your regulator is a finely balanced mechanism in which only those features that contribute to proper operation have been retained. One of the quickest ways to confound the regulator mechanism is the presence of water in LP-gas. And there is only one "non-freezing" regulator, the one that gets a water free diet of LP-gas.

The freezing regulator problem is eliminated by using only dry fuel and keeping the fuel water free until it passes through the regulator. Unfortunately, these desirable conditions cannot always be brought about. It is, therefore, important to know the conditions that cause freeze ups and what can be done to prevent them.

Since all the trouble begins from the presence of water in the fuel, where does the water come from? From a variety of sources: Fuel can be water saturated when received from the natural gasoline plant or refinery unless care is taken in dehydration; dry fuel may become saturated with water when transported in tank cars that previously carried wet product; hydrostatic testing may leave water in cylinders and tanks which the dry propane can pick up; empty cylinders standing in moist atmosphere with the valve open allow air to enter the cylinder where the moisture condenses and is trapped.

How much water does it take to cause freeze up problems? Table 1 gives some idea of the amount of water which liquid propane can "absorb." It doesn't seem like very much, but it doesn't take much to cause problems.

Table 1

TEMPERATURE OF THE LIQUID PROPANE	AMOUNT OF WATER IN A FULL 100 POUNDS (45,4 kg) CYLINDER	AMOUNT OF WATER IN A FULL 500 GALLON (1893 l) TANK
100°	3/4 ounce	16 1/2 ounces
32° (water freezes)	1/10 ounce	2 ounces

Note that the warmer the liquid the more water it can hold in solution. Almost eight times as much at the summertime temperature of 100 degrees as at freezing temperature! If your LP-gas comes to you in a tank car, it could be hiding three pints of water. Only a chemist could detect it. Let that propane cool to freezing temperature, however, and all but a part of the water is then free. Free to freeze up regulators.

But the water propane can carry as a liquid is hardly a drop in the bucket compared to what it can carry as a vapor. Look at Table 2.

Table 2

TEMPERATURE OF THE PROPANE VAPOR OR LIQUID	HOW MANY MORE TIMES THE WEIGHT OF WATER CAN BE CARRIED BY VAPOR THAN BY LIQUID PROPANE
100 degrees	4.2
40 degrees	8.3

It looks like the ability of propane vapor to carry water increases as things get colder. This isn't true. Table 2 means that the liquid loses its ability to hold water as things get colder faster than the vapor does. Table 3 shows how much water the vapor can hold. That goes down too, with lower temperatures.

Table 3

TEMPERATURE OF PROPANE VAPOR	AMOUNT OF WATER IN 855 CU. FT. (24,2 m^3) OF VAPOR (A 100 POUNDS (45,4 kg) CYLINDER OF LIQUID EXPANDED INTO GAS)	AMOUNT OF WATER IN 18,240 CU. FT. OF VAPOR (A 500 GAL. (1893 l) TANK OF LIQUID EXPANDED INTO GAS)
100 degrees	3 1/3 ounces	70 ounces
40 degrees	1 ounce	22 1/2 ounces

Let's look at actual operating conditions. Take a cylinder of gas, during the fall, with an outside temperature of 60 degrees. A cold spell drops the temperature to freezing, and water starts to collect in the bottom of the cylinder because neither propane liquid or vapor can "carry" the increased amount of water. It stays cold with the free water at the bottom of the cylinder. As vapor continues to be drawn off, the vapor robs the liquid propane of its water, since vapor can carry much more water than the liquid.

Mrs. Jones' stove and water heater are connected to this cylinder (through a regulator, of course). She starts cooking and Mr. Jones decides to take a bath. It's cold—about 35 degrees—and propane vapor at that temperature comes out of the cylinder to the regulator inlet at a pressure of about 57 psi (3,9 bar). The

D450146T012

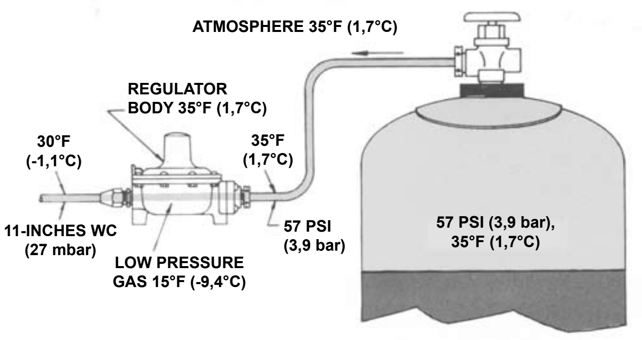

Figure 1

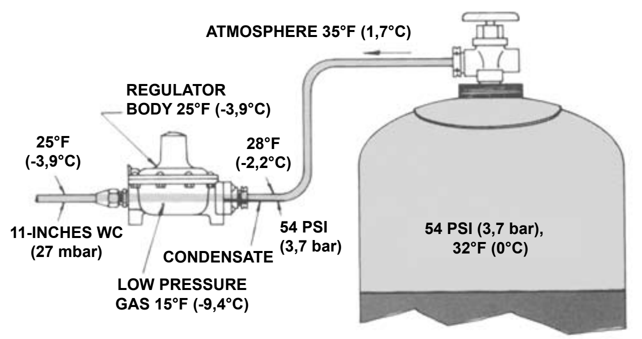

Figure 2

regulator goes to work maintaining proper appliance pressure, see Figure 1 which shows a conventional single stage regulator installed at the customer's home.

Note that the gas on the low pressure side of the regulator in Figure 1 is only 15 degrees. What has happened? It takes heat to expand the gas from its compressed volume at 57 psi (3,9 bar) to its enlarged volume at 11-inches wc (27 mbar) for the appliances. This heat comes from the surrounding air through the walls of the regulator. After the gas has left the regulator and entered the outlet tubing, it goes back up to 30 degrees. The only trouble is that the heat is where we don't need it—at the regulator outlet instead of the inlet.

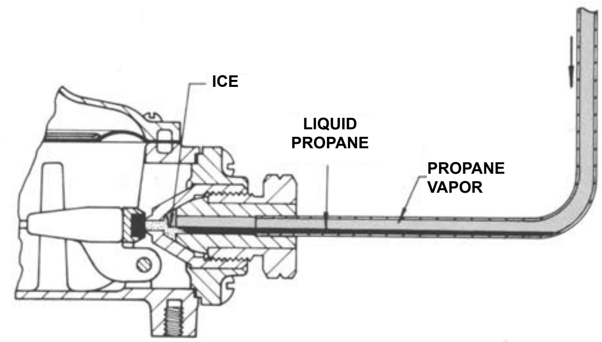

Figure 3

Figure 2 shows what can happen if the situation in Figure 1 goes on for some time. There have been slight changes in pressure and temperature within the cylinder. This always happens when vapor is drawn off, and 54 psi (3,7 bar) is plenty of pressure to do the job. But look what has taken place at the regulator inlet. The expanding gas has pulled the temperature down to 28 degrees and propane condenses at the inlet. Free water appears because we cool the vapor and reduce its ability to carry water. In Figure 2 the condensate forms just ahead of the regulator orifice.

Figure 3 shows the condensate turned to ice at the orifice. This causes a freeze up unless the action of the regulator can break the ice jam.

There are a number of things you can do to prevent this kind of situation. Number one on the list would be to make sure you're using dry LP-gas. Secondly, make certain that all tanks and cylinders are thoroughly dehydrated before they go into service.

Here are a few other hints and precautions:

1. Use methyl alcohol if you suspect water (one pint to 100 gallons (379 l) fuel).
2. Keep cylinder valves closed while cylinders are in storage.
3. Consider two stages of regulation, i.e., a first stage regulator and a second stage regulator. See Fisher's Handbook of Technical Data for more information.
4. Consider using a regulator with a larger orifice.
5. Install the regulator and pigtail so that condensate drains back to the cylinder.

The above practices should virtually eliminate freeze up complaints and the costly trouble calls that go with them.

LP-Gas Equipment

Emerson Process Management
Regulator Technologies, Inc.

USA - Headquarters
McKinney, Texas 75069-1872 USA
Telephone: 1 (800) 558-5853
Telephone: 1 (972) 548-3574

For further information visit www.fisherregulators.com/lp

EMERSON
Process Management