LPG PUMP PROBLEMS — Resistance-to-Flow In the LP-Gas Pump Discharge Line

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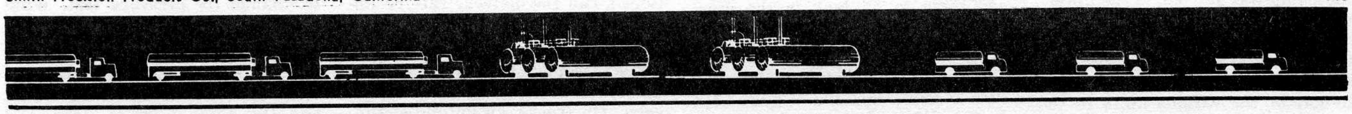

PREVIOUS articles in this series written by R. Stanley Smith, have emphasized the importance of correct design of the inlet line to the pump in obtaining the highest pumping efficiency and fastest delivery of fuel. In certain common types of installations, careful consideration of the discharge line is also highly important. Since the discharge side of the piping contains more parts subject to wear and to deterioration in service than the inlet line, more maintenance attention is required. The failure of one of these many parts is often the cause of marked reduction in speed of delivery.

This article will discuss the important portions of the discharge line, and will outline a simple test procedure whereby a defect in any part may be easily detected. Pumping installations involving meters are the most complicated. Therefore, we will discuss the trouble-shooting of a piping system with a meter designed for the usual 1000-gallon storage tank.

Figure 1 shows a bulk plant installation laid out in accordance with principles explained in previous articles. The installation shown is used in filling the fuel tanks of motor vehicles. Delivery truck piping is similar, having the same parts in the same order. However, the plan of this illustration is much easier to follow than a truck layout, where, because of lack of space, various parts are hidden behind tanks, frames, drive-shafts, etc.

QUESTION: When the pump on our truck was first installed, it did not deliver LP-Gas at its rated capacity, but it did a pretty fair job. Gradually, the pump has slowed down to the point where sometimes it will hardly pump at all. How can we tell if the pump needs repairs, or if the trouble is somewhere else in the system?

ANSWER: An LP-Gas pump moves liquid by creating a differential pressure; that is, by forming a greater pressure on its discharge side than on its inlet side. This differential pressure is necessary to overcome the resistance-to-flow due to friction in:

1. Discharge piping, valves, and fittings.
2. Meter and meter strainer assembly.
3. Meter back pressure valve.
4. Delivery hose (which is often of small size and very long).
5. Tank filler valve (these often have discharge holes as small as ¼ inch or even ⅛ inch in diameter in the case of some cylinders).

Then, after all this resistance is overcome, liquid finally reaches the tank being filled. Here, there has to be enough differential pressure left to collapse the gas in the cylinder into liquid, if the vapor return line is not used.

QUESTION: But what do differential pressure and resistance-to-flow have to do with our delivery speed? Our pump is rated at 50 gallons per minute, and we certainly are not getting that.

ANSWER: Many types of LP-Gas pumps are not rated by the manufacturer. Pumps that are rated are rated for transfer service, pumping against zero differential pressure. In other words, your pump is supposed to deliver 50 gallons per minute if perfectly installed, filling a large tank; and then, only if a large vapor hose is connected to fully equalize tank pressures, and when there is no meter or other restriction on the discharge line.

Pumps are very sensitive to differential pressure because of the extremely low viscosity of butane and propane (these liquids are one-tenth as "thin" as water). Capacities are reduced greatly as pumps are called upon to deliver fuel against higher and higher pressures.

For the units that we manufacture, we often figure roughly that a 50-gallon-per-minute pump loses about 5% (or 2½ GPM) of its capacity for every extra 10 pounds of differential pressure developed. If a 50-gallon-per-minute unit is pumping against 100 pounds differential pressure, the pump has lost 10 x 5% = 50% (25 GPM) of its capacity. This loss is in addition to other losses caused by vapor formation in the inlet lines. Many LP-Gas pumps, particularly centrifugal and turbine types, are even more sensitive to increases in differential pressure.

Maybe Pump Needs Repairs

QUESTION: That explains why we never did get 50 gallons per minute delivery from our pump even when it was new. However, it is difficult to understand what this has to do with our problem now. We have made no changes in our piping setup, and we are filling the same tanks that we always did, so apparently our resistance-to-flow and differential pressure is no greater now than it ever was. It seems to me our pump must be so worn out that it is not building up the differential pressure it used to. Do you think the pump needs repairs?

ANSWER: Yes, this may be the case. However, a surprising number of pumps are shipped to the factory each year for repairs, which, when opened, are found to be in practically new condition. The real trouble is then found to be in some other feature of the installation. Because removal of a pump, particularly from a truck, is usually difficult and expensive, other possibilities should always be checked first.

QUESTION: What are some of these other possibilities that would cause low delivery speed?

ANSWER: The bypass valve may have worn out, so that it is letting most of the liquid delivered by the pump go back to the storage tank. In addition, something may have occurred to increase the resistance-to-flow of any one or more of the five items listed above.

QUESTION: Is there any way to check these points?

ANSWER: There is, although checking involves the addition of test gages, not usually provided on older installations. Provision should be made for several ¼-inch pipe size threaded holes at different points in the pump discharge line. These may be put in when the installation is first made, or at some later time. The threaded holes are used for insertion of the pressure gages, and are shown as numbers 20, 21, 22, and 23 in Figure 1.

Since most gages now available show a tendency to vibrate and wear out, particularly if positive displacement pumps are used, it is suggested that a ¼-inch nipple be screwed into these holes, and a ¼-inch needle valve be screwed onto the other end of the nipple. If this is done, pressure gages may be inserted in the valve outlets and the valves opened. It is then unnecessary to blow down the lines before installing the gages, and, when the tests are completed, the gages may be removed and kept in a store room for future use.

QUESTION: Will you outline a test procedure for using the pressure gages?

ANSWER: *To Test Setting of Bypass Valve Spring*:

1. Insert pressure gage at 20.
2. Read and record pressure reading.
3. Start pump, leaving delivery hose valve closed, so that all liquid moved by the pump is returned to the storage tank through the bypass valve. Be sure to run the pump at its usual speed.
4. Read and record new pressure shown by gage.

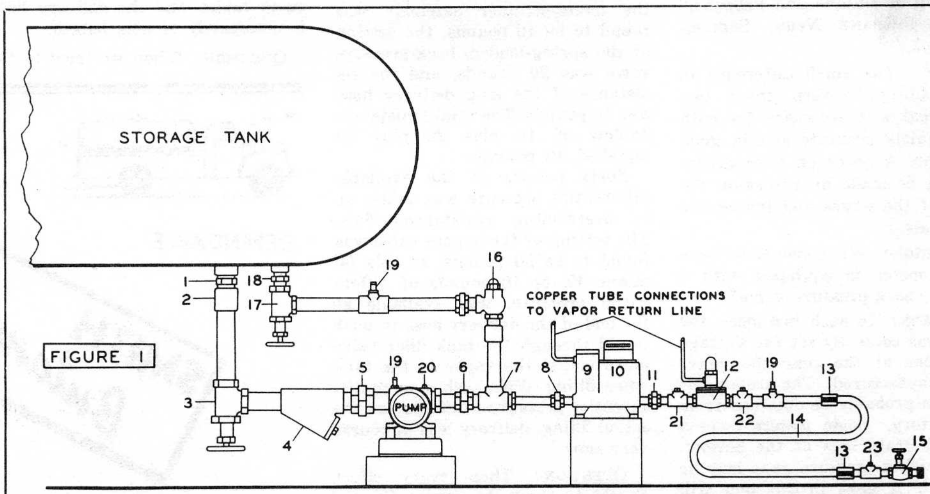

FIGURE 1 shows schematic layout of installation for filling small tanks from bulk storage or delivery truck. Liquid enters pump from storage tank through excess flow valve (1), coupling (2), angle valve (3), strainer (4), and union (5). Pump develops enough differential pressure to move liquid through union (6), tee (7), union (8), meter strainer (9), meter (10), union (11), back-pressure valve (12), hose coupling (13), hose (14), and hose valve (15). When delivery is completed and hose valve (15) (nozzle) is closed, bypass valve (16) opens and liquid output of pump is returned to storage tank through valve (17) and excess-flow valve (18). Three relief valves (19) are provided to relieve any possible hydrostatic pressure built up between closed valves when the system is not in use. It is suggested that tapped holes for the insertion of pressure gages be provided at points 20, 21, 22, and 23. The tapped hole (20) is sometimes provided in the pump housing by the manufacturer. If it is not, a hole anywhere between the pump discharge port and the meter inlet port will be satisfactory.

The difference between the pressure reading taken while the pump was running, and that taken before the pump was started, is the differential pressure developed to open the bypass valve. This difference is the maximum differential pressure available to overcome the resistance-to-flow of the various units in the pump discharge line, and thus move liquid.

To Test Setting of Meter Back-Pressure Valve Spring:

1. Insert pressure gage at 21.
2. Insert second pressure gage at 22.
3. Attach delivery hose to average sized tank, start pump, and proceed to fill the tank in the normal manner. Read and record the pressure shown by both gages.

The difference between the pressure at gage (21) and the pressure at gage (22) is the back-pressure valve setting. The diaphragm type valve, if installed with a copper tube connection leading back to the storage tank as shown in Figure 1, will give practically no restriction when filling small tanks.

Even when larger tanks are being filled, at no time should the pressure readings indicate a restriction of more than 10 pounds. If the difference in the readings of the two gages is more than this, the lock nut on the adjusting screw at the top of the valve should be loosened. Then unscrew this adjuster, one turn at a time, until the pressure tests, when repeated, show the correct 10-pound reading.

Spring - loaded, back - pressure valves, without a diaphragm, ordinarily cause considerably more restriction. Correct adjustment will be the minimum spring setting found necessary to prevent meter "spinning" when the delivery hose is first connected and the tank valve opened. For more complete details regarding the differences between the two types of back-pressure valves and their effect on metering, see the article "Accurate Metering of Butane and Propane," BUTANE-PROPANE *News*, September, 1947.

(Note: The small difference in the reading between these two gages makes it necessary for both to be fairly accurate and in good condition. A check on their accuracy can be made by reversing the order of the gages and trying the test again.)

QUESTION: What should be done if the meter is equipped with a built-in, back-pressure valve?

ANSWER: In such instances, the valve was correctly set for average conditions at the time the meter was manufactured. The proper setting can probably be obtained from the factory. Some meters have a plugged drain hole at the bottom. into which a pressure gage may be inserted. A gage in this hole will give you the pressure of the liquid before it enters the back-pressure valve, and would be substantially the same as a gage at point 21.

To Test Resistance - to - Flow of Meter and Meter Strainer Assembly:

1. Insert gage at 20.
2. Insert second gage at 21.
3. Attach delivery hose to tank, and begin to fill tank in the usual way. Read and record pressure at both gages.

The difference between the pressure at gage (20) and at gage (21) is the differential pressure necessary to move liquid through the meter assembly. If this pressure difference is greater than about 5 or 10 pounds, chances are the meter strainer is clogged with dirt. If the strainer screen is removed and found to be clean, possibly the meter may be worn, or its working parts may be clogged and require cleaning.

(Note: Again, due to the small difference between the gage readings, they should be reversed and the test repeated, as a check on gage accuracy.)

To Test Resistance - to - Flow of Hose Line:

Small diameter hoses of long length often cause considerable resistance, particularly after long periods of use.

1. Insert gage at 22.
2. Insert second gage at 23.
3. Attach hose to tank, start pump, and proceed to fill tank. Read and record pressure at each gage.

The difference in reading between gages is the differential pressure that the pump must develop to move liquid through the hose. The pressure readings will vary, depending upon the size and length of the hose, but a large reading probably indicates a defective hose lining. In such cases, installing a new hose, or, where it is practical, one of larger size, will often materially decrease the differential pressure required.

QUESTION: Suppose all these tests are made. How should their results be interpreted?

ANSWER: Let us take an actual example, wherein the resistance of the meter-strainer assembly was found to be 10 pounds, the setting of the spring-loaded, back-pressure valve was 20 pounds, and the resistance of the long delivery hose was 10 pounds. The total resistance-to-flow of 10 plus 20 plus 10 equalled 40 pounds.

Forty pounds of the available differential pressure was taken up in overcoming resistance-to-flow. The setting of the bypass valve was found to be 50 pounds, so only 50 minus 40, or 10 pounds of differential pressure, was available at the end of the delivery hose to push liquid through the tank filler valve and collapse the vapor in the tank when filling. With such a small differential pressure available for the actual filling, delivery was of course very slow.

QUESTION: Then every effort should be made to reduce the resistance-to-flow at these points?

ANSWER: That is correct. Every reduction of resistance-to-flow in the discharge line means that just that much more differential pressure is available for the actual filling of the tank.

QUESTION: After we have reduced resistance-to-flow as much as possible in these places you have mentioned, can the delivery rate be improved still further?

ANSWER: Yes, this is often very easily accomplished by increasing the spring setting of your bypass valve. On trucks, an unlimited supply of power is available to drive the pump. Truck bypass valves can be set to 70 pounds, and in some cases as high as 100 pounds. The resulting increase in the amount of differential pressure available to overcome resistance-to-flow will automatically increase the amount available at the end of the hose to fill the tank.

Some LP-Gas pumps are capable of operation at higher differential pressures than others, and the manufacturer of the unit in question should be consulted regarding the maximum differential pressure of which it is capable. Increasing the bypass valve setting may overload the electric motor in the case of bulk-plant pumps. The pump manufacturer should be consulted regarding the power consumption of the pump at various differential pressures.

QUESTION: Does not an increase in the bypass valve pressure setting cause excessive wear, necessitating frequent replacement?

ANSWER: An increase in the differential pressure will, of course, cause faster wear in the pump. In some instances, the best compromise between pump wear and a fast filling rate is a bypass valve setting of 50 pounds. However, considerable improvement has been made recently in the design and construction of LP-Gas pumps. Many dealers are now finding that in certain cases the savings resulting from speeding delivery are a great deal more than the cost of pump repairs. Particularly, a fairly high bypass valve setting is economical for delivery trucks where stops are not far apart, deliveries are mostly to small tanks, and the delivery hose is necessarily of long length.

QUESTION: When we tried to increase our bypass valve setting, we turned the adjusting screw down to the bottom, but this did not seem to change its pressure test. What is the trouble?

ANSWER: In discussing this question, it will be assumed that the strainer between the tank outlet and the pump inlet is clean, and that no trouble is being experienced with *pump starvation.* The bypass valve should be taken apart, and the valve and its seat should be checked for wear. When no wear is present, you probably need a heavier spring which can be obtained from the manufacturer of the bypass valve.

QUESTION: Can you explain why connecting the vapor return hose does not seem to speed up delivery when filling small tanks?

ANSWER: If your vapor hose is of a fairly large size and in good condition, the explanation might be that this connection only equalizes the pressures in the tanks by allowing the return of gas from the tank being filled. The pump still has to build up differential pressure to overcome every resistance-to-flow except the amount required to collapse the gas in the small tank to liquid. Particularly when straight butane is being handled, this part of the differential pressure absorbed is quite small compared to all the others.

QUESTION: Is it possible to determine the resistance-to-flow in some easier manner than you have outlined, perhaps by the use of only one pressure gage in one place, or by using none at all?

ANSWER: There appears to be no other way of checking the individual resistance-to-flow of each part of the installation. It is important that we get the separate pressure for each component part, because only then can we tell what is really going on. Without provision for making tests such as have been described, we have no definite information to work on. The time spent in providing for these tests and making them periodically will be well repaid by speeding delivery.