UNLOADING RAILROAD TANK CARS WITH LIQUID PUMPS: PART 2

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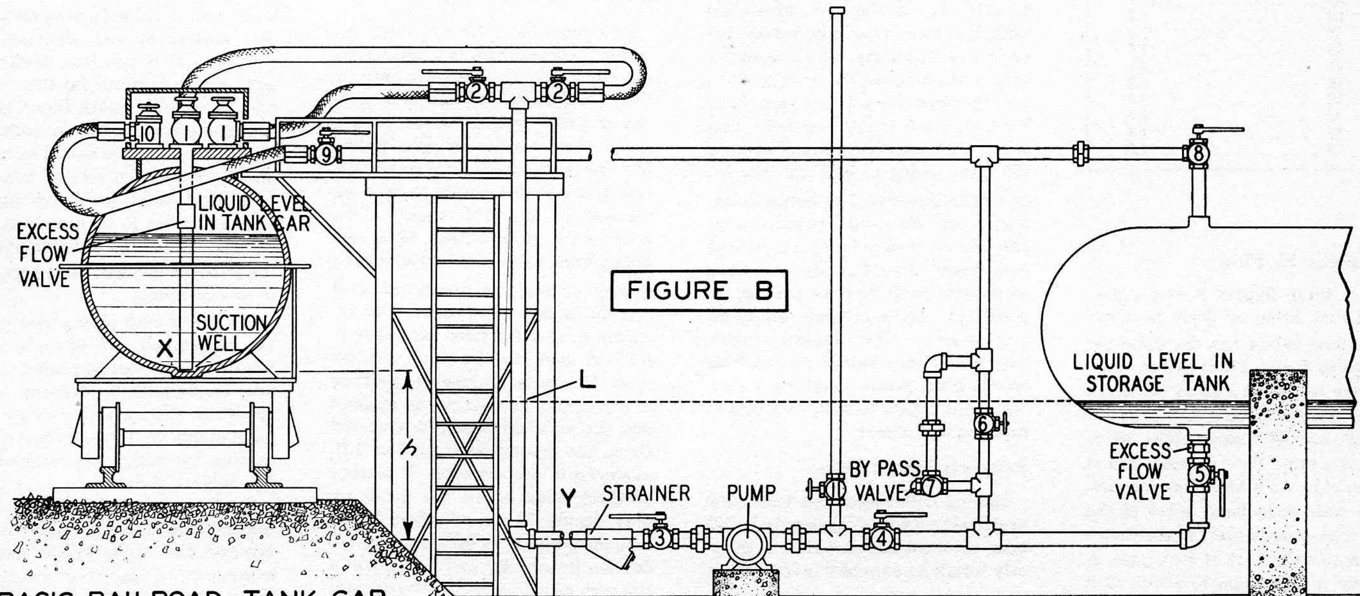

BASIC RAILROAD TANK CAR UNLOADING SYSTEM

FOR satisfactory pump operation, LPG liquid has to be brought up to the pump inlet by gravity head. LPG pumps will not efficiently bring liquids to their inlets by suction, because any pressure reduction in the inlet line will result in the formation of a large volume of vapor. Such vapor will displace an equal volume of liquid, and reduce the pump's capacity to deliver. There has to be enough gravity head in the tank being unloaded to move a flow of liquid equal to the pump's capacity through all of the restrictions, small passageways, holes, and turns in all the valves and fittings in the inlet line.

100-gpm Pump

Since the 100-gal.-per-minute pump is the model most commonly desired for unloading tank cars, let us discuss the piping system necessary for this size. The 100-gpm pump, *properly installed,* will unload all of the liquid in an LPG tank car in less than two hours. Notice we emphasize *properly installed.* If there are too many valves and fittings in the pump inlet line, and not enough gravity head to overcome their restrictions, large quantities of vapor will be formed, and it may take twice as long to unload a tank car.

Let's make a list of the valves and fittings in the inlet line, as a basis for further discussion. Referring to the accompanying illustration, and working from the pump back to the car, we have first, hand valve (3); then the strainer; then an elbow; then a tee; then two valves (2) running to two hoses, and two valves (1) in the tank car dome. Is this a complete list of all the fittings? Most of us would say it was, but we have actually failed to list the most important item, the one having by far the most resistance to flow. We have forgotten this because we have never seen it, and most of us have no idea what it looks like. This is the tank car excess-flow valve, one of which is installed in each liquid dip-tube within the car, in the approximate position shown on the drawing.

Data Hard to Obtain

It is difficult to get data on tank car excess-flow valves. They are not manufactured by the people who make the excess-flow valves that we find in our own tanks, such as Bastian-Blessing, Kerotest, Roney, Selwyn-Pacific, etc. None of the catalogs that we usually have in our offices show these valves, so we have no information on them. Tank car excess-flow valves are manufactured by suppliers of railroad items, such as the American Car and Foundry Co. (There may be other railroad companies that make this item, but we have been unable to find them.) However, we have secured the two sizes made by this company, and have carefully tested them to obtain resistance-to-flow data. There is a 2-in. size, No. 1402, and a 2½-in., No. 1401. Actually, these two valves are the same inside; they are merely threaded to take different pipe sizes. The test data on these valves ran as shown in Table 1.

TABLE 1.

TEST DATA ON TANK CAR EXCESS-FLOW VALVES

Flow Rate, GPM	Pressure-Drop (Resistance-to-Flow) In Feet of Propane
67	Valve Closes
65	11.7
60	9.7
55	7.8
50	5.8
45	4.9
40	3.9
35	2.7
30	1.9
25	1.5
20	1.0

Resistance to Flow

From these figures it was determined that either of these tank car excess-flow valves has the same resistance to flow as 970 ft of 3-in. pipe. In other words, it takes as much gravity head to force a flow of liquid through one of these valves, as to force the same flow through 970 ft of 3-in. pipe. As a basis for comparison, a wide-open hand valve of the angle type is equivalent in resistance to flow to only 40 ft of 3-in. pipe. A strainer is also equal to about 40 ft of pipe. Elbows represent only 8 ft of pipe. Thus we see that the tank car excess-flow valves are by far the greatest restrictions-to-flow in the entire pump inlet line. Further, they undoubtedly have more resistance than all the other valves and fittings combined. Remember, too, that we have a measure of control over our other valves and fittings. We can lower their restrictions any amount we wish, by choosing full-flow valves like the gate, plug, and ball types, which have practically no resistance, or by choosing to use valves, strainers, and fittings of larger sizes. But, we can't do anything about the excess-flow valves, as these come with the car and we are stuck with them. Thus, regardless of anything we may wish to do, *the rate of flow of LPG to the pump, and hence the pump's own delivery rate, will be largely governed by these excess-flow valves.*

Excess-flow Valves Touchy

Referring back to Table 1, we note that the valves we tested closed at a flow rate of 67 gpm. This means that it is absolutely impossible to draw more than 67 gpm out of one tank car dip tube. Since most cars have two liquid tubes, as shown in our illustration, each with an excess-flow valve, the two can be teed together to attain a maximum theoretical flow of twice 67, or 134 gpm. However, tank car excess-flow valves are known to be touchy. Light pressure surges often cause them to close at average flow rates lower than this. We are sure that the best unloading speed that can be counted upon is 100 gpm, which is 6000 gal. per hr, or a little less than two hours to unload a car. We would question anyone who claimed to be able to unload cars faster than this, as unloading equipment with faster speeds, regardless of make or type, would almost surely cause frequent trouble with excess-flow valves closing. This would often waste more time than one could expect to save with higher capacity equipment.

Properly Install Pump

Having determined the maximum practical unloading capacity to be 100 gpm, we must next see how to properly install a pump of this size rating. With a total flow of 100 gpm, we know that each excess-flow valve will be handling 50 gpm, and reference to Table 1 shows that at this rate the resistance-to-flow across the valve is 5.8-ft of propane. This means that for good pumping efficiency, the pump must be mounted at least 6 ft below the level of the bottom of the tank on the railway car. This is most important, so let us review it carefully to be sure it is well understood. *For good operation with a 100 gpm liquid pump unloading railroad tank cars, the pump should be mounted at least 6 ft below the level of the bottom of the car.*

In other words, the distance (h) on the drawing should be 6 ft or more.

Since this difference in level is about twice as great as most of us would at first think necessary, we should point out that if the tank car is 3 ft lower, we would lose about 10% of capacity with propane, 50% capacity with straight butane, and 25 to 30% capacity with an LPG mix, depending on the temperature of the day. This percentage reduction in pump capacity represents the amount of vapor formed in the pump inlet line by liquid *starvation*, caused by not having enough gravity "head" to overcome the resistance to flow in the excess-flow valves.

Level of Ground

How can we get this 6 ft difference in level? Some might suggest mounting the pump in a shallow pit, but this could be hazardous because of the gas that would collect there if leaks ever developed. We believe that the most satisfactory way to obtain this 6-ft distance is to take advantage of any differences in the level of the ground itself. With new bulk plants, we advocate that slightly sloping ground be purchased, and that the layout of equipment be arranged so that the tank car siding is at a high spot, and the pump at a low spot. If this is impossible, perhaps it is not too impractical to suggest that the tank car siding be elevated above the ground level by 2 to 3 ft, as shown in our drawing. If neither of these ideas seems too good, we may decide, if we are handling straight propane, to take the 10% reduction in capacity and figure that a 100-gpm pump handling 90 gpm will probably be good enough. The 10 gpm of vapor running through the pump will not be enough to harm it. But, if we are handling LPG mix, or butane, we cannot put up with a 25 to 50% loss in efficiency since this is enough to cause a dry running condition, resulting in vapor lock problems and excessive pump wear. In such a case we would either have to go to a compressor to do this job, or use a smaller capacity pump, say a 50-gpm model.

Pump Much Cheaper

Checking prices, you will find the pump much cheaper in first cost and upkeep. Further, since the 50-gpm pump would draw only 25 gpm from each excess-flow valve, we find from Table 1 that only 1½ ft of head (h) is needed to overcome the resistance-to-flow. This is easy to arrange. Of course, a large compressor would unload at a faster rate. However, a 50-gpm pump would do the job in a little over three hours and it is difficult for us to see the importance of great speed except in very large bulk plants handling several cars a day at peak periods.

We have heard the argument advanced that the pump is used for loading delivery trucks, filling cylinders, etc. during the day, and it isn't good to be without it for over three hours while it is unloading tank cars. The answer to this problem is, of course, that if you are thinking of getting a compressor for this reason, you should also think about getting a second pump for the unloading operation. You would be money ahead to install a second pump instead, and could, by specifying both of your pumps to be the same, have the advantage of duplication of working parts, which can be of great help in an emergency.

There are trick piping layouts that can be worked out, whereby liquid from tank cars can be loaded to storage, or, directly to delivery trucks, cylinders, etc., all with a single bulk-plant pump. We have reprints of such layouts available upon request, but we believe it is better to separate unloading and delivery systems in the interest of simplification of piping and freedom from complete breakdown in case of an emergency. Those who have two pumps in their bulk plants have never been sorry.

Summary

We would sum up what has been said in this discussion as follows:

(1) Tank car excess-flow valves control your unloading speed. Due to the design of these parts, a delivery rate of 100 gpm is the best you should ever expect in this operation, regardless of the type, size, or capacity of your unloading equipment.

(2) To attain an unloading speed of 100 gpm with a liquid pump, the level of the bottom of the tank on the railroad car should be 6 ft above pump level.

(3) In the case of straight propane only, differences in level as low as 3 ft can be used. However, with LPG mix or butane, levels smaller than 6 ft will result in excessive starvation if a 100-gpm pump is used. In such cases, the 50-gpm pump should be specified. ■

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