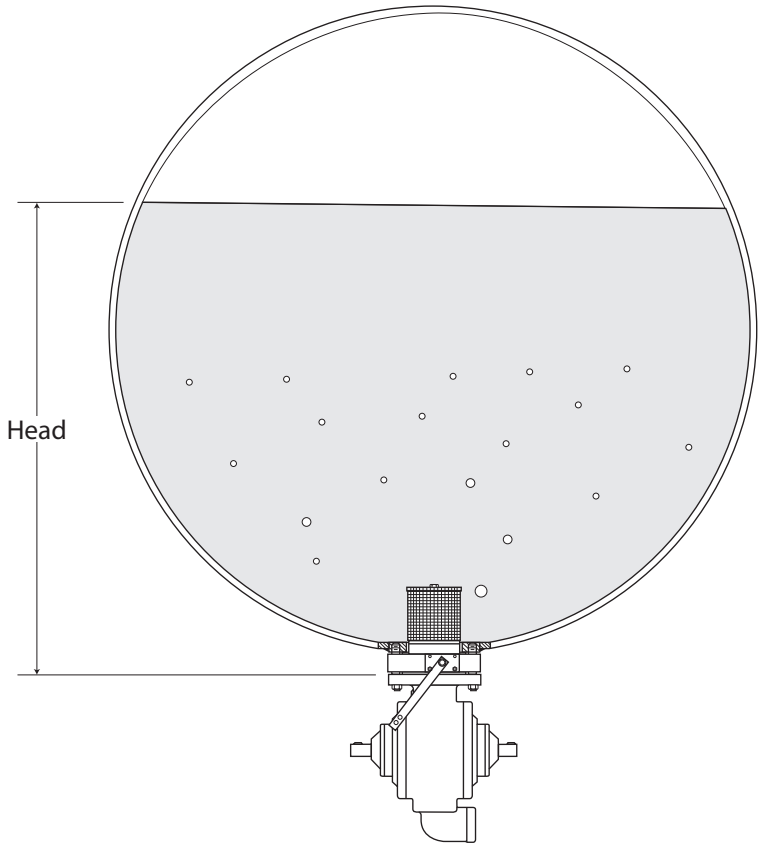
Bobtail Pressure Drop

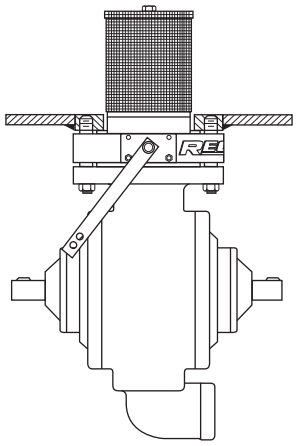


LP-GAS EQUIPMENT INC
• DISTRIBUTORS SINCE 1957 •

881 HERSEY STREET
ST. PAUL, MN 55114

PHONE (651) 646-1177
FAX (651) 646-1676

Bobtail Propane Delivery



Propane deliveries to customer tanks with a bobtail utilizes a liquid pump mounted to an internal valve on the bottom of the truck's storage vessel. The key to smooth operation and long pump life is providing a solid stream of liquid to the pump inlet. During a delivery the liquid propane, by it very nature, will boil both in the stored product and in the stream flowing to the pump. The vapor formed by this boiling not only reduces delivery capacity but is also extremely detrimental to the service life of the pump.

Understanding the principle of elevation head and the effects it has on the bobtail delivery system goes a long way in helping select the most efficient equipment for the truck. It is also essential for proper operation and troubleshooting pump performance.

The key concept here is maintaining a solid liquid stream to the pump inlet. The elevation head is the only energy maintaining the liquid stream.

Elevation Head

The pump mounting on a typical propane bobtail truck offers very little pump suction elevation head because it is mounted directly onto the tank internal valve. This mounting, although convenient, limits the amount of flow available for delivery.

The common bobtail barrel is 72" in diameter and contains approximately 58" height of liquid at 80% full. The elevation pressure offered by this height of liquid is a little more than 1 PSIG. This 1 PSIG provides the energy to drive the liquid into the pump.

As the height of the liquid level falls during a delivery, the available energy from elevation head falls proportionately. At 30% tank capacity the liquid height drops to 22" which only provides .40 PSIG elevation pressure to drive the liquid into the pump.

Figure 1
Elevation Head

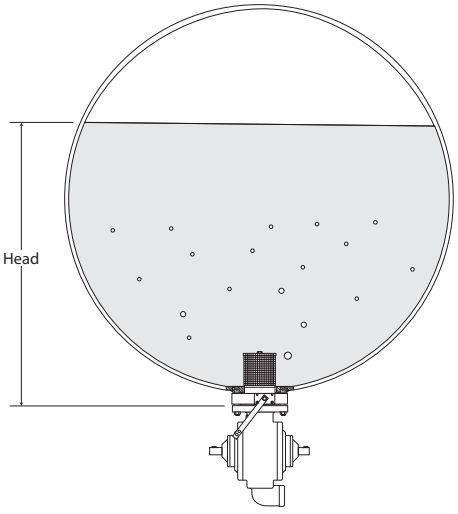


Table 1
Elevation Head (PSIG) Available vs Fill % for 72" Diameter Barrel

Barrel % Filled	Elevation Height	PSI Head Available*
80	58"	1.06
70	50"	.93
60	43"	.79
50	36"	.66
40	29"	.53
30	22"	.40
20	14"	.26
10	7.2"	.13

***Calculated for 60°F Propane**

Internal Valve Pressure Drop

The only item between the bobtail barrel and the pump inlet is the internal valve. As with any device, the internal valve presents a restriction to the flowing product and creates a pressure drop. Even though the internal valve manufacturers have designed their products for low pressure drop operation, the bobtail pumping system offers very little additional energy for product flow. With very little extra energy available, we can ill afford to give up much to pressure drop through the internal valve.

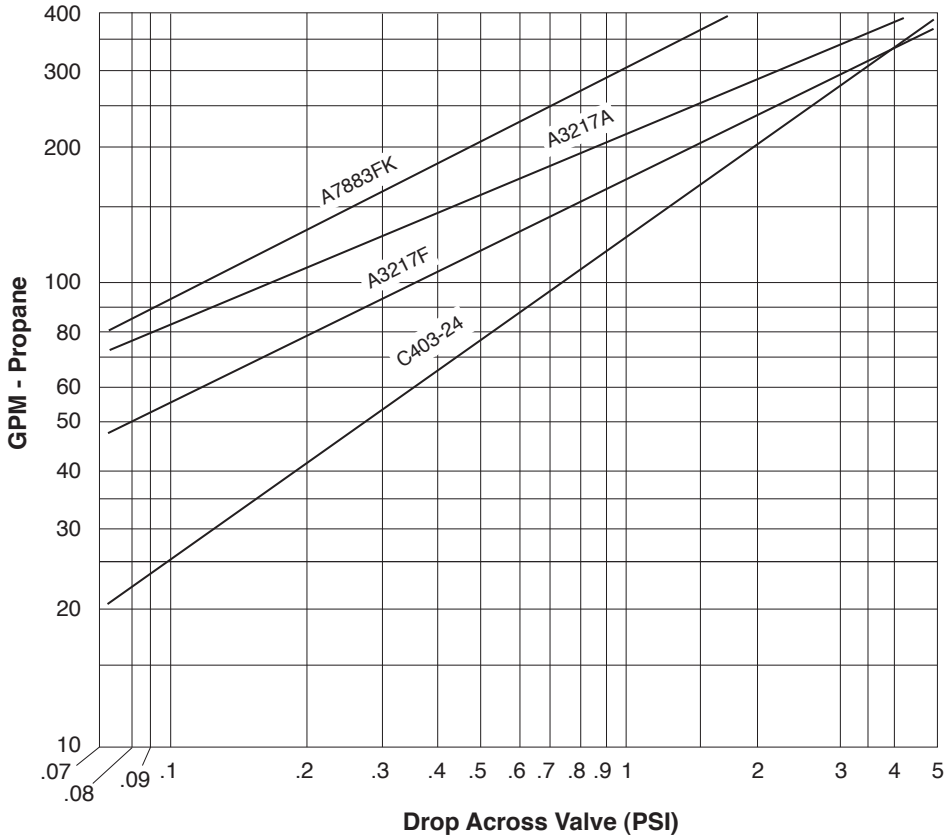
The Flow Characteristics curves of the popular internal valves are shown below. The flow in GPM is plotted against the pressure drop in PSIG. The pressure drop given for a particular flow rate can now be compared to the available pressure given in Table 1. Even though the pressure drops across the valves in the 70 GPM through 100 GPM flow range is not extreme, the values given can produce very adverse effects on the system for low tank volume percentages.

Example:

A pressure drop of only .40 PSIG from the Flow Characteristics Chart would prevent smooth pump operation starting at a barrel fill capacity of 30%. Lower barrel fill percentages than 30% would greatly accentuate the problem in this example.

Note: The excess flow closing rates (GPM) of the internal valves listed in the various catalog spec sheets have no effect on pressure drop. A valve with a 250 GPM closing flow has the same pressure drop as one with a 400 GPM closing flow.

Bobtail Internal Valve Flow Characteristics



Stored Product Boiling

Not obvious in the preceeding discussion is the further detrimental effect of the boiling which will occur in the stored propane during product delivery. We normally think in terms of gallons per minute when analyzing pump systems. But this is not what the system "sees" or "feels". The delivery operation rapidly removes cubic feet of product from the barrel which lowers the storage pressure. The liquid boils to replace the lost volume with vapor and regain the equilibrium that was upset by flow.

A pump moving a nominal 70 GPM relates to a little over 9 cubic feet per minute of product leaving the storage container. That is not an insignificant volume for a typical size bobtail barrel and the product undergoes quite a bit of boiling to compensate for the lost cubic feet. *(For the reader more in tune to the same effect of vaporization demand on a heating load, this is equivalent to a 564 CFH vapor load translated as 1,421,000 BTU/HR).*

Note the vapor bubbles depicted in the liquid of the Figure 1. These are created by the lowering of the stored product pressure during flow. Keeping in mind that we are trying to feed the pump with a solid stream of liquid, it is easy to see that the boiling effect will further degrade the system performance. Higher pump flow rates and lower product height will enhance this effect.

Pump Speed - The Great Equalizer

The typical pump used on bobtails is rated for a nominal 90 GPM at 640 RPM. This rating assumes that we are able to deliver 90 GPM of liquid to the inlet of the pump. As we have seen, delivering this volume of liquid from the storage barrel, through the internal valve and finally to the pump inlet is not always possible. The blades and rotor keep churning a specific volume through the pump. But what is passing through?

As the product level in the barrel falls, more and more of the product stream becomes vapor and a lesser portion of the product stream is liquid. The driver sees this as a slowing down of product flow through the liquid meter. The temptation is to rev up the truck engine to increase the pump speed to compensate for the slower flow rate. This of course is counterproductive and will only serve to cut the liquid capacity further while at the same time damaging the pump. A 90 GPM pump running with 30% vapor in the product stream is actually moving only 63 GPM of liquid.

Slowing the pump down a couple hundred RPM will give the pump a nominal 70 GPM capacity. A 70 GPM pump running with 0% vapor in the product stream is actually moving 70 GPM of liquid. A slower rotating pump with a higher flow and no abnormal wear and tear.

Use internal valves with low pressure drops

When all else fails, slow the pump down