Balancing Pump and Manifold Capacities in the Small Bottling Plant

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THE construction of the smaller type of bottling plant, principally for the filling of 100 lb. cylinders, has recently received much more attention from butane and propane dealers handling local distribution.

It is important in this service that the initial equipment cost be kept within reasonable limits. It is also just as important that the equipment be such that the operator may accomplish the everyday filling job with a minimum expenditure of time and effort.

In this service the rotary pump has come into quite extensive use. A direct-connected, electric-driven unit is compact and convenient to install, and under good installation conditions, will deliver economical and dependable service. It is the purpose of this article to briefly outline the possibilities, as well as the limitations, of such a bottling plant installation. Additional important detail information pertaining to general butane and propane pump problems has been covered in previous articles in this series, and these should be consulted.

In choosing a pump for bottling plant service, it is considered good practice to select one with a capacity rating not greater than three to four times what will be the actual manifold delivery. This proportion, it has been found, allows a good margin for usual pump "slippage" and at the same time assures an adequate flow through the pump to carry off any accumulation of heat or vapor.

Next in importance in making initial calculations, is to allow for a minimum actual filling time of not less than five minutes for each 100 lb. cylinder. Since a 100 lb. cylinder holds just under 25 gallons of fluid, this means that the flow rate into a single cylinder should not exceed five gallons per minute. One reason for this limitation on filling speed is the extremely small flow area of the valve passages through which a cylinder must be filled. The restricted passageway in these valves is such that it is necessary for the liquid to flow at a rate of almost 40 feet per second, assuming that this rate is maintained through the entire suggested five-minute period.

However, there is another still more important reason for allowing plenty of filling time, which is that as the liquid propane enters the cylinder, an equal volume of propane gas already in the cylinder must be compressed and condensed. This condensation of the propane gas within the cylinder, releases some 600 Btu (British thermal units) of heat energy which in turn must be absorbed by the entering fluid or dissipated by the cylinder walls.

This is enough heat to raise the temperature of the entire 100 lbs. of incoming fluid as much as 10° F. If this heat were evenly distributed throughout the fluid, this increased temperature alone would raise the pressure within the cylinder by not less than 20 lbs., and add just this much to the total differential pressure which must be pumped against.

Even when the cylinder is filled as slowly as here suggested, this released heat energy often does not have time to dissipate or even to become evenly distributed, with the result that a still greater momentary pressure is often created.

We have covered this subject in considerable detail because when these items are well understood, a much better appreciation of the filling problem is had, with the very obvious conclusion that slow filling is important.

Now, the simplest way to allow more time per cylinder, and yet not reduce the total volume output, is to have a number of cylinders filling at the same time. This is easily arranged for by providing the pump outlet with a cylinder manifold to connect up as many cylinders as requirements may dictate.

In practice, it is found that about 40 100 lb. cylinders per hour is as fast as the average operator can handle, off and on the scales, and operate his valves. Some may consider this too fast, but assuming this rate, and that a five outlet manifold is provided, we may assume that four of the five cylinders will be filling at all times, while the fifth is being changed. At the rate of only four gallons per minute into each container, our manifold discharge will be 16 gallons per minute, and based on the suggestion of a pump rating of three to four times the actual manifold flow, we could choose a pump up to 50 GPM capacity.

This might be considered a well balanced installation, although a sixth scale could be added and a greater production be realized with some additional operator help. On the other hand, with a lower pressure adjustment, and increasing the filling time to eight minutes per unit, an easy production of 30 cylinders could be realized with very comfortable pump pressure differentials.

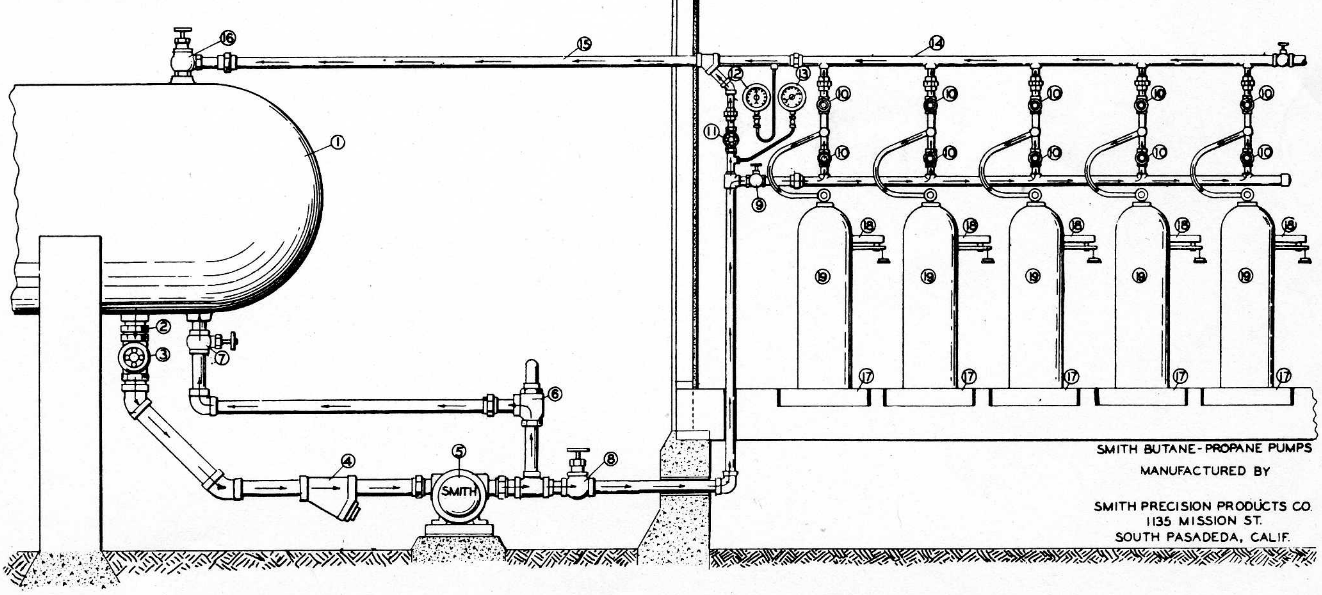
In the accompanying drawing, a pump and manifold assembly is illustrated. Here, a 50 GPM, direct-connected, electric-driven pump supplies propane to a five-scale manifold. In normal use, four of the five bottles are always filling, while one is being replaced. A continuous average manifold discharge of 16-2/3 GPM will make it possible to roll off one filled cylinder every 1½ minutes.

Automatic electric valve operation may be provided, or, when an operator has become accustomed to the work, hand closing of the valves is an entirely practical operation. A second manifold connected to the vapor return line is shown. This arrangement makes it possible to discharge any overage which may have entered a cylinder, as in the case of hand operation. Over-filling must, of course, be strictly avoided in compliance with safety regulations, and a double manifold, as shown, greatly simplifies any necessary weight correction.

An installation as indicated is easy to operate, and has many advantages over some more costly plants now in use. This system will insure an excellent output without resorting to excessive differential pressures, and this is a very desirable feature with any type of pump installation.

Typical, Well-Balanced, Small Bottling Plant Layout for 100-lb. Cylinders

1. Propane supply tank.
2. 3" Excess flow valve.
3. 3" Globe valve—300 p.s.i.
4. 2½" or 3" strainer—60 mesh screen.
5. 50 GPM propane pump.
6. 1½" Spring loaded by-pass valve.
7. 1½" Globe valve—300 p.s.i.
8. 1½" Globe valve—300 p.s.i.
9. 1¼" Globe valve—300 p.s.i.
10. ½" Quick opening manifold valve.
11. 1" Semi-needle hand by-pass.
12. Low pressure gauge—300 lb. scale.
13. High pressure gage—300 lb. scale.
14. 1¼" Vapor return manifold.
15. 1½" Vapor return line.
16. 1½" Globe valve—300 p.s.i.
17. Scale platform.
18. Scale beam.
19. 100 lb. cylinder.



Description

In this bottling plant layout, a double manifold is provided. The lower manifold distributes high pressure fluid, as usual, to the several cylinders on the scale platforms. The upper manifold is connected through the vapor return line back to the storage tank.

This arrangement has several useful features. For example, should a bottle be found overweight after closing the lower valve, the upper valve may be opened to permit ready discharge of any overage. The higher pressure due to vapor compression in a newly filled bottle makes this possible.

Operating Features

Another use is when a cylinder comes up slowly, due to unusual heating or possibly due to the inclusion of ethane or other non-condensable gas. By closing the lower valve and opening the upper valve, a rapid reduction of temperature and pressure takes place, after which filling may be resumed.

Valve 11, conveniently placed within easy reach of operator, provides for fast manual pressure adjustment or reduction in such emergencies as several containers "topping off" simultaneously.