Pump ED 101

Branch-Line Pumping and Other Options – Part 1

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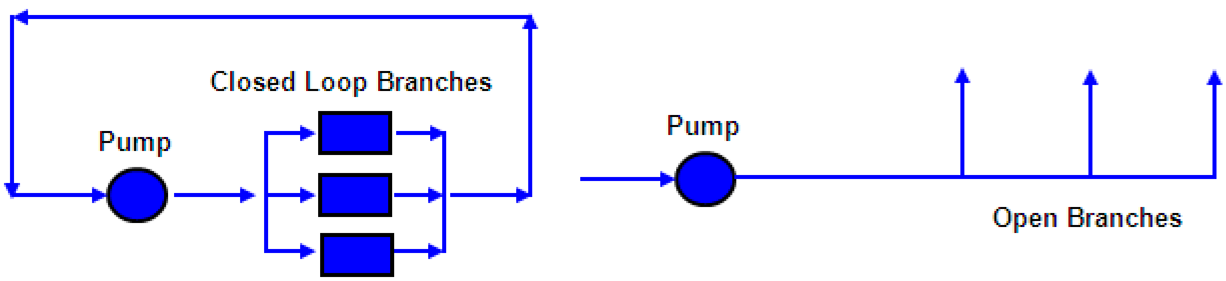
Branch-line pumping applications abound throughout the pumping industry. These systems consist of a pump (or pumps) discharging into a single line that feeds a network of individual piping segments. Branch-line systems can be closed loop or open ended. Figure 1 illustrates these two configurations.

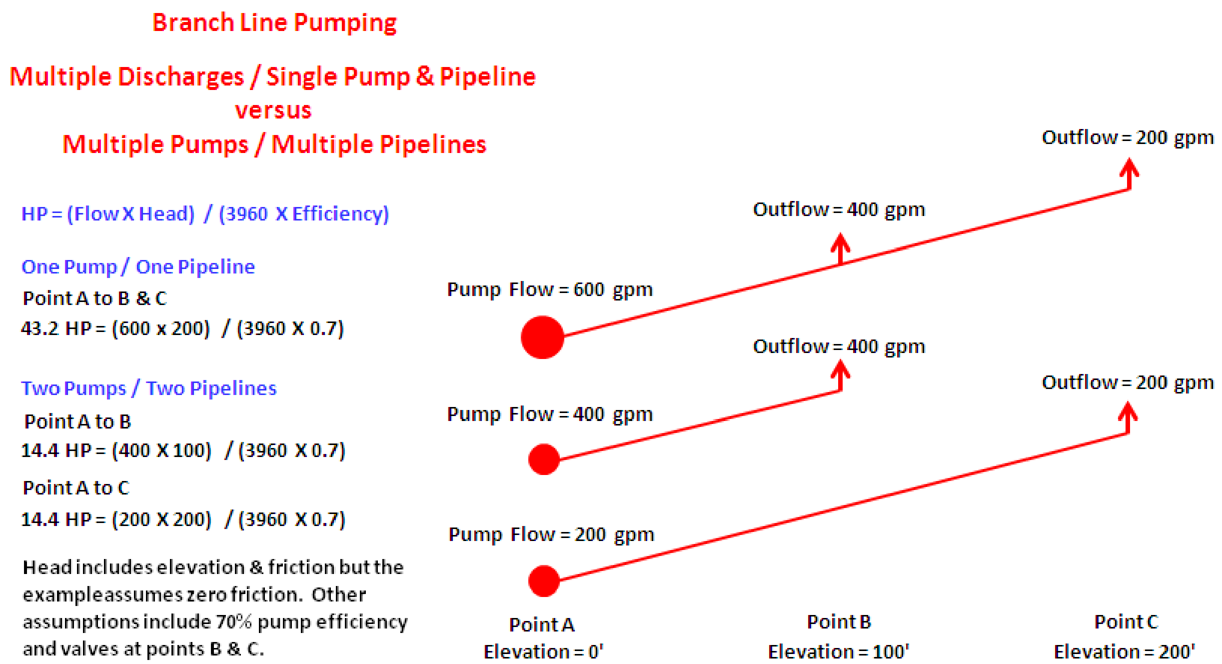


Closed loop systems are often seen in heat exchange applications in commercial and industrial processes. The most common example of an open ended system is the water piping in the typical home. Both the hot and cold water pipes branch out to the kitchen, laundry room and bathrooms. Many high rise buildings use booster pumps that feed a vertical riser with open branches to each floor. Industrial applications use open ended systems to distribute fluids to various locations within a plant. Open ended branch lines and be very effective in moving water from a single source to multiple points of use. They can also be efficient as long as friction is the main component of TDH. But, as elevation of the downstream branches increase, the total cost of pumping can increase quickly.

When a pump is supplying multiple branches simultaneously, its flow will be the sum of the branch flows. If all branches are at the same elevation the pump head will be that elevation plus the sum of the various friction heads between the pump and the branch outfalls. If, however, the branches are at various elevations the head required will be the sum of the various frictions heads and the elevation head of the highest branch. Even though the highest elevation may require a small percentage of the pump flow, its head requirement will dictate the operating pressure of the pump and therefore its required horsepower.

A water pressure booster system is a good example of how the upper elevation branches influence pressure and the cost of pumping. Suppose we have a 30 story building with a booster system that supplies additional pressure to floors 4 through 30. Floors 1 through 3 utilize street pressure (140'). The system must be sized to meet the flow required by all of the floors and the pressure required at the 30th floor. Although the lower floors require very little additional pressure, their branch lines will see far more pressure than the branch on the 30th floor. If the booster system is to provide street pressure on the 30th floor, it must provide about 300 feet of head to the system. That would mean that the 4th floor would see a branch pressure of about 410'. Now these individual floor pressures can be easily reduced with a pressure reducing valve (PRV) but the total energy consumption of the system will often dictate a different approach. High rise buildings can also be designed with multiple zones that utilize multiple riser pipes and multiple booster systems that can provide pressure to various floors far more efficiently. Several other alternatives are also available to the designer.

Figure 2 is an example from my "Branch Line Pumping Alternatives" spreadsheet. It allows a user or designer to compare a standard branch line pumping system with several alternative designs and calculate the potential cost savings of those alternative designs. It is an evaluation tool - - not a design tool.



In this example a single pump at Point A is supplying two branches at Points B and C. The system requires a pump that can provide 600 GPM at 200' TDH. Point B is at an elevation of 100' and has an outflow of 400 GPM. Point C is 100' higher and has an outflow of 200 GPM. This is illustrated by the upper red, angled line. In order to meet these conditions, 43.2 HP is required.

An alternative to a single line with two branches is two separate lines supplied by individual pumps. These are illustrated by the two lower angled, red lines. The first line delivers 400 GPM from Point A to Point B at a head of 100' and requires 14.4 HP. The second line delivers 200 GPM from Point A to Point C at a head of 200' and also requires 14.4 HP. The total HP for the two individual lines is just 66% of the single branch line so there are significant electrical savings available. Will the electrical savings make the two line system cost effective? Figure 3 is the calculator portion of the spreadsheet and it compares the variables offered by these two alternative designs.

Branch Line versus Multiple Line Analysis

REQUIRED DATA	**A to B & C**	**A to B**	**A to C**	**? to ?**
Pump Operation - Hours / Day	8	8	8	0
Pump Operation - Days / Year	365	365	365	0
Pump Flow - GPM	600	400	200	0
Pump Head - Feet	200	100	200	0
Pump Efficiency - %	70%	70%	70%	70%
Motor Efficiency - %	94.0%	90.0%	90.0%	90.0%
Energy Cost in $/KWH	$0.11	$0.11	$0.11	$0.00
Initial &Additional System Costs	$44,000.00	-10,000.00 *	17,000.00 *	
RESULTS				
Annual Flow	105,120,000	70,080,000	35,040,000	0
BHP At Design Point	43.3	14.4	14.4	0.0
Wire to Water Efficiency - %	66%	63%	63%	63%
Annual Energy Cost	$11,035.06	$3,841.83	$3,841.83	$0.00
KW Per 1000 Gallons Pumped	0.954	0.498	0.997	#DIV/0!
Cost Per 1000 Gallons Pumped	$0.105	$0.055	$0.110	#DIV/0!
PAYBACK				
Annual Savings - $$	$3,351.39			
Annual Savings - %	30%			
Additional cost	$7,000			
Payback - Years	2.1			

The required data is entered into the yellow cells. The column on the left is the branch line circuit and the two in the middle are the individual lines from A to B and A to C. The required data include run time, flow, head (including friction), efficiency, electrical cost, and initial & additional system costs. Although not shown in Figure 3, a complete set of instructions resides at the bottom of the sheet.

Column 1 shows that the total cost of the branch line system is $44000.00. Column 2 shows a cost reduction of $10000.00 due to the smaller pump required for flow from Point A to B. Column 3 shows an additional cost of $17000.00 for the line from Point A to C. This amount represents the cost of the additional piping required from A to B plus the additional pump and controls. The "Results" columns show the various calculated results for the two alternatives. These include annual flow, BHP required, wire to water efficiency and total energy costs. The "Payback" portion at the bottom computes the overall cost increase and energy savings and uses them to compute the payback period. In this example the two line, two pump alternative will pay for itself in a little over two years. The potential for increased maintenance costs is not included in this analysis but could be entered in the "Additional System Costs" in columns two and three.

The calculator is not limited to single point branches as shown in this example. The "A to B" column could also be a branch zone that feeds multiple branches within the zone. If more than three branches or zones are required, more columns can be added to the spreadsheet. Next month we will look at yet another alternative to the single line, single pump open branch design.

Joe Evans is responsible for customer and employee education at PumpTech Inc, a pump & packaged systems manufacturer & distributor with branches throughout the Pacific Northwest. He can be reached via his website www.PumpEd101.com. If there are topics that you would like to see discussed in future columns, drop him an email.