The Positive Side of Waterhammer

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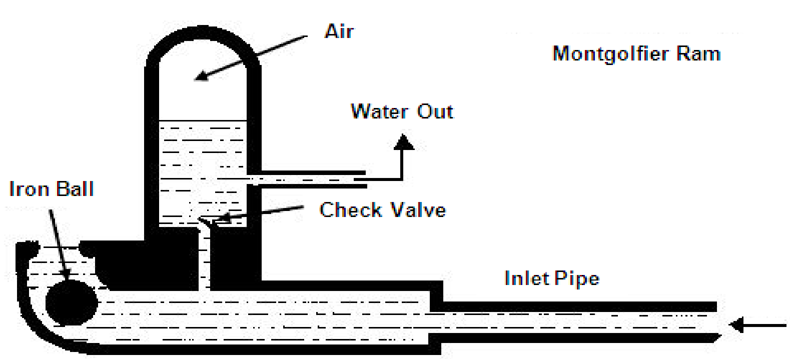
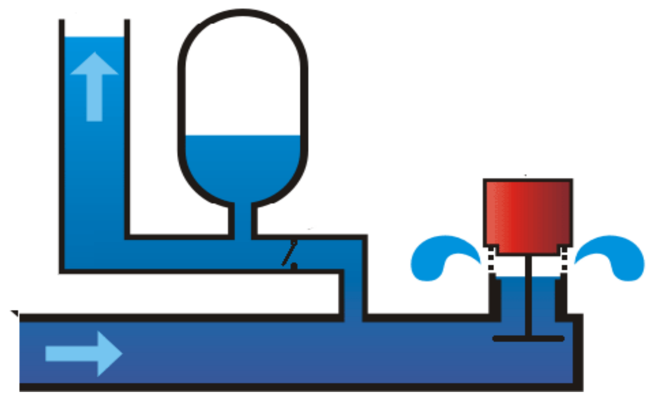
In 2008, I did a two part article on waterhammer and how it can be damaging to both pumps and piping systems. It is the result of a change in flow momentum and is often caused by the quick closing of a downstream valve. The resulting shock wave can cause significant damage to the system. There is, however, an application where waterhammer is a positive event. In this application, a quick closing valve allows waterhammer to supply the energy required to pump water.

The "Hydraulic Ram" was invented in the 1796 by Joseph Montgolfier, co-inventor of the hot air balloon, and was awarded a British patent in 1816. By the 1820's it was in widespread use in Europe and the USA. During that period, it was considered "one of the most significant inventions in the history of civilization". Rams have been designed to pump over 50,000 gallons per day and produce discharge heads of 300 feet and higher. Typical Rams available today range from 700 - 1800 gpd for a one inch model to 1000 - 10,000 gpd for a three inch model. Much larger models are also available. For those of us who appreciate simplicity, the Hydraulic Ram is an eloquent machine and its design has changed very little since its invention. It uses the low pressure provided by a short length of downhill pipe and converts it to a much higher delivery pressure.

Figure 1 is a drawing of the original machine. Its operation is extremely simple. Water enters the Ram from the inlet or "drive" pipe, flows through it, and discharges through the upturned end on the left. Inside the horizontal body of the ram is an iron ball. The flowing water accelerates the iron ball which, in turn, moves with increasing velocity towards the discharge. Since the ball is too large to exit the discharge, it seats itself and acts as a quick closing valve. This produces a water hammer effect that sends a high pressure shock wave back towards the inlet. A portion of this high pressure water enters the air chamber through a check valve



and then makes its way into the discharge pipe. When the pressure surge in the Ram subsides the check valve closes, the ball rolls back towards the right side of the Ram, and the cycle starts again. This cyclic pumping action produces the characteristic beating sound heard during operation. The pumping phases are often referred to as acceleration, delivery, and recoil.



The modern Ram works on the very same principles as the original. As seen in Figure 2 (courtesy of Wikimedia Commons), the only difference is that the iron ball has been replaced with a waste or impulse valve. In the modern Ram, water accelerating past the waste valve drags it until it slams shut. Again a high pressure shock wave is created that delivers high pressure water into the air chamber. When the delivery check valve closes, the remaining water in the drive pipe recoils against it. This creates a low pressure area that allows the waste valve to reopen. And, as before, the cycle begins again.

For almost two hundred years, the Ram has been a major player in the water pumping arena. They have provided water for industry, farms, and towns. The advent of the electric pump caused a decline in the use of Rams, but they are on the comeback. And well they should be. They are a simple, low cost, and environmentally friendly way to move water uphill when a source of falling water is available. The so called "waste" water is not really wasted. It simply returns to the steam or river from which it came. A fairly large number of companies still manufacture large Rams. Figure 3 shows a portion of the line produced by Green & Carter in Ashbrittle, England. They have been making them since the early 1800's.

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.