Water Hammer
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In Steam Systems

On a warm day in the late 60’s a chemical plant was going through its normal process of producing chemical by-products. The operators were nonchalantly going about their duties which was heating an extremely large volume of product in a vertical exchanger and storage tank. The tank was about 10 to 15 feet in diameter and approximately 60 feet high. An operator on the catwalk above the tank was opening a 3” gate valve to allow steam into the coils, which heats the product to its desired temperature.

Upon reaching temperature, the operator closed the steam valve, opened a drain valve on the steam system to allow any excess steam and condensate to flow through the exchanger and the trap draining the system. The next stage of the operation is to fill the system with cold water to lower the product temperature. After sufficient cooling time, the operator shuts off the cold water supply but this time he forgets to open the drain valve. Waiting only a couple of minutes, he then immediately and very quickly fully opens the steam supply valve. At this precise moment, sharp banging with visible vibrations occurred throughout the system, a moment later all one could hear was an enormously thunderous boom. The room was immediately filled with dust particles, product, and steam vapour mixed with concrete and materials that were lying around.

I was sitting in the engineering office when the call came in that one of our traps failed and three people were injured. The ensuing investigation from the insurance and M.C.R., found the cause of this disastrous accident, which took the life of one individual and seriously injured two others, to be WATER HAMMER. This accident is a result of very poor engineering design practices and operators performing mundane tedious jobs.

There are two types of water hammer: a steam-flow-driven water hammer and a condensate-induced water hammer. A steam-flow-driven water hammer is an impact event, where a slug of rapidly moving water strikes a stationary object. The exchange of momentum creates a pressure increase of a few hundred psi in the impact area.

A condensate-induced water hammer is the more powerful of the two types. A rapid condensation event occurs when a steam pocket, surrounds cooler condensate, and collapses into a liquid state.
Depending on the pressures and temperatures involved, the reduction in volume may be by a factor several hundreds to well over a thousand and the resulting low-pressure void allows the pressurized surrounding condensate to rush in, resulting in a tremendous collision. This generates serve over pressurization that can easily exceed 1000 psi. Gasket, fitting, and valves would be virtually susceptible to failure often with tragic consequences.

When the operator neglected to open the drain valve, he quickly pushed steam into a system, which contained cold water. The steam becoming in contact with this cooler water collapsed and created a condensate-induced water hammer condition. The ensuing hammer blew the bottom portion of the vessel, the steam trap, and fittings through a 12” cinder block wall killing a worker who was walking past this section of the wall at an inappropriate time. Two other unsuspecting tradesmen were seriously injured from flying debris were hospitalized for months, all from improper understanding of engineering principals and an operation procedure, which allowed an untrained operator to work to his own standards.

A few months after this accident I went with one of our sales reps to visit a job site where the contractor was having trouble keeping coils from corroding in a new installation. We met the contractor in the boiler room of Erindale College and started to take the long journey through the half-mile underground tunnel to the main building.

During our walk, we were asking questions about the job and then far off in the distance we heard a very distant muffled banging that was coming towards us. The closer it came to our position in the tunnel the louder it became, as it hit the position where we were standing the banging was very piercing, the 12” steam main was shaking, plaster and other particles were falling from the ceiling. Rick and I stared at each other, as we knew what this noise was, we started to slowly back out of the tunnel in the direction we came.

The contractor who was with us said not to worry this was just a little bang the big bang already ripped most of the anchor bolts from the ceiling which was holding the steam main and explained that problem was that some of the steam traps were faulty.
We immediately saw the problem; the drip traps from this high-pressure steam main were tied into a low-pressure return main from the main building. This installation could have been a major disaster; the engineers again not understanding the true problem were trying different types of traps to solve the problem. They installed small radiator fins between the outlet of the trap and the connection to the low pressure return main hoping that the fins would lower the temperature enough to solve the problem. The problem was solved after the owner demanded the problem be fixed in the proper manner, which was to install a high-pressure return line to the boiler room, which is the proper method in the first place.

These and other similar examples of steam hammer are command in many building that I have visited over the years. Water hammer can be heard in many building and almost every time the subject is brought up to the operator would say it is no problem just a little bang.

Water hammer in steam systems is extremely dangerous and should not be taken lightly. Unfortunately it is taken for granted and only looked at after many costly repairs are made to systems or after a serious accident.