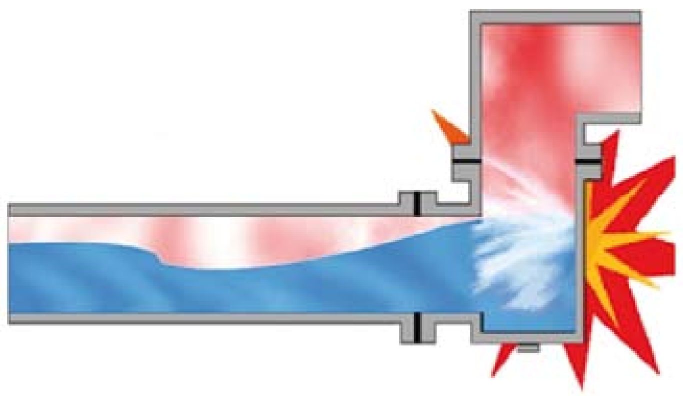
PHARMA

Case study

Elimination of water hammering



ARMSTRONG CASE STUDY

Case summary

Energy savings		Operational optimizations
Flash steam recovery	3,000 tons/year	Improvement of safety
CO_2	220 tons/year	Reduction of leaks and of their consequences on building hygiene
Financial savings	€ 55,000/year	Reduced maintenance needs
Investment	116,000 €	Increase of equipment service life
Payback time	25 months	Elimination of noise

Natural… though avoidable phenomena

Water hammering is a natural thermodynamic phenomena that occurs in several situations. First of all, it can occur in a poorly-drained steam pipe. Because the speed of steam is 10 times greater than that of condensate, steam has a trend to drag condensates. This leads to the formation of waves which sometimes block the entire section of pipe. These waves are pushed at a speed of 30 m/s and bump against any obstacle in their pathway: bends, valves, heat exchangers, etc. Water hammering is very powerful and can cause significant damage.

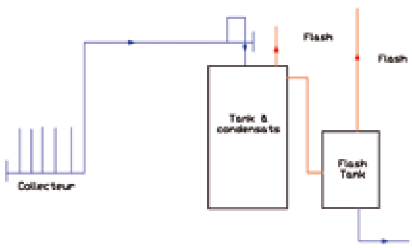
The shocks that occur in saturated condensate pipes represent another situation. This is typically the case at the top of a water column in the return, when a portion of the condensates revaporize due to the drop in pressure. As the specific volume of steam is about 1,000 times greater than that of the condensate, even small quantities of flash steam take up a large amount of volume in the return and increase pressure therein. When the steam bubbles suddenly implode (contact with colder condensate), the volume left empty is instantly occupied by the condensate. This phenomenon is similar to cavitation which occurs in electric pumps and can damage the condensate return installation.

Crucial measurements

In practice, it's not easy to determine the origin of water hammering and, thus, the solution to eliminate it. Only simultaneous measurements of pressure, temperature and mechanical shocks can provide the necessary information. Therefore, Armstrong engineers were forced to create a specific probe to detect water hammering as nothing of this type existed on the market previously.

As part of one of our studies in a factory, the regular presence of water hammering was detected (see diagram of condensate return configuration). We installed measurement probes at several locations:

- temperature probes on each condensate return pipe as well as on the condensate tank inlet
- pressure probes on the rising (6 m) and horizontal pipes located between the manifold and the condensate tank
- water hammer probes on the manifold and on the condensate tank inlet



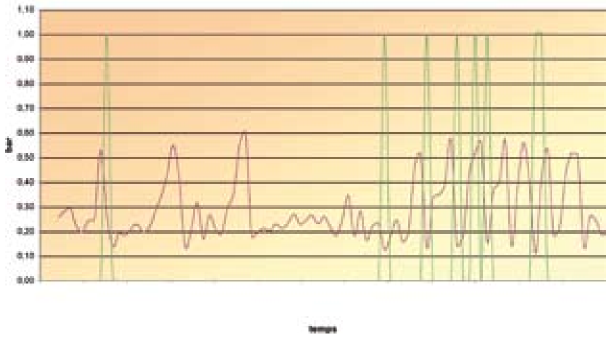
Condensate return configuration causing water hammering

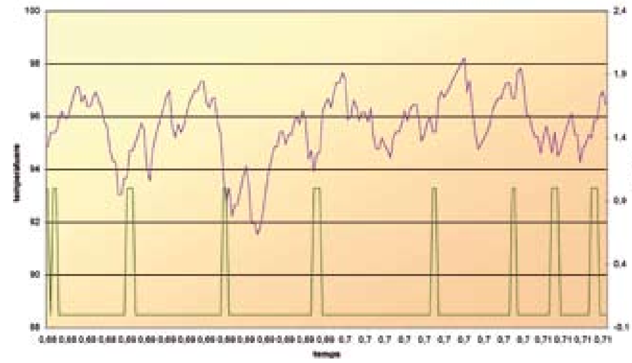
Case study

The results helped us to understand the cause of the water hammering, both in the manifold and at the condensate tank inlet.

The pressure probes on the vertical pipes showed great variations in the level of the water column. The vertical pipe fills slowly before the column reaches a height of 6 m (pressure of 0.6 bar). This allows the condensate to reach the horizontal pipes. Revaporization steam pushes this plug of condensate to the tank, thus emptying the vertical pipes (pressure drops to 0.1 bar). Shortly thereafter, a portion of the condensates returns to the horizontal pipes and drops to the manifold. This causes water hammering in the manifold – we detected 205 of them in 24 hours!

Temperature measurements at the condensate tank inlet confirmed this analysis. At low flow rates, the condensates stagnate in the horizontal pipes and cool down slowly. Once the biphasic mixture arrives (condensates and flash steam), it implodes in these cold condensates, reheating the entire mixture and pushing the whole fluid volume to the condensate tank.





Eliminate water hammering while saving energy

After complete analysis of the problem, several solutions to eliminate the water hammering were identified. Our customer opted for installation of a flash tank with integral coil located between the manifold and the condensate tank.

The coil integrated into the system allowed reuse of the calories in the flash steam to preheat water used for heating of the building. The resulting condensate was easy to pump to the return tank.

This solution eliminated the water hammering. A study performed one year after the installation showed that more than 500 kg/hour of flash team were generated and recovered using the coil integrated into the tank. The resulting energy savings made it possible to reimburse the cost of the installation within 25 months.

Are you familiar with the thermosiphon mixer?

Shocks, resulting from the implosion of revaporization steam during the mixture of hot and cold condensates, occur very often in condensate returns. A thermosiphon mixer is the ideal solution to eliminate this phenomenon. The thermosiphon mixer is a tank with an integrated coil in which the temperature of the two types of condensate is balanced before they are mixed.

The coil discharges into the tank, thus creating a thermal loop. The loop operates simply based on the difference in specific volume between hot and cold condensate. This is a purely thermodynamic phenomenon and, thus, requires no pump.

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