Water hammer in pipes
A common phenomenon of transient flow is the occurrence of water hammer in pipes. Fluctuations of pressure and flow rate can significantly exceed or fall below the designed pressure for a pipeline.

Water hammer is caused by:
- closing or opening shut-off elements in the pipeline
- startup and shutdown pumps and turbines
- re-commissioning systems
- change in the feed water level

Effects of water hammer
Water hammer causes damage to the affected system. Pipes can burst, pipe brackets may be damaged. Additionally, valves, pumps, mounts and other components of the pipe system (e.g. heat exchangers) are at risk. In drinking water pipelines a water hammer can lead to dirty water being drawn in from outside. Since damage to pipelines is not necessarily immediately visible (e.g. a damaged flange), it is necessary to deal with the potential occurrence of water hammer when planning a pipeline.

Reducing water hammer
At smaller nominal diameters, installing an expansion tank or the choice of valves affects the occurrence of water hammer. Valves and gate valves are less affected than shut-off valves and butterfly valves due to longer closing times. Safety valves can protect pipelines from damage caused by water hammer.

Water hammer in pipes with large nominal diameters and large head are mitigated or avoided by slowly opening the slide gate and using surge chambers at the entrance of the pressure pipes (similar to equalisation basins).

Principle of a surge chamber
Hydroelectric power stations use surge chambers to reduce pressure fluctuations. The water moving through the pressure pipe is deflected when valves in the surge chamber are closed. The water level can then oscillate up and down until it returns to rest. The kinetic energy of the flowing water in the pressure tube is therefore converted into potential energy of the increased water level in the surge chamber and not into destructive pressure energy.

The table shows an abstract from a common university curriculum. GUNT devices cover this content to the greatest extent.

CURRICULUM FOR THE FIELD OF TRANSIENT FLOW

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Experimental units in chapter 2

Experimental units in product range 4b

GUNT products expanded 4b

Outflow from tanks with variable water level: Discharge velocity

Water hammer: Investigation of water hammer and pressure waves in pipes, displaying vibrations in the water hammer, determining the speed of sound in water, determining reflection time, measuring water hammer (Joukowsky shock), how flow rate/closing velocity of valves affect water hammer

Hydraulic ram: Use of water hammer to pump water

Surge chamber oscillation: How a surge chamber works, natural frequency of the vibrations

Hydropoeaking: transient flow behaviour, e.g. in open channels

Transient drainage processes: Drainage, delayed drainage processes (retention)

Flood wave

Transient flow processes in hydraulic turbomachines: Cavitation