Steady flow of incompressible fluids

Fluid

Fluid mechanics is concerned with the study of forces and movements of liquids and gases. Both substances are continua whose elements can easily move against each other. They are grouped together under the term 'fluid'.

Incompressible flow

Liquids are **incompressible.** In technical fields of application of fluid mechanics, incompressibility is also assumed for gases as long as the flow velocity remains below Mach 0,3. Based on air at 20°C this limiting value corresponds to a velocity of approximately 100 m/s and the change in density is roughly 4 %. It is therefore broadly possible to treat liquid and gas flows with common fundamental principles in fluid mechanics.

Steady and transient flow

Steady flow: the velocity of a fluid particle changes with the position: **v = f(s)**.

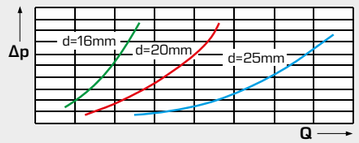
Transient flow: the velocity of a fluid particle changes with the time and the position: **v = f(s,t)**.

Transient flows occur during discharge processes, during startup and shutdown processes of turbomachines or in the case of fluid oscillations and water hammer processes.

Learning objectives

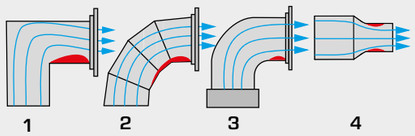
Flow in pipe systems

Velocity profile in fully developed flow
- laminar (left)
- turbulent (right)



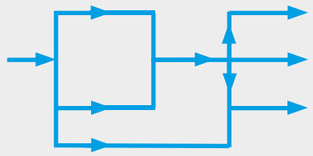
Δp differential pressure,
Q volumetric flow rate

Pressure losses in straight pipes

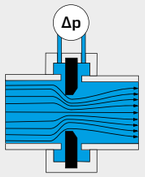


1 pipe angle,
2 segment bend,
3 pipe bend,
4 contraction

Pressure losses in pipe fittings
- enlargement / constriction / change of direction
- pipe bends
- segment bends / pipe angles



Losses in single-strand and multi-strand pipe systems

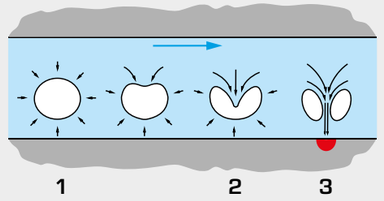


Δp differential pressure

Flow rate metrology: representation of the common industry measuring methods

Learning objectives

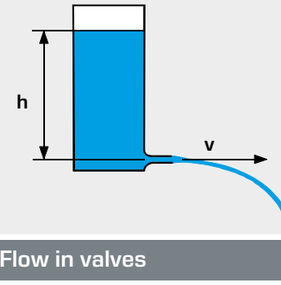
Cavitation



1 formation of the vapour bubble,
2 collapse of the vapour bubble,
3 jet of water hits the surface and leads to material destruction

Cavitation effects in industrial piping systems: formation and consequences

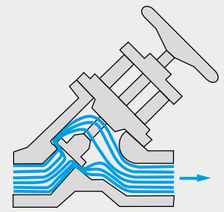
Discharge processes



h head,
v velocity

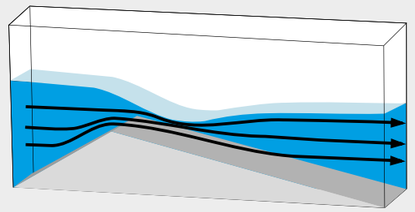
Flows from tanks
- how the discharge cross-section and the shape affect the jet cross-section
- vertical discharge / horizontal discharge

Flow in valves



Special emphasis on technical issues
- constructions
- valve characteristics
- K_{vs} values

Open-channel flow



- subcritical and supercritical flow
- control structures
- discharge measurement

For the field of **steady flow of incompressible fluids** we have tried to capture the many learning objectives found in the literature around the world within the list of learning objectives defined above. Of course, variations in some sub-fields are possible. For example, we could argue whether or not **industrial flow rate metrology** should be covered here.

GUNT provides a programme that allows to work through all of the items listed in the learning objectives in educational laboratory experiments.