Water parabola

More Details

In a rotating liquid, all liquid particles rotate at the same speed, with each liquid particle moving around the axis of rotation at a constant distance. As a result of the rotation, in addition to gravity, the “centrifugal force” arises. While gravity acts downwards, the centrifugal force acts outwards on each liquid particle, creating the curved water surface.

The centrifugal force acting on the liquid causes the fluid pressure on the container’s edge to increase. This happens automatically when the liquid surface rises outwards. The centrifugal force increases outwards with the distance to the axis of rotation. Thus, the pressure caused by the centrifugal force even increases outwards with the square of the distance from the axis of rotation. The result is a parabolic liquid surface that can be described by a quadratic function $y=x2+dx+c$.

Why do all parabolas, which are formed by varying rotational speeds of the liquid, pass through one point (marked red) – or more precisely: through two points that are symmetrical to the axis?

The fluid volume remains the same, the liquid just distributes itself differently, depending on the rotational speed. When cutting a parabola in a way that the shaded areas in Fig. 1 are the same size, the red marked point – the point of intersection of all parabolas – always lies in the same fraction of the radius $a = R/\sqrt{3}$. The ratio of the water levels u and v is 2:1.

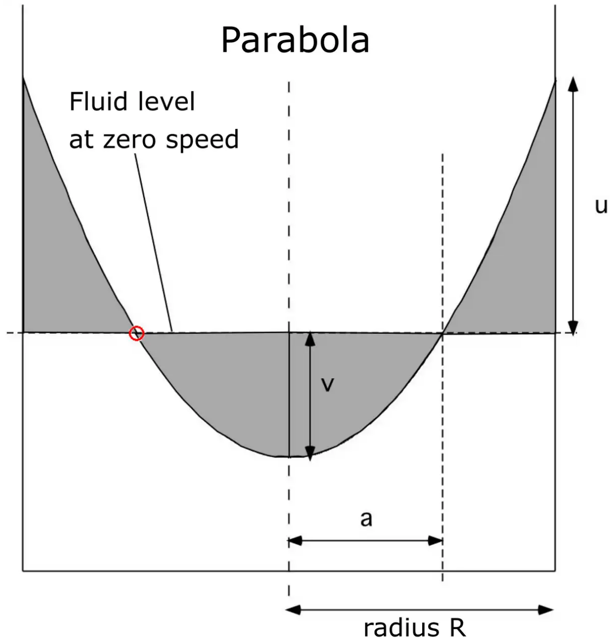

Fig. 1: For all parabolas where the shaded areas are the same u = 2v and a = R/√3.

All parabolas are similar to each other and can be transferred into each other by vertical stretch or compression.