2.2 Capacitors

A capacitor is a device that stores energy in the form of voltage. The most common form of capacitors is made of two parallel plates separated by a dielectric material. Charges of opposite polarity can be deposited on the plates, resulting in a

voltage V across the capacitor plates. Capacitance is a measure of the amount of electrical charge required to build up one unit of voltage across the plates. Stated mathematically,

$$C = \frac{Q}{V_C},$$

where Q is the number of opposing charge pairs on the capacitor. The unit of capacitance is the Farad (F) and capacitors are commonly found ranging from a few picofarads (pF) to hundreds of microfarads (μF).

In the hydrodynamic analogy to electronic circuits, a capacitor is equivalent to a bottle, as shown in *Figure 2.4*. The voltage across the capacitor is represented by the height of fluid in the bottle. As fluid is added to the bottle, the fluid level rises just as charges flowing onto the capacitor plate build up the voltage. A small capacitor is a thin bottle, where adding a small volume of fluid quickly raise the fluid level. Correspondingly, a large capacitor is a wide bottle, where a larger volume of fluid is required to raise the fluid level by the same distance.

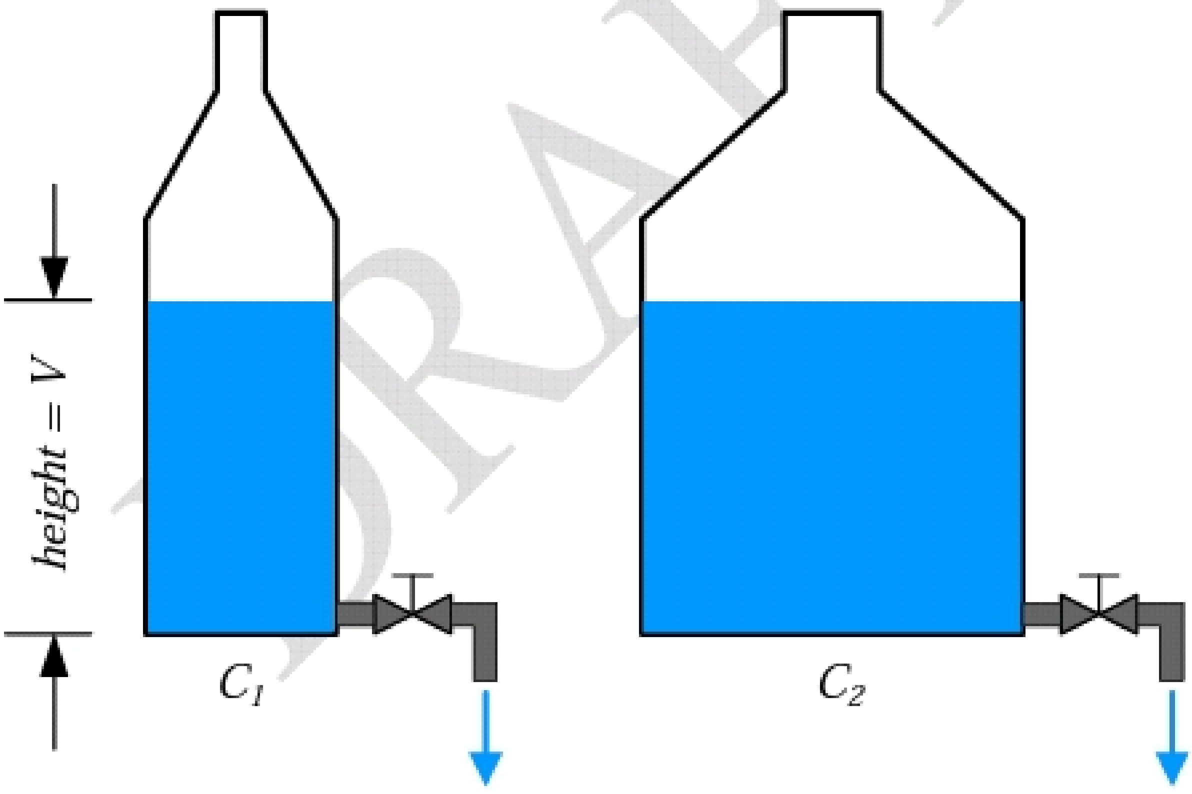

Figure 2.4: The hydrodynamic model of a capacitor is a bottle

The current-voltage relationship of the capacitor is obtained by differentiating $Q = CV$ to get

$$I = \frac{dQ}{dt} = C\frac{dV_C}{dt}.$$

Unlike a resistor, current in a capacitor is proportional to the derivative of rather than voltage itself. Alternatively, it can be said that the voltage on a capa proportional to the time integral of the influx current.

$$V_C = \int I dt$$

A typical example of a capacitor circuit is shown in *Figure 2.5* where the