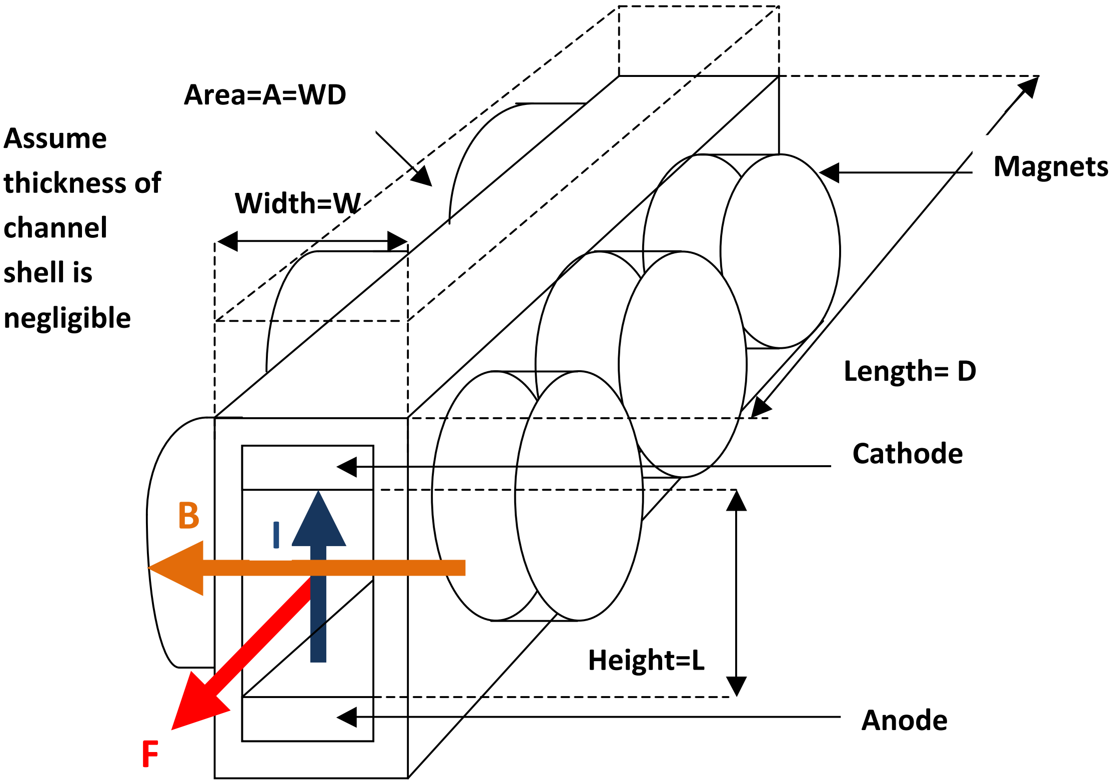
Figure 1: Schematic overview of the MHD propulsion engine



A current can flow, if a voltage, V, is connected across the anode and cathode and the inside of the channel is filled with a conducting fluid (e.g salt water) with resistivity, ρ. The current density, J can be related to the voltage by considering the electric field, E.

$$J = \frac{I}{A} \tag{2}$$

$$J = \frac{E}{\rho} \tag{3}$$

$$(2) = (3) \quad \rightarrow \quad I = \frac{EA}{\rho} \tag{4}$$

For this case since distance between the anode and cathode is L the electric field is

$$E = \frac{V}{L} \tag{5}$$

Substituting (5) and $A = WD$ (see figure 1) into (4) →

$$I = \frac{VDW}{L\rho} \tag{6}$$

This can now be substituted into (1) to give the following magnitude of $\boldsymbol{F}$.

$$|\boldsymbol{F}| = \frac{VDWB}{\rho} \tag{7}$$

This assumes $\boldsymbol{B}$ is uniform throughout the channel which is not the case particularly for circular disc magnets as shown in figure 1. In fact $\boldsymbol{B}$ is dependant on all three dimensions.