Solving the Leaky Tank Mystery

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Introduction

- The leaky tank mystery is a physics-based problem that explores the motion of a tank car under specific conditions.
- The aim of this project is to accurately determine the behavior of the leaky tank car.
- The objectives are to analyse this mystery using both simulation software and physical experimentation.

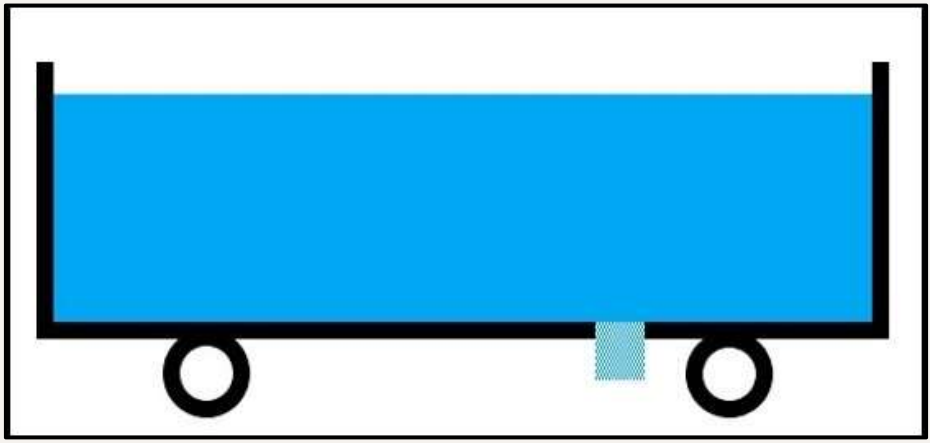

Figure 1: A tank car filled with water that has sustained an off-centre leak, such as the rail car within the leaky tank mystery.

Literature Review and Research

- The leaky tank or some variation of this problem has been the subject of studies conducted in the past.

- Differences across these studies includes different tank sizes and shapes or the liquid being considered as solid particles.

- The findings and expected results reported by these studies all vary based on the system, in addition to other factors.

- Although findings have been published, these are all theoretical, since the problem has not been completed practically/experimentally.

Methods

- Initial research included becoming familiar with the physical laws and concepts present within the leaky tank problem.
- A theoretical design of a model that would solve the leaky tank problem is then conceptualised and simulations are ran using this model.
- Following this, the theoretical design can be built and experimented upon to yield a set of results.

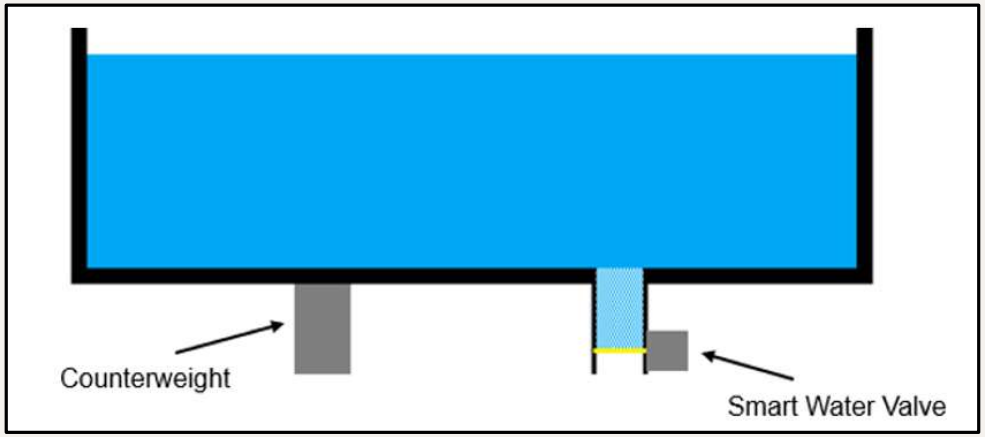

Figure 2: The conceptualised tank to be designed, using a smart water valve to allow water to be released.

Theory

- The motion of the tank is affected by several parameters. These include:
  - The size of the tank, location of the hole, size of the hole, and initial water level.

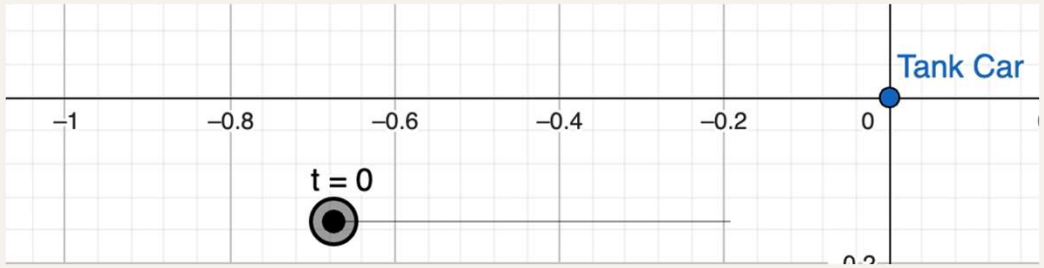

Figure 3: Animation of the position of the tank with respect to time. Where t is the time since flow begins, and the tank car point represents the position of the mid-point of the tank relative to its starting position.

Parameters used:

- Length = 2 m
- Initial water level = 1 m
- Width = 0.3 m
- Type of fluid = Water
- Hole location = 0.8 m to right of center
- Hole diameter = 5 cm

- Laminar flow must also be achieved by satisfying the condition,

$$\frac{VD}{v} < 2000$$

Simulation Analysis

- Motion can also be investigated through physics simulation programs such as ANSYS and COMSOL.
- Advantage over other methods is that the effect of each parameter can be investigated much quicker and in greater detail at any point in time.
- Variables are adjusted to find the maximum displacement of the tank, so that experimental results can be observed more easily.
- Assumptions made when modelling the tank must be reasonable for verifiable results.
- Progress is underway but has been impacted by delays with obtaining COMSOL License.

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Experimental Validation

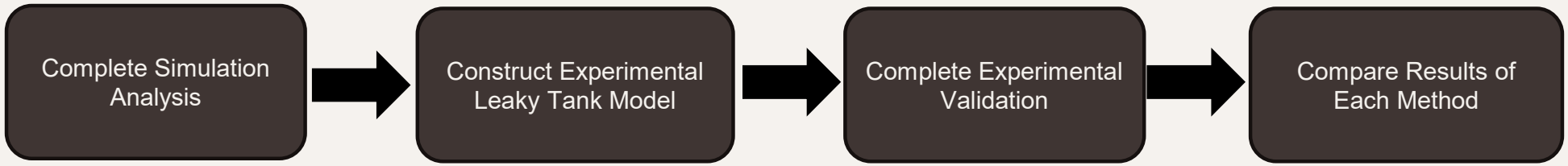
- Using results of simulated analyses, the ideal dimensions of the tank can be determined.
- Construction of the tank is to be completed by the technical resource team once dimensions of the tank are determined.
- Experiment can then be used to verify/ disprove theoretical and simulated results.
- During delays with simulation analysis, progress was made towards investigating materials and components that can be used.

Table 1: List of all components required, with several possible options listed.

Component	Option 1	Option 2	Option 3
Material of tank	Acrylic sheet	Perspex	Polycarbonate sheet
Remote release plug	Smart water valve	Irrigation tap with pneumatic device	Actuated mechanism to release plug
Hanging material	Thread	Fishing line	Twine
Measurement device	Laser sensor	Mirror and laser	Measuring tape
Method of connection	Holes drilled into the upper corners of the tank	Eye hooks screwed into tank	Cradle based support system

Completion Plan

- Encountered problems and delays with obtaining access to COMSOL.
- This delay has limited significant progress, as much of the work requires results from the simulation analysis to first be completed.
- Progress was instead made towards investigating potential components and resources required for the experimental analysis, limiting overall impact on the project.
- Progress towards simulation analysis is now underway and will be completed shortly.



Thank You For Your Attention