

Determining Hydraulic Ram Pump Feasibility

Summary Paper

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1 TARGET AUDIENCE

Organizations developing water projects in rural areas. Rural communities looking to construct small to mid-sized water supply systems. Manufacturers and installers of hydraulic ram pumps.

2 BACKGROUND

Hydraulic ram pumps have been used for over 200 years to pump elevated water without an external energy source. They can be constructed from common pipe fittings that are available in rural areas of developing countries. As a result, ram pumps are more affordable and easier to maintain than their alternatives. However, the feasibility and performance of hydraulic rams are difficult to predict. Currently, they are designed by experimental rules of thumb or incomplete sets of nondimensional equations. Both methods leave the designer to guess critical parameters which can result in a failed design. This uncertainty causes feasible projects to be abandoned, and projects destined for failure to be constructed.

3 PURPOSE

The purpose of this study is to provide an accurate and flexible model for predicting whether a ram pump design will deliver water to a certain height or at a certain pressure.

5 METHOD

A theoretical model of pump function was constructed using principles of fluid mechanics. A hydraulic ram pump was constructed from basic pipe fittings and experiments were conducted to collect performance data. These data were then compared to the model.

6 RESULTS

A flexible ram pump model was implemented with a Matlab script that can be used to predict pump feasibility for a wide range of applications. This model was used to determine the minimum site characteristics required for common pump designs to produce various ranges of pressure. The minimum characteristics are presented in a table for reference. Additionally, the model highlights how pump feasibility is affected by the fall to length ratio, which is often absent from ram pump design documents.

7 IMPLICATIONS FOR TARGET AUDIENCES

This research provides a table that allows users to determine the minimum requirements of a site arrangement for a hydraulic ram pump of various sizes and materials to deliver water. This table can be used to quickly gauge the feasibility of a hydraulic ram pump project with more accuracy than previously possible. Additionally, the Matlab model available in the appendix can be used to analyze and compare a wider variety of designs and scenarios. The model highlights the effect of the fall to length ratio on pump performance, which is usually absent from ram pump design documents. This observation implies that stand pipes can be implemented on many systems to increase performance. The availability of these methods allows individuals and organizations to implement hydraulic ram pumps with more confidence. This will increase the sustainability and affordability of water systems in developing areas.