Hydraulic Ram Pump Pressure Release Mechanism- Summary

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Abstract: In order to start a hydraulic ram pump, the user must first manually prime the pump. This involves manually opening and closing the waste valve in order to begin the pumping cycle. As part of the ESW Philippines Ram Pump Project I lead the design and construction of a working lever prototype for 3” AIDFI ram pumps here at Northwestern. This summer I then traveled to the pump site in order to fully field test the mechanism. During field testing and observations, it became clear that the originally planned methods of collecting observations would have to be changed due to ram pump construction schedules, time constraints, and cultural respect. Detailed observations of AIDFI technician lever field testing was done at two scheduled primary tests. The field testing provided vital information regarding regular use and conditions of testing. The lever design itself also changed quite drastically during testing with the help of new information.

Methodology: With the help of current information regarding testing conditions, the lever was configured on site into two different configurations prior to Test #2 (Figure 1), in order to test both pushing and pulling motions at the suggestion of AIDFI. This required a moving of the hinge from the top to the bottom (Figure 2) and a reconfiguration of the lever head (Figure 1). Testing was then primarily aimed at determining what motion was most comfortable, natural, and easy to use. The user was then asked to use the lever in each configuration. The major areas that were assessed were potential safety hazards, possible areas for design improvements, parts performance, and feedback from the AIDFI technicians. Observations and input were recorded in test observations. Other things assessed included observation of the tool’s impact on the people most likely to use this mechanism— the village ram pump technicians. The walk from Tres Hermanos to the pump site was approximately 2 km of rough uphill road. Observing and also participating with technicians in carrying the lever and other necessary tools gave deep insight into what was needed in a good lever design.

Results:

Test#1

Test #1 revealed the startling realization that pulling was not quite as effective as first thought in the current configuration. Pulling was considered by our team to be the best method due to its advantages in safety and leverage. However, although pulling was able to successfully start the pump, a previously unknown requirement hampered the performance of the pulling motion: tank flooding. Each pump is surrounded by a concrete retaining wall that always assures a water level that completely covers the waste valve. The purpose of the pump submersion is to improve ram pump efficiency. Normal waste water flow however is not enough initially to fill this self-draining tank so it must be filled manually by the operator by holding open the waste valve. The pulling lever alternative was not able to do this because of its lack of reach. The pulling alternative was only capable of applying enough force to the valve for it to open. It was
designed only to open the valve and not to hold it down. Test #1 revealed that the lever must be designed so it could follow the arc of the valve and hold down the waste valve while not requiring the user to reach extensively. Reaching extensively can present many dangers to the user because time is needed for the lever to clear the shutting waste valve. A longer motion means less time for avoiding the shutting valve.

Pulling also left very little space for truly comfortable maneuvering due to the straight bar handle which is not helped by the limited space due to the flooding walls and air tank. It was observed that a well designed bend in the handle could greatly increase ease of use and possibly improve safety.

**Test #2**

Test #2 was conducted after a design change was made from Test #1 (see Figure 1). The head was reconfigured and the bar was bent to facilitate a more comfortable motion and make sure that the handle fully cleared the flooding walls and air tank. The immediate results of this was that the pulling motion was greatly improved and required much less reaching and the handle was able to completely clear the air tank.

The pushing alternative, because of its lower contact point and positioning was able to follow the arc of the waste water valve much more easily without requiring the user to move extensively. It was able to hold the valve down for complete flooding. However, being able to flood also presented a new problem. When the valve was ready to be released after flooding, the built up water flow slammed the valve shut with powerful force. Enough force for the swinging lever arm to potentially harm the user.

The pushing motion alternative showed great promise because it completely cleared the flooding walls and proved comfortable as well. However, kickback after flooding proved to be a problem as the user must prevent the lever from contacting the wall.

**Conclusion:**

Pushing seems to be the better alternative at this point in prototype testing. It is able to simply solve the problem of flooding by having a full reach and range of motion that allows it to flood and prime while pulling cannot. In order for the pulling alternative to do the same, it appears that a more complex head design will be needed. The bent handle also performed well, but it is clear that it will need a well designed handle for better comfort at all points of the arc. The handle must be designed to protect the user as well as improve comfort because of the flooding kick back. That in combination with a well bent handle should not present a great danger to a well trained user.
Figure 1: (Left) is the original lever design used during Test #1. (Right) The reconfigured head and bent bar used in Test #2

Figure 2: Shown is the bottom mounted hinge used in Test #2