ELECTRIC POWER SUPPLY MEASUREMENT AS AN ALTERNATIVE TO MEASURE FLOW-RATES OF HYDRAULIC PUMPS

EXECUTIVE SUMMARY

1. INTRODUCTION

Increasing demands on the water resources of Southern Africa requires improved management of this commodity. Water metering is generally accepted as one of the most important vehicles in appropriate management of water, and is widely applied in practice, usually by means of mechanical flow meters.

The agricultural industry's inadequate implementation of water measurement could be ascribed to a number of factors, and this project's aim is to investigate an alternative to existing methods of implementation.

2. PROJECT OBJECTIVES

The objective of this project is to develop a procedure, or method, by which water pumped with an electrically driven pump, can be metered indirectly.

3. BACKGROUND

3.1 What does the Water Act say?

The National Water Act (Act 36 of 1998) specifies that the government, as the public trustee of the nation's water resources, must ensure that water is protected, used, developed, conserved, managed and controlled in an equitable and sustainable manner for the benefit of all people.

Reliable data on discharges and water uses cannot be obtained without the measurement of flow at various points in the system with a pre-determined degree of accuracy. The measurement itself is not the end product, but only becomes meaningful in the context of overall water management.

3.2 What is really happening in practice?

Although policies that give guidelines for water measurement have been developed, limited implementation was seen since the proclamation of the Act in 1998. Except for the efforts at the WMP pilot study sites, very few irrigation boards (or WUAs) are making a concerted effort to implement measurement, and then usually because they have encountered management problems that cannot be overcome by any alternative other than direct measurement.

3.3 Problems experienced with conventional water metering

Mainly two types of flow meters are currently used for measuring river abstractions on irrigation schemes, i.e. mechanical rotor type meters and electromagnetic meters.
Factors which complicate the installation and management of devices for the measurement of water abstraction at remote points, has mainly to do with maintenance and reliability, the cost of the measuring device and the installation thereof as well as practical difficulties with the installation thereof.

3.4 Theoretical principles of proposed measurement procedure

The possible practical procedure to indirectly determine the volume of water pumped by measuring the power consumption of the pump has a firm theoretical basis.

The proposed method is based primarily on the assumption that the efficiency of the motor and pump combination is constant for a specific flow-rate of the pump, and that this efficiency does not change significantly over time. The efficiency of the pumping action (η_T) is a product of the efficiencies of the motor (η_E), the coupling (η_C) and the pump η_P, i.e. $\eta_T = \eta_E \times \eta_C \times \eta_P$. Variation of the η-value for pumps will occur over time, but this is not a rapid change, provided good management and operational principles are followed.

3.5 Pilot studies

During 1997 MBB did a project for DWAF on possible monitoring methods applicable on irrigation by means of pumping-stations from the Theewaterskloof Dam. The study showed that water metering through electrical power measurement has great potential.

During April 1998 MBB submitted a proposal to the Water Research Commission (WRC) for a project to this effect, and in April 1999 they commissioned MBB to carry out a preliminary investigation.

The results of this investigation showed that there is a well-defined relationship between the flow-rate of the pump and the electrical power supplied to the system. It further showed that it is practical to measure the appropriate parameters in the field.

4. METHODOLOGY

4.1 General

The three-year project term can briefly be divided into two phases:

- *a) A first phase of doing various measurements in the field and in the laboratory (pre-proto-type phase).*
- *b) The second phase, the proto-type phase, during which proto-type meters were built, installed and monitored at a number of pumping stations.*

4.2 Pre-proto-type meter phase

Various alternative procedures were tried at the beginning of this phase. Existing testing facilities were also visited. Eventually most of the work for this phase was done in the laboratory of the Cape Technikon, using pumping equipment made available by the Department of Agriculture, Western Cape.

4.3 Proto-type meter phase

Five test sites were identified for field tests. These were done in conjunction with the project team of WRC project K5/1265/4, who are researching the application of flow-meters in irrigation water management.

The proto-type meters were installed, calibrated and monitored at these five sites. Without compromising on the accuracy and usefulness of the results, calibration procedures were altered and made simpler during the course of the phase.

5. LITERATURE STUDY

In the search for relevant work related to this project, several Internet searches were conducted, at some stage with the assistance of a patent attorney. Little literature of particular value could be found.

6. DISCUSSION OF TEST FINDINGS

The findings of the different phases of the project are discussed under four headings. For the research situation the emphasis was different than what it would be for non-research situations (referred to as normal use installation). The main differences between requirements for the research and for a normal use installation are highlighted.

6.1 Suitability of sites

A substantial amount of energy was spent on identifying suitable sites for monitoring work. Reasons are given why this has been a fairly difficult operation, and why the normal use installation will be much easier.

6.2 Installation of meters

The installation of the meters for research purposes involved a large number of activities not required for normal use installations. Several visits to the site were necessary, which will not be necessary for normal use installations. An estimate of time and costs is given for normal use installations.

6.3 Calibration of meters and verification of readings

The research calibration procedure started off with a very broad approach. The procedure was refined to become much simpler during the monitoring process, without loosing accuracy of the readings. Reasons are given for this, as well as an estimate of *the time to do the calibration.*

6.4 Meter performance

From the readings of all the tests done (laboratory and field tests) it is evident that there is a good correlation between power used by the pump and the flow-rate of the pump. What is more important is that this correlation is measurable and also that repetitive measurements give similar results.

These findings enabled the project team to design the first proto-type meter. The monitoring done with the proto-type meter proved that the design meets the basic requirements for its application.

The failures experienced with some of the instruments will have to be eliminated in order to make a meter available with acceptable accuracy and reliability for water management and billing purposes.

7. THE PROTO-TYPE METER

7.1 Introduction

The objective of the meter, which is basically an energy meter, is to measure and store the total quantity of water pumped by an electrically driven pump. An internal mathematical equation and calibrated internal look-up tables convert the electric power used by the pump into a flow-rate, and also record the accumulative water quantity.

The meter is installed in the electric supply to the motor. The data is stored in non-volatile memory, and will not be lost even if the backup battery should fail.

7.2 Description

A description of the meter components is given, and the specifications thereof are listed. The installation - , calibration -, and the operating procedures are explained.

Exhaustive tests have been done on the correct operation and procedures, and the *project team is confident that the present format of the meter is well suited for the purpose it was developed for.*

7.3 Financial aspects

The financial implications involved in the electronic water metering procedure are broken down to four levels. These are namely the cost of the meter itself, the cost of installation and calibration, and the cost of maintenance.

The estimated total cost of the meter is summarised in Table 8.2.

7.4 Tampering issues

Potential tampering aspects with the meter are highlighted, and possible ways to deal with it are given.

7.5 Safety and quality issues

The components sourced for the prototype meters are of a good quality, and should meet the standards (safety and quality) required by industry.

It is recommended that a qualified person do the installation.

7.6 Legal issues

The opinion of knowledgeable people in this field is that no major problems are foreseen. It is suggested that the legal issue be included among those issues to be addressed in the way forward for this project.

7.7 Comparative position

Based on the findings of this research project a comparison was made between the electronic water meter and other conventional methods. This comparison appears in Table 8.3. The remarks as it appears in the table reflect how the electronic meter compares with other conventional methods.

7.8 *Issues related to feasibility and acceptance*

Preliminary results show that this procedure can be accepted as a practical method to measure the volume of water used with an acceptable level of accuracy.

The fact that the meter must be recalibrated periodically is not necessarily a disadvantage, since these actions serve as a useful preventative pump maintenance operation, which would otherwise probably be neglected by management.

7.9 *Possible improvements*

A list of relatively small changes to the proto-type meter (mainly programming) is given. Apart from these issues, other useful aspects to investigate for implementation are also given.

8. *CONCLUSIONS*

The success of the project can be measured by comparing the results / findings against the project objectives. The objective of this project was namely to develop a certain measuring procedure, or method. In order for this procedure to be practical and acceptable by the industry (users of water), four criteria were specified. These criteria had to be kept in mind in developing the procedure.

The project team is of the opinion that the project objectives, as well as the criteria for accuracy and acceptability have been met. The method that was developed may well be accepted in the future as a practical alternative to measure water consumption at electrically driven pumping installations.

9. *THE WAY FORWARD*

The way forward will to a great extent be determined by the opinion of the steering committee of this project, as well as the WRC. A number of aspects to be considered in the way forward are listed and motivated.

10. CAPACITY BUILDING

During the more than three years that the project lasted, capacity building occurred, and mainly centered on personnel and students of the CT. The most important actions in this regard are described. Capacity building also occurred through regular contact with farmers and personnel of WUAs during the monitoring process.