PN-ABP-318

PRIDE

Project in Development and the Environment

Technology Review, Assessment and Recommendations for Water Filtration Systems

February 1993

Submitted to:
USAID/Washington
Submitted by:
PRIDE
AID Contract Number:
ANE-0178-Q-00-1047-00
AID Project Number:
398-0365

Sponsored by:
USAID/NE/DR/ENR
Operated by:
Chemonics International
and its associates

2000 M Street, NW, Suite 200, Washington, DC 20036
Telephone: (202) 331-1860 · Fax: (202) 331-1871

The objective of the Project in Development and the Environment (PRIDE) is to help the U.S. Agency for International Development (AID) design and implement programs that foster the agency's environmental and natural resources strategy for sustainable economic growth in the Near East and Eastern Europe.

PRIDE provides AID and participating countries with advisory assistance, training, and information services in four program areas: (1) strategic planning, (2) environmental policy analysis, (3) private sector and NGO institutional strengthening, and (4) environmental information, education, and communication.

The project is being implemented by a consortium selected through open competition in 1991. Chemonics International is the prime contractor; subcontractors include RCG/Hagler, Bailly, Inc.; Science Applications International Corporation; Capital Systems Group, Inc.; Environomics, Inc.; Industrial Economics, Inc.; Lincoln University; and Resource Management International, Inc. In addition, AID has entered into a cooperative agreement with the World Environment Center to support implementation of PRIDE.

The opinions expressed in this paper are those of the author(s) and do not necessarily reflect the positions of the sponsoring agency or contractors.

Printed on recycled paper

PN-ABP-318

INNOVATION
an engineering firm

Technology Review, Assessment and Recommendations

for

ELCO Sp. z o.o.
Ul. Gorczewska 62/64
01-401 Warszawa, Poland
Tel: 360155
Telex: 812299
Fax: 363285

INTRODUCTION:

On December 10, 1992, I visited ELCO, a manufacturer of water filtration systems located in Warszawa, with Dr. Kenneth Macek, the PRIDE Environmental Business Development Specialist for Warszawa. The purpose of the visit was to review and assess ELCO's water filtration systems and make technical recommendations for their improvement.

ASSESSMENT:

ELCO's primary area of expertise is in environmental science with an emphasis on mechanical engineering.

The equipment that ELCO presently offers for sale is relatively low cost, entirely mechanical and uniquely manufactured for each individual situation.

ELCO is in the early stages of product development and presently has only a few operating systems installed.

The operating equipment that I saw was a four unit water filtration system that is used to remove high concentrations of iron and manganese that can cause water discoloration, staining of fabrics and clogging of pipes. The system uses an aspirator that adds a small amount of air into the water of the pressure tank (see example, figure 1). This small amount of air in the water changes the dissolved iron and manganese, by precipitation, into rust and solid manganese. The rust and solid manganese particles are then filtered from the water in a nonchemical filter bed. The filters are cleaned manually by reversing the direction of water flow (a process called back-washing) approximately fifteen minutes once every two weeks. The procedure is done by manually opening and closing, in sequence, a series of water valves.

The design is technically sound. If the system is periodically cleaned (backwashed), it will function effectively. However, in certain respects, the design is impractical and uneconomic.

According to Jerzy Gorski, ELCO's president, ELCO's systems are manufactured one at a time and each system is unique.

The system that I saw did not have:

(1) operating or maintenance instructions;

(2) any means of identifying valves, or valve positions;

(3) standardized parts;

(4) a means of controlling the back washing proceedure; and

(5) any adjustable way to regulate discharge flow.

EVALUATION:

The design of the filtration system appears to be sound and in conformance with the principles and practices of similar systems used in the United States. However, the system's effectiveness can be greatly improved by:

(1) automating the cleaning process (backwashing) using electrically operated solenoid valves; and

(2) providing a means to regulate back washing water flow discharge (see figure 1).

This would significantly improve the system's effectiveness, reliability, fault tolerance and simplicity of operation.

RECOMMENDATION:

In conversations with ELCO's chief scientist, with Dr. Macek acting as a translator, I suggested that the product be redesigned for mass production with an emphasis on cost, maintainability, ease of manufacturing and reliability as design concerns. I also suggested providing maintenance, operating instructions and labeling valves, units, positions and other elements of the system. At a small cost, this would reduce operating problems customers were experiencing with the system. For example, I observed that a problem with bacterial growth that the customer attributed to equipment failure was resolved by an experienced ELCO technician simply cleaning (backwashing) the system properly.

I believe that the two most cost-effective, technical improvements for ELCO would be:

(1) the automatic control of filter cleaning; and

(2) control and regulation of backwashing water flow discharge.

The equipment needed to complete these two improvements is commercially available. They would not require a high level of electrical expertise to develop.

The proposed improvements would be compatible with ELCO's equipment and European electrical standards of 220 volts alternating current (VAC) @ 50 Hertz (HZ). They would be extremely low in cost, reliable, simple to operate and easy reconfigured for different applications.

I recommend using "off the shelf" irrigation products that are available in the United States and Europe and have selected Hardie Irrigation's products as being the most comprehensive and responsive to ELCO's needs. I am including Hardie's United States and international catalogs, with United States price lists, for ELCO's consideration. Hardie Irrigation has three separate locations:

(1) For products with American electrical power standards of 120 Volts, 60 Hertz:

Hardie Irrigation
Turf Products
788 Fairview Drive
Carson City, Nevada 89701-5456 USA
Tel: (800) 634-8873

(2) For products with European electrical power standards of 220 Volts, 50 Hertz:

Hardie Irrigation
International Division
1588 N. Marshall
El Cajon, California 92020 USA
Tel: (619) 562-2950
Fax: (619) 258-7960
Telex: 5719648

(3) Hardie's master distributor in Europe is:

RIS Irrigation (Italy) S.A.
Loc Prato Della Corte
Lott Scirocco 00065 Fiano Romano
Roma, Italy
Attention: Mr.Gianni Benna
International Sales Manager
Tel: (39 76 455 201
Fax: 39 76 455 386

A detailed working design is not possible without knowing water pressure, required flow, valve configurations, water quality and other specific site characteristics. However, I have developed a general design, which is depicted in figure 1.

The general design I have developed uses the concept of "one size fits all" modular design--meaning that it uses one standard class of parts (e.g., controller, valves) that can be reconfigured to different models or versions of a product. It is a common misconception that each model or version of a product must use totally different parts to minimize cost. The theory of this approach is that a company can save money by using, for each componet of a system, the least expensive part capable of performing the necessary function of that component. This approach considers equipment costs and ignores other costs such as inventory costs, design time costs, documentation costs and maintenance costs.

For instance, because the design example has only two valve states, a simple double pole double throw (DPDT) relay with a timer, or switch for manual control, could have been used. However, this would not have allowed for modifications; it would have required a separate power supply for the timer, valves and relays or 220 volt equipment, which would, in turn require costly 220 volt wiring. This type of "unique" design for each model or version of a product is very costly, time consuming and inappropriate.

As shown in figure 1, the United States catalog for Hardie Irrigation products, which can be cross referenced to the international parts catalog with 220 Volt 50 Hertz power, provides possible equipment choices. For simplicity I assume that the valves will interface to straight in-line pipe with 1 inch standard National Pipe Tread (NPT) threaded connections.

The controller and valve models that might be used are:

Controller model	page #	cost	Valve model	Catalog page #	cost
TC-6EX	10	$185	2400 TF	18	$24
RD 600EX	11	$143	2400 T	18	$22
446PR	13	$119	HRI-T	19	$25
H-4000-1	14	$60	HRI-TF	19	$27
304PR	15	$105	205-T	21	$22
			205-TF	21	$24
			700130	23	$48
			703130	23	$105
			102130	25	$88
			103130	25	$113
			311A	27	$36

The costs are for single unit retail purchases and the actual purchase prices would be less depending on the quantities purchased. All costs are in U.S. dollars and are for single unit sales.

The choice of a controller for a particular system depends upon the controller's ability to power the required number of valves, simplicity of operation, ease of programming, versatility, flexibility, fault tolerance (shorted valve detection, battery backup), environmental packaging and cost. For this system, I would always specify outdoor self contained power supply configurations.

The choice of valves for a particular system depends upon the required flow rate, water quality and quantity. Valves should be selected based upon their flow control, filtering and pressure regulation capabilities and for ease of cleaning and replacement. Maintainability, available valve configurations, environmental considerations and cost should also be considered.

For example I would choose normally open (N.O) (water can go through when power is not available) valve configurations for valves Z4 & Z7 and normally closed (N.C.) (water cannot go through when power is not available) valve configurations for valves Z3 & Z6. This type of fault tolerant design would allow filtered water to flow to facilities (normal operation) in the event of a valve or controller failure or a loss of electrical power.

If a valve with internal flow control capabilities, such as a 713DPR or 311A on page 26 of the Hardie Irrigation U.S. catalog, is used for valve Z6 in figure 1 it will have a flow regulation function and the constant flow regulator can be eliminated. This will significantly reduce total component cost, improve reliability (fewer parts) and improve maintainability (fewer parts to maintain)

The foregoing recommendations are an attempt to convey to readers whose technical backgrounds are unknow an engineering design and implementation methodology using electrical engineering terminology. It was impossible, in the time alloted, for me to investigate and weigh every possible factor that ought to be considered in developing a final, detailed design for a specific system. Therefore, in implementing these design recommendations, it is important to keep in mind that the general design I have recommended is not intended to be a schematic and that the final designs that are developed must take into account the current availability and cost of components, the local operating environments, the level of expertise of available personnel and other factors that I was not in a position to specifically evaluate.

Hardie/Richdel
Controller
Models

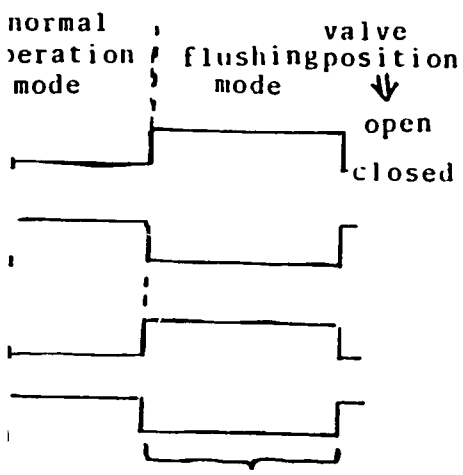
TC-6EX
RD 600EX
446PR
H-4000-1
304PR

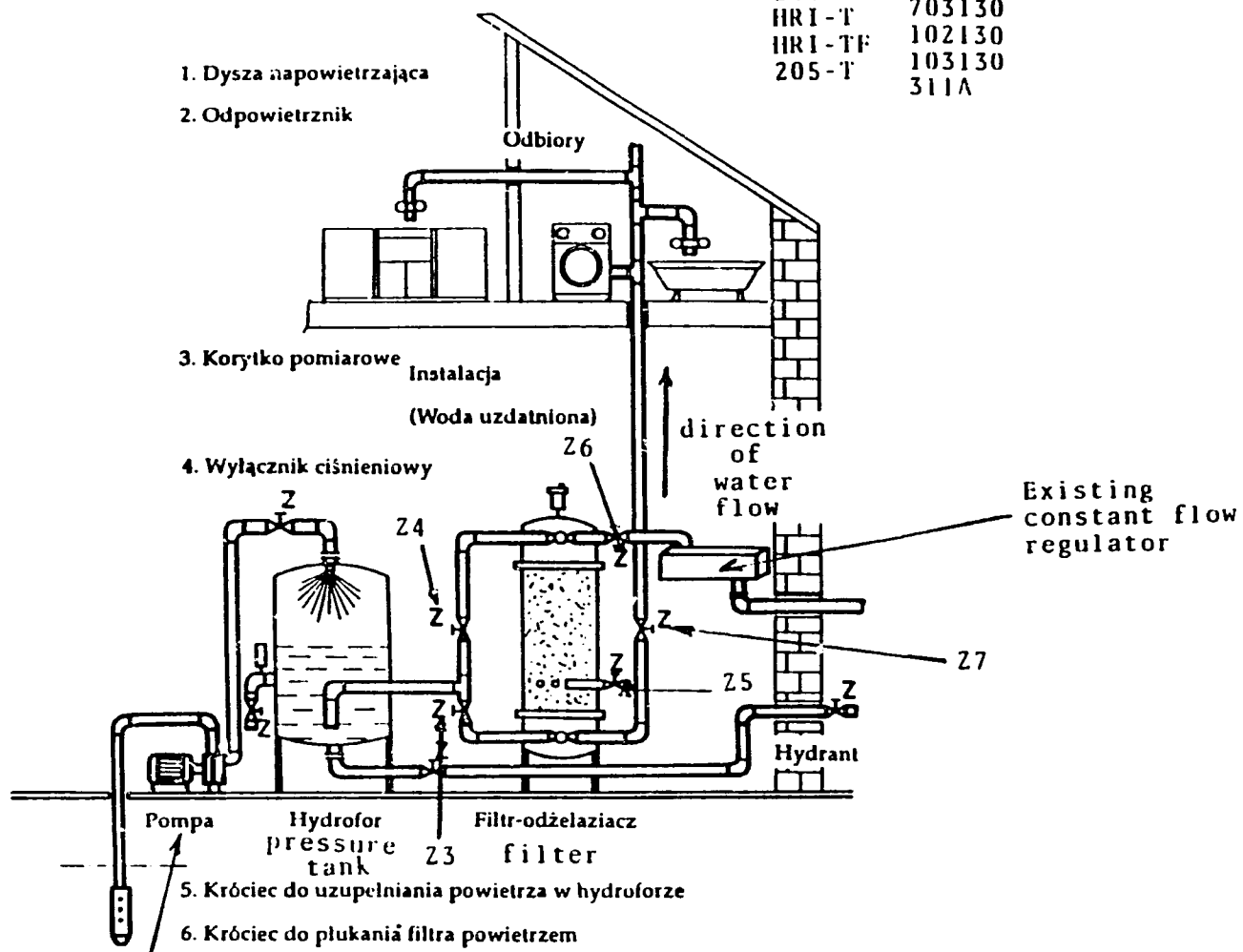
Z3 Z4 Z6 Z7

Hardie/Richdel
Valve
Models

Z3, Z4
Z6, Z7

2400 TF	205-TF
2400 T	700130
HRI-T	703130
HRI-TF	102130
205-T	103130
	311A





operation

	Z3	Z4	Z6	Z7
normal	cl	op	cl	op
flush	op	cl	op	cl

Note: Z3, Z4, Z6, & Z7 are flush control valves

Figure 1 Elco Example Operation