ENERGY SAVING IN PRESSURIZED IRRIGATION NETWORKS

ECONOMIE D'ENERGIE DANS LES RESEAUX D'IRRIGATION A PRESSION

Nosratollah Assadi[1] and Hamed Hadidian[2]

ABSTRACT

In the arid and semi-arid country Iran where fresh water availability is limited, adoption of pressurized irrigation system, as against the water-wasting flow irrigation is advocated. However, adequate energy availability and its efficient use are also important if the pressurized irrigation were to be adopted on a large scale.

In this paper, energy usage methods for operating pressurized irrigation system are studied for the Leylanchay Pressurized Irrigation Network for the following two situations:

1) *Energy supplied by pumping stations and*
2) *Energy supplied by the difference of head between the Leylanchay reservoir and the water intake of the pressurized irrigation network.*

Two cases were evaluated on 4000 ha fields in Leylanchay irrigation and drainage network. This study focused on economic analysis of irrigation costs, both ownership and operation. The study highlights key differences in the system design, cost and input requirements to provide stockholders with the background to choose a system that gives the best returns for their investment.

It is concluded that the using the height difference between Leylanchay reservoir dam to beginning of pressurized irrigation network consumes less energy and delivers more water than using centralized pumping station. It has better irrigation scheduling, seepage and evaporation reductions, less operation and maintenance costs, energy price bargains, and less labor requirement.

Key words: *Pressurized irrigation, Gravity force, Water pumping, Operation and maintenance cost, Lelanchay irrigation nerwork, Iran.*

1 Senior Irrigation & Drainage expert & Project manager in MahabGhodss consulting engineering, E-mail : noassadi@yahoo.com
2 Civil & Hydraulic engineer & Expert in MahabGhodss consulting engineering

RESUME

Dans les pays arides et semi-arides tels que l'Iran où la disponibilité de l'eau douce est limitée, il est proposé d'adopter le système d'irrigation à pression par rapport au système d'irrigation de gaspillage d'eau. Cependant, la disponibilité d'énergie suffisante et son utilisation efficiente sont également importantes si la méthode d'irrigation à pression devait être adoptée à grande échelle.

Dans ce rapport, sont étudiées les méthodes d'utilisation d'énergie pour le fonctionnement du système d'irrigation à pression de Leylanchay dans le cas de deux situations suivantes:

1) *L'énergie fournie par les stations de pompage et*
2) *L'énergie fournie par la différence de la perte de charge entre le réservoir Leylanchay et la prise d'eau du réseau d'irrigation à pression.*

Deux cas ont été évalués sur une superficie de 4000 ha de terre du réseau d'irrigation de Leylanchay. Cette étude a mis l'accent sur l'analyse économique des coûts d'irrigation - de la propriété et de l'exploitation. L'étude a souligné les principales différences de la conception du système, des exigences de coût et d'entrée pour fournir aux parties prenantes le plan du système qui donne les meilleurs résultats pour leurs investissements.

Il a été indiqué que la différence de hauteur entre le barrage réservoir de Leylanchay au début du réseau d'irrigation à pression consomme moins d'énergie et fournit plus d'eau par rapport à la station de pompage centralisé. Le système possède le meilleur régime d'irrigation, de réduction d'infiltration et d'évaporation. Il réduit aussi les coûts d'exploitation, de maintenance et d'énergie. Il exige moins de main d'œuvre.

Mots clés: *Irrigation à pression, force de gravité, pompage de l'eau, coûts d'exploitation et de maintenance, réseau d'irrigation de Lelanchay, Iran.*

1. INTRODUCTION

In pressurized irrigation methods energy can be provided by the pumping station and in certain circumstances by gravity utilizing the height difference between the source and location of water supply intake.

The basin where the Lelanchay pressurized irrigation network is located, ranges in altitude from 1307 and 1460 m above the mean sea level. In this paper, providing require head for pressurized irrigation network are studied for two alternatives in order to replacing an open ditch irrigation delivery system and pumping stations with buried GRP and Polyethylene pipelines to distribute gravity-based pressurized irrigation water.

Alternative 1) By pumping station

Alternative 2) By gravity pressurized Irrigation delivery system, using the height difference between leylanchay reservoir dam to the intake of the pressurized irrigation network.

2. BASIC INFORMATION

The Leylanchay catchment area is located between 46°, 08' - 46°, 18' (E.long) and 37°, 07' - 36°, 55' (N.lat).

2.1. Climatology

Average annual precipitation of Leylanchay watershed basin is about 370 mm. The different climatological parameters are presented in the Table.1

Table 1. Climatological parameters (all are average annual values)

Precipitation	307 mm
Temperature	12°C
Relative humidity	61%
Evaporation	1485.3mm
Potential transpiration	1188.0mm
Wind speed	2.5 m/sec

2.2. Dam Properties

The reservoir dam of Leylanchay is located at north-western part of Iran and at the south-western part of Eastern Azarbaejan Province.

Table.2 leylanchay dam properties

Dam Type	Earth fill with impervious core
Crest and river bed elevation	1495m,1432m
Crest Length & width	364m,12m
Volume of material in dam body	2.5 million m^3
Height of Dam from foundation & river bed	70m, 63 m

2.3. Irrigation System

Irrigation and drainage network of Leylan area, has a gross area of 7000 ha, from which 4000 ha are for new development and the remaining area (3000 ha) is regarded as water right provision.

The only resource of water for provision and development area of water is Leylan dam which is located 23 km away from Leylan town. Due to rough topographic condition of Leylan area, planning for flow irrigation is difficult and, therefore, pressurized irrigation systems (sprinkler, drip) are considered. The suggested cropping pattern for Leylan project consists of 80% annual crops (sprinkler Irrigation) and 20% orchard (drip Irrigation).

2.4. Project Development Zones

The Leylan region is divided into 9 developmental zones. The general data of the above-mentioned zones are presented in Table 3.

Table 3. The general data of developmental zones

Zone No	Name of village	Gross Area (ha)
1	Tazeh Kand	341
2	Jogalou	786
3	Lotfabad	236
4	Hassan abad	350
5	Leylan	856
6	Abdol abad	115
7	Gandehar	612
8	Gareh Khezr	659
9	Hossein abad	195
Total		4611

3. IRRIGATION AND DRAINAGE ALTERNATIVES

Two alternatives for Leylanchay irrigation and drainage network are identified for this evaluation.

3.1. Alternative 1

Joghaloo diversion dam was designed on Leylanchay River near Joghaloo village, downstream of Leylanchay reservoir dam. This diversion dam diverts all or a portion of the flow of the Leylanchay River into a main canal (FC) and pumping station no 1 (Fig. 1 Alternative 1).

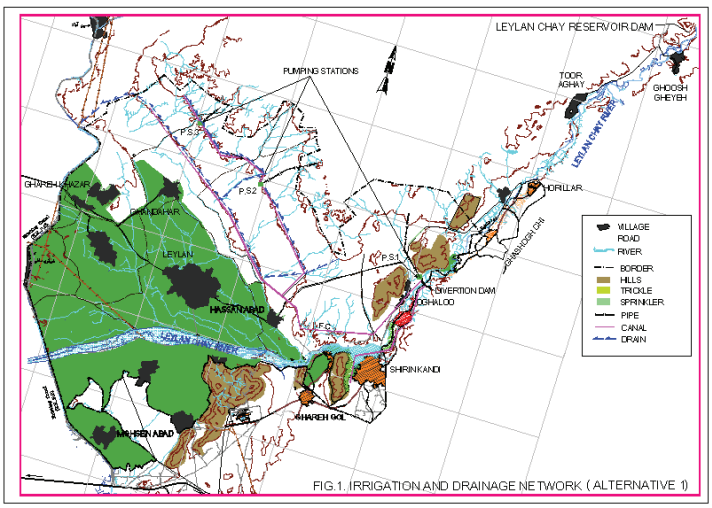

FIG.1. IRRIGATION AND DRAINAGE NETWORK (ALTERNATIVE 1)

Pumping stations no 2 and no 3 deliver irrigation water from main canal into the pressurized irrigation system.

In this alternative, pumping stations supply pressure head and irrigation water for 1550 ha of sprinkler and trickle irrigated farms. The water is then applied to crops through sprinkler systems, typically moving sprinkler irrigation. Surface irrigation is used for 2450 ha of project area.

3.1.1. Components of Alternative 1

Pumping stations. Table 4 shows characteristics of main pumping stations in alternative 1

Table 4. characteristics of main pumping stations

	Pumping station No 1	Pumping station No 2	Pumping station No 3
Discharge(cms)	0.458	0.333	0.417
Conveyance pipe length(m)	850	1000	1300
Pumping height(m)	53	53	87
Required Pump No.	3+1	2+1	3+1
Required Energy(kw)	450	300	610

Diversion dam. Joghaloo diversion dam was designed on leylan chay river near Joghaloo village, downstream of leylanchay reservoir dam. The Diversion dam specifications are:

Spillway type: concrete ogee crest

Spillway length: 40 m

Design flood discharge: 203 CMS

Height: 8.5 m

Others. Total concrete canal length: 35 km; Total earth drain length: 20 km.

3.2. Alternative 2

In this alternative, conveyance pipe (CPL), delivers water directly from Leylanchay reservoir dam to pressurized irrigation network and pressure head for sprinkler and trickle irrigation farm systems is supplied by height difference between leylanchay reservoir dam and the intake of the pressurized irrigation network (Fig. 1 Alternative 2).

3.2.1. Components of Alternative 2

Gravity conveyance pipe. Gravity conveyance pipe specifications are:

Length: 9 km

Diameter: 1400 mm

Type: GRP

Nominal pressure: 6 bar

Total main pipes. The main pipes specifications are:

Length: about 62 km

Diameter: from 125 mm to 1400 mm

Type: GRP and HDPE

Nominal pressure: From 6 bars to 10 bar

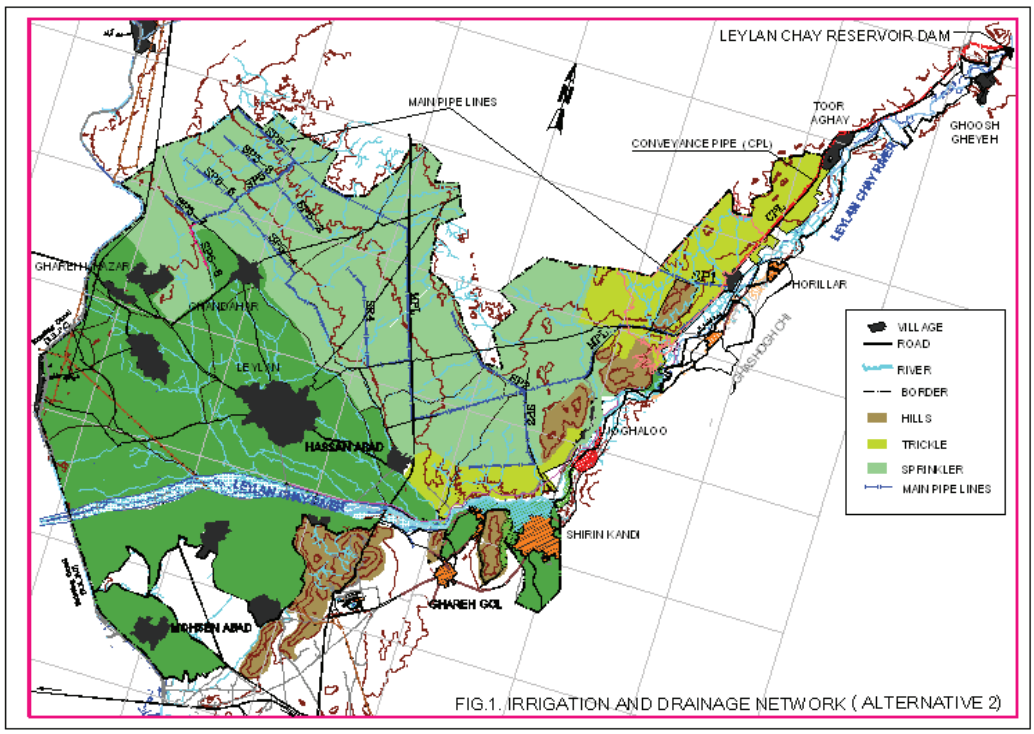

FIG.1. IRRIGATION AND DRAINAGE NETWORK (ALTERNATIVE 2)

4. CONCLUSIONS

Irrigation and drainage network in alternative 2 includes the construction, operation and maintenance of GRP and Polyethylene pipelines that provide for the delivery of gravity pressurized irrigation water to approximately 4000 ha surrounding Leylan plain, eliminating most of the need for pumping powered by electric motors. Water would only be drawn from the pipe when irrigation is required, eliminating overflow to the Leylanchay River. This network would eliminate about 90% of the water seepage loss from the canals and would eliminate the need for approximately 1,400 kw of electric motor pumps.

Pipelines are slowly gaining acceptance as a viable alternative to open canal as a means of distributing irrigation water.

Land tenure problems can be reduced to the point of elimination with pipe line, especially when a distribution system has to be routed through existing farmland having small, irregular and fragmented holdings. An underground pipe occupies no land that can be used for crops, nor does it interfere with land boundaries. Management losses, the biggest single contributor to canal water loss and low efficiencies, are potentially close to zero with closed or semi-closed pipeline.

Flexible delivery systems, in which the farmer is encouraged to take water as and when he requires it, are achievable with a pipeline but far more difficult with open canals.

Irrigation and drainage network costs in two alternatives are presented in Tables 5 and 6, respectively for Alternative 1 and Alternative 2.

Table 5. Irrigation and drainage network Costs-with diverted dam: Alternative 1

No.	Note	Cost (M.RLS)
1	Main network and related structures	50506
2	Joghaloo Diversion Dam costs	18458
3	sub main network with farm pumping stations	67702
4	Leveling costs	24350
5	Main pumping stations Costs	22605
6	Row 1 to Row 4	183622
7	Total with coefficients	290985

Year: 2006 Million Rials

Table 6. Irrigation and drainage network Costs-without diverted dam: Alternative 2

No.	Note	Cost (M.RLS)
1	Main network and related structures	85500
2	sub main network	94500
3	Row 1 to Row 2	180000
4	Total with coefficients	285246

Year: 2006 Million Rials

Tables 5 and 6 show that total cost of pressurized irrigation system in alternative 2 is less than alternative 1 and gravity-based pressurized Irrigation delivery system eliminates the need for approximately 1,400 kw from electric motor pumps and save electrical energy about 3.1 MWH.

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