REGULATOR RESERVOIR IN PRESSURIZED IRRIGATION NETWORKS
(CASE STUDY MOSALLASE GIVI IRRIGATION NETWORK)

Le rôle de réservoir REGULATEUR en gestion des opérations AMÉLIORATION DANS DES RESEAUX d'irrigation sous pression

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ABSTRACT

Efficient use of both water and energy resources are vital for productivity increase in agriculture, simultaneously maintaining environmental sustainability. Soil and water resources of arid and semi-arid regions can be managed to sustain the productive capacity of the land and to better cope with water scarcity. In this context, optimal use of water and applying modern irrigation techniques such a pressurized irrigation are needed. In pressurized irrigation system running energy expenditure is high. Energy can be supplied by pumping and in some cases by gravity when there is a good head difference between, say a reservoir and the intake of the pressurized irrigation network.

Mosallase Givi irrigation and drainage network is located in northwest of Iran in Ardebil province. Givi reservoir dam was constructed on Givi river is the source of water for the network. Project area is about 4500 ha and according to the limitation of water and soil resources, just about 2200 ha can be covered by trickle irrigation system. Since Givi project area is in a steep mountainous region. The head difference between the point of water diversion from the Givi reservoir and the irrigation network is about 180 m.

In this paper, two approaches were studied in designing of Givi irrigation network. In the first approach the design was based on sub-main and main pipe lay out from the reservoir to the farm. In second approach at the beginning of each sub main pipe a regulator reservoir was planned to store and supply water to the farms located at the downstream of the sub main pipe.
After comparing these approaches, the second approach was found better due to less operation and maintenance costs, better irrigation scheduling and less total capital costs.

Key words: Pressurized irrigation, Energy need, Regulating reservoir, Mountainous region.

1. INTRODUCTION

Water scarcity is one of the most prominent issues of discussion worldwide concerned with sustainable development, especially in the arid and semi-arid areas.

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Due to arid and semi-arid climate in most parts of Iran, fresh water is always scarce though it has a major role in agricultural economy. Soil and water resources of dry lands can be managed to sustain the productive capacity of the land and to better cope with water scarcity. For this, optimal use of the available limited fresh water and adopting modern and water-saving irrigation techniques are needed. The piped irrigation water supply system such as pressurized irrigation (trickle or sprinkler) is an effective solution for achieving water saving in irrigation. In this method, evaporation and seepage losses of water are avoided. The cost and energy required to install piped system can ultimately be repaid by the water savings and yield improvement.

Numerous pressurized irrigation systems have been developed during the last decades resulting in improved irrigation quality and water distribution efficiency. However, operation, maintenance and management of pressurized irrigation systems require technical expertise and knowledge which makes it difficult for local farmers in developing country such as Iran.

2. MATERIALS AND METHODS

2.1. Project Location

The project area is located between 48º, 19´ to 48º, 14´ E longitude and 37º, 41´ to 37º, 35´ N latitude in the north west of Iran and south of Ardebil province. The project area is bounded by Soorebaragh rood in the north, Givi River in the east, Sangvar River in the west and Firozabad village in the south.

2.2. Meteorological Data

Climate. Project area is classified as cold semi-arid. High altitude causes that the winter precipitations coming in the form of snow.

Annual precipitation. The major resources of precipitations in project area are moisturized systems that enter the area from October to May. Average annual Precipitation in project area is 325mm.

Temperature. The average annual temperature is about 9.8ºC. The minimum temperature is - 38.5ºC and the maximum is 43ºC. The coldest month in the year is January and the warmest month is July.

Frost days. In project area there is 129 days in a year when the temperature is sub-zero.

Relative humidity, Minimum RH occurs in summer and the maximum occurs in winter. The average relative humidity in the project area is about 57%.

Sun shine hours. Most of the sunny hours have been observed in July and the least have been recorded in January. Average sunny hours are 2654 hours per year.

Wind speed and direction. The average wind speed is 1.66 m/s. The wind direction in October February and March is from east to west and in the other months is west to east.

2.3. Development Plan

Among the different types of irrigation delivery schemes, the on-demand scheme offers the greatest potential. This scheme provides farmers with great flexibility, allowing them to adjust water application to crop water requirements. On-demand design of collective irrigation networks must meet the discharge requirements during the peak period. A minimum hydrant pressure must also be guaranteed to ensure appropriate on-farm performance.

Pressurized (Trickle and sprinkler) irrigation system is selected for this project so all of the conveyance systems comprise pressure pipe network.

As mentioned before, there is a large height difference between the first point (point of diversion) and last point of irrigation network. This height difference is about 180 m. Pressure release valves are use for decreasing dynamic pressure, but these valves cannot decrease static pressure head.

In this paper, two approaches were studied in designing of Givi irrigation network for managing the high and extra pressure in the system.

3. ALTERNATIVES

The purpose of this paper is to identify the effects of regulating reservoir in pressurized irrigation networks, replacing high pressure pipes with regulator reservoir and low pressure pipes.

3.1. Description of Alternative Plans

Two project alternatives are identified for this evaluation. These are:

Alternative A: Using high pressure pipes and instruments and
Alternative B: Reservoir for regulating the pressure and store water.

Alternative A. In this alternative (Fig. 1), along the pipes path, considering the changes in static pressure, pipes nominal pressure changed too. Based on this approach, pipe lines are chosen among 6 bar to 25 bar classes. Also valves and other facilities are compatible with high pressure. According to this approach, the operational pressure is higher than required and suitable for the sub mains in the irrigation network. So, pressure break valves and safety facilities were designed to regulate the pressure in the network. In this approach it is noticeable that:

- When the pressure is going to be higher than the required pressure in the system, higher pressure pipes and regulation valves and safety facilities must be selected, which increase networks costs and makes operation, maintenance and monitoring of irrigation system more complicated than usual.

- Based on this principal that the irrigation must occur 24 hours a day, if for some reason one or more of the farms could not use its time for taking water from its turnout, it may make many problems for covering the demand of that farm in the future.

Alternative B

In this alternative, regulator reservoir is used for decreasing static pressure head along the pipes network. When the pressure gets higher than operating pressure; a reservoir was designed to prevent the increasing of the pressure. These reservoirs would store water when system demand is low and release it when the pipeline needs more water (Figure 2).

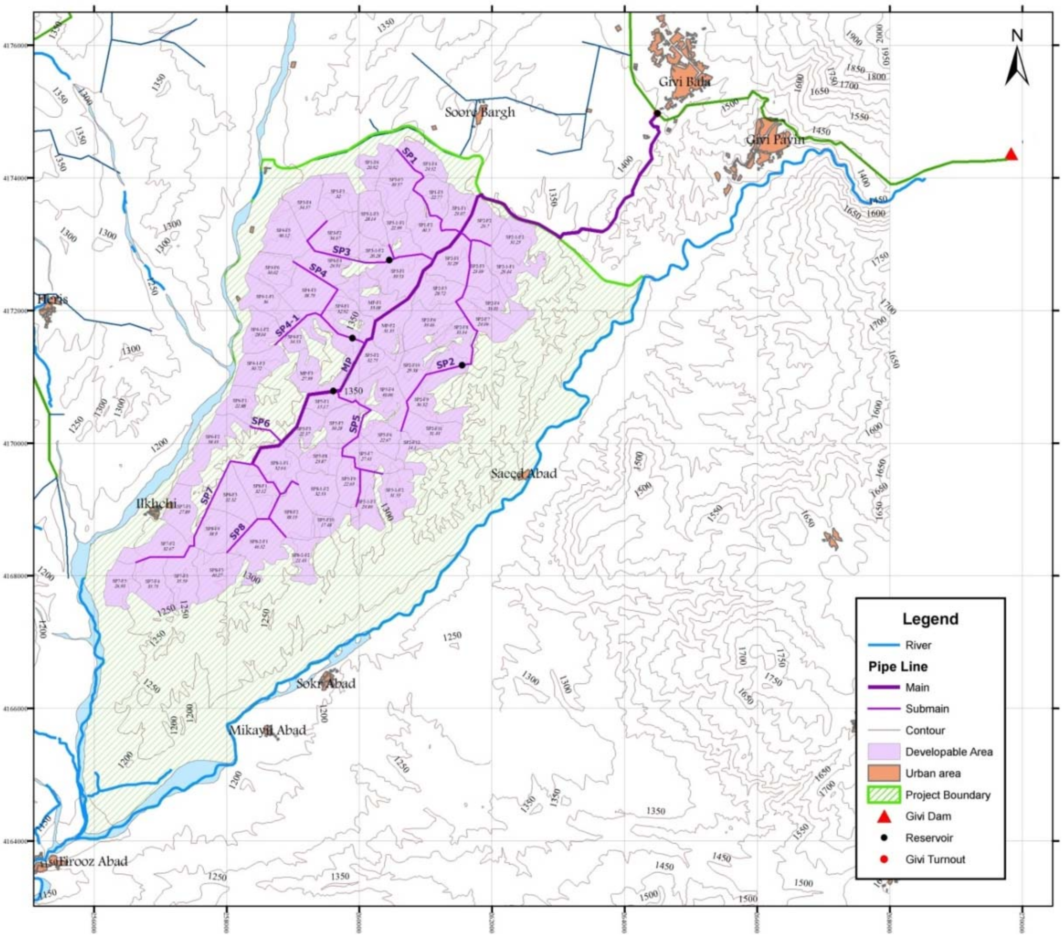

Figure 1. Project layout

In this case water from a pressurized pipe comes to the open reservoir (regulator structure). Another pipe conveys water from reservoir to the system with pressurized situation.

- Open reservoirs was mentioned for regulating the pressure in the system, According to that, the pipes in the irrigation network were chosen among usual classes such as 6bar and 10bar and rarely 16 bar. The costs of irrigation network are more reasonable than the first approach.
- Since there are some reservoir already designed in the network, so the minimum number of regulation valve and safety instrument (for preventing the surge problems) are required.

Irrigation regulating reservoirs shall have a usable capacity sufficient to permit the existing irrigation stream to be regulated so that irrigation water can be applied with a high efficiency.

Due to the differing requirements between agriculture and subdivision watering demands, no flow fluctuations beyond the point of the diversion will be acceptable to the district unless special district consent is given. If storage is required, underground storage or a pond may accomplish it. The storage facility shall be sized to accommodate water flow during the demand period without exceeding the daily water right of the property. The purpose of the storage facility is to store water during the low periods of demand in order to provide the increased flow during the anticipated watering window of the subdivision. The storage facility will also allow a constant flow of water onto the property from the point of diversion.

Elevation changes within the system shall be carefully considered so that the pressure in the system does not exceed 90 psi. If there is more than a 20% pressure variance in the system, pressure regulators shall be used at the individual lot services. Mainline pressure regulators shall be used as necessary to equalize system pressures within the pipelines.

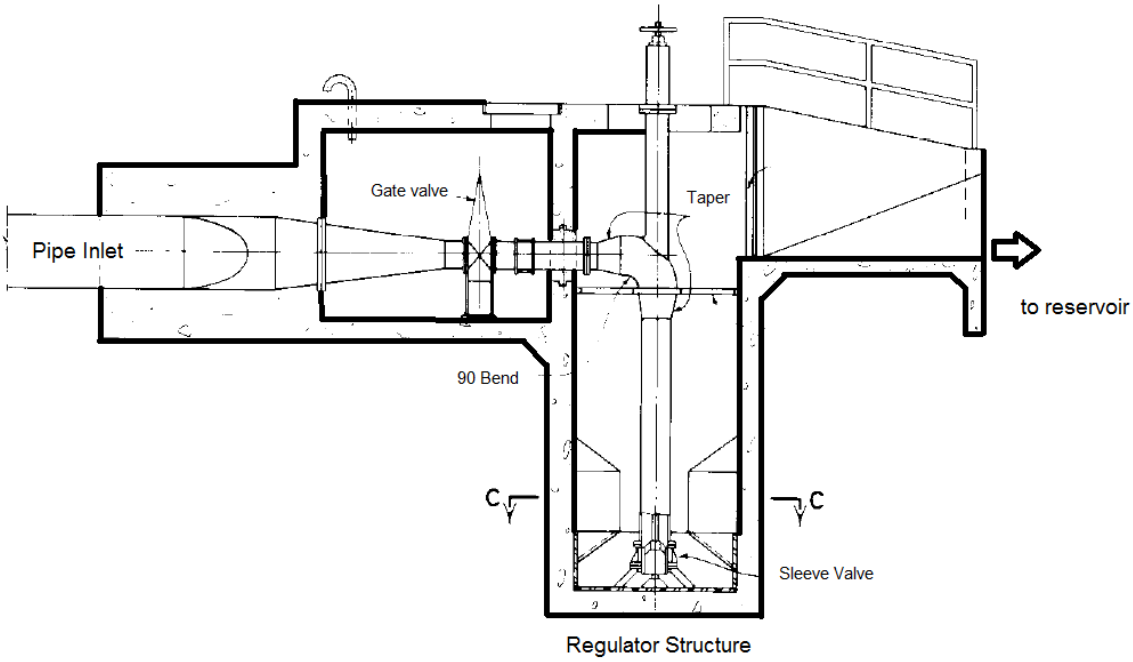

Figure 2. Regulator Structure (energy dissipater) before reservoirs

4. SUMMARY AND CONCLUSIONS

Comparison of the approaches

In the first alternative the network was designed in classic form while the pressure wasn't normal and it made the designers to use high pressure pipes and a large number of regulation valves and safety facilities. It made the costs of the network too high and the operation and maintenance could also be complicated. The comparison of the prices for the two alternatives is shown in Table 1 & Fig 3).

Table1. Comparison of costs (in Rials) between Alternative A and Alternative B

Cost (RLS)	**Pipes**	**Reservoirs**	**Regulating and safety facilities**	**Total(RLS)**
1st alternative	33,487,462,973	0	1,500,000,000	34,987,462,973
2nd alternative	29,010,576,965	1,202,500,000	0	30,213,076,965

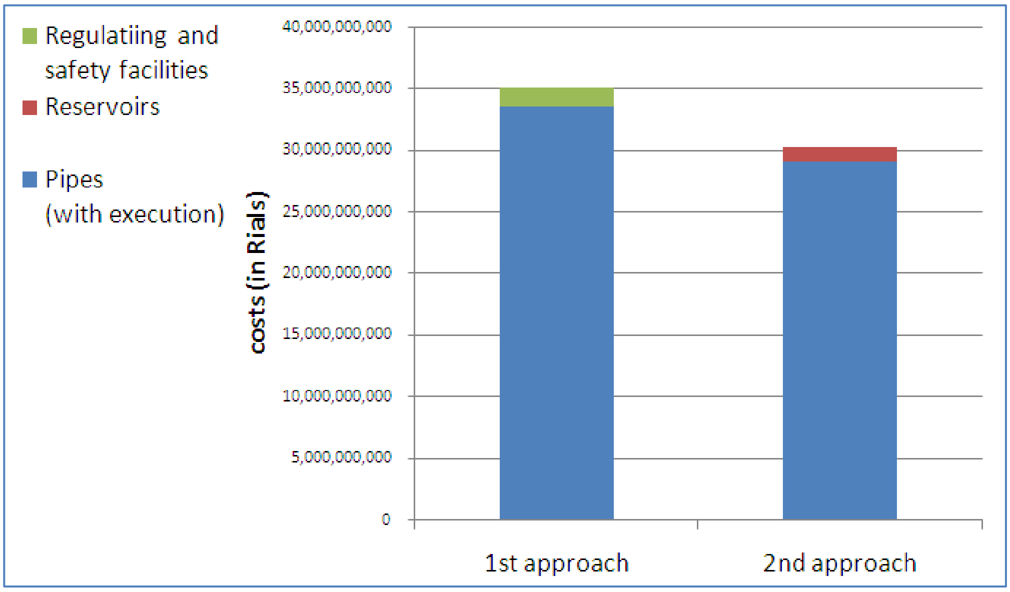

Figure 3. Cost comparison between the Alternatives A (1st approach) and Alternative B (2nd approach)

From the point of operation and maintenance when reservoir is considered in a network, the network gets more flexibility when it faces hydraulic changes. Also having too many facilities for regulating and safety in an irrigation network makes the operational process too hard or maybe impossible. According to that, it seems the Alternative B is simpler to operate.

However because of the many calculations and complicated process in designing network and too many trial and errors during the calculations, usage of hydraulic modeling software will be needed for increasing the precision of the calculations. In this project the designers preferred to use Water Gems 8 for modeling the network.

The main problem in pressurized irrigation systems is operational matters and also management of these systems is a big problem. It seems by correctly diagnosing the probable operational constraints during designing, most of the problems in the future can be solved. Based on that, simplifying the operational and maintenance phase, as an important and necessary matter, can cover the additional costs for a pressurized irrigation network.

5. REFERENCES

1. U.S. department of agriculture natural resources conservation service, 2007, Environmental assessment Marysville irrigation and drainage company Gravity pressurized irrigation and delivery system, Fremont County Idaho.
2. Mahabghodds consulting Eng., 2011, Criteria and fundamental design principles for54 Mosallase Givi irrigation and drainage network main pipelines.
3. Mahabghodds consulting Eng., 2010, Technical report of Mosallase Givi pressurized irrigation network.