Application of water leak detection program in El-Behira governreate

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The leak detection program is presented and discussed to show one of the important methods, this method is applied successfully at Abo-Hummos, Kafr-El-Dawar and other areas. This program is used to minimize the losses and increase the efficiency of water network. The procedure of leak detection program is explained in details. The main function of leak detection program is measuring the flow, pressure, consumption and other flow characteristics. Measurements included field data before, during and after repairing. The main aim of this program is to improve the feeding with water to the network by collecting and recording the previous basic data. In this paper the description of the equipment, the reasons of this leakage and how to come over it are discussed. The analysis of flow, pressure, consumption leakage and other flow characteristic are obtained and presented in graphs to show the effect of leakage on flow and pressure in the network. According to this study, it is recommended to apply this leak detection program in water networks in all over Egypt.

المحافظة على البيئة من أهم الموضوعات التى تؤخذ فى الاعتبار عند عمل أي دراسة لأي مشروع وبالتالي مشروعات المياه، وشبكات مياه الشرب من المشروعات التى تهتم بها دراسات البيئة سواء لمنع التلوث للوصول للشبكات أو تقليل الفاقد الذى يتسبب فى تلوث البيئة وكذلك للمحافظة على المياه. تقليل الفاقد فىشبكات مياه الشرب يتم بتقليل التسرب من المواسير، وذلك عن طريق برنامج تقليل الفاقد فى شبكات مياه الشرب. ومما سبق يتضح إن الهدف من البحث توضيح وشرح برنامج تقليل الفاقد فى هذه الشبكات لإظهار مدى أهميته ومدى إمكانية تطبيقه فى كل أرجاء مصر، حيث تسمح المياه التى تم توفيرها سوف تستخدم فى مواجهة الزيادة السكانية والمناطق الصناعية ولتغطية الاحتياجات على مدى ٢٤ ساعة/اليوم دون الحاجة لإنشاء محطات مياه جديده. وبالاضافه لشرح خطوات هذا البرنامج يتم شرح أنواع أهم المعدات المستخدمة فى الدراسة وكذلك مناقشة حالات للدراسة لإظهار أهمية تأثير التسرب على خواص السريان. تقوم الاستنتاجات بإظهار مدى أهميه هذا الموضوع ، مع الأخذ فى الاعتبار عدة ملاحظات ظهرت خلال تنفيذ برنامج تقليل الفاقد فى المناطق المستخدمة في البحث وهى ابوحمص وكفر الدوار. وهذه الملاحظات تساعد فى تحسين نتائج البرنامج وكذلك أداء الشبكات فى الطبيعة.

Keywords: Leak , Network, Flow net, Water

1. Introduction

The study of losses for water network shows that minimizing these losses is the best solution to improve the condition of supplying water. The losses in pipeline are due to friction and leakage. Applying the leak detection program can minimize the leakage. This leak detection program consists of:

1. Collection of Basic Data.
2. Pipe Network Inspections.
3. Office Report.
4. Execution of Work.
5. Measurement of Input Main Flow.
6. Consumption Measurements.
7. Flow and Pressure Measurement.
8. Evaluation of Losses & Flow Feeding.

The objective of this study is to show the applicability of leak detection program to minimize the losses. The success of such program will encourage its use all over Egypt, saving big quantities of precious potable water. The saved water will be used to face increment of population, and new industrial areas to supply all networks 24 hours/day with enough water without the need for constructing new water treatment plants. The Leak detection work faced many problems. These problems can be solved through the rehabilitation work. The field data were collected through the leak detection work which consists of a lot of measurements of flow, pressure, consumption, location of leaks, length of pipelines, correct diameters etc. The leak

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pipelines. correct diameters etc. The leak detection work and water loss studies are the main frame of rehabilitation for existing networks. The collected data covered the entrance of water work to the main trunk and all areas through branches of pipelines for different areas.

In this paper, the steps of leak detection program are explained. The details of leak detection fieldwork are also presented. These details include the method of field data collection, and the method of measurements. Equipment used will be shown and the discussion of collected field data is considered to show the effect of leakage on the flow characteristics. A case study will also be presented. In this case study, the field data were collected for the period from 1985 to 1989. These data were used to verify the mathematical model that tries to simulate the field conditions with the leak detection work [1,2]. The fieldwork was conducted from El-Behira water supply project at Abo Hummos.

1.1. Problems and factors affecting the leak detection studies

The main problems facing the leak detection work are age of pipes, diameter, depth of pipe, working pressure, water table conditions, soil characteristics, and traffic loads on the road. The most important factors affecting leak detection studies are input and output flow, working pressure, the total length of network, the status of connections, living standard, consumption for public big consumers, and the number of consumers without connections.

2. Background

The main sources of losses are the friction losses and reaction of leakage. A literature review proved that little attention has been given to study leakage detection program in pipe network.

Paul F. Bouls and DON J. wood [3] studied the design of a network and its function. They did not include the leakage factor. The development for their design, operation, and calibration parameters for pipe network assisted in reaching an evaluation and specification of pressure and flow constraints.

Leak detection work is one of the most important tools for evaluation analysis of data for an existing network. A study was done by Ranko S. Pudar, and James A. Liggett [4], to the find the answer for the following question: can a leak be located by pressure measurements in a pipe network by using little data? The answer depends on the configuration of the system, the accuracy of pressure measurements, pipe friction and the accuracy of the required demands.

Data collected from field during two years were used to verify the proposed model (1) and (2). These data were collected through leak detection work [5].

There is not enough work done for studying what is the effects of leakage, the method of repairing the leaks, and how to know the correct results by measurements and tests on the fields.

3. Leak detection procedure

The procedure of leak detection program as show in Fig. 1 is as follows.

3.1. Collection of basic data

The collection of basic data started during the field investigation. This work consisted of surveying, mapping and arranging the drawings according to the following stages:

3.1.1.Field investigation

To inspect and record the pipeline routes and draw the maps with normal length, diameter, type, age. location for water work, poster pumps, and elevated tanks with the direction of flow. The surveying groups followed the routes to record all the above mentioned components of the network. The data collected were recorded, arranged and tabulated.

3.1.2.Office work

The office work included collection of all previous data in maps, fixing the main point of feeding with water, dividing all network area to district [1] according to the direction of flow and fixing the boundary of these districts. Input points, and output points of feeding to be measured by the appropriate equipment.

3.2. Pipe network inspections

At every district detection of the weak points, was carried connect out through inspection of the condition of; every valve, water crossing, and dead end, and using leak detection pipelines to determine the location of leak These field information were analyzed in the office report.

3.3. Office report

The office work should follow the field work to record the data which are obtained from the field by preparing required repair reports, and establishing the location of the bulk meter chamber, the wastewater chamber, and the valve chamber.

3. 4. Execution of work

A clear picture of network conditions can be obtained from inspection including the weak points. The repairing of weak points was executed through the rehabilitation work which was done according to the following phases.

3.4.1.First phase of work .

The first phase of execution work consisted of four stages. In the first stage, the measurement chamber (wastemater, and bulkmeter) should be constructed and pipe, valves, crossing repairs and installing boundary valves are used out to isolate the districts. The repair work should be done according to the repair reports. In the second stage, the flow and pressure should be measured for the main feeding point. Then, in the third stage measurements of consumption samples (house Connections, mosques, big consumers and public tapes-standpipe.) should be carried out. In the fourth stage night flow test (NFT) should be carried out. The NFT is a test for flow at night to study the condition of network with low consumption. This test should be done at the end of any phase of work to check the progress of rehabilitation work by minimizing leakage from starting value about 65-75 %.

3.4.2. Second phase of work

The second phase of work is to complete the repair work for new leaks that appear after first night flow test (NFT) through many stages. The second phase of work consists of five stages. The first stage is relaying pipelines & deepening. The second stage includes the repair of surface pipe and watermeter installation. The third stage is starting the flow and pressure measurements for main feeding at bulkmeter points and wastemeter The fourth stage is starting consumption measurements samples (house connections, mosques. big consumers and public tapes-stand pipe.) NFT should be fifth stage which done at the end of this phase.

3.5. Measurement of input main flow

The measurement of input main flow can be done as follows:

1. At the same time of the first phase of work, the main flow should be measured from all sources by at the boundary of the network.
2. The input flow for every district should be measured at the wastewater, at the beginning of the district. The main reason to measure flow for these periods is that consumption and leakage fluctuate from time to time, season to season and also between day and night. A lot of data was collected from September 1985 to September 1987 at Abo Hummos markaz and followed by Mahmodia and kafr El-Dawar The flow and pressure for every district is listed in tables.
3. The difference between in and out flow from bulkmeter and wastemeter to district is equal to the leakage rate from main trunk.

Field work Diagram

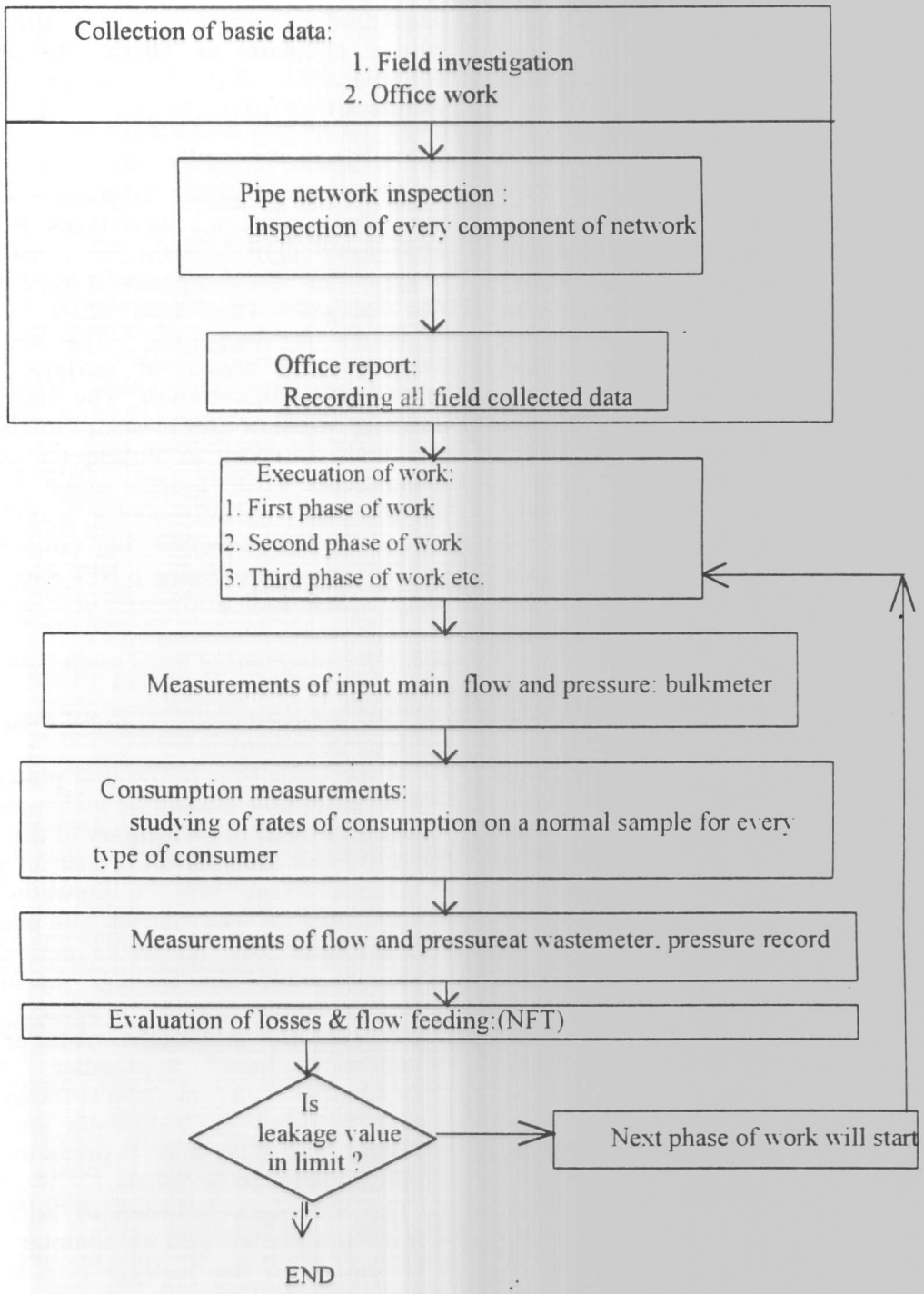

Fig. 1. Procedures of leak detection program.

3. 6. Consumption measurements

The measurement of consumption of potable water is very difficult because consumption is affected by many factors. These factors are the reason of the long period the measurements. The modified method should be used because there is no regular reading of watermeter. During the first phase and the second phase of work the example for measuring in village was started. The chosen village has normal consumption (follow the average consumption). The measurements should be arranged in the following steps:

1. Taking a sample of fifty house connections for a period of measurements not less than 45 days at every season. The reading of consumption was done in the morning, at noon, at midnight and at early morning.
2. Taking a sample of public standpipes for the previous period and timing, and different number of standpipes was taken. The number of standpipes was sampled according to the number in the districts making not less than 30%.
3. Taking a sample of mosques for the previous period, timing and method.
4. The samples for the big consumer should be taken. The big consumers are chicken farms or factories or public buildings and schools. The average consumption of every type for every district was recorded.

3.7. Flow and pressure measurement

The wastemeter and pressure records with charts were used many times to read weekly and daily flow and pressure. The measurement of flow and pressure was repeated to obtain accurate recordings for all seasons during the first and the second phase of work. The evaluation of charts shows the maximum and minimum of consumption and also shows how much leakage was recorded according to the studies of consumption. This reading gives an indication about the NFT evaluated charts and whether they were within limits or not. The difference between consumption flow at step (6) and input flow at step (7) is equal to the leakage value of this district.

3. 8. Evaluation of losses and flow feeding

At the end of the first phase of work night flow test was arranged for every district according to the following steps

1. Arranging step test to close and open the valves for every district. The main procedure for NET is the step test. The moment of close valve, the chart was installed on the wastemeter to record the change of flow. The same subject for recording pressure happened at pressure record with its chart. The decrease of flow or its increase shows whether a leakage exist or not. Then it is compared with the pressure at the time of minimum consumption at night from 10 pm to 6 am. The closing boundary valves for district should be started with enough time before starting NFT to increase the pressure inside the district and to know the exact consumption.
2. Start to measure the flow and pressure during the step test starting (10 pm to 6am).
3. From the average consumption measurement as explained, the total consumption should calculated. The difference between the consumption and input flow equals the total quantity of leakage. The comparison between flow and pressure measurements is done to determine the branches that include the leak points. Then its location is checked to repair it for the second phase face of work using the appropriate equipment.
4. After the second phase the night flow test with the same previous steps. must be done to know the exact percentage of losses and whether it was within limits or not.
5. If the percentage of losses exceeds the limits, the third phase of work should take place with the same previous steps.

The location of the districts are Abo Hummos Markaz /district 1. Kafr El Dawar Markaz/district 2.

To understand the leak detection work, the type and purpose of equipment used in the leak detection program should be described. There are many instruments, the following section will explain the most common ones.

4. The leak detection equipment

The leak detection program for rehabilitation work requires many types of equipment. The following equipment (1) and instruments are very important to complete the above mentioned work:

4.1. The wastemeter

The wastemeter is used to measure the flow at the beginning of the district by using charts. There are two types:
A) Deacon wastemeter. and B)Kent wastemeter. The wastemeter measures and records the flow passing through it and enter to the district by installing it on by pass. The by-pass was used for the period of the measurements.

4.2. The pressure record

This equipment is used to measure the pressure by using the charts at the beginning of the district. It has the same mechanism of wastewater except the arm here is horizontal. The arm moves under the pressure connected to the arm, which draw on horizontal circular charts. The circular chart is fixed on a circular moving glass plate connected to a watch to be timed daily or weekly.

4. 3. The leak detector corolator

It shows the location of leaks, working by water emanating from a pressurized main creating a characteristic noise propagation in both directions along the main. Sensors are mounted on accessible fittings(hydrants or valves) which pick up the arriving sound. After filtering and amplification, the leak noise proceeds via cable or radio to the corrector for evaluations.

4.4. The pipe and cable finder (pipe locator)

It is an important instrument to stop any damage of pipe and cable. Finding it before excavation does the stopping of damage to cable and pipe. There are many methods to fix the location of pipe or the cable. An important step is fixing and defining many points on line that will be the center of the pipeline.

4. 5. The leak detector (for water Pipeline) HL2000

For quickly relocating the water leak. the contact microphone is used to listen for leak sounds on accessible parts of the water system. These parts include valve, hydrants and other points of direct contact. The memory feature of this instrument is used to store leak sound intensity measurements for up to eight different contact point locations. The leak should be located between the two points of highest sound intensity measurements.

4. 6. Water pressure reducing valve

It saves up to 30% of the water feeding the branches by controlling the inter flow pressure. Using this type of valve keeps the leakage to a minimum by keeping the pressure at a certain level. It is preferable to use a grade of pipe sufficient for this pressure only.

4.7. Repair clamp

Stainless steel tapping sleeve consists of two pieces of stainless steel deformed sheets in the shape of the required repairing part of pipe with inside rubber layer. and bolts at edges to collect two parts together. It is very good and suitable for main trunk pipeline and at entrance of water works which are not easy to close and it switches off the water for long periods to repair any damage.

4. 8. Air valve

The single orifice air valve and double orifice air valve prevent negative pressure in

two cases; when starting to feed at higher points, or feed pipe line with air in case of suction in pipe lines to prevent the action of hammer effect. The air valves are the leak detection instruments because they prevent great damage in the pipelines after the rehabilitation.

4. 9. Fitting and joint of pipeline

Using the suitable correct fitting and joint for all pipe line and surface pipe will prevent the leak points at connections.

5. Case study

The discussion of flow characteristic was done by constructing charts of pressure and head less against different types of flow. the discussion was made for two districts at Abo Hummos at districts (1) and Kafr El Dawar (2) (The symbol used are AH/D1 and KD/D2) as following:

5. 1. The total flow and pressure

In this case, the relationship of flow and pressure shows that the slope of chart very steep at node with low leakage and sharp at areas with high leakage at district AH/D1 Fig. 1. At Kd/D2 Fig. 2, the slope of chart is steep for most nodes only two nodes at the middle have the big leakage.

5. 2. The consumption and pressure

In this case. the relationship of consumption and pressure AH/D1. Fig. 3 shows that the slope is very smooth at midle with low leakage and steep at areas with high leakage at district. At KD/D2. Fig. 4. the slope of chart is steep and smooth. which means the leakage at average and no higher values at any nodes.

5. 3.The leakage and pressure

The charts at AH/D1. Fig. 5 shows that the higher value of leakage happened after the third node. For KD/D2. Fig. 6 shows the steep slope which prove the condition of leakage for this district which followed the average values.

5. 4. The total flow and head losses

For district AH/D1. Fig. 7. the effect of the leakage effect is clear at the middle of chart. For KD/D2, Fig. 8. the normal condition of flow characteristic of flow and pressure are clear on the chart.

5.5. The consumption and head losses

If the discussion tries to check this charts at .AH/D1, Fig. 9, and KD/D2. Fig. 10. the results will be obtained.

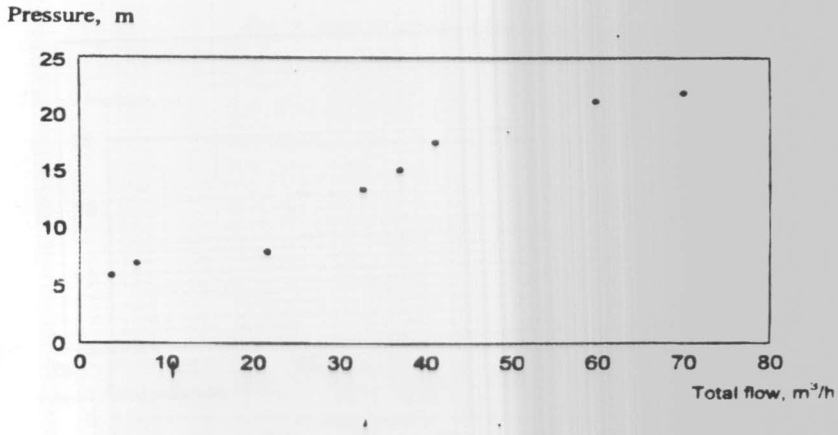

Fig. 2. Abo-hummos field data, district 1.

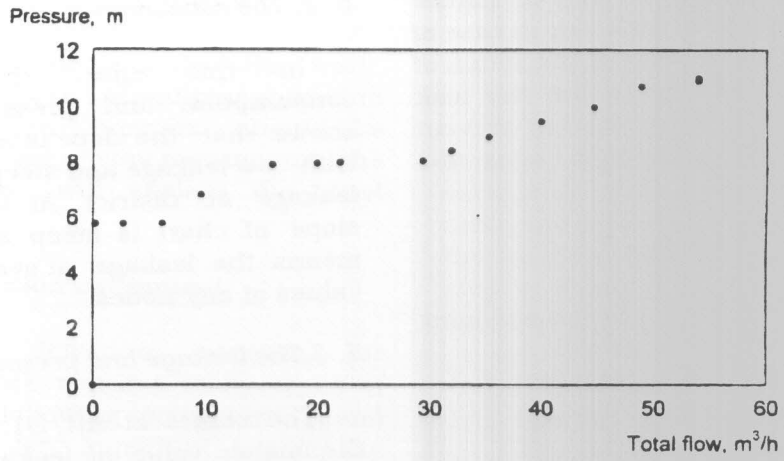

Fig. 3. Kafr El-dawar field data, district 2.

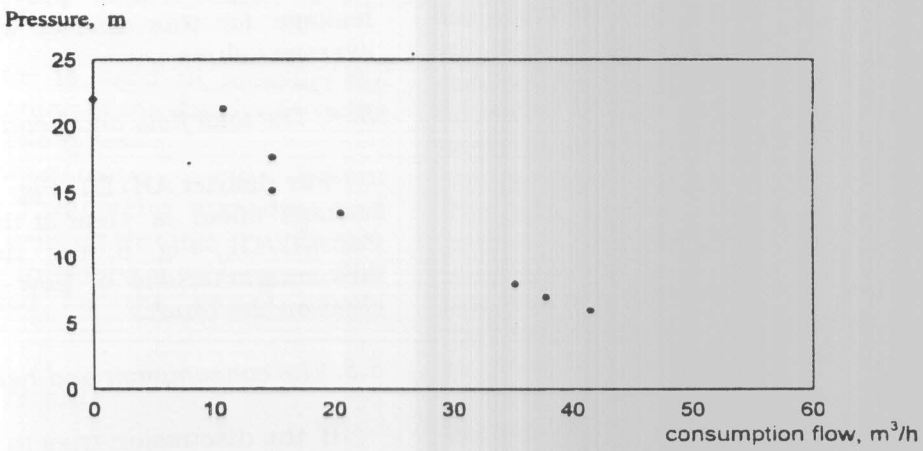

Fig. 4. Abo-Hummos field data, district 1.

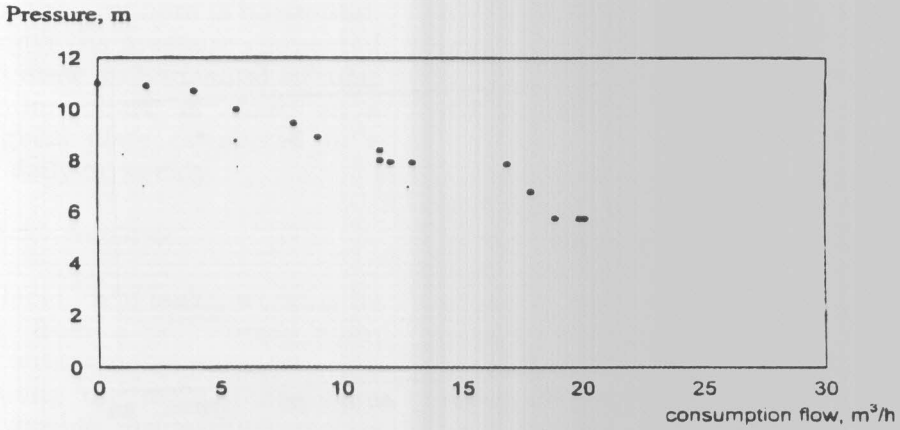

Fig. 5. Kafr El Dawar fied data, district 2.

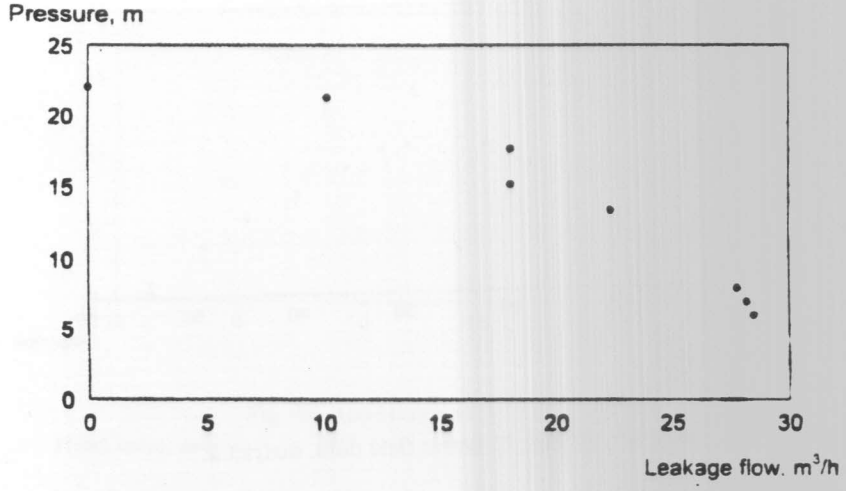

Fig. 6. Abo Hummos field, district1.

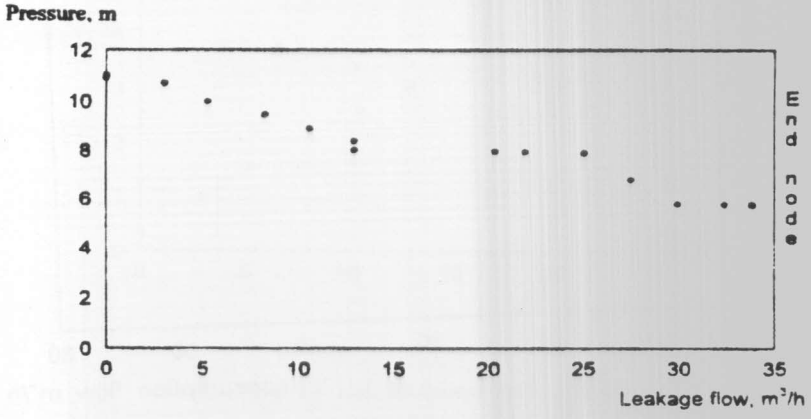

Fig. 7. Kafr El-dawar field data, district 2.

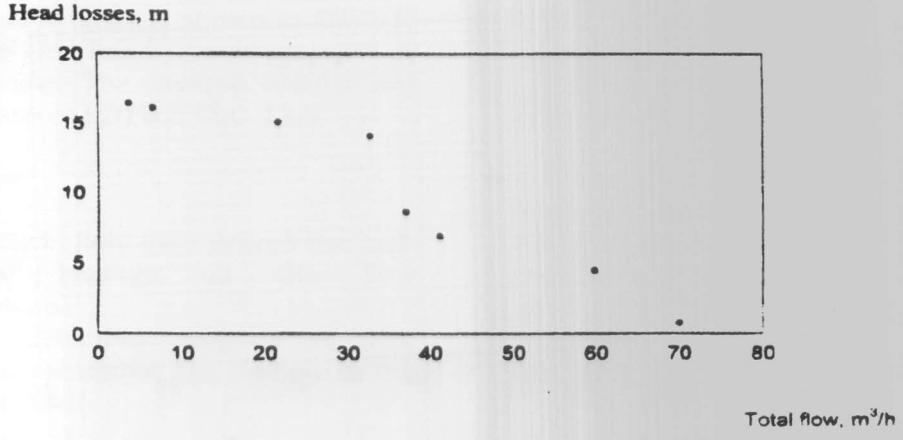

Fig. 8. Abo Hummos field, district 1.

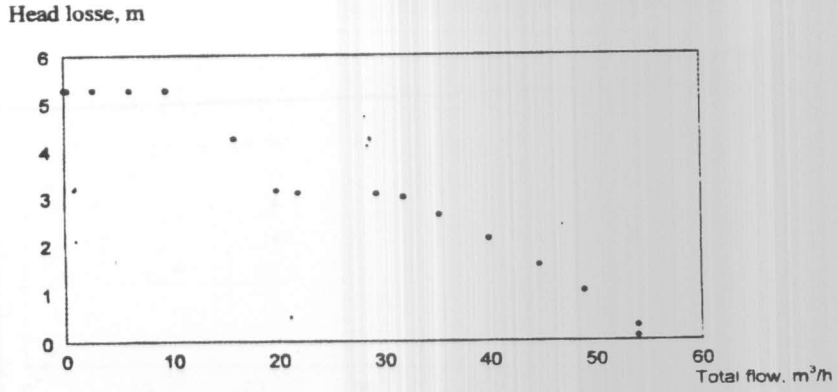

Fig. 9. Kafr El-dawar field data, district 2.

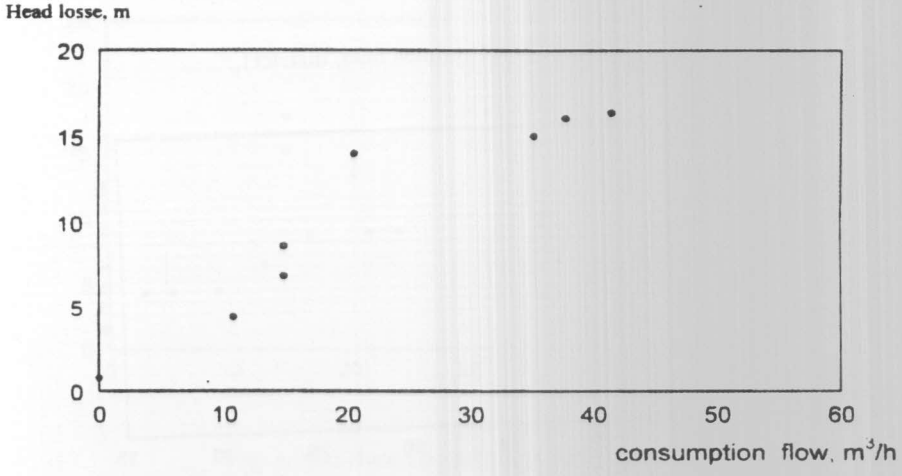

Fig. 10. Abo Hummos field, district 1.

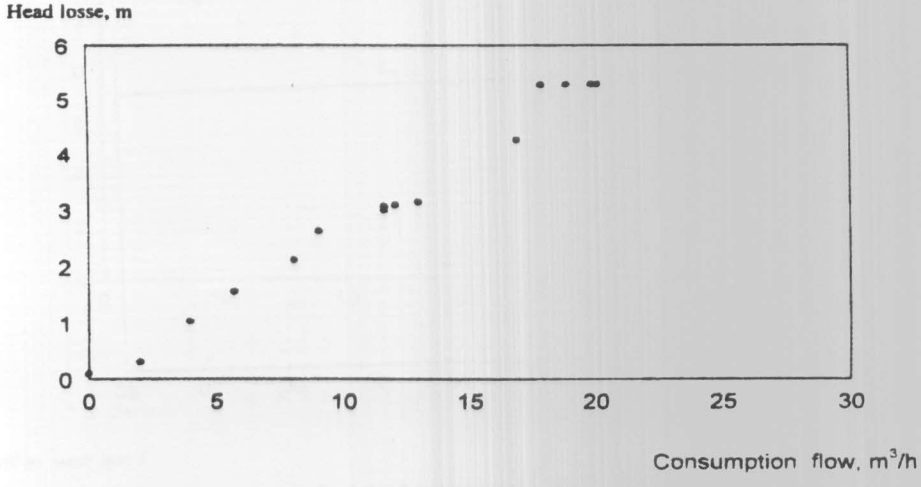

Fig. 11. Kafr El-dawar district 2.

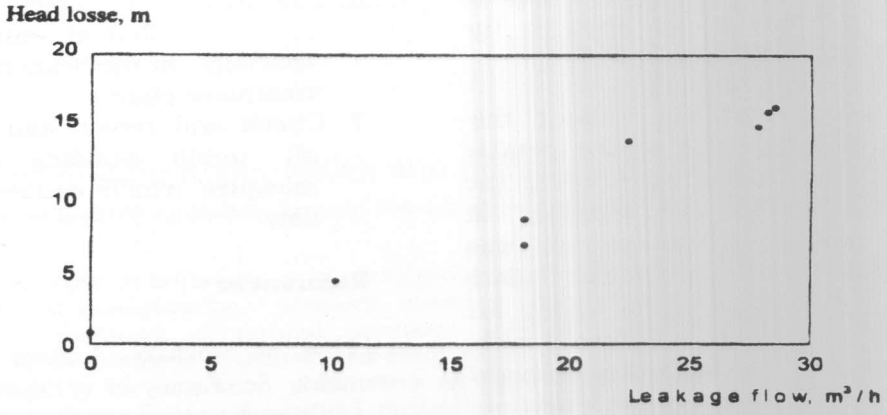

Fig. 12. Abo Hummos field data, district 1.

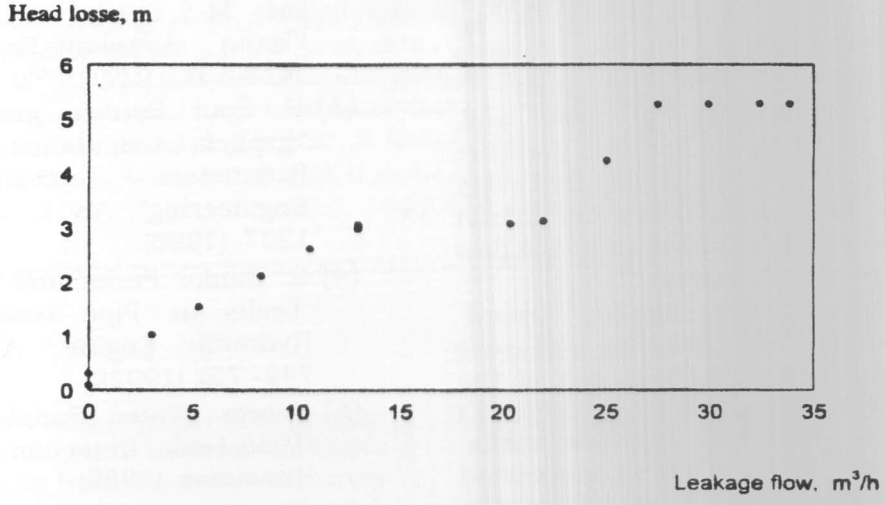

Fig. 13. Kafr El-Dawar field data, district 2.

5.6. The leakage and head losses

The effect of leakage is shown at AH/D1, Fig. 11, prove the head losses increase at leakage increase. The inverse results are obtained for case of KD/D2, Fig. 12,6.

6. Conclusions

1. The collected field data proved the bad effect of leakage on the flow characteristics.
2. The leak detection program is best solution to minimize the leakage in the existing network.
3. The head losses increase when the leakage increases.
4. If the leakage decreased the flow and pressure should be increased.

7. Recommendations

The saving water losses is the important items for feeding with the same quantity of water much areas with sufficient flow and pressure for all networks all over Egypt will need the following points to success the complete net works feeding:

7.1. The net work must be consider as a dynamic system which is permanent under modification and change in flow

and pressure. which need the complete check of networks by applying the system of rehabilitation.

1. Making enough studies about the behavior of consumers of the potable water and the timing for needing the high consumption for example at industrial areas the consumption was noticed increase at two hours before and after the change shifts timing for their factories and for a farmer at early morning and at the beginning of night period.
2. Bringing and obtaining the necessary equipment and the required training of engineer staff to work on it for permanent measuring and check after a completion of rehabilitation program
3. Regular measurement of flow and pressure by using the flow and pressure measuring equipment are required every month at the beginning of every district and the strategic points at in or out flow at the boundary of markaz.
4. Steady and permanent regular record and account the number of new consumers to face the required of the consumption.
5. The most systems of all Egypt net works are tree type which cause big losses and need to minimize it by completing the circulation.
6. The pressure reducing valve are required to be installed at entrance of branches specially at the branches near the water treatment plant .
7 Check and repair and closed all tabs in all public building and school and mosques which caused many losses of flow.

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