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By Dr. Faez Alkathili & Dr. Monther Alalousi

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Dr. Faez Alkathili [α] & Dr. Monther Alalousi [σ]

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An integrated 5,50 m high filtration unit was constructed in the laboratory, it included four main units: an axial flocculating unit, a filtration unit , injection unit for pumping coagulants and clay materials, and a backwashing unit, a piezometric board is also included to give reading at each 10cm of filter height . Water is supplied to the system through a constant head tank by gravity action. filtration is done through two mediums ,a crushed brick layer2 to 5mm sizes(30to40)cm deep and a quartz sand layer 0-.60to 0.75mm (30to40)cm deep.

The lab experimental test, using drinkable water supply, with addition of kaolin (fine mud used as turbidity) to increase turbidity & find the best combination of variables, loading, to highest water yield together with highest efficiency, experiments were run to find the effect of filtration rate, type & depth of filtration materials, effect of coagulating material & catalyst in addition to flocculation time and velocity gradient.
Results of above showed that:-

1. Suggested crashed brick should be washed perfectly to clean away any salts that might be within the brick materials, then sieved to have homogenous particles.
2. All tests indicate the possibility of using crashed bricks as top layer in gravity multimedia filtration with very positive results,
3. Increasing efficiency through proper control of mixing, turbidity, filtration rate and velocity gradient.
4. Experimental filtration gives V.good Results for filter working cycle" filtration cycle increased to at least twice ", double quantities of water production & best quality.
5. Labs tests shows a positive results on removing about 10%-15% TDS from influent water.
6. It is recommended to use polymer with alum for coagulation for better Results.
7. Filtration efficiency increased to up to 98% at laboratory Tests. When using the proposed crashed brick as first layer.
8. It is important to check Coagulant potential value for better Results.
9. Crashed bricks have to be replaced with new layer after approximate 60 cleaning cycle.
10. Tests also indicate that there will be presented an intermediate layer between cashed brick and the top sand layer " this layer will be a mixed of proposed crashed brick with top fine sand " the tests also indicate that this layer will be about 10 cm in thickness:.
11. All gravity filters have its own standard coefficient which is called filtration coefficient "lumda". during those experimental test we tried also to calculate the values of this coefficients" which ranged from 1 to 0.66 "
12. The new investigations are, when the filter depth is shorter than 0.4 m, no significant efficiency is observed. For filter depth ranging from 0.4 -0.8 m, a significant increase is observed in the filter efficiency.
13. The filtration Rate slowly affect the removal efficiency when filtration Rate < 4 $m^3/m^2/h$.
14. The removal efficiency reaches up to 80 %. When filtration rate is 4 $m^3/m^2/hr$ >filtration Rate < 12 $m^3/m^2/hr$.
15. With more increase in filtration Rate, the removal efficiency comes down to less than 40%.
16. Only crashed brick is used in this study, it is highly recommended to check the possibility of crashed stone, crashed concrete, and even palm tree leaf.

Keywords: drinking water purification, filtration, water, crashed brick, sand, kaolin, turbidity.

I. Purpose

The purposes: compliance with treatment technique regulatory requirements; targeting impurities; and producing a longer filtration cycle and better water purification. When source water is generally within the turbidity range of 1 to 5 NTU, it may be a candidate for water treatment gravity filtration.

II. Introduction

Water purification is the removal of contaminants from untreated water to produce drinking water that is pure enough for the most critical of its intended uses, usually for human consumption. Substances that are removed during the process of drinking water treatment include suspended solids, bacteria, algae, viruses, fungi, minerals such as iron, manganese and sulfur, and other chemical pollutants such as fertilizers.

Measures taken to ensure water quality not only relate to the treatment of the water, but to its

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conveyance and distribution after treatment as well. It is therefore common practice to have residual disinfectants in the treated water in order to kill any bacteriological contamination during distribution.

World Health Organization (WHO) guidelines are generally followed throughout the world for drinking water quality requirements. In addition to the WHO guidelines, each country or territory or water supply body can have their own guidelines in order for consumers to have access to safe drinking water.

Algae are common and normal inhabitants of surface waters and are encountered in every water supply that is exposed to sunlight. Algae typically range in size from 5 to 100 microns.

Many microorganisms commonly found in source waters do not pose health risk to humans, As Filters represent the key unit process for particles removal in all surface water treatment. Optimization used prior to the filtration process will control loading rates while allowing the system to achieve maximum filtration rates. Using crashed brick as first layer in addition to the other filter media such as fine quartzite sand and gravel, may be considered as one of several treatment processes that can be applied in combination with others to produce potable water. Low turbidity (<20 NTU) and algae count in the order of 106 units/liter among other factors,

III. History of the Gravity Water Filter

1835… London, England. Queen Victoria recognized the increasing health dangers of the drinking water supply. Cholera and typhoid epidemics were commonplace.

She requested John Doulton (of later to become Royal Doulton), to produce a water filter with his ceramic making capabilities. Using various earth and clay materials, he created the first gravity water filter stoneware, Doulton water filters. With her satisfaction in the filter, Queen Victoria bestowed upon Doulton the right to apply the Royal Crest to each of his units.

1862…John Doulton's son, Henry Doulton introduced the Doulton Manganour (new, efficient purifying medium which could be readily renewed), carbon water filter. With Louis Pasteur's new findings about bacteria in this same period, a more advanced understanding of bacteria made it possible for the creation of a porous ceramic which could filter out tiny organisms. Gravity fed water filtration! And the Berkey…? We're getting there…

1901… King Edward VII knighted Henry Doulton and honored his company use to the word ROYAL in reference to its products. Hence the name "Royal Berkey", one of the larger gravity water filter units available today. Doulton's water filters gained popularity and wide spread use by hospitals, laboratories and residential water filtration throughout the world as far away as Africa and the Middle east.

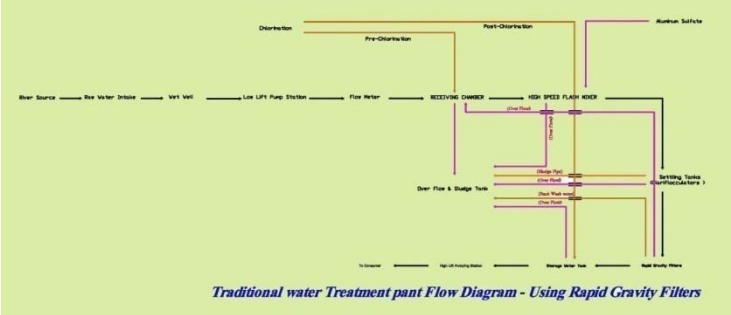
Throughout the decades, the Doulton company modified the ceramic filters by adding small, pure silver particles (anti-microbial), which made the filter elements self-sterilizing and they registered the trade name "British Berkefeld". Once these improvements were made, the gravity filters became popular with, and trusted by relief organizations such as UNICEF, the Peace Corps, Red Cross and used in over 140 countries throughout the world.

1998…Through a distribution partnership with British Berkefeld, the US based company, "New Millennium Concepts", began distributing their products locally. NML pushed the envelope of the product and created the "Black Berkey" purification element. Black Berkey purification elements are more powerful than any other gravity filter element currently available. They were tested with 10,000 times the amount of pathogens required for standard protocol and removed 100% of the pathogens (tested under an electron microscope), setting a new standard in water purification.

IV. Processes for Drinking Water Treatment

A combination selected from the following processes is used for municipal drinking water treatment worldwide:

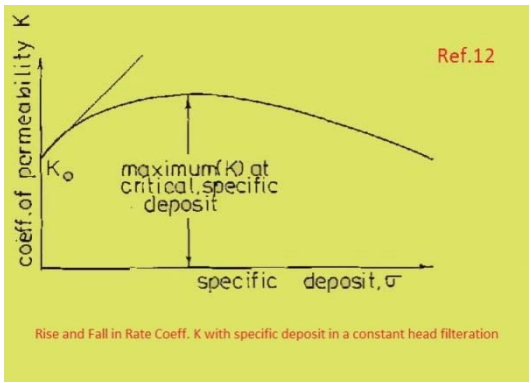
- Pre-chlorination - for algae control and arresting any biological growth
- Aeration - along with pre-chlorination for removal of dissolved iron and manganese
- Coagulation - for flocculation
- Coagulant aids, also known as polyelectrolyte - to improve coagulation and for thicker floc formation
- Sedimentation - for solids separation, that is, removal of suspended solids trapped in the floc
- *Filtration* - removing particles from water
- Desalination - Process of removing salt from the water
- Disinfection - for killing bacteria.



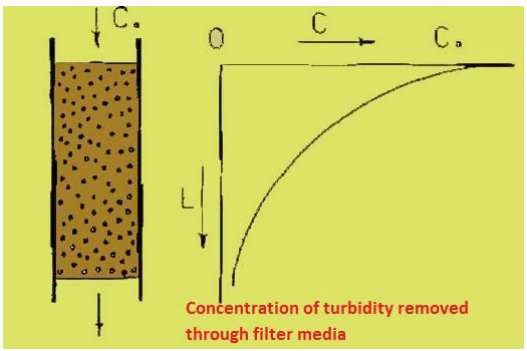
Technologies for potable water treatment are well developed, and generalized designs are available that are used by many water utilities (public or private). In addition, a number of private companies provide patented technological solutions. Automation of water and waste-water treatment is common in the developed world. Capital costs, operating costs available quality monitoring technologies, locally available skills typically dictate the level of automation adopted

V. Effect of Filter Depth on the Removal Efficiency

It is well known that, the filter depth has a direct relation with the filter efficiency, i.e., increasing the filter depth will increase the filter efficiency. Effect of filter depth on the removal efficiency.



The new investigations are, when the filter depth is shorter than 0.4 m, no significant efficiency is observed. For filter depth ranging from 0.4 -0.8 m, a significant increase is observed in the filter efficiency.

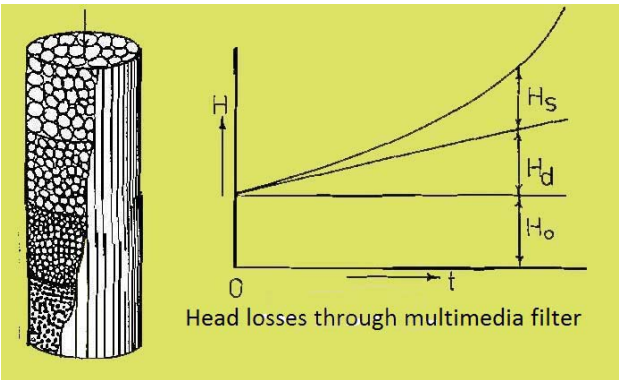


VI. Effect of Filtration Rate on the Removal Efficiency

1st - The filtration Rate slowly affect the removal efficiency when filtration Rate < 4 $m^3/m^2/h$.

2nd – The removal efficiency reaches up to 80 %. When filtration rate is 4 $m^3/m^2/hr$ >filtration Rate < 12 $m^3/m^2/hr$,

3rd - With more increase in filtration Rate, the removal efficiency comes down to less than 40%.

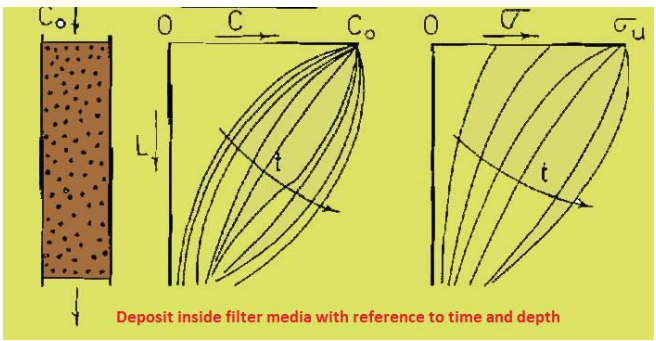


VII. Effect of Media Particle Size on Removal Efficiency

The Media particle size strongly affects the filter efficiency.

1st - High effect of grain size on the performance of direct filtration. Removal efficiency comes down to insignificant value at using particle of size >5mm.

2ND - Particle size of 0.1-2 mm is recommended. At some cases of pre-treatment work, particle size greater than 3 mm may be of use.

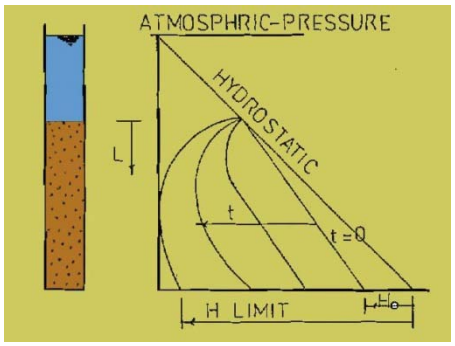


VIII. Effect of Alum Dose Concentration on the Removal Efficiency

Several factors may Govern the optimum dose of alum such as, size of Turbidity particles, turbidity level, and the G potential of Coagulation, surface loading, etc. many studies shows the effect of coagulant dosage on the performance of direct filtration, some stated that, there exist an optimum dose at which the filter produces high effluent efficiency.

IX. Filtration Mechanism

Filtration depends mainly on kind of particles, and the filter media. In addition to Rate of filtration, Dosage and type of coagulants Used In general One or more of below factors affect the filtration:-

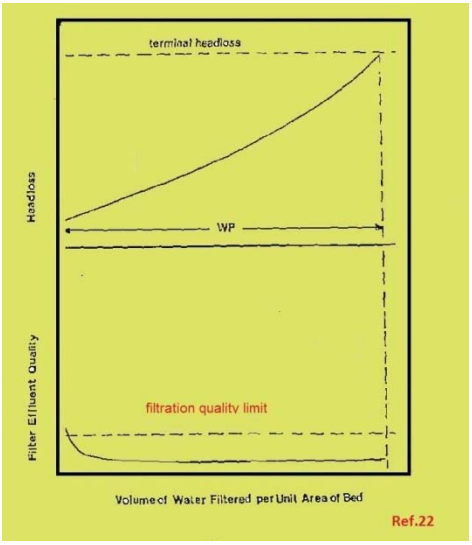


1st - deposit mechanism, as the particles bigger than the size of media porosity will be settled over the media, also the suspended solid take a specifies path depend mainly on porosity but even though some of the particles pass through the media, as there are some factors affecting the mechanism such as direct distortion, Brownian movement or van der wave forces,

2nd – fixation mechanism, which is the sedimentation of particles over the filter Surface as part of slow filtration flow, or vibration of particles because of different electrical charges ,or van der waals forces.

3rd – detachment mechanism, as part of above forces and particles being catch either over the surface /or in side media porosity, the filtration rate may increase, and the flow may change from laminar flow to Turbulent, so particles may separated again and move deep or even pass through the filter media, this can be solved using stronger polymers, and variable filtration flow,

To solve above we can do either



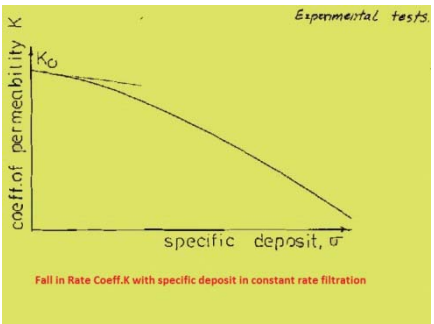
1st – increase particles size inside the media be injecting polymers inside the filter.

2nd – reduce particle size inside the passing solution by pumping water from down to up.

3rd – Reduce filtration rate. Inside each layer. Which can be done using radial filtration?

X. Theoretical Analysis of Filtration

As deep filter media used to inshore removal of collides, then continues increase in head losses till the filter reach its blocked stage. And then Back wash should be done.

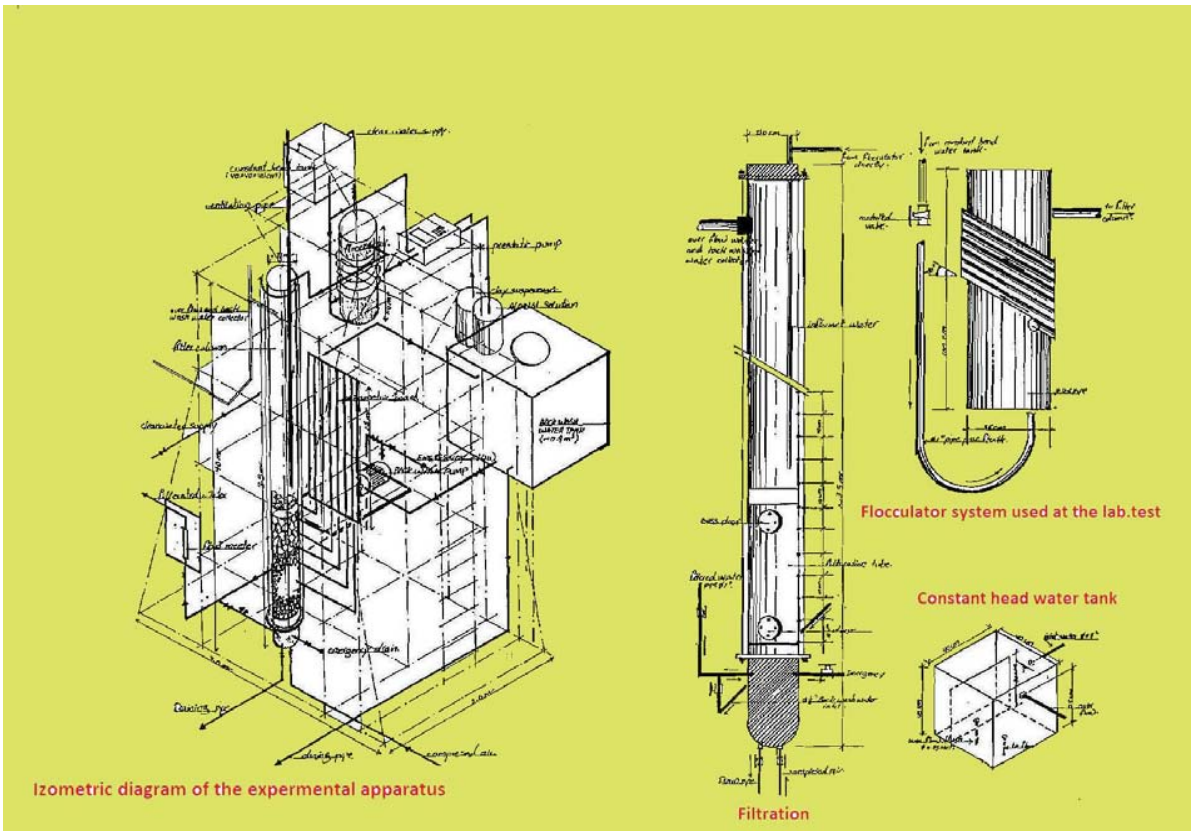


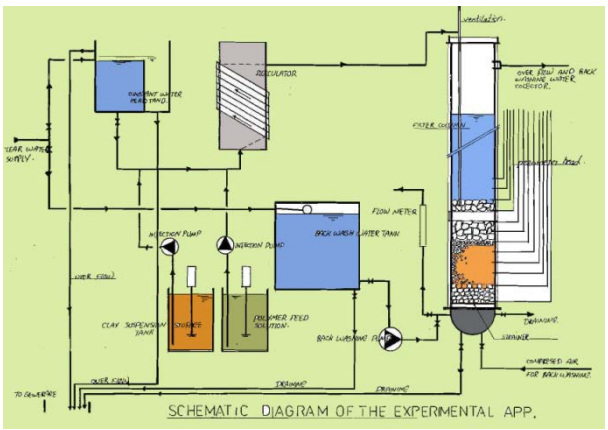
XI. Laboratory Tests Performed

An integrated 5,50 m high Direct filtration unit was constructed in the laboratory, it included four main units: an axial flocculating unit, a filtration unit , injection unit for pumping coagulants and clay materials, and a backwashing unit, a piezometric board is also included tot give reading at each 10cm of filter height . Water is supplied to the system through a constant head tank by gravity action. filtration is done through two mediums ,a coarse media layer with 2 to 5mm sizes (30to40)cm deep, and a quartz sand layer 0-.60to 0.75mm (30to40)cm deep.

The first stage included the laboratory procedure, using the constructed filtration system, Baghdad water supply was used, with the addition of

kaolin (fine mud used as turbidity)to increase turbidity to find the best combination of variables, loading, to highest water yield together with highest efficiency, experiments were run to find the effect of filtration rate, type &and depth of filtration materials, effect of coagulating material and added catalyst in addition to the control of flocculation time and velocity gradient.





a) Filtration Unit

As this study is very important, and to get best results, a complete filtration unit is constructed at the lab. Filter depth is according to real gravity filters with surface area of 0.0246m2, and filtration rate up to 750 l/h . a serious of tests was made with different filtration media and depth to achieve the best results.

Alla experimental test are perfumed using constant rate filtration as the water level will stay constant throughout test time, which in another words the filtration rate will be variable all the time depending on the deposit of turbidity within filter media voids,

b) Additional apartments used with the lab. Tests

Turbidity reader in FTU "DRALANGE-LTD,5"

Magnetic mixer "Magnetic stirrer KAMAG RET, TYPE RET, 620 W"

Turbidity injection pump "STA-PERLSTIC PUMP, LABSCO."

Mixer type LASCO Germany

PH Reader "LAVIBONDA, 2000"

Conductivity & Temperature reader "PHILIPS, PW 9525"

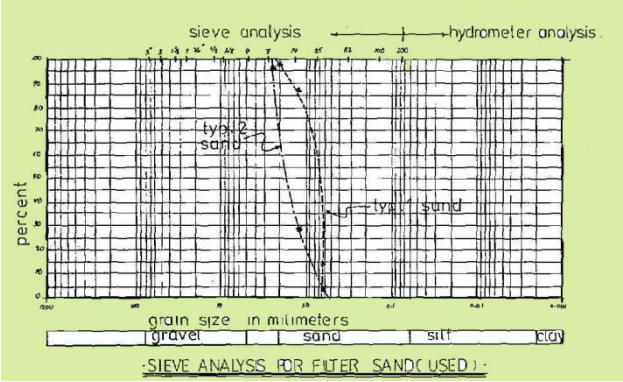
Digital balance "SARTORIUS, TYPE 1501"

Air compressor "KHOSLA, INDIA 2.2 KW, 400 R.P.M"

c) Materials used in the test

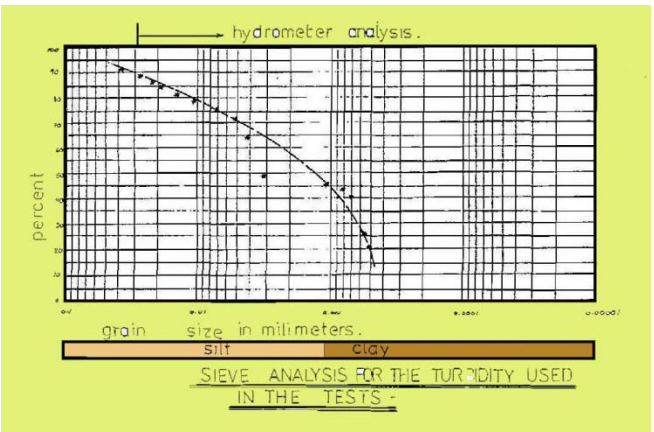
See table No.1

1. Corse sand type 1 & 2, effective diameter 0.75 millimeters and homogenous factor of 2,66.
2. Coarse crashed brick, effective diameter 4,50 millimeters and homogenous factor of 1,45.



SIEVE ANALYSS FOR FILTER SAND(USED).

3. Fine crashed brick, effective diameter 2,90 millimeters and homogenous factor of 1,37.
4. Homogenous gravel, Coarse crashed brick, effective diameter 8 - 10 millimeters.



SIEVE ANALYSIS FOR THE TURBIDITY USED IN THE TESTS.

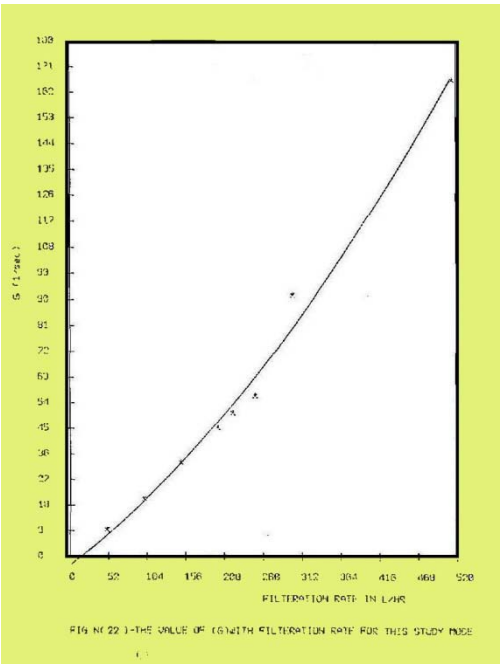


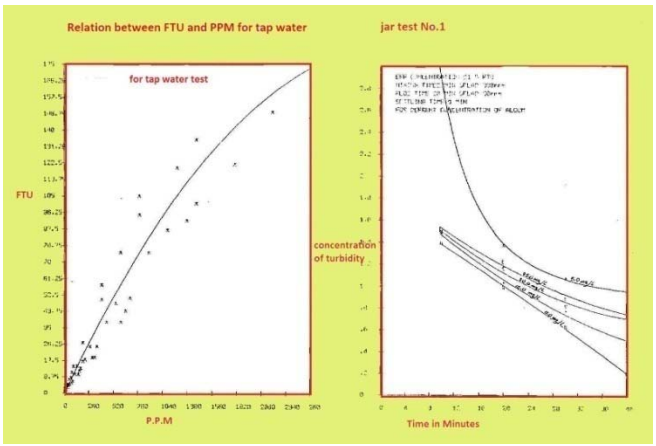
FIG N(22)-THE VALUE OF (G)WITH FILTERATION RATE FOR THIS STUDY MODE

d) Jar test

Jar test was done to define the best quantities of coagulant to be injected each time all water test done at the past years indicates that the maximum turbidity not exceed 320.0 milligram per letters (p.p.m) equal to FTU=21.5 (FORMAZIN TUBIDITY UNIT).

Alum was injected at the rates 5,10,15,20,25 milligram/litters, attached diagram shows the flocculation, and clearly indicates that 15 milligram / litters is the optimum.

Second group of test was performed fixing alum dose as 15.0 milligram / letters, and variable speed from 20 to 500 rpm for 20 minutes.



Also number of test was performed to find best velocity and best time of mixing. results as per attached fig.

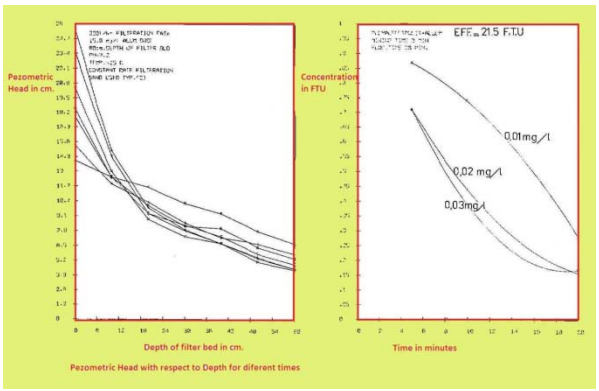
e) Depth of crashed brick to be used

To establish the best depth of crashed brick Type-1,physical property for the used media are shown in the table below :-

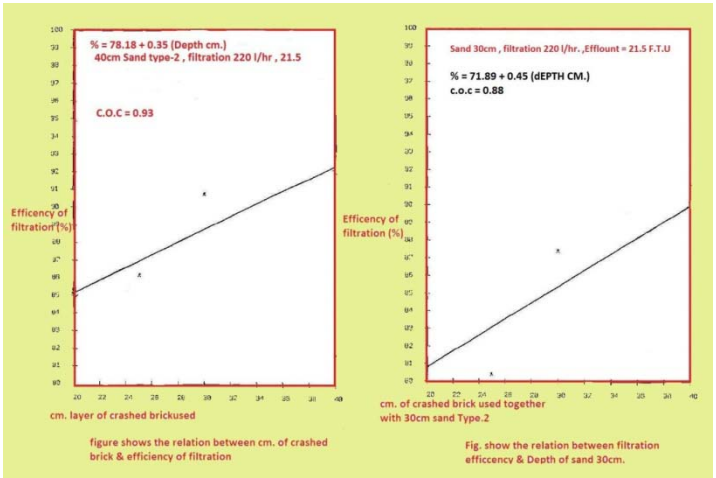
specification / material.	coff.of permeab. cm/sec	density gm/cm³	porosity %	specific weight	D_{10}	D_{16}	D_{50}	D_{60}	effective size (E)	coeff. of uniformity	geometric mean size (Mg)	geometric standard deviation (σg)
sand typ. 1	0,205	1,775	30,799	2,565	0,60	0,58	0,65	0,70	0,60	1,1666	0,65	1,1206
sand typ. 2	0,445	1,569	37,506	2,511	0,75	0,90	1,8	2,00	0,75	2,6666	1,90	2,00
cr.brick typ.1	8,78	1,072	5 5,72	2,421	4,50	4,80	7,00	8,00	4,50	1,777	7,00	1,4583
cr.brick typ.2	4,155	1,145	52,705	2,421	2,90	3,00	3,50	4,00	2,90	1,379	3,50	1,1666
sand(1-2(1:1))	0,553	1,531	40,56	2576								

TABLE NO(1).

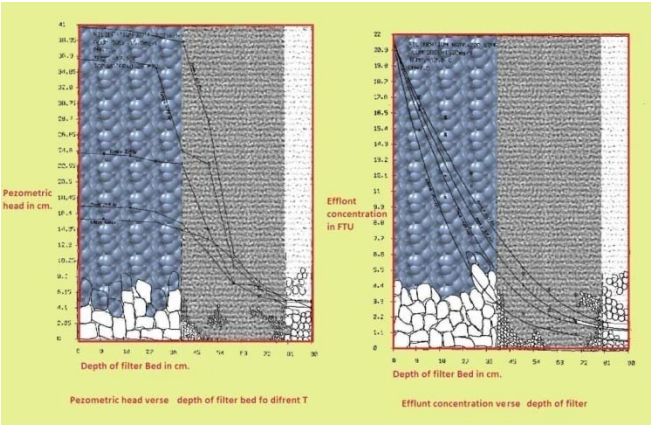
Number of experimental test was performed by fixing filtration rate at 220 l /hr. and influent turbidity "Co" equal to Av=21.5 F.T.U which equal 230 milligram / litter (p.p.m), alum dose 15.0 milligram / litter (p.p.m) and depth of sand media 30 ,40 cm , calculating effluent turbidity "C" from time to time to calculate the filter efficiency,



Figures bellow indicates the relation between filter efficiency with respect to different crashed brick depth together with 20 & 40cm sand media,



Results show clearly that the efficiency of filtration increased up to crashed brick layer of 40 cm, then the efficiency droped. According to this information the sand layer is fixed to be 40 cm and the crashed brick layer type-1 is fixed to be 40 cm during the following experimental tests



XII. Experimental Test at Lab

A number of experimental test perfumed at lab. Using drinking water from city main mixed with controlled kaolin as turbidity, tests divided in groups where all variables are fixed and only one character is changed to study the results. About 20 full lab. Tests are chosen from 68 tests for this study as final results.

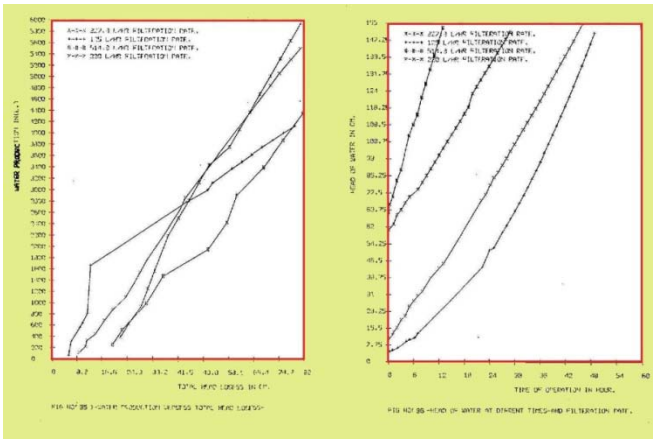
Coagulants used in the tests is Alum with dosing rates of 15.0 milligram / litter ,in groups 1,3,5 , and alum with Polly electrolytes dosing rage 0.1 to 0.01 milligram / letter in groups 2,4,6 .

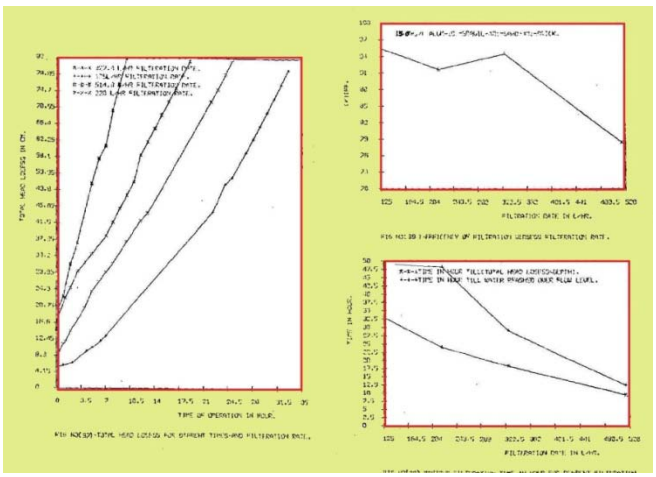
Filtration rates used in lab. Tests are 125,220,327.3,514.3 letter / hr. “equal to 2.6, 6.25 ,9. 43, 14.82 m3 /h respectively “

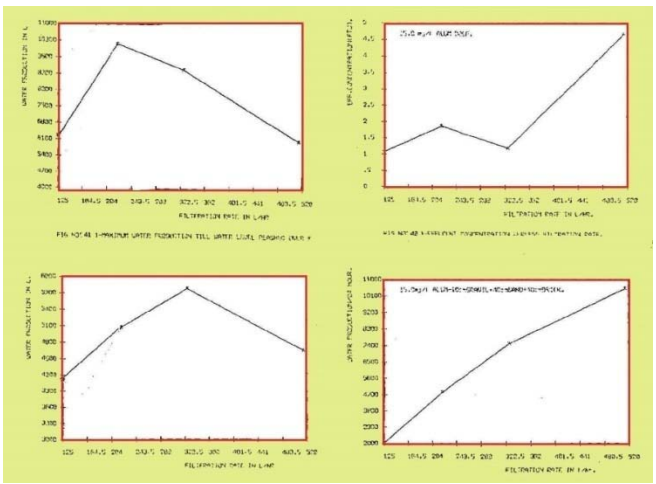
Filtration media multiple media filters are used, crashed brick and sands are as described previously.
Tests results are shown in bellow figures:-

First Group Test
Variable filtration Rate
Coagulant: Alum 15.0 mg/l
Sand: Type 2
Depth of Filtration Media: 40cm
Aggregate layer : 10 cm

SPECIFICATION.	TEST NO.1	TEST NO.2	TEST NO.3	TEST NO.4
FILTER TYP	DUAL MED.	DUAL MED.	DUAL MED.	DUAL MED.
SAND TYP.	NO.2	NO.2	NO.2	NO.2
SAND DEPTH IN CM.	40cm.	40cm.	40cm.	40cm.
CRASHED BRICK TYP.	NO.1	NO.1	NO.1	NO.1
BRICK DEPTH IN CM.	40cm.	40cm.	40cm.	40cm.
GRAVIL DEPTH IN CM.	10cm.	10cm.	10cm.	10cm.
FILTERATIN RATE.	327.3L/HR	125L/HR	514.3L/HR	220L/HR
INFLUNT TURBIDITY.	22 FTU 236.7MG/L	23 FTU 249.3MG/L	21.8FTU 234.1mg/l	22.7 FTU 246.7mg/l
EFFLOUNT TUBIDITY.	1.21FTU	1.0714FTU	4.685FTU 13.0mg/l	1.876 FTU
EFFICIENCY(%)	94.5%	95.34%	78.5%	91.76%
WATER TEMPRETURE.	15.6 C	16.6 C	16.1 C	16.6 C
PH	7.4 PH	7.4 PH	7.4 PH	7.4 PH
COAGULANT.TYP.	ALUM	ALUM	ALUM	ALUM
COAGULANT DOSE(mg/l)	15.0mg/l	15.0mg/l	15.0mg/l	15.0mg/l
VELOSITY GRADENT(G)	(90.524)	(25.579)	(166.63)	(52.873)
TIME FOR BACK WASH.	29 HR	49.1 HR	13.56 HR	48.2 HR
TIME FOR TOTAL HEAD LOSSES =80 cm.	18.4 HR	33 HR	9.6 HR	24.1 HR
TOTAL WATER PROD.	9077 L	4537.5 L	6063.1 L	10174.5L
TOTAL WATER PROD.TIL T.H.L=80 cm.	5760 L	2937.5 L	4642.3 L	5070.5 L
T.H.L VERSUS TIME SEE FIG NO.	(37)	(37)	(37)	(37)
WATER LEVEL VERSUS TIME(SEE FIG NO.)	(36)	(36)	(36)	(36)

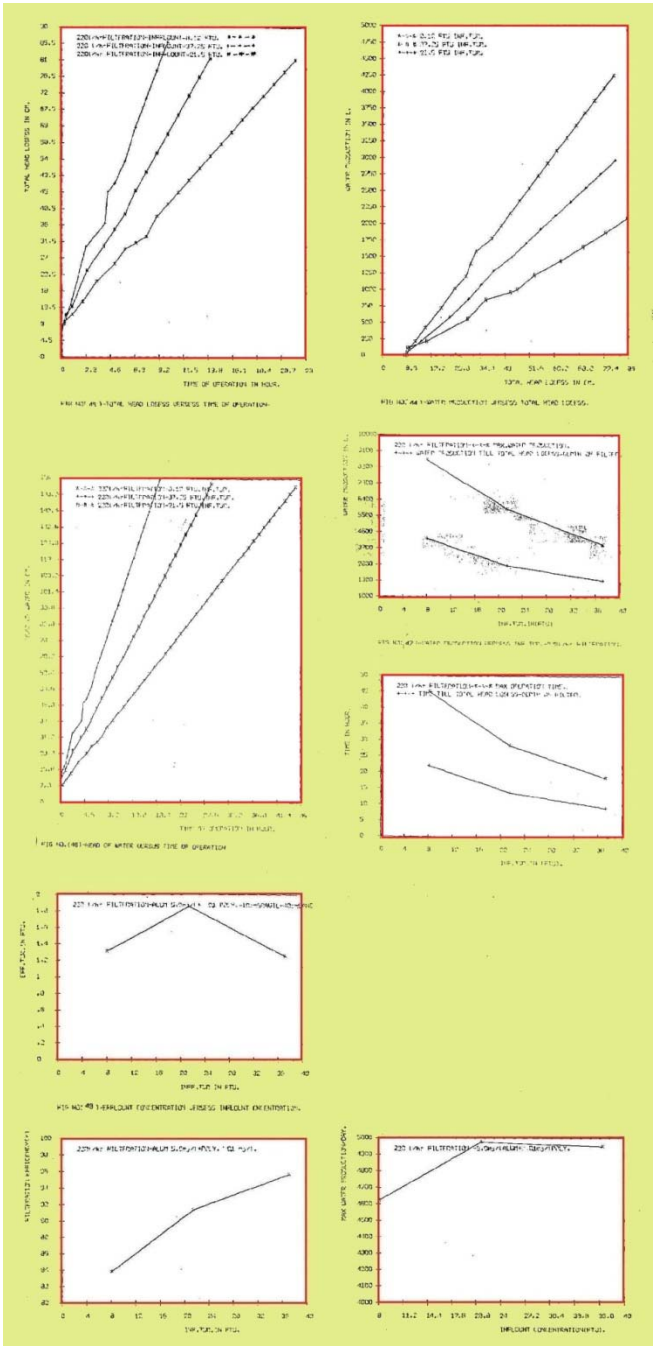






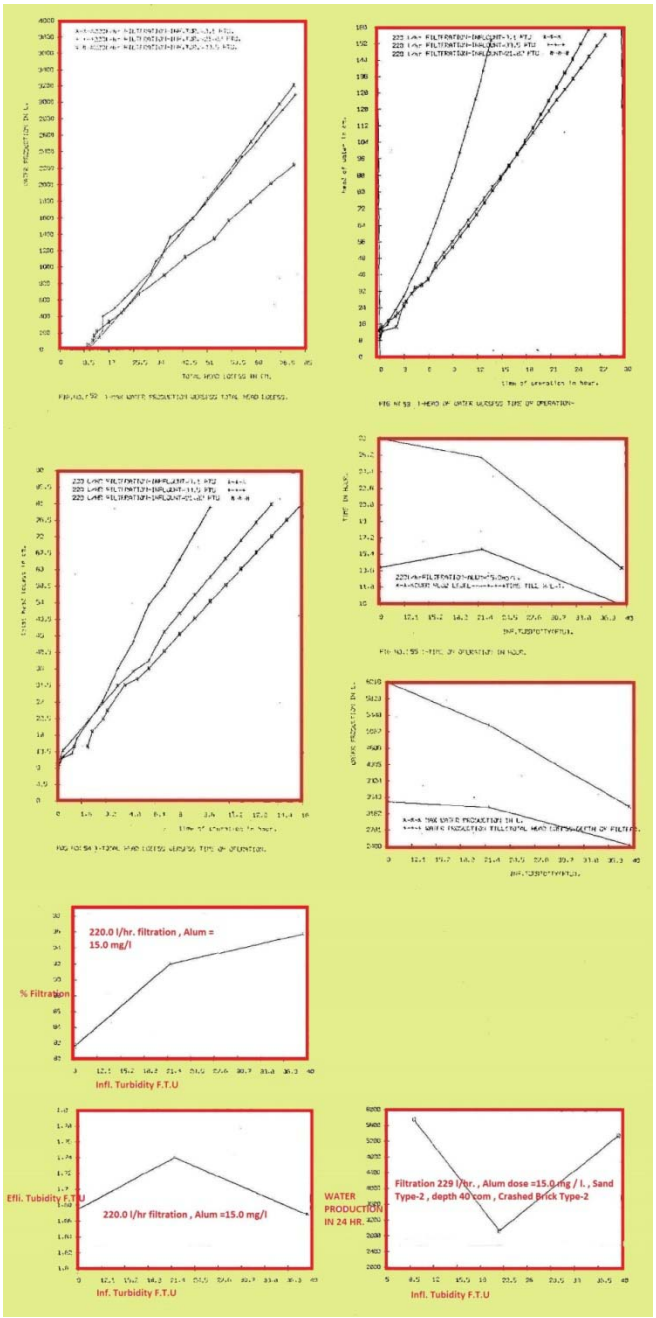
Fixed filtration Rate
Coagulant: Alum5.0mg/l
+Polyelectrolyte 0.1mg/l
Sand: Type 2
Depth of Filtration Media: 40cm
Aggregate layer : 10 cm

SPECIFICATION.	TEST NO.5	TEST NO.6	TEST NO.7
FILTER TYP	DUAL MED.	DUAL MED.	DUAL MED.
SANB TYP.	NO.2	NO.2	NO.2
SAND DEPTH IN CM.	40cm.	40cm.	40cm.
CRASHED BRICK TYP.	NO.1	NO.1	NO.1
BRICK DEPTH IN CM.	40cm.	40cm.	40cm.
GRAVIL DEPTH IN CM.	10cm.	10cm.	10cm.
FILTERATIN RATE.	220 L/HR	220 L/HR	220 L/HR
INFLUNT TURBIDITY.	8.12 FTU 57.5mg/l	37.25 FTU 432.5mg/l	21.5 FTU 231.5mg/l
EFFLOUNT TUBIDITY.	1.313FTU	1.257FTU	1.875FTU 13.0mg/l
EFFICIENCY(%)	83.83%	95.625%	91.363%
WATER TEMPRETURE.	11.6 C	14.8 C	14.3 C
PH	7.4 PH	7.4 PH	7.4 PH
COAGULANT.TYP.	ALUM+POLY	ALUM+POLY	ALUM+POLY
COAGULANT DOSE(mg/l)	5.0 ALUM+ 0.1 POLY.	5.0 ALUM+ 0.1 POLY.	5.0 ALUM+ 0.1 POLY.
VELOSITY GRADENT(G)	(50.816)	(49.5408)	(49.728S)
TIME FOR BACK WASH.	45 HR	18.4 HR	28.4 HR
TIME FOR TOTAL HEAD LOSSES =80 cm.	22 HR	9.1 HR	13.7 HR
TOTAL WATER PROD.	8612.5L	3928.8L	5899.4L
TOTAL WATER PROD.TIL T.H.L=80 cm.	4242.5L	1929.3L	2749.4L
T.H.L VERSUS TIME SEE FIG NO.	(45)	(45)	(45)
WATER LEVEL VERSUS TIME(SEE FIG NO.)	(46)	(46)	(46)
WATER PRODUCTION VERSUS T.H.L(SEE FIG NO.)	(44)	(44)	(44)



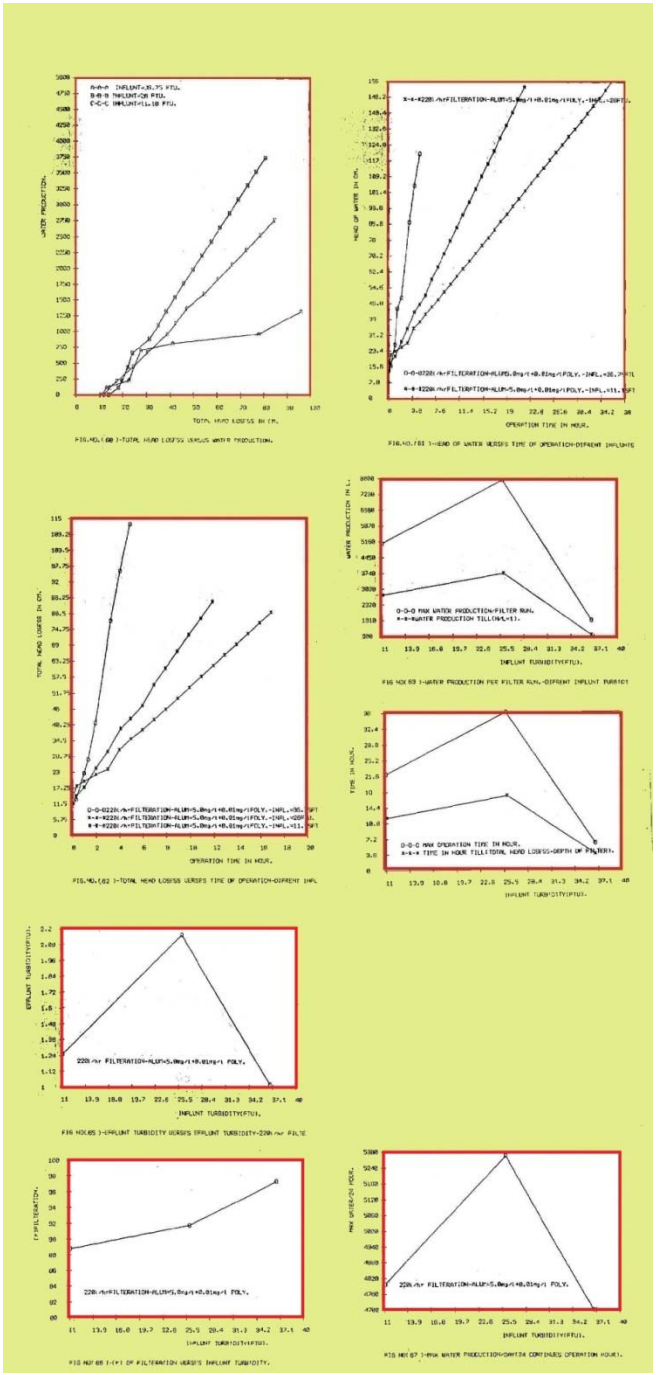
Third Group Test
Fixed filtration Rate
Coagulant: Alum 15.0mg/l Sand: Type 2
Depth of Filtration Media: 40cm
Aggregate layer: 10 cm

SPECIFICATION.	TEST NO.8	TEST NO.9	TEST NO.10
FILTER TYP	DUAL MED.	DUAL MED.	DUAL MED.
SAND TYP.	NO.2	NO.2	NO.2
SAND DEPTH IN CM.	40cm.	40cm.	40cm.
CRASHED BRICK TYP.	NO.1	NO.1	NO.1
BRICK DEPTH IN CM.	40cm.	40cm.	40cm.
GRAVIL DEPTH IN CM.	10cm.	10cm.	10cm.
FILTERATIN RATE.	220 L/HR	220 L/HR	220 L/HR
INFLUNT TURBIDITY.	9.1 FTU 70.06mg/l	39.5 FTU 462.9mg/l	21.87 FTU 235.1mg/l
EFFLOUNT TUBIDITY.	1.675FTU	1.668FTU	1.74FTU
EFFICIENCY(%)	81.56%	95.776%	92.044%
WATER TEMPRETURE.	19.6 C	16.2 C	17.6 C
PH	7.4 PH	7.4 PH	7.6 PH
COAGULANT.TYP.	ALUM	ALUM	ALUM
COAGULANT DOSE(mg/l)	15.0mg/l	15.0mg/l	15.0mg/l
VELOSITY GRADENT(G)	(51.2541)	(53.043)	(52.4577)
TIME FOR BACK WASH.	28 HR	14 HR	26 HR
TIME FOR TOTAL HEAD LOSSES =80 cm.	14 HR	10 HR	16 HR
TOTAL WATER PROD.	6202.66L	3340.5L	5223.75L
TOTAL WATER PROD.TIL T.H.L=80 cm.	3442.66L	2460.5L	3333.75L
T.H.L VERSUS TIME SEE FIG NO.	(54)	(54)	(54)
WATER LEVEL VERSUS TIME(SEE FIG NO.)	(53)	(53)	(53)
WATER PRODUCTION VERSUS T.H.L(SEE FIG NO.)	(52)	(52)	(52)



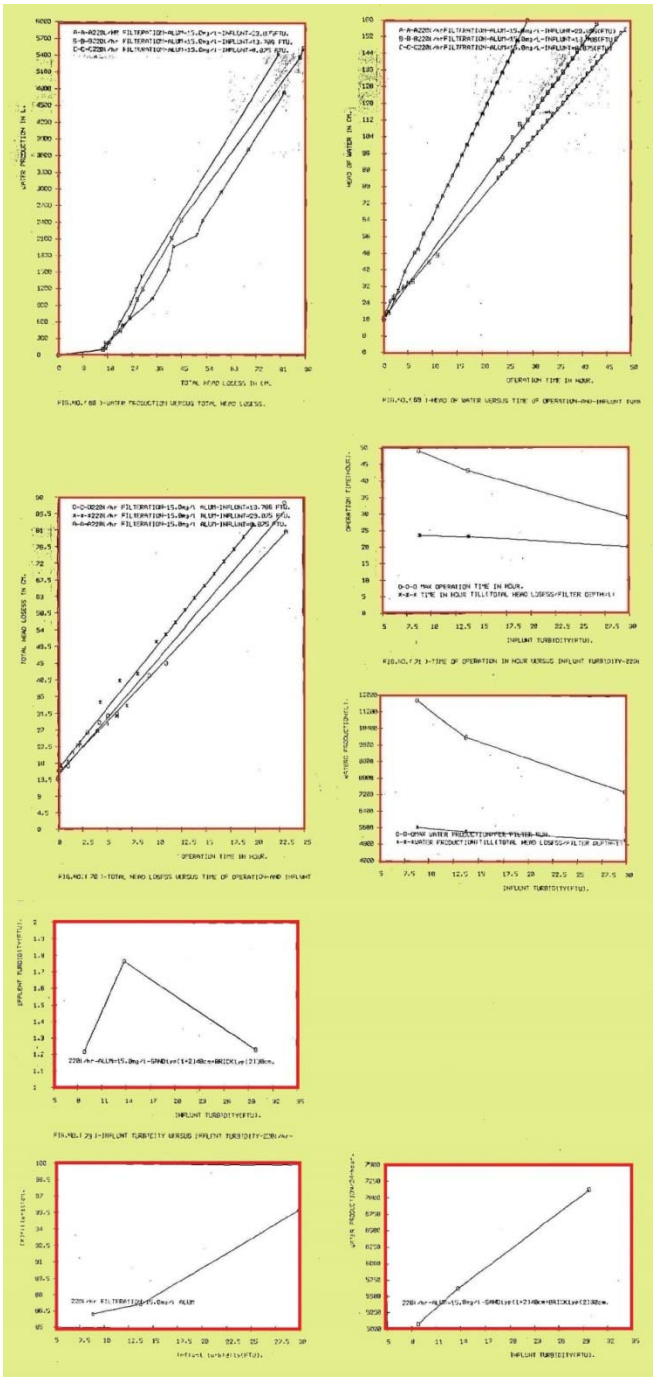
Forth Group Test
Fixed filtration Rate
Coagulant: Alum 5.0mg/l + polyelectrolyte 0.1mg/l
Sand: Type 2
Depth of Filtration Media: 40cm
Aggregate layer: 10 cm

SPECIFICATION.	TEST NO.11	TEST NO.12	TEST NO.13
FILTER TYP	DUAL MED.	DUAL MED.	DUAL MED.
SAND TYP.	NO.2	NO.2	NO.2
SAND DEPTH IN CM.	40cm.	40cm.	40cm.
CRASHED BRICK TYP.	NO.1	NO.1	NO.1
BRICK DEPTH IN CM.	40cm.	40cm.	40cm.
GRAVIL DEPTH IN CM.	10cm.	10cm.	10cm.
FILTERATIN RATE.	220 L/HR	220 L/HR	220 L/HR
INFLUNT TURBIDITY.	36.75 FTU 427.3mg/l	26.0 FTU 282.4mg/l	11.15 FTU 96.55mg/l
EFFLOUNT TUBIDITY.	1.02 FTU	2.15 FTU	1.25 FTU
EFFICIENCY(%)	97.22%	91.72%	82.78%
WATER TEMPRETURE.	11.1 C	12.3 C	9.8 C
PH	7.4 PH	7.4 PH	7.4 PH
COAGULANT.TYP.	ALUM+POL.	ALUM+POLY	ALUM+POLY
COAGULANT DOSE(mg/l)	5.0 ALUM+ 0.01 POLY	5.0 ALUM+ 0.01 POLY	5.0 ALUM+ 0.01 POLY
VELOSITY GRADENT(G)	(51.0398)	(50.5286)	(47.7903)
TIME FOR BACK WASH.	6 HR	36 HR	22 HR
TIME FOR TOTAL HEAD LOSSES =80 cm.	3.5 HR	17 HR	12 HR
TOTAL WATER PROD.	1632.25L	7924.833L	5086L
TOTAL WATER PROD.TIL T.H.L=80 cm.	964.8L	3744.833L	2766L
T.H.L VERSUS TIME SEE FIG NO.	(62)	(62)	(62)
WATER LEVEL VERSUS TIME(SEE FIG NO.)	(61)	(61)	(61)
WATER PRODUCTION VERSUS T.H.L(SEE FIG NO.)	(60)	(60)	(60)



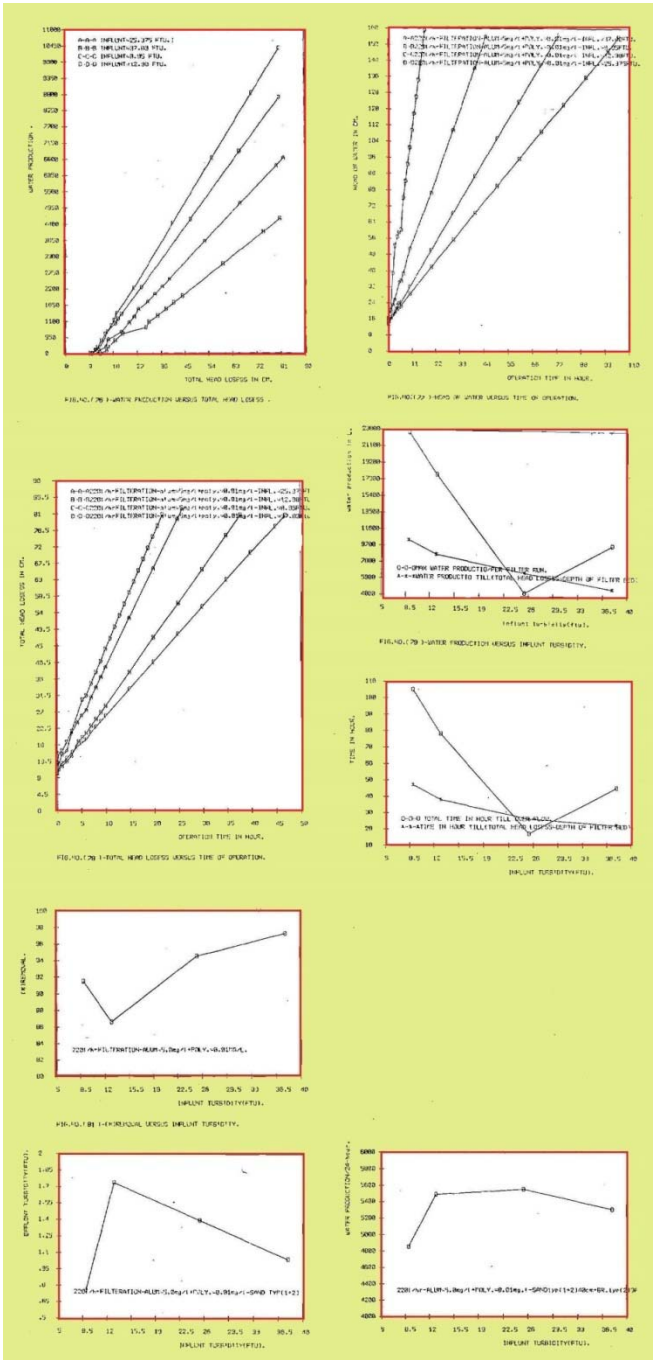
Fifth Group Test
Fixed filtration Rate
Coagulant: Alum 15.0mg/l
Sand: mixed Type 1+2(1:1)
Depth of Filtration Media: 40cm
Aggregate layer: 10 cm

SPECIFICATION.	TEST NO.14	TEST NO.15	TEST NO.16
FILTER TYP	DUAL MED.	DUAL MED.	DUAL MED.
SAND TYP.	NO.(1+2) (1:1)	NO.(1+2) (1:1)	NO.(1+2) (1:1)
SAND DEPTH IN CM.	40cm.	40cm.	40cm.
CRASHED BRICK TYP.	NO.2	NO.2	NO.2
BRICK DEPTH IN CM.	30cm.	30cm.	30cm.
GRAVIL DEPTH IN CM.	10cm.	10cm.	10cm.
FILTERATIN RATE.	220 L/HR	220 L/HR	220 L/HR
INFLUNT TURBIDITY.	15.786FTU 130.6mg/l	29.87FTU 338.5mg/l	8.875FTU 67.15mg/l
EFFLOUNT TUBIDITY.	1.765FTU	1.235FTU	1.217FTU
EFFICIENCY(%)	97.197%	95.86%	86.28%
WATER TEMPRETURE.	11.1 C	10.5 C	11.1 C
PH	7.4 PH	7.4 PH	7.4 PH
COAGULANT.TYP.	ALUM	ALUM	ALUM
COAGULANT DOSE(mg/l)	15.0mg/l	15.0mg/l	15.0mg/l
VELOSITY GRADENT(G)	(51.0959)	(51.3062)	(51.0398)
TIME FOR BACK WASH.	43 HR	29 HR	49 HR
TIME FOR TOTAL HEAD LOSSES =80 cm.	23 HR	20 HR	23.5 HR
TOTAL WATER PROD.	9933.6L	7360.3L	11749.25L
TOTAL WATER PROD.TIL T.H.L=80 cm.	5438.6L	5047.3L	5629.25L
T.H.L VERSUS TIME SEE FIG NO.	(70)	(70)	(70)
WATER LEVEL VERSUS TIME(SEE FIG NO.)	(69)	(69)	(69)
WATER PRODUCTION VERSUS T.H.L(SEE FIG NO.)	(68)	(68)	(68)



Sixth Group Test
Fixed filtration Rate
Coagulant: Alum 5.0mg/l + Polyelectrolyte 0.01mg/l Sand: mixed Type 1+2(1:1)
Depth of Filtration Media: 40cm
Aggregate layer: 10 cm

SPECIFICATION.	TEST NO.17	TEST NO.18	TEST NO.19	TEST NO.20
FILTER TYP	DUAL MED.	DUAL MED.	DUAL MED.	DUAL MED.
SAND TYP.	NO.(1+2) (1:1)	NO.(1+2) (1:1)	NO.(1+2) (1:1)	NO.(1+2) (1:1)
SAND DEPTH IN CM.	40cm.	40cm.	40cm.	40cm.
CRASHED BRICK TYP.	NO.2	NO.2	NO.2	NO.2
BRICK DEPTH IN CM.	30cm.	30cm.	30cm.	30cm.
GRAVIL DEPTH IN CM.	10cm.	10cm.	10cm.	10cm
FILTERATIN RATE.	220 L/HR	220 L/HR	220 L/HR	220 L/HR
INFLUNT TURBIDITY.	25.375FTU 280.4mg/l	12.98FTU 120.3mg/l	8.95FTU 68.1mg/l	37.83FTU 441.3mg/l
EFFLOUNT TUBIDITY.	1.575FTU	1.737FTU	0.755FTU	1.0417FTU
EFFICIENCY(%)	94.5%	86.62%	91.56%	97.25%
WATER TEMPRETURE.	11.4 C	11.8 C	11.2 C	11.6 C
PH	7.4 PH	7.4 PH	7.4 PH	7.4 PH
COAGULANT.TYP.	ALUM+POLY	ALUM+POLY	ALUM+POLY	ALUM+POLY
COAGULANT DOSE(mg/l)	5.0 ALUM+ 0.01 POL.	5.0 ALUM+ 0.01 POL.	5.0 ALUM 0.01 POL.	5.0 ALUM+ 0.01 POL.
VELOSITY GRADENT(G)	(50.9094)	(50.7302)	(50.9961)	(50.8234)
TIME FOR 'BACK WASH.	17 HR	78 HR	105 HR	45 HR
TIME FOR TOTAL HEAD LOSSES =80 cm.	25 HR	38 HR	47 HR	22 HR
TOTAL WATER PROD.	4340L	17906.7L	22672.7L	9918.5L
TOTAL WATER PROD.TIL T.H.L=80 cm.	6653L	8706.7L	10352.6L	4858.5L
T.H.L VERSUS TIME SEE FIG NO.	(78)	(78)	(78)	(78)
WATER LEVEL VERSUS TIME(SEE FIG NO.)	(77)	(77)	(77)	(77)
WATER PRODUCTION VERSUS T.H.L(SEE FIG NO.)	(76)	(76)	(76)	(76)



XIII. Results

1. Suggestion of the use of crashed brick, washed perfectly to clean away all salts that might be within the brick materials, and sieved to have homogenous particles.
2. All tests indicate the possibility of using crashed bricks as top layer in gravity multimedia filtration,
3. Increasing efficiency through proper control of mixing, turbidity, filtration rate and velocity gradient.
4. Experimental filtration gives V.good Results for filter working cycle" filtration cycle increased to at least twice ", and quantities of water production& Quality.
5. Labs tests shows a positive results on removing TDS within the supplied water.
6. It is recommended to Use Polymer with Alum for Coagulation for better Results.
7. Filtration efficiency up to 98% at laboratory Tests. When using the proposed crashed brick as first layer.
8. Minimum depth of sand media is calculated to be 20 cm.
9. It is important to check Coagulant potential value to have better Results.
10. Crashed bricks have to be replaced with new layer after approximate 60 cleaning cycle.

11. Tests also indicate that there will be intermediate layer between cashed brick and the top sand layer : this layer will be a mixed of proposed crashed brick with top fine sand , the tests also indicate that this layer will be about 10 cm in thickness:.
    Results of experimental tests indicate the efficiency of filtration increased up to crashed brick layer of 40 cm, then the efficiency droped. According to this information the sand layer is fixed to be 40 cm and the crashed brick layer type-1 is fixed to be 40 cm during the following experimental tests.
12. Specific coefficient "Segma " value is calculated to be "ranged from 0.015 to 0.135 ,see attached figure
13. The increase of deposit inside the filter media with time will cause continues change in filter porosity; below figures indicate these changes for different type of filter media.
14. Coefficient of permeability increased in value when head losses ratio decreases. Attached figure shows this elation for different type of filter media.
15. Production of water with reference to deposit parameters. This relation theoretically should be linear, but experimental tests give parabolic elation due to : at the beginning of filtration cycle the filter media is clean and the deposit will be settled within the porosity randomly ,with time the deposit will be more regular, this unsymmetrical relation is due to the value of "beta"
16. Relation between maximum water production can be achieved theoretically compared with real water production are shown below, maximum percentage is 74% , from group test NO.1.
17. Results also indicates the advantages of using valuable filtration rate compared with fixed rate filtration ",filtration rages from 3.6 to 14.0 m3/m2/hr".
18. All gravity filters have its own standard coefficient which is called filtration coefficient "lumda". during those experimental test we tried also to calculate the values of this coefficients" which ranged from 1 to 0.66 "

XIV. Recommendation

Only crashed brick is used in this study, it is highly recommended to check the possibility of crashed stone, crashed concrete, and even palm tree leaf.

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