Nozzle Filter Modification for Water Pre-Treatment Technology In Water Treatment Plants (Case Study: Toroq Water Treatment Plant)

Babak Mehravaran, Hossein Ansari, Ali Asghar Beheshti

Abstract*: *Nozzle filtration can be considered as a major pre-treatment process for water and waste water, since they efficiency separate fine solids particles over prolonged periods without addition of chemicals. Proper nozzle performance can reduce operating costs, reduce maintenance costs, and improve cleaning quality. this review article summarized and evaluates modification to nozzle filtration technology .achieved results in this study shows that nozzle filtration may be considered as efficient pre-treatment process incase surface water is used as water supply. With pass of muddy water sample due to current rainfall in stilling basin of Toroq water treatment plant from nozzle filters in laboratory pilot, Turbidity Removal efficiency and also Suspended solids equal 9.6% and 86% respectively was obtained .And the results of Additional tests represent that Turbidity Removal and also solid suspensions efficiency by nozzle filters due to algae making inlet water to Toroq water treatment plant in warm seasons is 4/6% and 47% respectively The obtained results of the study indicate that use nozzle filters caused Increase the efficiency of the process water treatment, and it is prevents from emergency exits the Toroq water treatment plant.

Keywords:* *Nozzle filter, Muddy water, Algae water, Suspended solids, turbidity

I. INTRODUCTION

More than 1 billion people lack access to freshwater, nearly 17% of the world's total Population[1].This makes the water no longer useful for drinking but also renders it unsuitable for several other purposes, Such types of contamination can be due to the presence of suspended solids, dissolved solids, chemicals, or any other combinations. The solution to this problem is water purification and the different methods which may be embraced to achieve it [2]. Overgrowing algae have brought negative impacts on daily production of water plants which are rarely eliminated by common methods. To efficiently remove algae from drinking water, a strengthening process or combined process [3]. A major problem for growing algae in water treatment plants, While increasing color and turbidity of water due to the taste and odor in drinking water are common in treatment facilities around the world. Taste and odor are perceived by the public as the primary indicators of the safely and acceptability of drinking water and are mainly caused by the presence of two semi-volatile compounds – 2-methyl isoborneol (MIB) and geosmin[4].

Treatment may consist of chemical, biological, or physical processes or a combination thereof. Water may be treated to any level of quality desired; however, as its purity increases, so does the cost of attaining that purity. The required quality of water is dictated by its intended use, for example, aquatic life, drinking water, or irrigation[5].There are many types of filter, each of which may be suited to a particular application.Filters may be categorized according to the mode of operation (continuous or batch) and the driving force for filtration (vacuum, pressure or centrifugal). Each filter type has many possible variations. Industrial filtration equipment has evolved through innovation and technical development [6].The filters are divided by the force that causes filtration: vacuum,(a negative pressure at the filter medium),gravity alone (the hydrostatic head of the liquid above the medium),centrifugal force (an amplified gravity effect),fluid pressure (imposed by the suspension feed pump), mechanical pressure (a squeezing effect), and the use of other force fields[7]**.** The separation of particles from a fluid for a particular application is controlled by the filter medium. Any material that is porous or can be rendered porous or made into a porous structure, whether the pores are the size of a person's fist or smaller than a micrometer, can serve as a filter medium .A filter medium should be strong (in tension at least), flexible, resistant to corrosion and abrasion, easily manipulated into the required shapes and capable of being made with a range of porosities [7]. There are seemingly unlimited forms and types of media that are possible, Choosing a filter medium can be a daunting task[8].

Filtration is the process of passing water through material to remove particulate and other Impurities, including floc, from the water being treated. These impurities consist of suspended particles (fine silts and clays), The actual removal mechanisms are interrelated and rather complex, but removal of color and turbidity is based on the following factors: chemical characteristics of the water being treated (particularly source water quality), nature of suspension (physical and chemical characteristics of particulates suspended in the water) and type and degree of pre-treatment (coagulation, flocculation, and clarification)[9,10.11,12]. As much as 90% of the removal of color and turbidity is affected in the pre-filtration stages of treatment.

Manuscript published on 28 February 2017.
* Correspondence Author (s)
Babak Mehravaran*, Ph.D Student, Department of Water Engineering, International Campus, Ferdowsi University of Mashhad, Iran.
Hossein Ansari, Associate Professor, Department of Water Science and Engineering, Ferdowsi University of Mashhad, Iran.
Ali Asghar Beheshti, Assistant Professor, Department of Water Science and Engineering, Ferdowsi University of Mashhad, Iran.

The degree of pretreatment applied prior to filtration depends on the quality of the raw water, type of filtration (pressure or gravity filter) and the size of the treatment facility [13,14,15]. Solids removal efficiency depends largely on: the quality of the water being treated; the effectiveness of the suspended particles for removal by clarification and filtration; and filter operation . Filter unit design and filter media type and depth also play a role in determining solids removal efficiency, but are less important than water quality and pre-treatment consideration [16, 17, 18, 19]. Straining is a term used to describe the removal of particles from a liquid (water) by passing the liquid through a filter or sieve whose pore are smaller than the particles to be removed. While the straining mechanism does play a role in the overall removal process, especially in the removal of large particles [20, 21], If you think about surface water sources, i.e., lakes, rivers, and reservoirs, you realize they contain varying amounts of suspended and dissolved materials [22]. This material may include turbidity, color, taste, odor, microorganisms, fish, plants, trees, trash, etc. The material may be organic or inorganic, suspended or dissolved, inert or biologically active, and vary in size from colloidal to a tree trunk. Some of these larger items can impede equipment in the treatment process, such as a tree limb getting stuck in a water pump impeller. So the first process in conventional water treatment is to screen or strain out the larger items. This is often accomplished using a large metal screen, often called a bar-screen, which is placed in front of the water source intake. Large items are trapped on the screen as the water passes through it. These screens must routinely be raked or cleaned off.

Nozzles are used in liquid/solid separation. Nozzles can also be used as collectors at the bottom of the vessels by installing a number of nozzles uniformly across a tray plate. The combination of high open area and a non-plugging slot design makes this nozzle/collector application popular [23]. In Toroq water treatment plant, from nozzle filters as a pre-treatment process and filtering In order to reduce and control Turbidity and input suspension particles due to algae growth in summer and also muddy water in results of seasonal rainfall to water treatment plant is used. Nozzle filters have ability to install as a Flange form and in bottom of stilling basin. Applications of the filter nozzles include: drinking water treatment, production of demineralized water, urban and industrial wastewater treatment, filtration of river or well water for irrigation and water for swimming pools, etc. Nozzles are available in several models and sizes (slots, thread, thread length and the length of the nozzle) and are made of polypropylene in different colors. In accordance with the mechanical and chemical properties, Surface water is sometimes the only available safe water source. Typical problems encountered can be caused by high suspended solids, Turbidity, agricultural runoff.

II.MATERIALS, EQUIPMENT AND METHODS

The grassy or fishy odor is highly dependent on the enormous growth of algae in the warm months. In Toroq dam reservoir, Geosmin is the major cause of odor in water. The main sources of the Geosmin in this reservoir are from Growth of algae in the warm seasons .Another problem that we face in Toroq water treatment plant is Muddy water condition in stilling basin of Toroq water treatment plant as a result of heavy rain fall due to emergency exits the Toroq water treatment plant Which is caused by increased turbidity and suspended solids.

A. Filtration Rate

Filtration rate also has a significant influence on the treatment removal. Good removal in nozzle filter are achieved with low filtration rate because low filtration rates are critical to retain particles that are gravitationally deposited to the surface of the media[24].The Nozzle filter capable of removing turbidity and color at a filtration rate of 8/7 L/min.

B. Experience

In a pilot built in Laboratory of toroq water treatment plant found out, nozzle filter used for remove of Suspended solids and turbidity. To evaluate filtration process efficiency, familiarity with the measurement of turbidity, color, pH and temperature

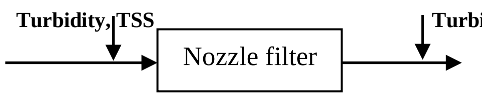


Fig1: Filtration Process Monitoring – Parameters and Locations

In Fig 2, the Schematic of (a)Muddy water condition in stilling basin of Toroq water treatment plant as a result of heavy rain fall(b)Algae water condition in stilling basin of Toroq water treatment plant due to Warming weather in the summer are presented.

a

b

Fig 2 . (a) Muddy water condition in stilling basin of Toroq Water treatment plant as a result of heavy rain fall (b)Algae water condition in stilling basin of Toroq water treatment plant due to Warming weather in the summer.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-6 Issue-3, February 2017

III.RESULTS AND DISCUSSION

In table 1, Turbidity Removal efficiency and also Suspended solids by nozzle filters in pre-treatment experiment under muddy water condition are provided.

Table1. Removal Efficiencies of the Nozzle Filter (In Muddy Water Condition)

Parameters	unit	Inlet	Outlet	Removal%
Turbidity	NTU	252	228	9/6
TSS	mg/l	244	34	86

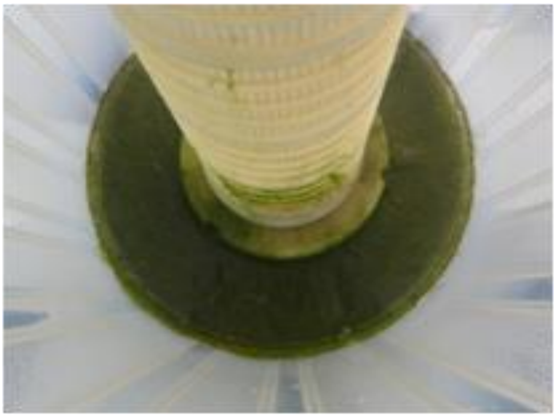
In table2, Turbidity Removal efficiency and also Suspended solids by nozzle filters in pre-treatment experiment under Algae water condition are provided.

Table2. Removal Efficiencies of the Nozzle Filter (In Algae Water Condition)

Parameters	unit	Inlet	Outlet	Removal%
Turbidity	NTU	323	308	4/6
TSS	mg/l	633/3	333/4	47

In fig3, Images of suspended solids removed using Nozzle filters in pre-treatment experiment under (a) muddy water condition and (b) algae water condition are presented.

a



b

Fig3.Images of suspended solids removed using Nozzle filters in pre-treatment experiment under (a) muddy water condition and (b) algae water condition

In Table 3, Removal efficiencies of the Nozzle filters are provided.

Table3. Removal Efficiencies of the Nozzle Filters

Parameters	unit	Inlet	Outlet	Removal%
TDS	mg/l	433	433	0
EC	µS/cm	655	654	0/15

As we can be seen from the results presented in Table 3, there is no change the rate of Total dissolve solids of Raw water in pass of nozzle filter, therefore, we can use from TS changes instead TSS changes in nozzle filters. Of course, the impact of nozzle filters on the rate of EC changes of passed raw water is low, however, if on inlet raw water, there are Colloidal Compounds and charged, increase removal efficiency of EC.

Schematic changes of suspended particles and turbidity in the outlet water of the Variation Turbidity and Total suspended solids in the Nozzle filters during pre- treatment with Nozzle filters are provided in Figure.4. The lines show the first order equation fitted to the data for muddy and algae water conditions.

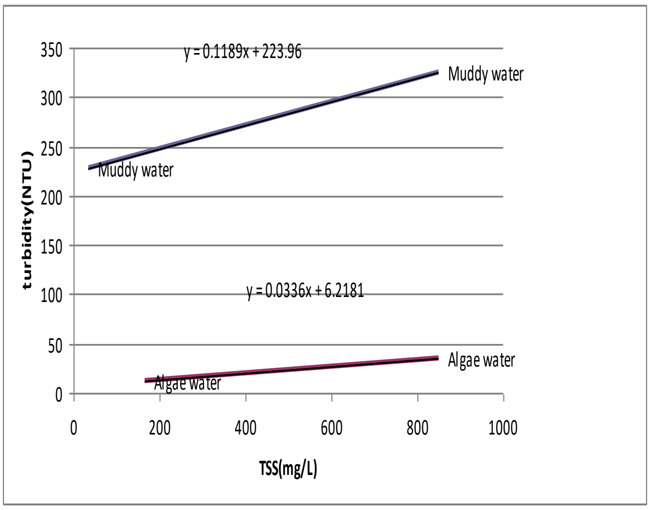


Fig.4. Variation Turbidity and Total suspended solids in the Nozzle filters during pre- treatment with Nozzle filters (The lines show the first order equation fitted to the data for muddy and algae water conditions)

Turbid metric is an analysis that to study optical properties on scattering .Due to scattering in water is the existence suspended solids such as, Colloidal materials, organic materials, microorganism and even Macromolecule. Because turbidity creates aerosol in water and also sediment, turbidity control is very important.

According to Fick's law the filter efficiency can be expressed by the filter coefficient or,

$$, \frac{dc}{dx} = -\lambda\, c \qquad (1)$$

Where;

C=Solids concentration.

X=Filter depth

λ=filter coefficient or coefficient of proportionality From the above equation it can be stated that the removal of the suspended particles is proportional to the concentration or the particles present in the water.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

The total suspended solid concentration after a length of Δx of the filter cell can be expressed:

$$C_{outlet} = \sum^{c} inlet\, e \wedge -\lambda_i\, \Delta x \qquad (2)$$

Where:

λ_i =filter efficiency of each filter cell

Δx=Length of experimental filter cell

c_{inlet} and c_{outlet} = Concentration of particles in the inlet &outlet of the filter

It is to be stated that after evaluating the filter depth (length) and the filter coefficient and the Suspended Solids concentration, The performance efficiency of the filter can be predicted .According to Weglin (1996), the effluent quantity for the n number of compartments is given by [25]:

$$C_e = C_0 * E_1 * E_2 * E_3 * E_4 \cdot ....E_n \qquad (3)$$

Where:

C_0 = Concentration of the HRF influent

C_e = concentration of the HRF effluent

$E_1, E_2, E_3, E_4 \cdot ....E_n$ = Filtration efficiency for the each compartment (1, 2,3 respectively).

The basic expression for the above relationship is expressed by:

$$C_e = C_o\, e^{eiL} \qquad (4)$$

Where:

ei= coefficient of filtration

L= Length of the filter

The filter efficiency is given by:

$$E = C_e / C_o = e^{-eiL}$$

$$C_e = C_{o*} E \qquad (5)$$

E_i = Filter efficiency for (i-1, 2, 3…n) compartments.

The description of the theory above showed that showed that solid removal by filtration can be described by exponential equation.

Additional tests indicated That If the conditions of water entering the Nozzle filters combined of algae and muddy water, The relationship is derived analytically can be described by exponential equation.

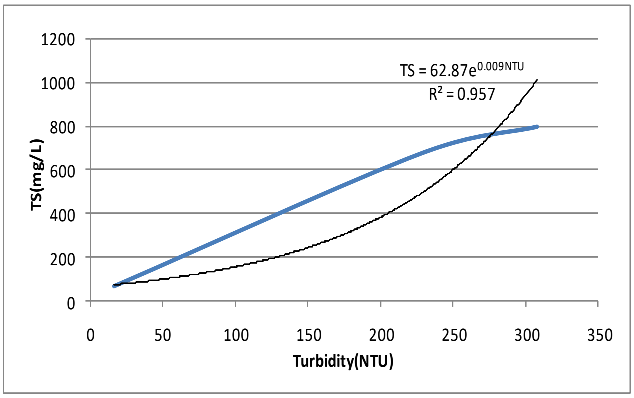


Fig.5.Effect of Nozzle filters on the removal of turbidity and total solids of algae-muddy water

In table4, the physical properties and filters dimensions used in laboratory pilot are provided

Table4. Filter Dimensions of Nozzle Filter

Nozzle filter description	Nozzle height(cm)	Nozzle diameter(cm)	SLOT SIZE(mm)
The Cylindrical flange	24	8	0/2

To evaluate filtration process efficiency, familiarity with the measurement of turbidity, Color, pH, temperature is essential,

In figures 6 shown the layout of nozzle filters instilling basin of Toroq water treatment plant, as we see the below of nozzles as a flange has ability install in the bed of the stilling basin, and the number of nozzle filters due to nozzle elevation and discharge proportional to flow rate of inlet water to stilling basin is determined which in the design for flow rate 2000m3/h is determined.

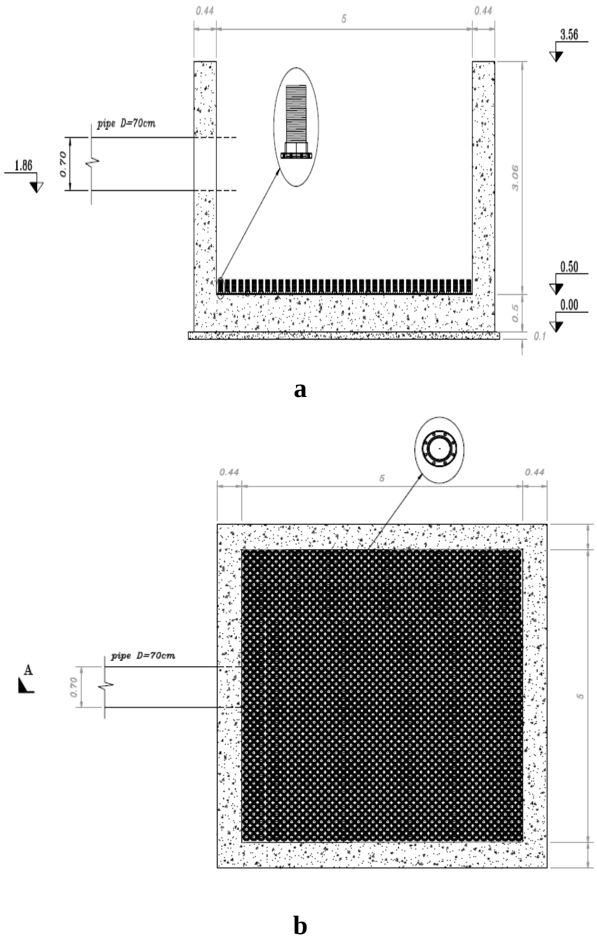


Fig.6. schematic of Toroq stilling basin with Nozzle filters located at the bottom of the stilling (a) side view (b)Top view

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

The figures below show how pressure loss coefficient is related to flow rate through Nozzle filter .The effects of the nozzle were further investigated by means of an analytical model that correctly predicted the pressure drop of the water flow through the Nozzle filter. The model confirmed that the distribution of the slots in the under drain was a critical factor for determining the length of the region with a non-uniform flow [23].

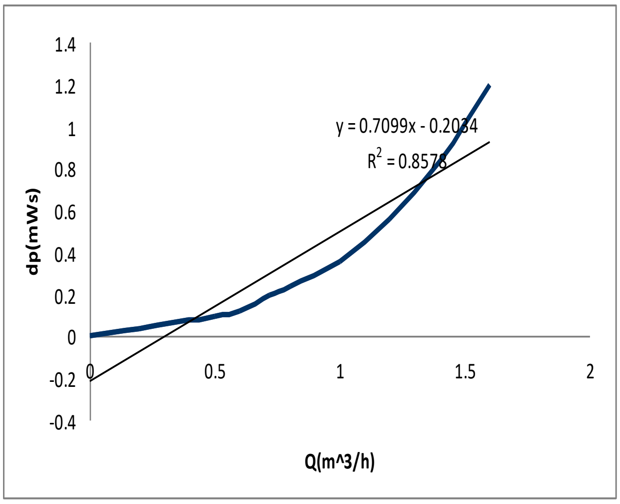


Fig.7. The Results of Filter Nozzle Testing for Process of Filtration

Filtration nozzles for water treatment have been manufactured for over 50 years. Applications include: treatment of drinking water, demineralised water production, urban and industrial waste water treatment, filtration of river/well water for irrigation, water for swimming pools, steel works, food production, etc.

IV.CONCLUSION

The point that the majority of easily accessed water resources are surface water resources, by applying self-reliant processes, which are economic important, the mentioned process such as nozzle filtration, Considering removal efficiency for total suspended solids, turbidity, color and algae, this system has shown convincible results. Achieved results in this study shows that nozzle filters may be considered as efficient pretreatment process incase surface water and water treatment plants is used as water supply for treatment. Nozzle filters does not require chemical use, energy input and mechanical parts. not demand high operating costs. The filtration rate depends largely on height of filter, the water characteristics, desired turbidity reduction, variations in the filter porosity and width of nozzles. The use of Nozzle filters was successively replaced by chemical water treatment processes. From this research we can conclude, the use of nozzle filters has high efficiency to remove turbidity and suspended particles of algae and muddy water, So that the turbidity removal and suspended solids percent by filtration for muddy water Respectively 9/6%,86%and for algae water Respectively 4/6%,47%is obtained. The results of this study have allowed defining the first order equation fitted to the data for muddy and algae water conditions and in the combination muddy-algae water condition can be described by exponential equation. Further work is also needed to investigate flow arrangements in order to improve the process performance and to enable treatment of higher flow rates.

REFERENCES

1. Herron. A. Hope, & Dabelko, Geoffrey, (2006),“ Introduction: Water Stories”, Water Stories: Expanding Opportunities in Small-Scale Water and Sanitation Projects, pp 1-8, Woodrow Wilson International Center for Scholars
2. P. SanjivKanade, S. Someshwar, Bhattacharya ,(2016),Chapter 1-Introduction to Water World A Guide to Filtration with String Wound Cartridges, 2016, Pages 1-10,
3. Q . Shen, J. Zhu, L .Cheng, J. Zhang, Z. Zhang, X. Xu,(2011), Enhanced algae removal by drinking water treatment of chlorination coupled with coagulation, Desalination, Volume 271, Issues 1–3, 15 April 2011, Pages 236-240
4. R. Srinivasan, G. A. Sorial ,(2011),Treatment of tast and odor causing compounds 2-methyl isoborneol and geosmin in drinking water: A critical review, Journal of Environmental Sciences, Volume 23, Issue 1, January 2011, Pages 1-13
5. A.J. Englande Jr., P. Krenkel, J. Shamas, Reference Module in Earth Systems and Environmental Sciences,
6. T. Sparks, (2012), filter Design, Pages 81-124
7. K.Sutherland,(2008), Types of Filter, Filters and Filtration Handbook (Fifth Edition), 2008, Pages 97-207
8. T. Sparks, G. Chase,(2016),Filters and Filtration Handbook (Sixth Edition), 2016, Pages 55-115
9. Department of the Environment, (1990), Cryptosporidium in Water Supplies: Report of the Group of Experts. Chairman: Sir John Badenoch. HMSO, London.
10. Department of the Environment (1994) Proceedings of Workshop on Cryptosporidium in Water Supplies. Edited by A. Dawson and A Lloyd. HMSO, London.
11. Smethurst, George (1990) Basic Water Treatment. Second Edition, Thomas Telford Ltd., London .
12. American Water works Association. Water Quality and Treatment A Handbook of Community Water Supplies, Fourth Edition . A .W.W.A., 6666 W. Quincy Ave., Denver, CO 80235.
13. C .Twort, Law, F. M., Crowley, F. W., and Ratanayaka , D.D., (1994), Water Supply. 4th Edition. Edward Arnold, London.
14. European Communities (Quality of Water Intended for Human Consumption) Regulations 1988. (S. I. No 84 of 1988) Stationary Office, Dublin.
15. Code of Practice for the Safety, Health and Welfare at Work (Chemical Agents) Regulations, 1994, (S.I. No. 445 of 1994). Stationery Office, Dublin
16. Peavey, Howard, Rowe, Donald and Tchobanoglous (1986) Environmental Engineering Mc Graw - Hill, New York.
17. Flanagan, P.J., (1992) Parameters of Water Quality –Interpretation and Standards. Second Edition. Environmental Research Unit, Dublin.
18. Engineering School, UCD (1972). Course Notes - Water Quality Management. Department of Civil Engineering, University College, Dublin.
19. Safety, Health and Welfare at Work Act, 1989 (No. 7 of 1989). Stationery Office, Dublin.
20. US EPA (1994) Water Treatment Plant Operation Volume 1: A Field Study Training Program. Third Edition
21. Supplies. Fourth Edition. A. W.W.A., 6666 W. Quincy Ave., Denver, CO 80235. Edward Arnold, London.
22. Department of the Environment (1990). Cryptosporidium in Water Supplies: Report of the Group of Experts. Chairman: Sir John Badenoch. HMSO, London.
23. T.Pujol, G. Arbat, J. Bove, J. Puig-Bargues, M. Duran-Ros, J. Velayos, F. Ramírez de Cartagena ,(2016), Effects of the underdrain design on the pressure drop in sand filters,Biosystems Engineering, Volume 150,Pages 1-9
24. M. Boller (1993), Filter mechanisms in rousing filters;j water Supply Res. Technol. Aqua. 42(3): 174-85.
25. M. Wegelin. (1996). Surface water treatment. A design, construction and operation manual, Swiss Federal Institute for environmental science and Technology (EAWAG) and department water and Sanitation in developing countries (SANDEC)

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

Babak Mehr Avaran, University: Ferdowsi University of Mashhad Ph.D student of water engineering Babak_mehravaran@yahoo.com

Professional & Executive Experiences:

-Environmental Expert of Technical Office in Neyshaboor Combined Cycle Power Plant.
-Engineer of Water and Wastewater Treatment Plant Process 2012 up to present time.
-Lecturing the engineering subject titles (water & soil) in Payem Noor University since 2011 up to now.
-Holder of license of technical and engineering services issued by Ministry of Industry, Mine & Trade for presenting technical consultation in industries.
-Member of Construction Engineering Organization.

Scientific & Research Records

Holder of Gold Medal in International Olympiad of Inventions 2007, Malaysia.
-Holder of Gold Medal in International Olympiad of Inventions 2007, Kuwait.
-Holder of Silver Medal in Modern Technologies of National Inventions Olympiad 2011, Iran.
-Holder of Bronze Medal in National Inventions Olympiad 2010, Iran.
-Holder of Five Patents.
Presenting a research plan in 3rd International Olympiad of Inventions 2012, Iran.

Interests & Professional Activities:

MATLAB Programming.
Research in the field of modern methods of Industrial Wastewater Treatment.
Research in the field of Nano composites. Research in the field of optimizing the Water and Waste water Treatment Processes. Introduction to Aspen Plus Software.

Hossein Ansari

HOSSEIN ANSARI

University: Ferdwosi University of Mashhad
Associate Professor,
Water Science and Engineering Department,
Mashhad, Iran.
Ansary@um.ac.ir
(98) 513 880 224 0

Home: #11 Soroosh ave.
Mashhad, Iran.
Postal Code: 9177948978
Ansariran@gmail.com
(98) 915 310 819 1

EDUCATION

1998-2004 **Ph.D. in Irrigation and Drainage, Tarbiat Modares University, Iran.**
'Monitoring and Zoning of Drought Using Fuzzy Logic and GIS'
Tarbiat Modares University, Tehran/Iran, Water Science and Engineering Department.
Supervisor: Professor H. Sanai.

1995-1998 **MSc. in Irrigation and Drainage, Tarbiat Modares University, Iran.**
'he Effect of Water Stress on Yield and Water Use Efficiency of Early Corn'

1990-1994 **BSc. in Irrigation Engineering, Ferdowsi University of Mashhad, Iran.**

RESEARCH

- ✓ Water Balance Modeling in Farm
- ✓ On- farm Water Management
- ✓ Applying Fuzzy Logic in Water Resources Management
- ✓ Water Pricing
- ✓ Drought Monitoring

TEACHING EXPERIENCE

Course Title	Level
General Irrigation, Theory/ Lab	B.Sc.
Irrigation systems design	B.Sc.
Engineering Economics	B.Sc.
Soil, Water and Plant Relation	B.Sc.
Pressurized Irrigation System Design	B.Sc.
Surface Irrigation System Design	B.Sc.
Surface Irrigation	M.Sc.
Sprinkler Irrigation	M.Sc.
Trickle Irrigation	M.Sc.
Water Resources Economics	M.Sc.
Advanced Topics in Water and Soil Physics	Ph.D.
Surface Irrigation Hydraulics	Ph.D.
On-Farm Water Management	Ph.D.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)