

# ► Results of testing of the Tulip Filter

Lab testing in Mozambique

In cooperation with National laboratory of Hygiene of Food and Water of the  
Ministry of Health, Mozambique



## Contents

1	SUMMARY .....	2
2	INTRODUCTION .....	2
3	OBJECTIVE .....	2
4	EXPECTED OUTCOMES.....	3
5	METHODOLOGY .....	3
6	RECOGNIZED LIMITATIONS.....	3
7	RESULTS .....	4
7.1	MICRO BACTERIOLOGICAL CONTAMINATION.....	4
7.2	TURBIDITY .....	4
7.3	CHEMICAL .....	4
7.3.1	PH.....	4
7.3.2	ELECTRICAL CONDUCTIVITY (EC).....	5
7.4	ADDITIONAL OBSERVATIONS .....	5
8	CONCLUSIONS .....	5

Date : November, 2010

Prepared by:

## **WE Consult**

*Consultores em Água Subterrânea & Ambiente*

Kwame Nkrumah 1013 1º andar-direito  
C.P. 3248, Maputo, Moçambique

☎: 21417377, 82-4208200  
Fax: 21417377  
E-mail: [mozambique@we-consult.info](mailto:mozambique@we-consult.info)  
Website: [www.we-consult.info](http://www.we-consult.info)



# Testing of the Tulip Filter

## Lab testing in Mozambique

### 1 Summary

The Tulip filter was tested in Mozambique by the National laboratory of the Ministry of Health. Testing involved both micro biological pollution as well as turbidity. The testing simulated individual usage of 20 litres per day over a period of 85 working days. In total more than 1500 litres of water were filtered.

The results were unambiguously positive. Cleaning of turbid water to less than 0.5NTU was achieved (with regular cleaning of the filter). Bacteriological pollution was reduced with at least 99% (more detail was not possible) was observed over the whole period of time and no reduction of performance was observed even after the 1500 litres had passed.

Concluding, the filter was found suitable as household filter and no performance loss was observed over time.

### 2 Introduction

The Tulip filter was introduced in Mozambique by Connect International a couple of years ago. At that time, initiatives were undertaken to produce the filter locally, but this was not carried out for various reasons, most notably costs and quality aspects.

The filter has since been further developed abroad and been attributed the name “Tulip Filter”. It is now re-introduced into Mozambique as a considerable more complete product.

However, in order to get the Mozambican public, as well as ministries and organizations on board, testing should not only be limited to international institutions, but national accredited laboratories have to be involved. The most recognized laboratory is the LNHA (Laboratory Nacional de Higiene, água e Alimentação) of MISAU, in Maputo. All testing was done at this laboratory.

This report describes the main results of the tests on the Tulip filter at the LNHA. The report includes the objective, methodology, results, conclusions and recommendations.

The described methodology was developed by the team of Connect International and WE Consult. The testing of the Tulip filters started on the 4<sup>th</sup> of April and continued till the 20<sup>th</sup> of July.

### 3 Objective

The objective of the testing was to confirm in laboratory circumstances within Mozambique that the Tulip filter lives up to the claim that:

- 99.99% of the biological pollution is eradicated
- the filter works for more than 7000 liters of water

In order to achieve these objectives, the following sub objectives are recognized:

1. Testing of cleaning of turbid water for at least 1000 liters
2. Testing of cleaning of micro-biological polluted water for at least 1000 liters
3. Analyze results and identify trends

#### 4 Expected outcomes

From the testing of the filter under laboratory circumstances, the following was expected:

- In country experience with the Tulip filter
- Understanding and recognition of the working of the Tulip filter
- A workable base for further steps such as field testing and possible certification

#### 5 Methodology

At the beginning of April two filters were delivered at the LNHA and the laboratory was instructed for the tests.

Two filter-units were set-up next to each other. Each consisted of an open bucket on top, containing polluted water, and a clean bucket on the floor, to catch the filtered water.

The two set-ups were used for the following tests:

- A. Micro biological pollution of visibly turbid water
- B. Micro biological pollution of visibly clear water

The sources of pollution were discarded samples of polluted water samples which were already tested by the laboratory. In addition, non chlorinated borehole water was added to ensure sufficient water quantities.

Every work day the laboratory filtered 20 liters of water. On average the filtered water was tested once a week. In the beginning analysis were carried out more regularly (twice a week), in the end it was done once every 1.5 weeks.

Before and after filtering, the water was tested for pH, electrical conductivity (EC), turbidity, color, the presence of deposits, coliform fecals and e-coli. The test results were compared and analyzed. Annex I

contains an example of the test result. The water sample that is used as an example is pre-filtered turbid water (agua turva bruta) analyzed on 14 April.

#### 6 Recognized limitations

- The minimum tested amount is targeted to be at least 1000 liters. It is recognized that this is below the claimed 7000 liters, but it is assumed that the trends of time will give a good indication for longer term usage.
- The testing does not have as objective to get official acceptance (approval) of either MISAU or DNA. Such a process is much longer and the current testing should be seen as one of the steps to this larger objective.
- It is recognized that the filter does not have any capacity to filter chemical pollution and testing of this has not been included.
- It is recognized that laboratory circumstances are not representative for actual use at household level. Cultural aspects, hygiene behavior, variable temperatures, and irregular usage could all influence the effectiveness of the water filter at household level.
- The effectiveness of the filters is enhanced as it uses nano-silver. The current tests do not cover this aspect, but previous certified testing (Waterlaboratorium Noord – NL) indicated values of 3 – 6 ppb, which is well below international guidelines (50-100 ppb).

## 7 Results

Testing of the Tulip filters started on the 4<sup>th</sup> of April and continued till the 20<sup>th</sup> of July. This period comprises of 85 work days, resulting in a total of 1700 liters of water being filtered.

The first day the water was tested was on 12 April, 120 liters of water had passed through the filters at that moment. On 20 July, the water was tested for the last time; at that moment 1540 liters of water had passed through the filters.

### 7.1 Micro bacteriological contamination

Prior to filtering the number of colonies of coliform fecais and e-coli in 100ml of water was above 100, both in turbid and clear water. This was the case on all occasions, except for three on which the amounts were significantly lower:

- The turbid water prior to filtering on 28 April 2010 contained 28 colonies of coliform fecais and e-coli in 100 ml of water.
- The visibly clear water prior to filtering on 3 May 2010 and on 7 July 2010 contained respectively one and thirteen colonies of coliform fecais and e-coli in 100 ml of water.

After filtering the water, the number of colonies of coliform fecais and e-coli in 100 ml of water was smaller than one. This was the case on all occasions.

The filtering capacity therefore is at least 99%. More significant analysis was not possible with the current set-up.

### 7.2 Turbidity

Turbidity is measured in NTU (Nephelometric Turbidity Unit). The higher the NTU value, the less light is let through (more turbid).

The visibly turbid water prior to filtering had an NTU of 5. After filtering the visibly turbid water the NTU

had decreased to 0.5. This was the case on all occasions.

The visibly clear water prior to filtering had an NTU of 0.5, except for one occasion where it was 5 (on 28 April). After filtering the turbidity of the water was 0.5 on all occasions.

Figure 1 shows the difference in turbidity (before – after filtering) for the visibly turbid and the visibly clear water. The peak in the graph for the clear water indicates the occasion on 28 April, when the turbidity of the visibly clear water was by mistake 5 NTU, prior to filtering.

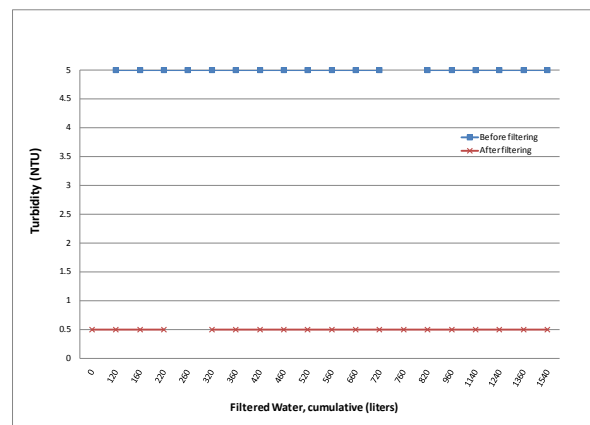


Figure 1 – The difference in turbidity, before and after filtering.

### 7.3 Chemical

The chemical analyses comprised of measuring the pH and the electrical conductivity (EC).

#### 7.3.1 pH

The pH was measured with a pH meter. The pH meter is an electronic instrument that measures pH as the activity of hydrogen ions surrounding the electrodes. This is a measure for the acidity or alkalinity of the water.

The pH values prior and after filtering do not vary significantly. On average, the pH of the visibly turbid water was 6.98 prior to filtering and 7.07 after

filtering. For the visibly clear water, the average pH prior to filtering was 7.16 and 7.18 after filtering.

These measurements confirm that the filter has no influence on the chemical properties of the water.

### 7.3.2 Electrical conductivity (EC)

The electrical conductivity (EC) is a measure for the total dissolved salts or ions in the water. The EC was measured with an EC meter. This is an electronic instrument that measures the electrical current passing through the water.

Like the pH, the EC values do not vary significantly. The average EC of the water prior to filtering was 788  $\mu\text{S}/\text{cm}$  for the visibly turbid water and 765  $\mu\text{S}/\text{cm}$  for the visibly clear water. After filtering the average EC was 756  $\mu\text{S}/\text{cm}$  and 766  $\mu\text{S}/\text{cm}$  for the visibly turbid and visibly clear water respectively.

### 7.4 Additional observations

Besides the measurements and analyses described above, the laboratory also described if the water samples were colored and if they contained visible deposits.

On all occasions the visibly turbid water was colored and deposits were visible. After filtering the water was colorless and deposits were not visible anymore.

The visibly clear water was colorless and did not contain visible deposits. This was the case for all samples, prior as well as after filtering. There was one exception, on 28 April, when the water sample before filtering was colored and deposits were present. As was mentioned earlier the turbidity of that sample was 5 NTU, which explains the color and deposits.

## 8 Conclusions

The TULIP water filter performed with excellent results. After filtering 1500 liters of water the filter effectively filters out deposits (turbidity), coliform fecais and e-coli. The filter has no significant effect on the pH and EC of the water.

At present, there are no indications of any reduction in effectiveness of the tulip water filter. The filter is therefore found to be viable option for household filtering and should be welcomed with open arms in the sector.

## 9 Next steps

The testing of the filters has been undertaken in a controlled environment. Field testing, with daily, normal household use should be undertaken, in particular to identify any practical aspects that could decrease the functionality of the filter (e.g. irregular cleaning).





### *Boletim de Análise de Água*

Nº Ficha:                      Código: 005CE                      Subcódigo:                      Nº Registo: 1040/10

PROVENIENCIA: Consultores em águas subterrâneas (Tulip Filter)

Tipo de Amostra: Água turva bruta

Data da Colheita da Amostra: 14-Abr-10      Data da Chegada no Lab e análise: 14-Abr-10

Motivo da Análise: Investigação

Parâmetro Analisado	Resultado
pH:	6,8
Condutividade µS/cm:	815
Turvação NTU:	5
Côr:	Corada
Deposito:	Presente
Coliformes Fecais Nº de Colónias/100 mL	> 100
E.Coli Nº de colónias/100mL	> 100

JUÍZO

Observação:

A pagar a importância de:                      **250,00 Mt**

*Directora do Laboratório*

*Machungo*

*Data 16/4/10*

**RESULTS OF TURBID WATER FILTERING**

Date:		04-Apr	12-Apr	14-Apr	19-Apr	21-Apr	26-Apr	28-Apr	03-May	05-May	10-May	12-May
Litres filtered ->		0	120	160	220	260	320	360	420	460	520	560
before filtering	Code		985/10	1040/10	1091/10	1137/10	1189/10	1206/10	1247/10	1298/10	1332/10	1405/10
	ph		6.8	6.8	7.1	6.85	6.9	6.75	6.85	6.8	7.1	6.85
	EC		721	815	795	790	785	765	790	795	725	790
	<b>Turbidity</b>		5	5	5	5	5	5	5	5	5	5
	Color		Coloured	Coloured	Coloured	Coloured	Coloured	Coloured	Coloured	Coloured	Coloured	Coloured
	Deposits		Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
	<b>Coliform fecais</b>		100	100	100	100	100	28	100	100	100	100
<b>E-coli</b>		100	100	100	100	100	100	28	100	100	100	100
after filtering	Code	1138/10	989/10	1041/10	1090/10		1188A/10	1205/10	1246/10	1297/10	1333/10	1406/10
	ph	7.08	6.8	7.1	7.1		7.15	7.1	6.85	7.05	7.15	7.1
	EC	740	721	790	750		780	775	790	780	730	780
	<b>Turbidity</b>	0.5	0.5	0.5	0.5		0.5	0.5	0.5	0.5	0.5	0.5
	Color	No colour	No colour	No colour	No colour		No colour	No colour	No colour	No colour	No colour	No colour
	Deposits	Not present	Not present	Not present	Not present		Not present	Not present	Not present	Not present	Not present	Not present
	<b>Coliform fecais</b>	0	0	0	0		0	0	0	0	0	0
<b>E-coli</b>	0	0	0	0		0	0	0	0	0	0	

Date:		19-May	24-May	26-May	31-May	09-Jun	22-Jun	29-Jun	07-Jul	20-Jul	Average
Litres filtered ->		660	720	760	820	960	1140	1240	1360	1540	
before filtering	Code	1514/10	1575/10		1627/10	1814/10	1930/10	1994/10	2095/10	2198/10	
	ph	7.59	6.9		6.85	6.9	7.4	7.58	6.8	6.8	6.98
	EC	817	795		795	815	800	817	785	795	788
	<b>Turbidity</b>	5	5		5	5	5	5	5	5	5.00
	Color	Coloured	Coloured		Coloured	Coloured	Coloured	Coloured	Coloured	Coloured	
	Deposits	Present	Present		Present	Present	Present	Present	Present	Present	
	<b>Coliform fecais</b>	100	100		100	100	100	100	100	100	96
<b>E-coli</b>	100	100		100	100	100	100	100	100	96	
after filtering	Code	1513/10	1576/10	1620/10	1629/10	1813/10	1932/10	2036/10	2097/10	2197/10	
	ph	7.04	7.1	7.1	7.15	7.1	7.1	7.04	7.1	7.1	7.07
	EC	704	780	780	790	700	690	706	785	785	756
	<b>Turbidity</b>	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.50
	Color	No colour	No colour	No colour	No colour	No colour	No colour	No colour	No colour	No colour	No colour
	Deposits	Not present	Not present	Not present	Not present	Not present	Not present	Not present	Not present	Not present	
	<b>Coliform fecais</b>	0	0	0	0	0	0	0	0	0	0
<b>E-coli</b>	0	0	0	0	0	0	0	0	0	0	

### RESULTS OF CLEAR WATER FILTERING

Date:		04-Apr	12-Apr	14-Apr	19-Apr	21-Apr	26-Apr	28-Apr	03-May	05-May	10-May	12-May
Litres filtered ->		0	120	160	220	260	320	360	420	460	520	560
before filtering	Code			1042/10	1089/10	1136/10	1186/10	1204/10	1245/10	1295/10	1334/10	1408/10
	ph			7.1	7.18	7.05	7.16	6.75	7.15	7.1	7.15	7.15
	EC			780	721	785	800	815	715	788	740	790
	<b>Turbidity</b>			0.5	0.5	0.5	0.5	5	0.5	0.5	0.5	0.5
	Color			No colour	No colour	No colour	No colour	Coloured	No colour	No colour	No colour	No colour
	Deposits			Not present	Not present	Not present	Not present	Present	Not present	Not present	Not present	Not present
	<b>Coliform fecais</b>			100	100	100	100	100	1	100	100	100
	<b>E-coli</b>			100	100	100	100	100	1	100	100	100
after filtering	Code		988/10	1043/10	1088/10	1135/10	1187/10	1203/10	1244/10	1296/10	1335/10	1407/10
	ph		7.14	7.9	7.16	7.18	7.18	7.1	7.2	7.15	6.95	7.16
	EC		718	779	725	760	790	780	780	700	810	780
	<b>Turbidity</b>		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Color		No colour	No colour	No colour	No colour	No colour	No colour	No colour	No colour	No colour	No colour
	Deposits		Not present	Not present	Not present	Not present	Not present	Not present	Not present	Not present	Not present	Not present
	<b>Coliform fecais</b>		0	0	0	0	0	0	0	0	0	0
	<b>E-coli</b>		0	0	0	0	0	0	0	0	0	0

Date:		19-May	24-May	26-May	31-May	09-Jun	22-Jun	29-Jun	07-Jul	20-Jul	Average
Litres filtered ->		660	720	760	820	960	1140	1240	1360	1540	
before filtering	Code	1512/10	1577/10	1618/10	1628/10	1812/10	1931/10	1995/10	2096/10	2196/10	
	ph	7.94	7.16	7.1	7.2	7.1	7.14	7.16	7.1	7.15	7.16
	EC	704	785	790	780	780	710	708	790	780	765
	<b>Turbidity</b>	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.75
	Color	No colour	No colour	No colour	No colour	No colour	No colour	No colour	No colour	No colour	No colour
	Deposits	Not present	Not present	Not present	Not present	Not present	Not present	Not present	Not present	Not present	Not present
	<b>Coliform fecais</b>	100	100	100	100	100	100	100	13	100	90
	<b>E-coli</b>	100	100	100	100	100	100	100	13	100	90
after filtering	Code	1515/10	1578/10	1619/10	1630/10	1811/10	1933/10	2035/10	2098/10	2195/10	
	ph	7.04	7.2	7.2	7.3	7.15	7.1	7.16	7.1	7.1	7.18
	EC	705	755	805	770	816	790	708	790	785	766
	<b>Turbidity</b>	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.50
	Color	No colour	No colour	No colour	No colour	No colour	No colour	No colour	No colour	No colour	No colour
	Deposits	Not present	Not present	Not present	Not present	Not present	Not present	Not present	Not present	Not present	Not present
	<b>Coliform fecais</b>	0	0	0	0	0	0	0	0	0	0
	<b>E-coli</b>	0	0	0	0	0	0	0	0	0	0