Name:……

Ver.1.0 Tomas Ärlemo/Swedish Red Cross

(The purpose of this document is not to give a scientific explanation of the processes of flocculation or chlorination, but to give an understanding of how to make jar/bucket tests in field to find correct amounts of aluminiumsulphate and chlorine to be used when treating water for consumption.)

# Jar test to determine the need of "Alum" (Aluminiumsulphate)

The aim of adding "Alum" to raw water is to make the water less turbid (turbidity is the term used for explaining how clear the water is and the unit used is NTU). Final turbidity in the water should be less than 5. The process is called *flocculation* and when the water has been treated with "Alum" it is called *pretreated water.*

To optimize the flocculation process we need to adjust the quantity of "Alum" added according to the quality of the raw water.

If the amount of "Alum" added is too small the floccs are not formed and the water will remain turbid. If too much "Alum" is added the process is not effective and the water will remain turbid. Too much "Alum" added can lead to excess of aluminium (residual aluminium) in the treated water which should be avoided.

To find out how much "Alum" should be added to the raw water for effective flocculation we use a simple test, called *jar test*.

## Practical example of jar test

### Material

- 6 jars (water bottles)
- 6 sticks for stirring (one for each jar)
- "1%-Alum stock solution"
- Turbidity tube
- Syringe
- Watch

### "1%-Alum stock solution"

1. Prepare "1%-Alum stock solution" by adding 10g of "Alum" in 1L of clean water.

The concentration of "Alum" in the stock solution is:
10g "Alum"/L => 10 000mg "Alum"/L => 10 000mg "Alum"/1000ml =>
=> 10 ~~000~~mg "Alum"/1~~000~~ml => 10mg "Alum"/ml

**In other words: 1ml of the stock solution contains 10mg "Alum"!**

(Units: 1g=1000mg, 1L=1000ml)

The stock solution can be kept in a bottle for later use!

## Jar test

1. Measure the turbidity and pH of the raw water and record the results (so that you can compare with the samples in the jars and see if the treatment with "Alum" is successful.)
2. Draw a table to record the results of the test (see Table 1, below)
3. Fill each jar with 1L of raw water
4. By using the syringe add 1.5, 2, 2.5, 3, 3.5 and 4ml of the stock solution in the jars (If the turbidity of the raw water is very high, increase the amount of "Alum" added to for example: 2, 4, 6, 8 and 12ml)
5. Stir for about 10 min and leave to settle for 30 min.
6. Measure the turbidity and pH of the water in each jar and note the results in the table
7. Choose the jar with water that has a turbidity of less than 5 NTU with the least amount of "Alum" added. In the example below jar number 2 would be the best choice because the turbidity is less than 5 and it was reached by using as little "Alum" as possible.

***Note: It is not necessary to measure pH every time!***

Turbidity of raw water before the test:…….. pH of raw water before the test:……..

| **Jar no** | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|
| **Raw water** | 1L | 1L | 1L | 1L | 1L | 1L |
| **ml of stock solution added** | 1.5ml | 2ml | 2.5ml | 3ml | 3.5ml | 4ml |
| **mg of "Alum" added** | 15mg | 20mg | 25mg | 30mg | 35mg | 40mg |
| **Concentration of "Alum" in jar** | 15 mg/L | **20mg/L** | 25mg/L | 30mg/L | 35mg/L | 40mg/L |
| **Turbidity (NTU) measured after 30 min** | *For example:* *10* | *For example:* *less than 5* | *For example:* *less than 5* | *For example:* *20* | *For example:* *50* | *For example:* *100* |
| **pH after the test** | *7.0* | *6.8* | *6.7* | *6.7* | *6.5* | *6.5* |

*Table 1.Table to record the results of the jar test*

## Calculation

If for example **20 000L** raw water is to be treated and you have chosen the "Alum"-concentration **20mg/L** then the amount of "Alum" to add will be:

20 mg/L x 20 000L = 400 000mg
(1g = 1000mg)
400 000mg = **400g**

## Dosing

1. Mix 400g of "Alum" and water in a bucket
2. Fill 1/3 of the tank with raw water and gently add roughly half of the "Alum"-mix to the tank
3. Fill up to 2/3 of the tank and add the rest of the mix.
4. Fill the tank completely

# Chlorine demand test (bucket test for chlorine demand)

When chlorine is added to dirty water bacteria (germs) are "neutralized". When all bacteria are neutralized, and if enough chlorine was added, some residual *free chlorine* remains in the water. Free chlorine in the water is desirable since it can neutralize bacteria in dirty jerry cans, water tankers, etc. The level of free residual chlorine should be about 0.5mg/L (higher in cholera areas) *at tapstands or distribution points*. The level of free chlorine decreases over time, especially in hot environments and if the water is not distributed immediately, so it is advisable to aim for a concentration higher than 0.5mg/L in the tank (for example 1.0mg/L as in the example below).

The amount of bacteria in the water varies over time. For example the amount of bacteria can increase after rainfall when more substances are flushed into the water source by the rain water. It is therefore difficult to guess how much chlorine needs to be added to reach the level of free residual chlorine we want. A simple test called *Chlorine demand test* (bucket test) is used to find the required amount of chlorine to be added.

## Practical example of Chlorine demand test

### Material

- 6 buckets
- 6 sticks for stirring (one for each bucket)
- "1%-Active chlorine stock solution"
- Pooltester and/or Merck-testkit for chlorine
- Syringe
- Watch

### "1%-Active chlorine stock solution"

1. Prepare "1%-Active chlorine stock solution" by adding 10g of *active* chlorine in 1L of clean water. On the label of the NaDCC-bucket it says that 55% of the content is *active* chlorine. That means we need to add 10g /0,55 = **18g NaDCC** to 1L of water.
   (Likewise, if it says that 67% of the content is *active* chlorine, we need to add 10g/0,67 = 15g)

   The chlorine stock solution has to be prepared every time the test is done and cannot be saved for later!

The concentration of *active* chlorine in the stock solution is:
10g active chlorine/L => 10 000mg active chlorine/L => 10 000mg active chlorine/1000ml =>
=> 10 ~~000~~mg active chlorine/1~~000~~ml => 10mg active chlorine/ml

**In other words: 1ml of the stock solution contains 10mg active chlorine!**

### Chlorine demand test

1. Draw a table to record the results of the test (see Table 2 below)
2. Fill each bucket with 10L of pretreated water (water that has been treated with "Alum"). Scoop water from the surface of the tank in order to get as clear water as possible.

3. By using the syringe add 0.5, 1, 1.5, 2, 2.5 and 3ml of the "1%-Active Chlorine stock solution" in the buckets
4. Stir for about 10 min and leave to react for 30 min ("contact time").
5. Check the level of free chlorine in each bucket and note the results in the table
6. Choose the bucket in which the water has the level of free chlorine you want, for example 1.0mg/L. The example in Table 2 shows that if you add 2.5mg of active chlorine per liter, the concentration of free chlorine after 30 min will be 1.0mg/L (The explanation for this is that 1.5mg/L is consumed for neutralizing the germs in the water).

| **Bucket no** | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|
| **Pretreated water** | 10L | 10L | 10L | 10L | 10L | 10L |
| **ml of stock solution added** | 0.5ml | 1ml | 1.5ml | 2ml | 2.5ml | 3ml |
| **mg of active chlorine added** | 5mg | 10mg | 15mg | 20mg | 25mg | 30mg |
| **Concentration of active chlorine after 0 min (calculated)** | 0.5mg/L (=5mg/10L) | 1.0mg/L | 1.5mg/L | 2.0mg/L | **2.5mg/L** | 3.0mg/L |
| **Concentration of free chlorine <u>after 30 min</u>** | For example: *0 mg/l* | For example: *0 mg/l* | For example: *0 mg/l* | *For example: 0.5 mg/l* | *For example: 1.0 mg/l* | *For example: 1.5 mg/l* |

*Table 2.Table to record the results of the bucket test for chlorine demand*

## Calculation

If for example **20 000L** water is to be treated and you want to add **2.5mg/L** active chlorine (see table 2, above) then the amount of active chlorine to add will be:

2.5 mg/L x 20 000L = 50 000mg
(1g = 1000mg)
50 000mg = **50g of *<u>active</u>* chlorine**

On the label of the NaDCC-bucket it says that **55%** of the content is *active* chlorine.
(1% = 1/100 = 0.01 => 55% = 55/100 = **0.55**)

That means we need to add 50g /0.55 = **<u>91g NaDCC</u>**

(Likewise, *if* it says that 67% of the content is *active* chlorine, we need to add 50g/0.67 = 74g)

## Dosing

1. Mix 91g of NaDCC and water in a bucket
2. Add the mix to the pure water tank while filling. Make sure the water is mixed thoroughly. Never add chlorine which has not dissolved!
3. After 30 min, check the level of free chlorine