WATER TREATMENT: Beverage Industry
Design & Operating Parameters

1. **Objective:** Produce high quality water free of any bacteria, taste and odor problems or contaminants on a consistent and reliable basis.

2. **Elements to Achieve Objective**

- Plant Design
- Operating Parameters
- Activated Carbon

3. **Plant Design**

3.1. **Key Elements**

- Multi-barrier
- Bacteria-free
- Sanitization
- Reliability and ease of operation

3.2. **Carbon Adsorbers**

- ACF Design (nozzle plate type is very common but has serious flaws – for example, very susceptible to microbial contamination)
- Empty Bed Contact Time (EBCT)
- Bed Depth

4. **Operating Parameters**

4.1. **Water Quality**

4.1.(A) **Raw Water Analysis**

- Key Parameters: pH, alkalinity, turbidity, taste & odor, TOC, TSS, Coliform, HAB, pesticides and total P, N and Iron

4.1.(B) **Bacteria**

a) common problem in bottling plants

b) difficult to eradicate due to their ability to adapt to adverse conditions

c) biofouling is responsible for degeneration of water quality in terms of:
- Off-taste
- Turbidity
- Sulfide odor
- Color

- Change in chemistry
- Hygiene risk
- Flow rate
- pH
- Iron deposits and staining

d) Conditions conducive to biofouling:
- TOC, P, N, content in water
- Stagnant/slow flow water points
- Porous and anodically charged surfaces such as sand and activated carbon which can serve as a substrate to sustain microbial growth
- Improper ACF design

4.1.(C) THM
- EPA limit: 80 ppb
- Not easily removed by activated carbon so carbon adsorbers need to be specially designed
- Logically one would expect coconut carbon consisting of only micropores to provide the best THM removal efficiency but field experience has proven that the micropores become blocked by larger contaminant compounds present in the water and that GAC offering both micropores and mesopores (such as coal carbon) provides the best result.

4.1.(D) Organic Contaminants
- Include compounds such as phenol, benzene, MTBE and pesticides
- Removal rate and efficiency depends on type and activity level of activated carbon

4.1.(E) Taste & Odor
- Mainly result of microbiological activity

4.2. Microbial Test Methods
- The two most popular and traditional test methods have inherent limitations which produce false negative or positive results

a) Agar Plate Count
Established for medical bacteriological practices and cannot accommodate field imposed constraints such as the time lag between sampling and testing (should be limited to 3 hours for reliable results) and the impact of transportation.

b) ATP (Adenosine Triphosphate)
Major limitation is that the test measures all living cells and is not specific for any type of bacteria

c) BART™ Biodetection System(Biological Activity Reaction Test)
Test kits developed to measure the specific bacteria types listed above. Simple and easy to use which overcomes field imposed constraints such as time lag, environmental conditions (temperature, transportation), etc. The reliability of these tests have already been demonstrated vs. local biological laboratories overseas which gave false negative results. A Test Protocol has been developed to determine microbiological contamination in soft drinks as well as possible contamination points in the water treatment system.

4.3. Sanitization Methods

1) Steam
The use of steam or hot water at 85°C minimum for 4 hours is the most effective treatment to sanitize activated carbon followed by cooling to 60° F and then flushing out all the residual organic matter with chlorinated water.

2) Chlorination
Chlorination is an effective sanitization treatment for coliforms but is less effective for other types of bacteria that can exist in biofilms due to their ability to compress/shrink and thus prevent chlorine penetration into the cells. The other limiting factor for chlorination is the formation of by-products such as trihalomethanes.

3) Ultraviolet Radiation
This is a commonly used method for water treatment and can reduce the organic loading on the carbon filters. However, the effectiveness of UV treatment is reduced in water with high suspended solids levels and biocolloids which can provide a screen for the biofilms and prevent UV penetration. U.V. does not have any residual which presents serious operational limitations.

4) Ozone
Possibly the most effective form of sanitization treatment but can produce oxidation by-products which may be undesirable. The half-life of ozone is very short which presents limitations.

5) Acids
Acids are not recommended and any acids that provide a good nutrient source to support bacteria growth should be avoided completely. Such acids include citric, acetic and phosphoric.

4.4. Plant Maintenance & Efficiency

- Maintaining the carbon filters in good working order is essential to optimizing the performance of the water treatment process
- Recommended backwashing and sanitization procedures

4.5. Q.C./Audit Program

- Establish appropriate Q.C. parameters to monitor the water quality and ensure that the plant operators are knowledgeable of their system details and operating parameters
- Key Q.C. parameters for water quality: pH, alkalinity, free chlorine, taste & odor, THM level, TOC, TSS, HAB, Coliform, APB, SRB, SLYM

5. Activated Carbon

5.1. Quality Requirements

- Carbon performance is dependent on the following key properties (refer to chart):
  Adsorption capacity ($\propto$ surface area)
  Hardness
  Apparent density
  Dechlorination performance
  Pore structure
  Toxicological properties

5.2. Service Life

- Carbon is considered to be saturated or not performing efficiently when either of the following criteria are satisfied:
  1) apparent density increased by 10%
  2) iodine number decreased by 30%
- This condition is difficult to predict (due to the variable type and concentration of contaminants in the water, etc.) so it is recommended that the carbon is replaced every 12 months as the only means to prevent premature breakthrough

5.3. pH Issue

- All carbons require water washing to minimize the leachable component (predominantly associated with the ash content) and stabilize the pH
- Field tests have proven that even though the total ash content of coconut carbon is lower than coal based carbon, pH stabilization is achieved quicker with coal based carbon (due to the fact that the water soluble ash content is lower).
- Acid washed carbon will expedite this process and should be considered when low pH is important
- Acid washed carbons are needed for post treatment of membrane systems due to the ultra high purity of the water and low ionic content
- pH case study

5.4. Preparation and Preconditioning of New Carbon Filters

- Appropriate and adequate filter preparation and preconditioning of the carbon is essential and critical to the successful performance of new filters in terms of microbial contamination, efficiency, etc.