THE HEBREW UNIVERSITY OF JERUSALEM
האוניברסיטה העברית בירושלים

בית הספר למדע יישומי ע"ש פרדי ונדין הרמן
היחידה למדעי הסביבה
המעבדה לטכנולוגיה של טיפול במים

דו"ח מדעי סופי

אצות וחלקיקים מרחפים במי הירקון: אפיונם, גורלם ובקרתם

מוגש למשרד לאיכות הסביבה

ע"י
פרופ' אבנר עדין

בהשתתפות
פרופ' אינקה דור
סיון חייט
איריס זוהר
לובה רובינשטיין

אפריל 2003

Abstract

The Israeli water administration has been under a large deficit in its water reserves as well as in a severe degradation in the water quality in the wells and aquifers for the past few years. It seems that a reuse of marginal water resources has become a must in these days. With suitable treatment, downstream water from the Yarqon River can use as such resource for urban irrigation. The suspended matter in the Yarqon consists of colloidal particles and settleable particles, while their character is mainly organic, from biological source and effluent organics, and only a small fraction is mineral. Therefore, the suspended matter in the Yarqon reflects the combination formed when discharging effluents to a natural stream channel.

The current work is a continuation of a two year research which studied the characterization of algae and other suspended particle in the Yarqon, examined their transport, aggregation and settling mechanisms. In the presented research, treatment technologies to remove these particles were studied, in order to examine a potential reuse of the treated water, for purposes such as public gardens irrigation, ornamental fountains, fire protection etc.

The Yarqon water for these experiments were sampled from "Sheva Ta'hanot" at January-November of 2001, and were pumped from an average depth of 30-40 cm. Sheva Ta'hanot is a downstream sampling station, in which the water are contaminated but are not yet mixtured with the sea water, though the organic load there is lower as compared to upper stream contaminated locations. The efficiency of two different physicochemical treatment technologies was studied: contact filtration and ultrafiltration (UF). The efficiency parameters examined were: turbidity, zeta potential, UV-254 nm absorption for the presence of humic like compounds, particle count, PSD, TSS and residual iron and aluminum. The study was consisted of 3 parts: jar tests, contact filtration tests with ferric chloride and UF tests with membranes of 4-50 kDa.

The initial purpose of the jar tests was to compare the efficiency of alum to that of ferric chloride. Ferric chloride was found efficient at broader pH range, 4.5-8.5, compare to that of alum, 6.5-8.5. Lowering the pH to an acidic level was significant in the removal of organic matter from the Yarqon water, as measured with UV-254 nm absorption, which provided an advantage to ferric chloride. In addition, the dose of

ferric chloride needed to remove turbidity was mostly lower than alum. In light of these findings, the combination of ferric chloride in contact filtration was chosen. Since the character of the Yarqon water is given to rapid changes, a jar test was conducted previously to each filtration test in order to set the coagulant dose.

The filtration test were performed through two columns of 20 cm bed depth, for the purpose of examining two sand grain sizes, a fine medium with average diameter of 0.8 mm, and a coarser one with average diameter of 1.2 mm. The fine grain size showed better removal efficiencies, while the coarse grain showed a moderate head loss development. Filtration rates of 5-15 m/hr were tested, while the intermediate rate of 10 m/hr was the most efficient and brought to a 90% turbidity removal with a small dose of 5 mg/l. Lowering the Yarqon's water pH to 5-5.5 improved the filtration process and the filtrate turbidity reached to a minimum value of 1.1 NTU.

The UF tests were conducted in a DE laboratory unit that included a stirred filtration cell. In the bottom of this cell, 5 cm diameter sheets membranes were placed. These experiments, which integrated the examination of pre-treatment of coagulation with ferric chloride, brought to an efficient turbidity removal, mostly to values lower than 0.15 NTU, independently of the dose and membrane diameter (MWCO). A better removal of humic matter occurred in UF experiments taken after pre-coagulation with pH value of 5. A dominant influence of membrane diameter was observed in the UF tests without pre-treatment or with pre-coagulation when pH of the Yarqon water wasn't changed. As the MWCO is smaller, the removal efficiency rises, so UF through membrane of 4 kDa gave removal of 60-65% humic compounds in comparison to 30-35% with UF membrane of 50 kDa. However the flow through the 4 kDa membrane is the lowest.

All of the above filtration results indicate that the Yarqon's water turbidity can be lowered to the level required in the Ministry of Health guidelines as well as the strict US EPA guidelines for water reuse as urban irrigation, though the addition of microbiological measurements is still required to complete the study for its application. Furthermore, due to constant variation in the Yarqon's water quality, an addition of reservoir prior to the water inlet to the contact filtration unit is recommended in order to decrease the sensitivity of the filtration process to suspended matter loads. UF on the other hand, would not require such a reservoir.