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An Experimental technique in lowering total dissolved solids in wastewater

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An Experimental Technique in Lowering
Total Dissolved Solids in Wastewater

A Thesis Submitted in Partial Satisfaction
of Requirements for the Degree of
Bachelor of Arts
in

Environmental Studies
University of Nevada
Las Vegas

By
Aaron Crotts

Spring 1996

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Laboratory Director

ABSTRACT

An experimental method for lowering total dissolved solids in wastewater. This thesis project has been undertaken by Aaron Crotts in partial fulfillment of requirements for the degree of Bachelor of Arts in Environmental Studies. The problem undertaken in this thesis is to apply an experimental technique in wastewater treatment in hopes of reducing the total dissolved solids. Total dissolved solids consist of various dissolved ions in water such as calcium, magnesium, sulfur and sodium. In looking at one industry in particular a local Ice Cream manufacture, the problem with total dissolved solids is evident because of their manufacturing process, an abundance of dissolved solids is discharged in their wastewater. Limited by state permits on their discharge, the industry will eventually have to limit total dissolved solids. In applying an experimental method using ammonium hydroxide in the influent wastewater of the plant the total dissolved solids can be decreased. Due to the particular treatment process the manufacturer undertakes and the properties of the ammonium hydroxide which raises the ammonia and total suspended solids level, application of the ammonium hydroxide to the influent was chosen over the effluent. In performing experimentation varying concentration of ammonium hydroxide were used to assess the effectiveness of the ammonium hydroxide. At the highest ammonium hydroxide, the total dissolved solids were lowered by 52.7%, and even at the lowest concentration it was lowered by approximately 6.0%.

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INTRODUCTION

This thesis deals with an experimental method in removing certain constituents from wastewater. The prime constituent for removal in this experiment is what is termed TDS or total dissolved solids. Total dissolved solids consists of microscopic ions such as Na, Cl, Mg, and Ca. Total dissolved solids (TDS) encompasses the material in water which is termed unfilterable because of its minute size, the particulates pass through existing filters when filtered. This constituent is important in an economic manner.

The targeted industry of this experimentation, is the Good Humor Bryers Ice Cream plant in Henderson. In certain food manufacturing industries which are dependent upon using salts in there manufacturing processes face difficulties in complying with regulations in regard to treating their industrial wastewater. In complying with state and national regulations these industries use a variety of methods in treating their water before sending it to the municipal treatment.

The problem occurs when the salts and dissolved solids from the industrial processes run unchecked through the wastewater treatment process, and end up in the discharge effluent. Unlike the larger particles (suspended solids) which can be settled and filtered out through mechanical processes, dissolved solids remain in suspension.

Solutions have been devised in certain municipal wastewater treatment facilities to remedy this problem. In the final step of treatment, after the removal of total suspended solids, biochemical oxygen demand, and certain nitrogen compounds, the water is ready for tertiary treatment

which contribute to the TDS.

The ammonium hydroxide will increase pH, ammonia, and if not removed total suspended solids. "The pH of a solution is a measure of the hydrogen ion concentration. An acidic solution has an excess of hydrogen ions, a basic or alkaline solution has a dearth of hydrogen ions (or an excess of hydroxide ions." (Vesilind, Peirce, & Weiner 1990) This is where the key feature of the process comes in. If added at the beginning of the treatment process, the increase in these constituents can be dealt with through regular processes. Most pretreatment ice cream plants have a primary treatment settling area, which flows into an activated sludge pond. The sludge pond is the secondary treatment which is designed to remove BOD. The activated sludge pond houses aerobic organisms which consume oils, fats, grease, and other material which is oxygen depletive.

Many of these bacterial organisms require forms of nitrogen for their continued existence. Some of the manufacturing plants add urea, an ammonia containing compound to there influent which is nitrogen poor, to fulfill the bacteria's need for nitrogen. If the ammonium hydroxide were applied at the influent stage of the process, it could provide the nitrogen for the bacteria as well as lower dissolved solids in the process. This could save the industry money, and in turn help them to comply with state permitting standards.

METHOD

All analyses were conducted using EPA approved methods except for ammonia which was performed using a "Hach Ammonia Kit". Because of

color comparator is a small box with two slots for each color viewing tube. Each slot contains a window which the samples can be viewed, and in front of one of the slots is a transparent plastic wheel which when turned, will display varied hues of yellow and subsequently indicates the various concentrations of ammonia in the sample. The comparator is then held up to a light source and viewed through the two window compartments. the color disc is then rotated to obtain a color match between the sample with the Nessler reagent and the sample behind the color disk. When the colors are matched, then the numbers denoted on the side of the wheel is read to determine the concentration.

Total Dissolved Solids Dried at 180° C

a. Principle: a well mixed sample is filtered through a standard glass fiber filter, and the remaining filtrate is evaporated to dryness in a pre-weighed dish and dried at 180 C until all moisture is driven off. Evaporation is achieved in a more timely manner commonly by placing the dishes above some sort of steam bath. The increase in dish weight represents the total dissolved solids. Some possible interferences that can occur are highly mineralized waters with a considerable amount of calcium, magnesium, chloride and, sulfate may be hygroscopic (readily taking up and retaining moisture) and require extra drying time, proper dessication after drying, and rapid weighing. Samples high in bicarbonate may need the drying time extended at 180° C to ensure complete conversion of bicarbonate to carbonate. One of the most important interferences that must be overcome is that an overabundance of residue in the dish can entrap water in a crust which prevents its evaporation, it is important to limit samples to no more than 200 mg of residue by controlling initial sample volume.

temperature. if the dish is not allowed to cool to room temperature, an inaccurate weight can occur. This drying cycle is repeated until a constant weight is obtained.

Basis of method for total suspended solids (TSS): A well mixed sample is filtered through a pre weighed glass fiber filter. The residue retained on the filter is dried at 103-105°C to a constant weight. The difference in weight between the pre weighed virgin filter and the filter after filtration containing the residue encompasses the total suspended solids. If filtration is hampered by the inability of the sample to be filtered then total suspended solids can be determined via subtracting the total dissolved solids results from the actual total solids. (TS- which represent TSS and TDS, and is determined by evaporating all water from the sample without any sort of filtration)

Interferences with the method can come in the form of large floating particles, or submerged conglomerates of material which does not accurately represent the sample. As in total dissolved solids, excess residue is not desirable because of its ability to retain moisture throughout drying. Because of this, it is best to limit the sample size to produce no more than 200 milligrams of residue. Also, prolonged filtering times may be attributed to a clogged filter and may bias results because of excess particulate capture on the congested filter.

Equipment needed for the examination of total suspended solids include all of the same for total dissolved solids with the addition of an aluminum planchet (small aluminum container for containment of filter) and the exception of the evaporating dish, and steam bath.

The procedure is similar to total dissolved solids. Filters should be

in wastewater can come from treatment processes, and large concentrations can come from water used for laundering or other cleaning, because these materials are constituents of many cleaning materials. Phosphates are also present in fertilizers, and can be found in sewage from human body wastes.

Phosphorus can be a limiting nutrient in the growth of organisms, and if it runs unchecked into bodies of water can stimulate growth of photosynthetic organisms to nuisance levels.

The phosphorus analysis consists of two steps: conversion of the phosphorus form of interest to dissolved orthophosphate, and the colorimetric determination of dissolved orthophosphate. The method used for this experimentation, was the Ascorbic Acid Method in which the compound ammonium molybdate and potassium tartarate react in an acidic environment with orthophosphorus to produce a blue coloration within the sample. This coloration can be measured, and correlated with the amount of orthophosphorus present.

This is considered a colorimetric analysis, and equipment able to read the coloration. A spectrophotometer is an instrument used to measure color change in samples. This instrument consists of a light source and filter with the ability to allow light of certain wavelengths to be emitted, a photocell which converts light energy into electricity, and a transparent cell in which the sample is placed. Light is converted into electrical current at the photocell, after the light passes through the transparent cell containing the sample. Certain wavelengths of light reflect certain colors, and within the transparent cell this can be amplified if the colors are intense. If the color intensity within the transparent cell is very intense, than very little light will

solids results turned out promising. The hardness which makes up a significant portion of the TDS, was dramatically lowered, demonstrating that the this particular wastewater contains reasonably high amounts of calcium and magnesium.

Sample Ia: October Influent

The influent sample ran in October resulted in a TDS of 8240 mg/L. The total suspended solids were 2835 mg/L. When treated with a 1 N NH_4OH solution the TDS fell to 4336 mg/L, and the TSS rose to 3865 mg/L, an increase of 36.3% in TSS and a 47.4% decrease in TDS. When the same sample was treated with a 0.1 N NH_4OH solution the TDS decreased to 6890, this is a 16.4% decrease. The TSS increased to 3750 mg/L which is a 32.3% increase. At the lower concentrations, the results seemed negligible. At 0.05 N the TDS was 7429 mg/L, a 9.8% decrease. The TSS was 3328 mg/L, a 17.4% increase. When using a 0.025 N solution, the TDS result was 7894 mg/L, a 4.2% decrease, and the TSS increased to 3162 mg/L an increase of 11.5% . 0.0125 N solution resulted in 7953 mg/L, a 3.5% decrease; the TSS increased to 3007 mg/L or 6.1%. (Table 1)

The October sample influent showed an initial pH of 5.23. When treated with the 1 N NH_4OH , the pH increased to 10.45, a 99.1% increase. When treated with the 0.1 N NH_4OH the pH increased to 9.73, an 86.0% increase. Then when treated with the 0.0125 N NH_4OH , the pH increased to 8.86, a 69.4% increase. (Table 1)

October's influent sample yielded an initial ammonia count of 105

(Table 2) The October effluent sample, untreated, had a TDS of 3285 mg/L, and a TSS of 9 mg/L. After treatment with a 1 N solution the TDS dropped to 1892 mg/L, a 42.4% decrease while the TSS increased to 287 mg/L, a 3089% increase. Treated with 0.1 N NH_4OH , the result was 2458 mg/L, a 25.2% decrease in TDS and a TSS of 223 mg/L which is about a 2377% increase. With the 0.05 N solution, the TDS result was 2788 mg/L, a 15.1% decrease, and the TSS result was 216 mg/L which is a 2300% increase. When the 0.025 N solution was applied the TDS dropped to 2862 mg/L, a 12.9% decrease, and the TSS raised to 203 mg/L a 2156% increase. At the 0.0125 N NH_4OH concentrations the percent decreases were to 2932 and a 10.7% decrease. The TSS concentration was 172 mg/L, an 1811% increase.

Table 2. Test Results for October 1995: Effluent

| Treatment | | TDS mg/L | TSS mg/L | pH s.u. | Ammonia mg/L | Hardness mg/L |
|-----------|--------------------------|-------------|-------------|------------|-----------------|------------------|
| Effluent | | 3285 | 9 | 7.32 | 7.0 | 1596 |
| 1 | N NH_4OH | 1892 | 287 | 10.56 | 850 | 638 |
| 0.1 | N NH_4OH | 2458 | 223 | 10.27 | 765 | 845 |
| 0.05 | N NH_4OH | 2788 | 216 | 10.12 | 450 | 910 |
| 0.025 | N NH_4OH | 2862 | 203 | 9.94 | 450 | -- |
| 0.0125 | N NH_4OH | 2932 | 172 | 9.13 | 25 | -- |

The effluent pH in October also vastly increased. (Table 2) The initial pH was 7.32. After being treated with the 1 N NH_4OH the pH increased to

increase. The 0.025 N application resulted in the TDS decrease to 4753 mg/L, an 18.5% decrease, and the TSS increased to 3267 mg/L, a 14.0% increase. At the 0.0125 N concentration, the TDS decreased to 5237 mg/L, a 10.2% decrease. The TSS concentration of the sample rose to 3195 mg/L, an 11.6% increase.

In the November sample, the influent showed an initial pH of 5.08. When treated with the 1 N NH_4OH , the pH increased to 10.62, a 109.1% increase. When treated with the 0.1 N NH_4OH the pH increased to 10.02, an 97.2% increase. With the treatment with the 0.0125 N NH_4OH , the pH increased to 8.74, a 72.1% increase. (Table 3)

Table 3. Test Results form November 1995: Influent

| Treatment | | TDS mg/L | TSS mg/L | pH s.u. | Ammonia mg/L | Hardness mg/L |
|-----------|--------------------------|-------------|-------------|------------|-----------------|------------------|
| Influent | | 5834 | 2864 | 5.08 | 155 | 2553 |
| 1 | N NH_4OH | 2477 | 4674 | 10.62 | 6790 | 1085 |
| 0.1 | N NH_4OH | 4367 | 4268 | 10.02 | 2005 | 1317 |
| 0.05 | N NH_4OH | 4367 | 3759 | 9.67 | 1450 | 1524 |
| 0.025 | N NH_4OH | 4753 | 3267 | 9.13 | 975 | -- |
| 0.0125 | N NH_4OH | 5237 | 3195 | 8.74 | 265 | -- |

November's influent sample yielded an initial ammonia count of 155 mg/L. The 1 N NH_4OH treatment resulted in an effluent hardness of 6790 mg/L. The 0.1 N NH_4OH treatment resulted in a concentration of 2005 mg/L.

mg/L. The 1 N NH_4OH treatment resulted in an effluent hardness of 1130 mg/L. The 0.1 N NH_4OH treatment resulted in a concentration of 790 mg/L. The 0.05 N concentration resulted in a final hardness of 725 mg/L. The 0.025 N NH_4OH treatment resulted in a concentration of 525 mg/L. The 0.0125 N concentration resulted in a final hardness of 205 mg/L. (Table 4)

A decrease in November's effluent sample also occurred. The initial hardness count was 1740 mg/L. The 1 N NH_4OH treatment resulted in an effluent hardness of 766 mg/L, a 56.0% decrease. The 0.1 N NH_4OH treatment resulted in a concentration of 880 mg/L, a 49.4% decrease. The 0.05 N concentration resulted in a final hardness of 969, a 44.3% decrease. (Table 4)

Table 4. Test Results for November: Effluent

| Treatment | | TDS mg/L | TSS mg/L | pH s.u. | Ammonia mg/L | Hardness mg/L |
|-----------|--------------------------|-------------|-------------|------------|-----------------|------------------|
| Effluent | | 3032 | 7 | 7.62 | 2.0 | 1740 |
| 1 | N NH_4OH | 1458 | 289 | 10.78 | 1130 | 766 |
| 0.1 | N NH_4OH | 1691 | 239 | 10.59 | 790 | 880 |
| 0.05 | N NH_4OH | 2232 | 225 | 10.05 | 725 | 969 |
| 0.025 | N NH_4OH | 2341 | 176 | 9.85 | 525 | -- |
| 0.0125 | N NH_4OH | 2450 | 147 | 9.20 | 205 | -- |

Sample IIIa: December Influent

Samples from December are as follows: The original untreated

When treated with the 0.1 N NH_4OH the pH increased to 9.67, an 73.9% increase. With the treatment with the 0.0125 N NH_4OH , the pH increased to 8.83, a 58.9% increase. (Table 5)

December's influent sample yielded an initial ammonia count of 180 mg/L. The 1 N NH_4OH treatment resulted in an effluent hardness of 7720 mg/L. The 0.1 N NH_4OH treatment resulted in a concentration of 2050 mg/L. The 0.05 N concentration resulted in a final hardness of 1875 mg/L. The 0.025 N NH_4OH treatment resulted in a concentration of 1005 mg/L. The 0.0125 N concentration resulted in a final hardness of 395 mg/L. (Table 5)

Influent sample December had an initial hardness of 3598 mg/L. After the 1 N treatment, it decreased to 1468 mg/L, a 59.2% decrease. With treatment with the 0.1 N NH_4OH , it resulted in a result of 1518 mg/L, a 56.8% decrease. The 0.05 N treatment results in a concentration of 1831, which constituted a 49.1% decrease. (Table 5)

Sample IIIb: December Effluent

December's untreated effluent sample had a TDS of 2885 mg/L, and a TSS of 7 mg/L. After treatment with a 1 N solution the TDS dropped to 1220 mg/L, a 57.7% decrease while the TSS increased to 348 mg/L, a 3018% increase. When treated with 0.1 N NH_4OH , the result was 1659 mg/L, a 42.5% decrease in TDS and a TSS of 281 mg/L which is about a 3018% increase. The 0.05 N solution reduced the TDS to 2109 mg/L, a 26.9% decrease, and the increased the TSS to 208 mg/L which is a 2214% increase. When the 0.025 N solution was applied the TDS dropped to 2299 mg/L, a 20.3% decrease, and the

Effluent sample for December had an initial hardness count was 1219 mg/L. The 1 N NH_4OH treatment resulted in an effluent hardness of 396 mg/L, a 67.5% decrease. The 0.1 N NH_4OH treatment resulted in a concentration of 511 mg/L, a 58.1% decrease. The 0.05 N concentration resulted in a final hardness of 589, a 51.6% decrease from the initial hardness count. (Table 6)

Sample IVa: January Influent

The untreated influent sample for January showed an initial TDS of 4390 mg/L, and a TSS of 5600 mg/L. After treatment with 1 N NH_4OH the TDS was decreased to 1620 mg/L, a 63.1% decrease. The TSS rose to 7957 mg/L, a 42.1% increase. When treated with 0.1 N NH_4OH , the TDS decreased to 1774 mg/L, a 59.6% decrease, and the TSS rose to 7375 mg/L, a 31.7% increase. With the 0.05 N solution the TDS decreased to 2880 mg/L, a 34.4% decrease. The TSS increased to 6933 mg/L, a 23.8% increase. The 0.025 N application resulted in the TDS decrease to 3736 mg/L, an 14.9% decrease, and the TSS increased to 6126 mg/L, a 9.4% increase. At the 0.0125 N concentration, the TDS decreased to 4039 mg/L, a 8.0% decrease. The TSS concentration of the sample rose to 5891 mg/L, an 5.2% increase. (Table 7)

January's influent sample demonstrated an initial pH of 5.05. When treated with the 1 N NH_4OH , the pH increased to 10.37, a 105.3% increase. When treated with the 0.1 N NH_4OH the pH increased to 10.10, an 100.% increase. With the treatment with the 0.0125 N NH_4OH , the pH increased to 8.82, a 74.7% increase. (Table 7)

mg/L, and a TSS of 29.5 mg/L. After treatment with a 1 N solution the TDS dropped to 1326 mg/L, a 42.1% decrease while the TSS increased to 663 mg/L, a 2147% increase. When treated with 0.1 N NH_4OH , the result was 1885 mg/L, a 27.3% decrease in TDS and a TSS of 595 mg/L which is about a 1717% increase. The 0.05 N solution reduced the TDS to 1885 mg/L, a 17.7% decrease, and the increased the TSS to 492 mg/L which is a 1567% increase. When the 0.025 N solution was applied the TDS dropped to 1940 mg/L, a 15.3% decrease, and the TSS raised to 270 mg/L, a 816% increase. At the 0.0125 N NH_4OH concentrations the TDS was down to 1968 mg/L, a 14.1% decrease and an increase in the TSS concentration that read 142 mg/L, a 382% increase. (Table 8)

Table 8. Test Results for January: Effluent

| Treatment | | TDS mg/L | TSS mg/L | pH s.u. | Ammonia mg/L | Hardness mg/L |
|-----------|--------------------------|-------------|-------------|------------|-----------------|------------------|
| Effluent | | 2291 | 29.5 | 7.26 | 5.5 | 1003 |
| 1 | N NH_4OH | 1326 | 663 | 10.51 | 1370 | 431 |
| 0.1 | N NH_4OH | 1666 | 595 | 10.37 | 965 | 539 |
| 0.05 | N NH_4OH | 1885 | 492 | 10.07 | 710 | 608 |
| 0.025 | N NH_4OH | 1940 | 270 | 9.85 | 395 | -- |
| 0.0125 | N NH_4OH | 1968 | 142 | 9.22 | 215 | -- |

The initial pH for the effluent sample in January yielded a 7.26 reading.

29.9% decrease. The TSS increased to 4006 mg/L, a 41.3% increase. The 0.025 N application resulted in the TDS decrease to 4268 mg/L, an 12.1% decrease, and the TSS increased to 3342 mg/L, a 17.9% increase. At the 0.0125 N concentration, the TDS decreased to 4505 mg/L, a 7.2% decrease. The TSS concentration of the sample rose to 3093 mg/L, an 9.1% increase. (Table 9)

The influent sample for February revealed an initial pH of 5.64. When treated with the 1N NH₄OH, the pH increased to 10.63, a 88.5% increase. When treated with the 0.1N NH₄OH the pH increased to 9.62, an 70.5% increase. With the treatment with the 0.0125 N NH₄OH, the pH increased to 8.61, a 52.7% increase. (Table 9)

Table 9. Test Results for February: Influent

| Treatment | | TDS mg/L | TSS mg/L | pH s.u. | Ammonia mg/L | Hardness mg/L |
|-----------|----------------------|-------------|-------------|------------|-----------------|------------------|
| Influent | | 4855 | 2835 | 5.64 | 130 | 2532 |
| 1 | N NH ₄ OH | 2326 | 4700 | 10.63 | 7300 | 879 |
| 0.1 | N NH ₄ OH | 2991 | 4173 | 9.62 | 1865 | 1010 |
| 0.05 | N NH ₄ OH | 3403 | 4006 | 9.37 | 960 | 1274 |
| 0.025 | N NH ₄ OH | 4268 | 3342 | 9.13 | 720 | -- |
| 0.0125 | N NH ₄ OH | 4505 | 3093 | 8.61 | 210 | -- |

February's influent sample yielded an initial ammonia count of 130 mg/L. The 1 N NH₄OH treatment resulted in an effluent hardness of 7300

the treatment of the 0.1N NH_4OH , the pH increased to 10.26, a 37.3% increase. The treatment of 0.0125 N concentration increased the pH to 9.52, a 27.4% increase. (Table 10)

February's effluent sample yielded an initial ammonia count of 3.5 mg/L. The 1 N NH_4OH treatment resulted in an effluent hardness of 1155 mg/L. The 0.1 N NH_4OH treatment resulted in a concentration of 840 mg/L. The 0.05 N concentration resulted in a final hardness of 685 mg/L. The 0.025 N NH_4OH treatment resulted in a concentration of 460 mg/L. The 0.0125 N concentration resulted in a final hardness of 255 mg/L. (Table 10)

Table 10. Test Results for February Effluent

| Treatment | | TDS mg/L | TSS mg/L | pH s.u. | Ammonia mg/L | Hardness mg/L |
|-----------|--------------------------|-------------|-------------|------------|-----------------|------------------|
| Effluent | | 2692 | 14 | 7.47 | 3.5 | 1427 |
| 1 | N NH_4OH | 1036 | 342 | 10.52 | 1155 | 681 |
| 0.1 | N NH_4OH | 1324 | 269 | 10.26 | 840 | 786 |
| 0.05 | N NH_4OH | 1866 | 155 | 10.10 | 685 | 842 |
| 0.025 | N NH_4OH | 2046 | 136 | 9.98 | 460 | -- |
| 0.0125 | N NH_4OH | 2251 | 126 | 9.52 | 255 | -- |

The sample used in February for effluent had an initial hardness count was 1427mg/L. The 1 N NH_4OH treatment resulted in an effluent hardness of 681 mg/L, a 52.3% decrease. The 0.1 N NH_4OH treatment resulted in a

The influent sample for March exhibited an initial pH of 5.15. When treated with the 1N NH_4OH , the pH increased to 10.40, a 101.9% increase. When treated with the 0.1N NH_4OH the pH increased to 9.87, an 91.7% increase. With the treatment with the 0.0125 N NH_4OH , the pH increased to 8.77, a 70.3% increase. (Table 11)

March's influent sample yielded an initial ammonia count of 165mg/L. The 1 N NH_4OH treatment resulted in an effluent hardness of 7450 mg/L. The 0.1 N NH_4OH treatment resulted in a concentration of 1655 mg/L. The 0.05 N concentration resulted in a final hardness of 1050 mg/L. The 0.025 N NH_4OH treatment resulted in a concentration of 865 mg/L. The 0.0125 N concentration resulted in a final hardness of 320 mg/L. (Table 11)

The initial hardness for influent March was 1168 mg/L. After the 1 N treatment, it decreased to 424 mg/L, a 63.7% decrease. With treatment with the 0.1 N NH_4OH , it resulted in a result of 540 mg/L, a 53.8% decrease. The 0.05 N treatment resulted in a concentration of 592, which constituted a 49.3% decrease. (Table 11)

Sample VIb: March Effluent

March's effluent sample untreated had a TDS of 3672 mg/L, and a TSS of 11 mg/L. After treatment with a 1 N solution the TDS dropped to 1743 mg/L, a 51.2% decrease while the TSS increased to 433 mg/L, a 3928% increase. When treated with 0.1 N NH_4OH , the result was 2561 mg/L, a 28.3% decrease in TDS and a TSS of 346 mg/L which is about a 3045% increase.

The 1 N NH_4OH treatment resulted in an effluent hardness of 1220 mg/L. The 0.1 N NH_4OH treatment resulted in a concentration of 870 mg/L. The 0.05 N concentration resulted in a final hardness of 770 mg/L. The 0.025 N NH_4OH treatment resulted in a concentration of 405 mg/L. The 0.0125 N concentration resulted in a final hardness of 235 mg/L. (Table 12)

Effluent sample for March had an initial hardness count was 1673 mg/L. The 1 N NH_4OH treatment resulted in an effluent hardness of 729 mg/L, a 56.4% decrease. The 0.1 N NH_4OH treatment resulted in a concentration of 860 mg/L, a 48.6% decrease. The 0.05 N concentration resulted in a final hardness of 1052 mg/L, a 37.1% decrease from the initial hardness count. (Table 12)

Sample VIIa: April Influent

The initial influent TDS, in April, was 5247 mg/L, and a TSS of 3121 mg/L. After treatment with 1 N NH_4OH the TDS was decreased to 3001 mg/L, a 42.8% decrease. The TSS rose to 4850 mg/L, a 55.4% increase. When treated with 0.1 N NH_4OH , the TDS decreased to 3295 mg/L, a 37.2% decrease, and the TSS rose to 4188 mg/L, a 34.2% increase. With the 0.05 N solution the TDS decreased to 3699 mg/L, a 29.5% decrease. The TSS increased to 4151 mg/L, a 33.0% increase. The 0.025 N application resulted in the TDS decrease to 4712 mg/L, an 10.2% decrease, and the TSS increased to 3717 mg/L, a 19.1% increase. At the 0.0125 N concentration, the TDS decreased to 4890 mg/L, a 6.8% decrease. The TSS concentration of the sample rose to 3611 mg/L, an 15.7% increase. (Table 13)

treatment with the 0.1 N NH_4OH , it resulted in a result of 1316 mg/L, a 47.6% decrease. The 0.05 N treatment resulted in a concentration of 1470, a 41.5% decrease. (Table 13)

Sample VIIb: April Effluent

April's influent sample had a TDS of 2075 mg/L, and a TSS of 3 mg/L. After treatment with a 1 N solution the TDS dropped to 948 mg/L, a 54.3% decrease while the TSS increased to 184 mg/L, a 6037% increase. When treated with 0.1 N NH_4OH , the result was 1399 mg/L, a 32.6% decrease in TDS and a TSS of 160 mg/L which is about a 5241% increase. The 0.05 N solution reduced the TDS to 1672 mg/L, a 19.4% decrease, and increased the TSS to 151 mg/L which is a 4922% increase. When the 0.025 N solution was applied the TDS dropped to 1834 mg/L, a 11.6% decrease, and the TSS raised to 116 mg/L, a 3754% increase. At the 0.0125 N NH_4OH concentrations the TDS was down to 1865 mg/L, a 10.1% decrease and an increase in the TSS concentration that read 93 mg/L, a 3008% increase. (Table 14)

April's effluent sample revealed an initial pH of 7.38. After being treated with the 1N NH_4OH the pH increased to 10.63, a 44.0% increase. With the treatment of the 0.1N NH_4OH , the pH increased to 10.29, a 39.4% increase. The treatment of 0.0125 N concentration increased the pH to 9.68, a 31.2% increase. (Table 14)

April's effluent sample yielded an initial hardness count of 1109 mg/L. The 1 N NH_4OH treatment resulted in an effluent hardness of 401 mg/L, a 63.8% decrease. The 0.1 N NH_4OH treatment resulted in a concentration of 642 mg/L, a 42.1% decrease. The 0.05 N concentration resulted in a final

portion binds to the TDS ions, such as calcium, magnesium, chloride, sodium and sulfate, the quantity of TDS is reduced because it is precipitated and then filtered. The precipitated ions along with the suspended particles make up a residue at the bottom of the sample. This residue is therefore unable to pass through the pores in a filter. The lesser concentrations lowered the TDS also, but not as dramatically. This is because there is not enough of a hydroxide concentration to bind with the TDS ions. At the same time TSS is increased due to the fact that the ammonium hydroxide acts as a coagulant and precipitates suspended particles and dissolved particles into a floc, a sludge. The greater the concentration of ammonium hydroxide the greater the binding of dissolved particles and suspended particles. This in turn increases the amount of unfilterable material or TSS. A great portion of the influents suspended solids is made up of fats and oils from the industrial processes. The pH level is more acidic in the influent sample because of citric acids used in the industrial processes. When the ammonium hydroxide solution was added to the sample the pH levels increased. This is due to the alkaline nature of the ammonium hydroxide. This is because the an acidic pH is high in hydrogen ions where as a basic pH is high in hydroxide ions. The smaller concentrations of ammonium hydroxide tended to make the sample basis. The hardness which consists mainly of Calcium and magnesium decreased significantly when all levels of ammonium were added. The decrease was maximized when the 1 N concentration was added because more ammonium hydroxide binds calcium and magnesium just like the TDS. Demonstrating that the influents TDS is approximately 50% Calcium and magnesium make up.

These industries fall under what is termed pre-treatment guidelines, which are determined by the state in which the industry resides under the EPA. These pre-treatment guidelines were established for industries which discharge into municipal treatment systems. Because some pollutants can interfere with the operation of the municipal treatment facilities, certain industries must pre-treat their industrial effluents before releasing them into the municipal system. Pollutants can interfere with the treatment facility by destroying some of the viable microorganisms used in the municipal facilities' processes, or the industrial pollutant could possibly pass through the treatment facility unhindered.

In this particular study, a new technique for helping control dissolved solids industrial effluent has been examined. The problem now occurs where to implement the process. In examining certain industrial water treatment works, a possible location for introducing the ammonium hydroxide could be in the influent stage of the treatment process.

In talking with Don McKaughan, the operator of the Good Humor Bryers Ice Cream water treatment facility in Henderson Nevada, I found that a certain nutrient is added to the influent to promote growth of certain microbiological organisms in the treatment process. The microorganisms float freely about in a pond, and collectively they make up what is termed activated sludge. These organisms are aerobic (requiring oxygen), and they function to decompose certain organic constituents to CO_2 and H_2O . The particular activated sludge at the site removes constituents such as fats, oils, and other hydrocarbons. To satiate these particular organisms, a compound known as urea is added to the influent. The urea actually contains an

guidelines. Removal of this ammonia in the effluent stage could also prove to be costly in requiring additional biological treatment. Dr. Stark, a biologist at UNLV agreed with the possible application of this treatment, but explained "the microorganisms used in treatment processes are very dependent usually upon having a stable neutral pH." This is the case at the industrial plants, but in examining the pH of the influent, I found that it was actually somewhat acidic (pH of approximately 5). The present nutrient used in the influent as stated previously is the urea, and it has a slightly basic pH from 7.8-8.0. The urea added also then slightly buffers or increases the pH to a more neutral pH. While the experimentation increased the pH significantly, because of the acidic nature of the influent, a slight buffer could be used to normalize the pH. Dr. Stark suggested that nitric acid could be used to buffer the pH, and although there would be residual nitrogen, this could be used as nutrient for the microorganisms.

The application of this ammonium hydroxide in the treatment facility may have some drawbacks. Unlike the urea compound that is currently being used, the ammonium hydroxide is only found in liquid solution form, consequently, vapors can be produced that are harmful to human health. This problem can be overcome if a fume hood (device for ventilation) or some other method for proper ventilation while the ammonium hydroxide is being applied. In considering the cost of the ammonium hydroxide, the lowest price found for the ammonium hydroxide was about \$3.96 per liter, whereas the urea compound is sold in a dry form, and it cost about 3¢ per gram. As shown, a 1 N solution of ammonium hydroxide seems to significantly lower the TDS. A 1 N solution of ammonium hydroxide can be made by diluting 66.6 ml of 15 N ammonium hydroxide to 1000 ml of water.

Figure 1. Averages of Results for TDS/TSS Influent Analysis

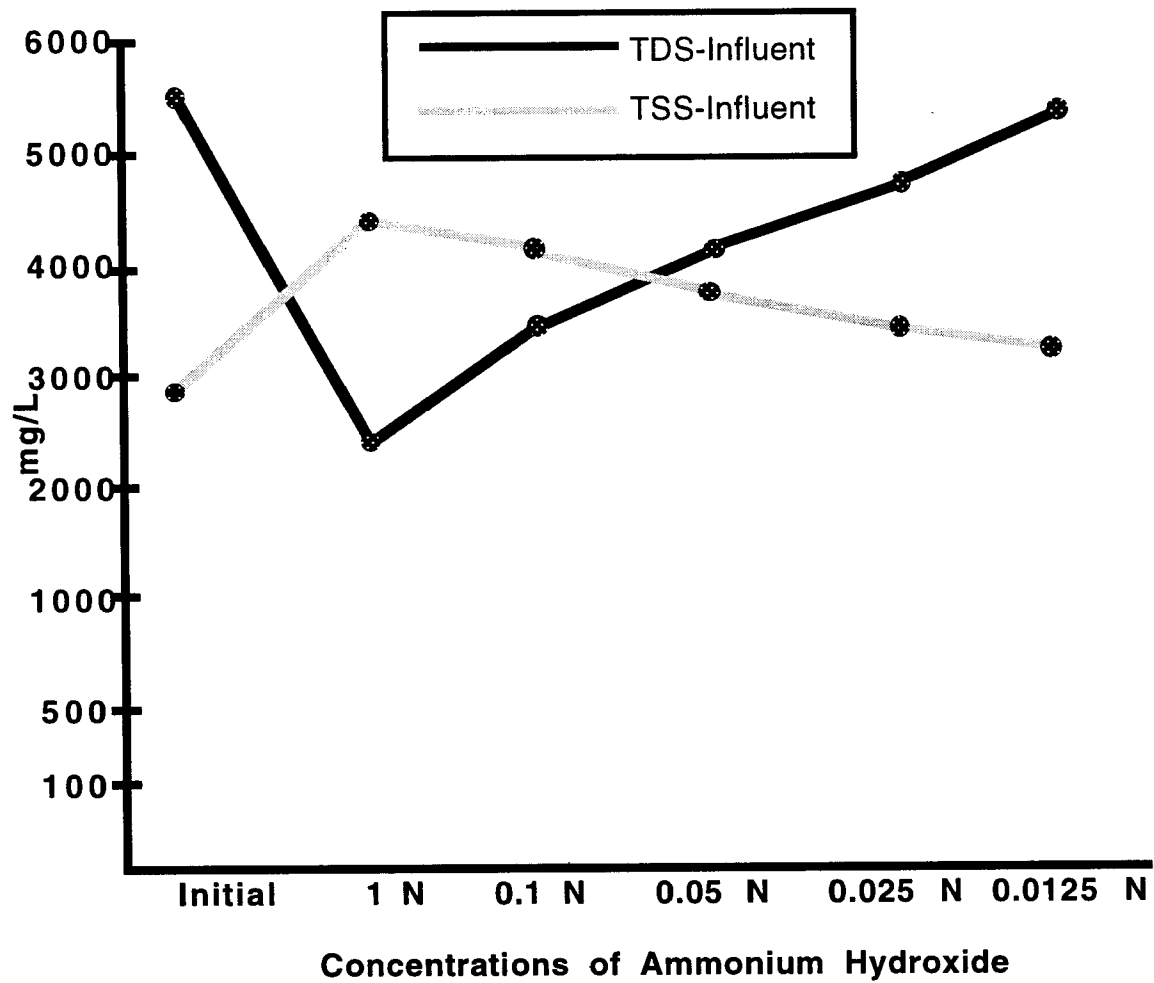


Figure 3. Averages of Results for pH Analysis

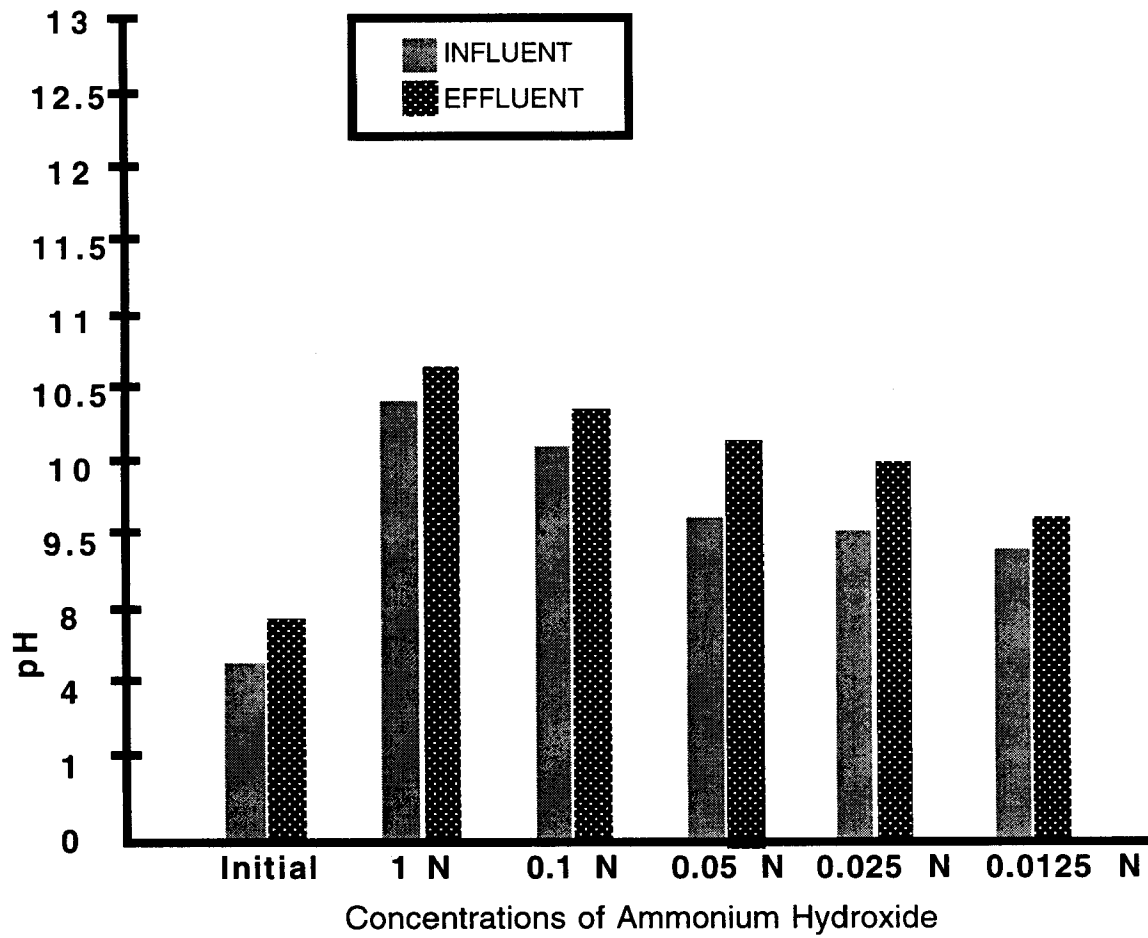
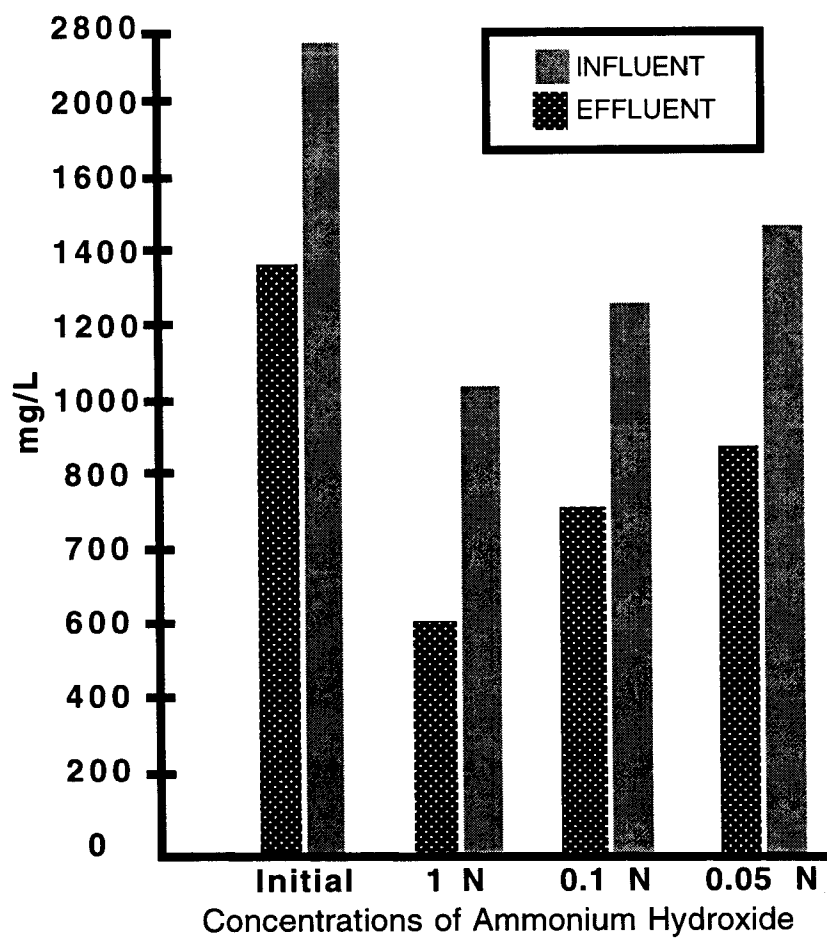


Figure 5. Averages of Results for Hardness Analysis



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