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CLOG REMOVAL OF AQUEOUS BIOWASTE IN DRAIN SYSTEMS USING SODIUM SALTS

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ABSTRACT. *Biowaste materials like hair, oil, grease and fish scale often clog kitchen sink and bathroom piping system. The grease and oil always tend to form a thin sticky layer on the pipe wall and other waste materials will accumulate on top of this layer, and gradually the pipe will get clogged. Usually caustic or acidic chemicals are used to ease the clogged problems. In this work, various mixtures of sodium salt solutions were prepared at different concentrations, and tested for the most effective formulation to ease clogged problems. During the test, a keratin solubility was used as an indicator for the effectiveness of the formulated mixture. The result reveal that a specific mixture of sodium salts can dissolve keratin within 5 minutes and was also found to be stable.*

KEYWORDS. Sodium salts, solubility of protein, solution stability, clog, keratin

INTRODUCTION

Everyday, domestic waste materials were thrown into kitchen sink and piping system in the house. Some of these waste materials were left in the piping system in the form of dirt. These dirt remnants can either be classified as organic or inorganic dirt. Generally, materials that cause clogged drains are organic dirt materials such as oil, grease, protein, sugar, carbohydrate and cellulose origin. Oil and grease are the major cause of clogged piping system. The oil and grease have the tendency to accumulate at pipe wall and causing flow restriction. Hence, avoidance of oil and grease from the piping system is an important step to enable smooth flow of water. To break down oil and grease lump into small particle that can easily be washed out, surfactants were used. Besides surfactants, sodium hydroxide can also be used to form soap compound with oil and grease. Protein is the other most discarded material that can often be found in kitchen sink. Protein waste can be in the form of meat, milk, egg and others food products. Protein waste can also be found in bathroom.

Hair that contains keratin (a protein's component) is the major waste that is found in the bathroom. Protein is polymer that does not dissolve in water and difficult to remove by using normal conventional method (Lange, 1994). Nevertheless, the waste materials that contain protein can be removed by reacting with an alkaline solution. When reacting with an alkaline solution, protein will be hydrated to form salt compound. Complicated protein molecule can also be broken down into smaller ones and diluted easily. This reaction is called peptization reaction. In addition to the protein's waste, other matter such as complex keratin can also be removed by oxidization process using sodium hypochlorite. Sodium salts like sodium hypochlorite, sodium hydroxide, sodium silicate and sodium carbonate can be used to remove this discarded garbage material. Sodium hypochlorite is a salt that produce negative charge of hypochlorite and positive charge of sodium in ionic form (McGrath & Blackford, 2001). Pure hypochlorite is an unstable chemical and very reactive. In liquid form, hypochlorite will produce various by products such as oxygen, chlorine gas, salt, and hypochlorous acid which is a strong oxidizing agent. This chemical property enables hypochlorite to act as sanitizer or disinfectant to destroy microorganisms and bio-based product by oxidizing. In removing the discarded material, sodium hypochlorite reacts with organic waste matter, where several chemical reactions will occur simultaneously. The reactions that occur are reaction between fatty acid and sodium hydroxide to form soap and glycerol; reaction between amino acid and sodium hydroxide to form salt and water; other reaction which involves hypochlorous acid to form chloramines and water (Spano et al., 2001). Besides these reactions, hypochlorous acid and hypochlorous ion also help in reduction and hydrolysis of amino acid (Estrela et al., 2002). For simplicity the reaction involving of sodium hypochlorite can be written as:-

$$NaOCl + H_2O \longleftrightarrow NaOH + HOCl \longleftrightarrow Na^+ + OH^- + H^+ + OCl^-$$

Sodium silicate is another chemical used to sanitize, deodorize and clean (Lewis, 1999 and Kroschwitz & Grant, 1993). In clog removal process, sodium silicate always acts to give high alkalinity level and reduces the corrosive effect of other sodium salts that are used to remove the clog and enables other chemicals to act more effectively as chelate agent or as stabilizer.

Sodium carbonate acts as builder to reduce water hardness and retains the effectiveness of surfactants. In addition it also retains solution alkalinity and assists in removing the dirt by emulsifying the oil (McGrath & Blackford, 2001).

MATERIALS AND METHODS

Preparation of sodium salt solutions is the basic step to begin the process of clog removing. The sodium salt that are used to remove clogged are sodium hypochlorite, sodium

hydroxide, sodium silicate and sodium carbonate. In this work, three levels of tests were done. The concentration of sodium hypochlorite and sodium hydroxide were prepared between 2% to 10%, while concentration of sodium silicate were tested from 0.5% to 2.5%, whereas concentration of sodium carbonate is from 0.2% to 1.0%. All solutions were prepared in triplicate. Next, sodium salt solution is prepared by using mixture of two type of chemicals which are mixtures of sodium hypochlorite with sodium hydroxide; sodium hypochlorite with sodium silicate; and sodium hypochlorite with sodium carbonate. Third, the preparation of sodium salt solution involves mixture of three type of chemicals. Where combination of mixture is consisted of sodium hypochlorite, sodium hydroxide with sodium silicate; and the mixture of sodium hypochlorite, sodium hydroxide with sodium carbonate. After the sodium salt solution was prepared, a cut of 3 cm keratin was dipped in to the 50 ml sodium salt solution, and time was simultaneously taken until the keratin is dissolved. The difference between final time and the beginning time is called the time of solubility. For stability test purposes, three types of sodium salt solutions were selected. The selection of these solutions were based on the best performance of these solutions in dissolving keratin. These solutions were kept in closed space at room temperature for a week after formulation to see if any changes in the appearances. Then the solutions were centrifuged to see if any formation of precipitation. The stability criteria of the mixture is identified by the changes of appearances and the formation of percipitation.

RESULTS AND DISCUSSION

Individual Chemical effect on Keratin Solubility

Sodium hypochlorite is known as a strong oxidizing agent which is normally used to remove clog. Figure 1, shows the ability of sodium hypochlorite as an oxidising agent for keratin. This figure also shows that all of the solution with 4%, 6%, 8%, and 10% of sodium hypochlorite can dissolve keratin within 10 minutes, whereas the solution with 2% sodium hypochlorite took about 16 minutes.

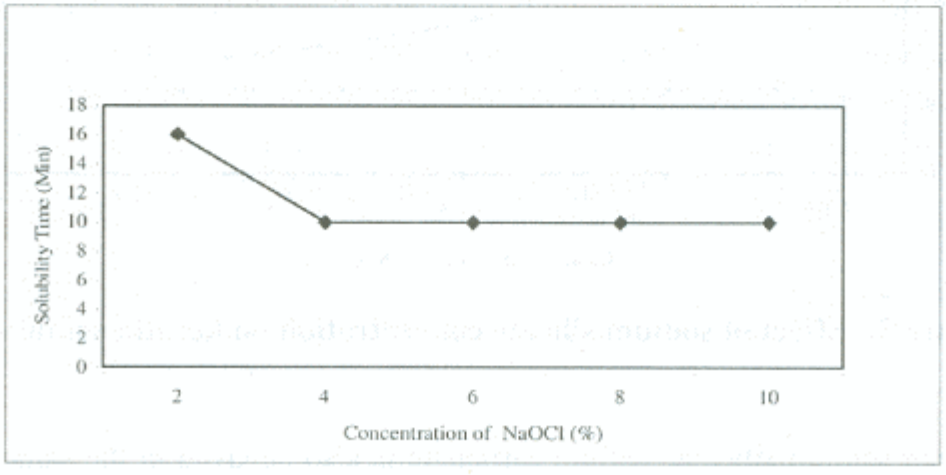

Figure 1. Effect of sodium hypochlorite concentration on keratin solubility

Result from the keratin solubility test in the solution sodium hydroxide, it was found that sodium hydroxide is not suitable as dissolving agent, since it takes more than two hours to dissolve the keratin (see Figure 2). Sodium hydroxide cannot function as effectively as sodium hypochlorite since it is not an oxidizing agent but it will act as an alkaline solution that reacts with amino acid to form salt and water.

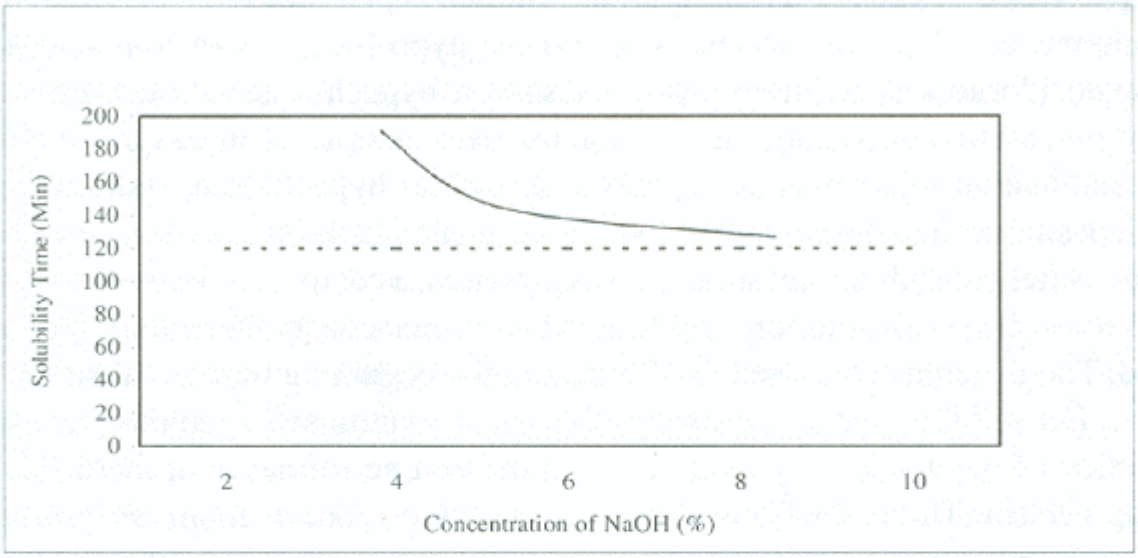

Figure 2. Effect of sodium hydroxide concentration on keratin solubility

Sodium silicate forms clear solution within the range of 0.5% to 2.5% but found to be ineffective as a clog remover. This can be shown in Figure 3 where it took long time to dissolve keratin. Therefore, sodium silicate will be used as a stabilizer rather than a dissolver.

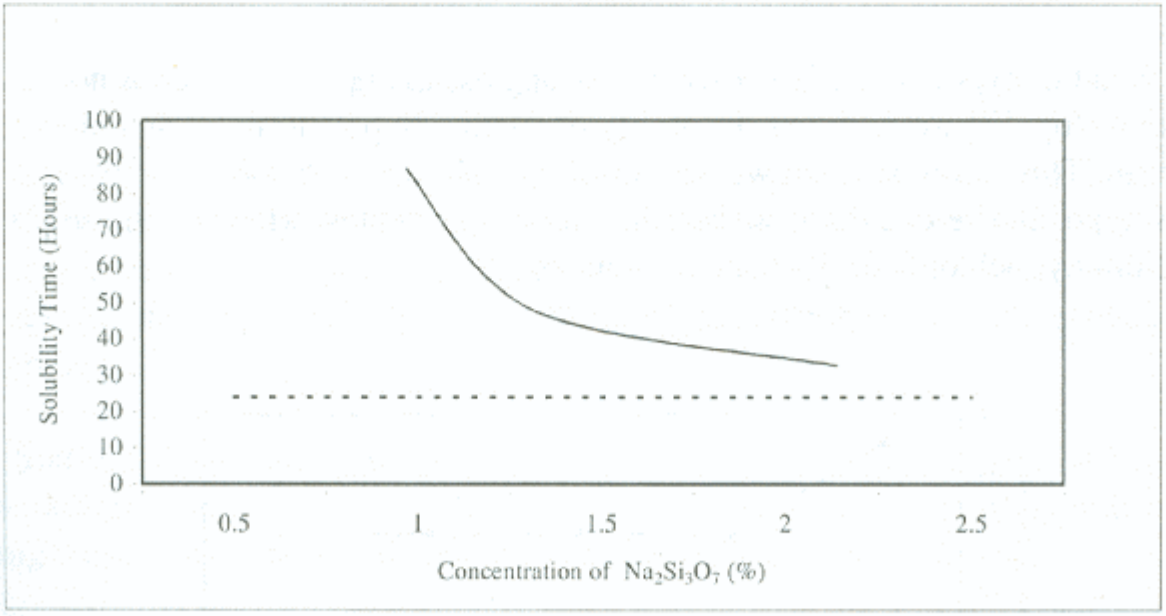

Figure 3. Effect of sodium silicate concentration on keratin solubility

Other than sodium silicate, sodium carbonate is also behaved in the same way. Hence, sodium carbonate will be used as stabiliser.

Combined sodium salt effect on solubility

A mixture of 6% of sodium hypochlorite with 6% of sodium hydroxide were found to be able to dissolve keratin in less than 5 minutes (see Figure 4). In comparison to pure solutions of sodium hydroxide and sodium hypochlorite, the mixture of these salt solution performed better in solubility of keratine.

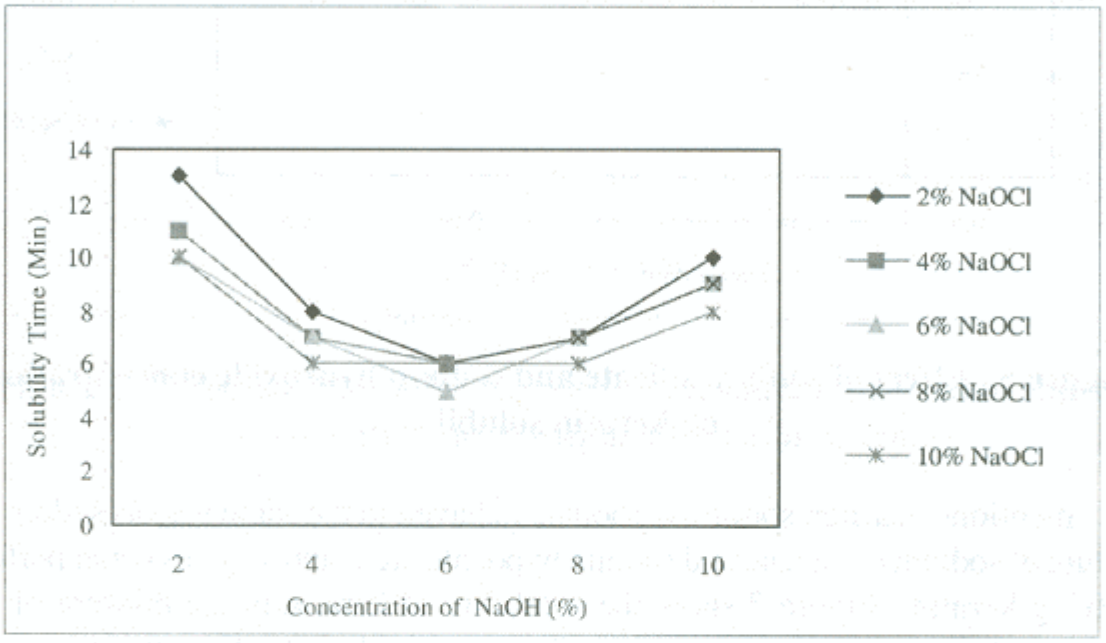

Figure 4. Effect of sodium hypochlorite and sodium hydroxide concentration on keratin solubility

Figure 5 and Figure 6 show the performance of the mixture of sodium hypochlorite, sodium hydroxide and sodium silicate in solubility of keratin. These figures show that keratin dissolves with less time by lowering the concentration of sodium silicate and increasing the concentration of sodium hydroxide. This phenomena might be due to silicate will inter-reacting with sodium hypochlorite and sodium hydroxide more frequently at higher concentrations, and thus impeding the activity of sodium hypochlorite and sodium hydroxide. Figure 6, also shows that the shortest time achieved to dissolve keratin is 5 minutes with the formulation of a mixture of 4% NaOCl, 6% NaOH and 0.5% $Na_2Si_3O_7$.

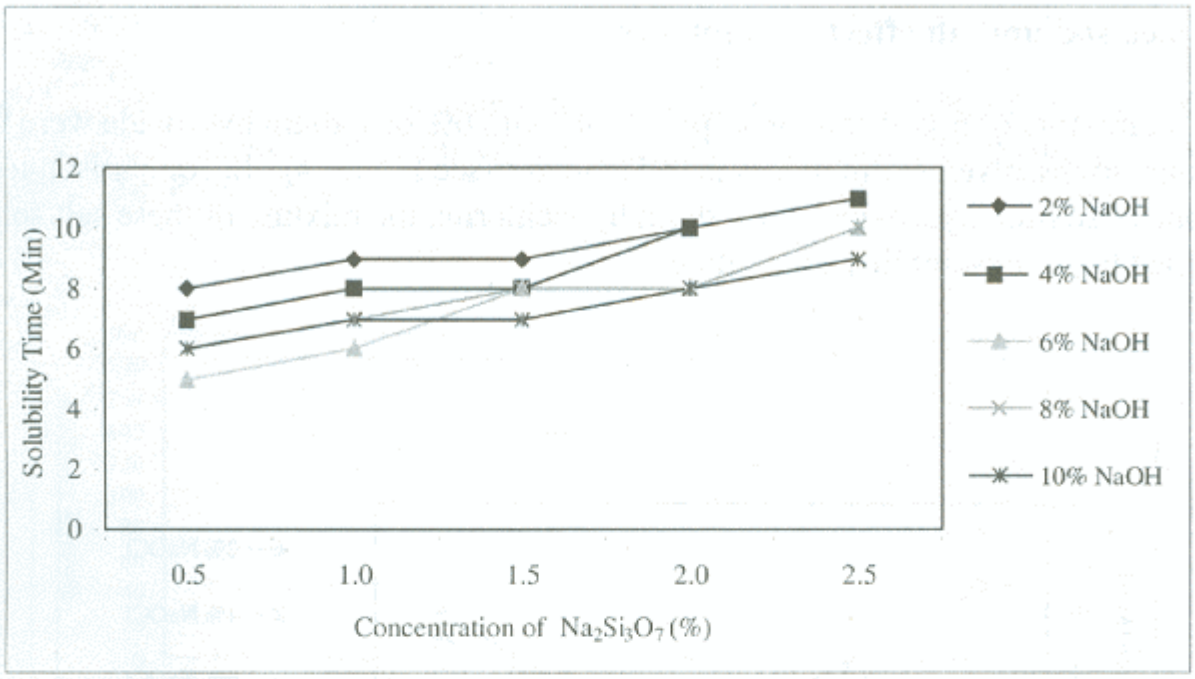

Figure 5. Effect of sodium silicate and sodium hydroxide concentration on keratin solubility

As mentioned earlier, sodium carbonate behaved in the same way as sodium silicate but a mixture of sodium carbonate and sodium hypochlorite solution gives better performance in dissolving keratin. Figure 7 show the solubility of keratin in the mixture of solution sodium hypochlorite, sodium hydroxide and sodium carbonate. For the mixture of 2% NaOCl, 10% NaOH and 0.2% Na_2cO_3 it found to be able to dissolve keratin in 6 minutes.

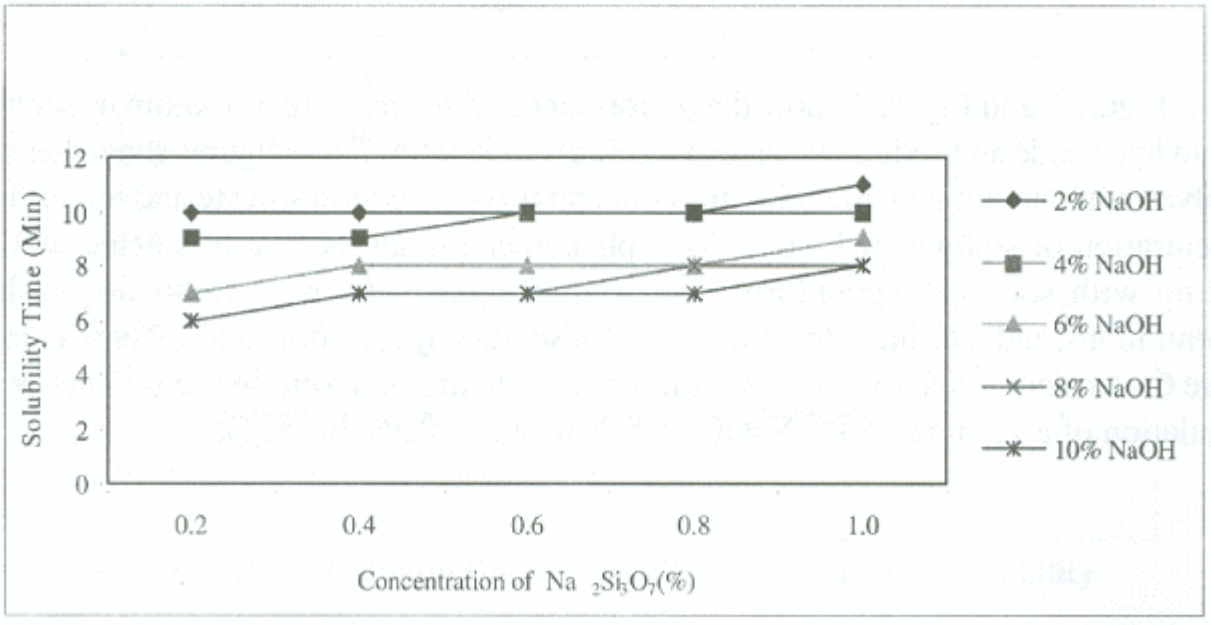

Figure 6. Effect of 4% sodium hypochlorite, sodium hydroxide and sodium silicate concentration on keratin solubility

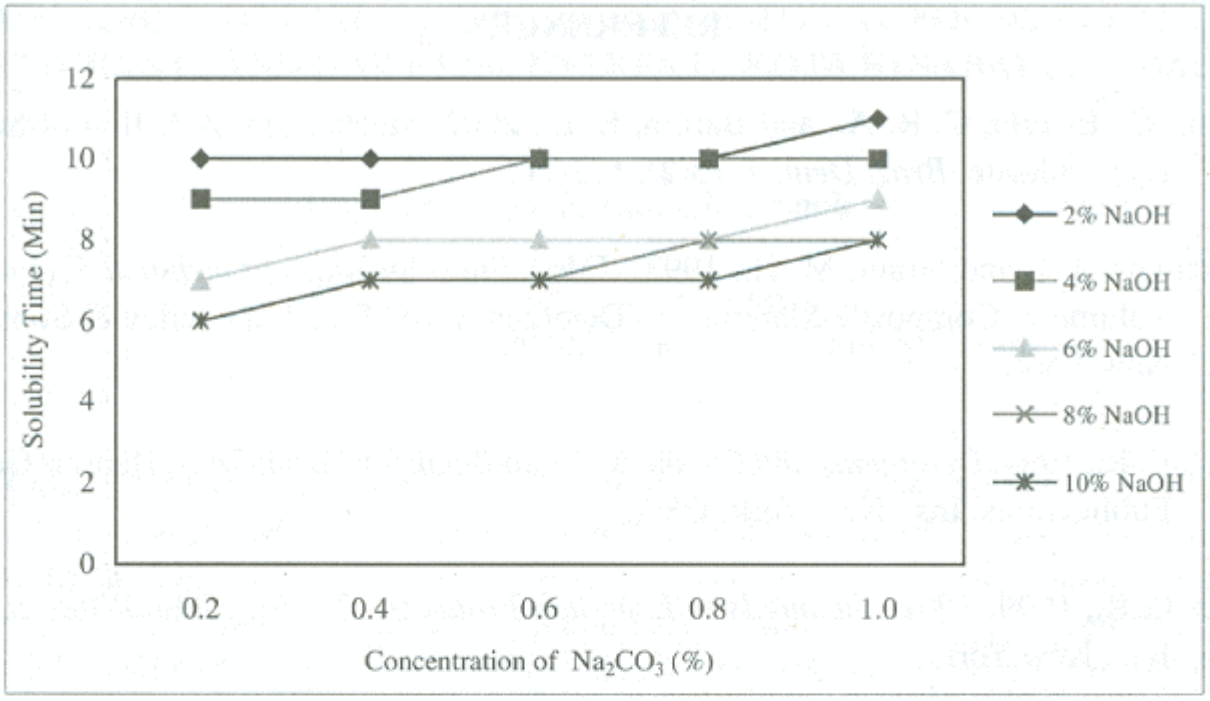

Figure 7. Effect of 2% sodium hypochlorite, sodium hydroxide and sodium carbonate concentration on keratin solubility

Stability

Three sodium salt solutions of (a) 6% NaOCl and 6% NaOH; (b) 4% NaOCl, 6% NaOH, and 0.5% $Na_2Si_3O_7$; and (c) 2% NaOCl, 8% NaOH and 0.2% Na_2CO_3 were selected for stability test. The result shown that the sodium salt solution (b) found to be very stable. This solution did not show any changes in the appearance and also did not form any precipitation by centrifugation. Other solutions (a) and (c) showed the formation of pecipitation after centrifugation. It is shows that sodium silicate acts as a better stabilizer.

CONCLUSION

Sodium salts found to be very effective chemical for biowaste clog and associated biomass removal. Result of this study shows that the mixture of sodium salt solution of 4% sodium hypochlorite, 6% sodium hydroxide, and 0.5% sodium silicate is able to dissolve keratin within 5 minutes. Besides its performance to remove biowaste clog it is also very stable in handling and storage. This shows the solution has a potential for commercial application as clearing and cleaning agent in aqueous biowaste drain systems of residential, commercial, and restaurant areas ensuring free flow of liquid wastes, and thus keeping the sanitation and hygiene.

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