Determination Of Caustic Drain Out Period Of Glass Bottle Washerand Impact Of Total And Effective Caustic Strengths For Glass Bottle Washing In Soft Drink Plant

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ABSTRACT: One of the most important processes in soft drink production is bottle washing; high quality of the product depends on that. A main objective of the present study is to determine the impact of total caustic and effective caustic strength on the washing performance of glass bottles. Total and effective caustic strength in samples were measured based on titration results. Four parameters were considered on the washing performance of glass bottles such as Microbiological Tests (APC and Yeast & Molds), Methylene blue test, Phenolphthalein test and Physical inspection. Ten samples were tested for every test per each time and three times were considered for a day and conduct for 43 days (within two caustic drains out periods). Negative correlations in between total, effective caustic strengths with time (Days) indicate from 29 days onward in tanks. There is a Positive correlation ($P < 0.05$) in between Carbonates (g/ml) and time (Days) onward. Positive correlations ($P < 0.05$) indicate from 35 days onward for the number of algae present bottles, number of dirty bottles and APC too. Twenty nine days from the initial charge of caustic soda can be taken as the most suitable day for the caustic discharge. Under the practical scenario, mean differences of total and effective caustic strengths (%) are negligible compared to the standard value and not significantly difference ($P > 0.05$).

Key words: bottle washing, Total and effective caustic strength, Microbiological Tests, Methylene blue test, Phenolphthalein test,Physical inspection

1. Introduction

One of the most important processes in soft drink production is bottle washing. Empty glass bottles are returned to the soft drink plant in different conditions of cleanliness. But all those bottles should be delivered to the filling machine in clean and sterile conditions. The cleaning and sterilization of bottles depend on contact time, caustic strength,pressure, additive strength and the temperature of the detergent (Downing, 1996).Caustic soda (NaOH) solutions, most commonly used as chemical cleaning detergent on an industrial scale (Henck, 1995; Alvarez *et al* ., 2006). The caustic drain out time periods are not steady under the practical situation. Therefore, a proper caustic drain out period was introduced by studying the washing performance of glass bottles with the time. It may helpful to the effectiveness of caustic soda on the glass bottle washing. Several parameters are used to check the washing performance of glass bottles such as Physical inspection, Microbiological Tests (Aerobic plate count (APC) and Yeast and Molds), Phenolphthalein test and Methylene blue test. Specification for caustic soda lye says that minimum concentration of NaOH is 43.5% (+1) and Na_2CO_3, NaCl, Fe, Na_2SO_4 are the rest of caustic soda lye. Therefore, impact of total caustic strength and effective caustic strength on the washing performance of glass bottles use in soft drink plant is determined. Total caustic strength is the percentage in both total weight of NaOH and Na_2CO_3 in the unit sample of caustic soda and effective caustic strength is the percentage in weight of NaOH in the unit sample of caustic soda which is effectively caused for the washing performance of the glass bottles.

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2. Material and Methodology

2.1 Measurement of total caustic strength and effective caustic strength (Jeffery *et al.,* 1989)

About 0.5 N hydrochloric acid solution was loaded to a burette. Then, 10 ml aliquot of sample (VS) was poured in to conical flask. About 2-3 drop of phenolphthalein solution was Introduced, and titrated with 0.5 N hydrochloric acid solution until the solution lost the pink color. The burette mark (Vphth) was read. After that, 2-3 drops of methyl orange solution was introduced to the same sample, and titrated with 0.5 N hydrochloric acid solution until the solution just begin to change color from yellow to red. The burette mark (Vmo) was read. Titration was repeated for two times. The median volumes of used hydrochloric acid solution were calculated. The composition of the solution can be deduced from the relative volumes of acid needed to titrate equal volumes of the sample.

$$\text{Total caustic strength} = \frac{V_{phth} \times N_{HCl} \times M_{NaOH}}{VS}$$

$$\text{Effective Caustic strength} = \frac{V_{phth} - (V_{mo} - V_{phth}) \times N_{HCl} \times M_{NaOH}}{VS}$$

2.2 Parameters regarding the washing performance of glass bottles

Ten samples were tested for every test per each time and three times were considered for a day. Tests were done for 43 days (within two caustic drains out periods).

2.2.1Microbiological Testing procedures

The samples were analyzed for Aerobic Plate Count, Yeasts and Molds. Rinse method was use for the microbiological testing as describe by Devlieghere and Huyghebaert, (1997).

2.2.1.1 Aerobic Plate count (modified method of SLS 516: part 1:1991)
Volume of 20ml ringer solution was added to each and every bottle. The bottles were thoroughly washed with ringer solution by laying and rolling through the table. For glass bottles, 1ml of ringer was used to inoculate. After inoculation the Petri film was pressed and then incubated at 35±1°C for 48 hours.

Calculation
Aerobic Plate Count = No: of colonies * Dilution factor/ml

2.2.1.2 Yeast and mold count (modified method of SLS 516: part 2:1991)
As above, 20ml of ringer was added and 1ml of them is inoculated into Petri film. The inoculation was spread well and placed at room temperature (25°C) for 72 hours.

Calculation
Yeasts and Molds Count = No: of colonies * Dilution factor/ml

2.2.2 Methylene blue test
The random samples of washed glass bottles, representing each path in the washer were taken and bottles were washed with Methylene blue. Then Methylene blue was washed away and then checked whether there were any algae in the bottles. If algae present, they were colored by Methylene blue.

2.2.3 Phenolphthalein test
Phenolphthalein was added to the washed glass bottles and checked whether there was any remaining caustic soda. If caustic soda was presented, gives pink color with phenolphthalein.

2.2.4 Physical inspection
Inside of the bottles were observed for scale and they were consider as dirty bottles from their physical appearance.

2. Results and Discussion

Negative correlations in between total caustic strength, effective caustic strength and time (Days) indicate from 29 days onward in tanks within 43 days. There is a Positive correlation ($P < 0.05$) in between Carbonates (g/ml) and time (Days) onward.

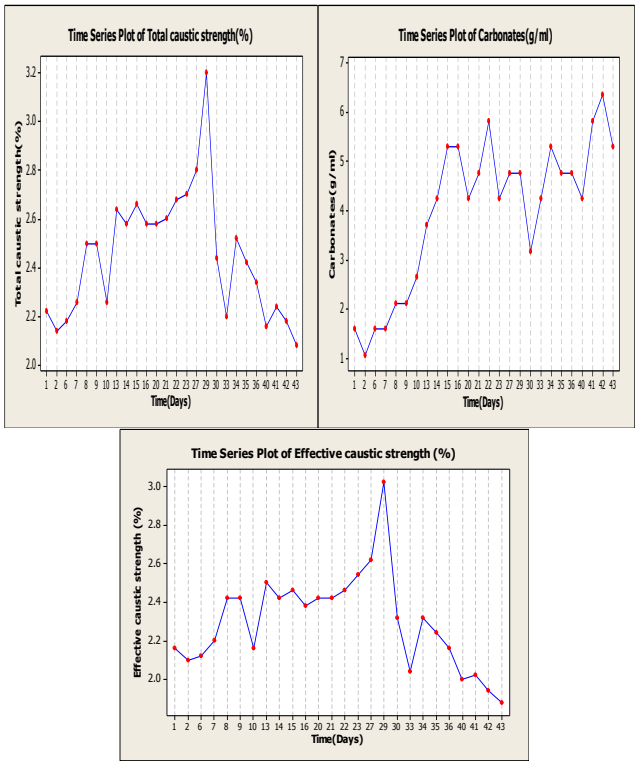

Figure 3.1: Time series plots of Total caustic strength (%), Effective caustic strength (%), Carbonates (g/ml) in tanks

Positive correlations indicate from 35 days onward for the number of algae present bottles, number of dirty bottles and APC within 43 days. Therefore, washing performance was not much shown for that period of time. Yeast & Mold counts and numbers of residual caustic present bottles were zero with the time.

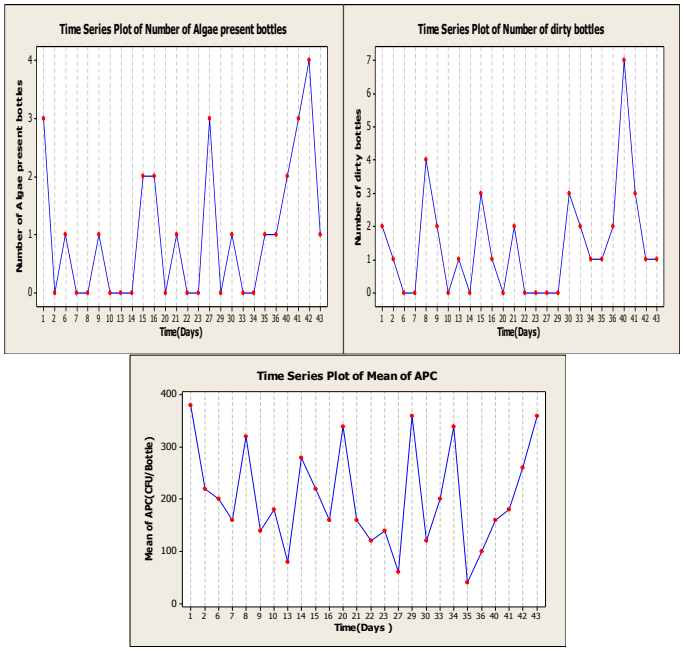

Figure 3.2: Time series plots of number of Algae present bottles, number of dirty bottles from their physical appearance, mean of APC

Twenty nine days from the initial charge of caustic soda can be taken as the proper caustic drain out period according to the results obtained.

Caustic tank	95% CI for mean difference oftotal caustic strength and effective caustic strength
1	(0.111408, 0.154746)
2	(0.100114, 0.142963)
3	(0.127555, 0.173984)

Table 3.1: Mean difference of 95% Confidence Interval

Statistically, total caustic strength (%) and effective caustic strength (%) have a significant difference at 95% confident intervals. Under the practical situation, mean differences of total caustic strength (%) and effective caustic strength (%) are negligible compared to the standard value. Therefore, Total caustic strength (%) and effective caustic strength (%) have not significant (P > 0.05) difference.

4. Conclusions

Negative correlations in between total caustic strength, effective caustic strength and time (Days) indicate from 29 days onward in tanks within 43 days. The correlations oftime (Days) and Carbonates (g/ml) in all tanks had positive correlations. Positive correlations indicate from 35 days onward for the number of algae present bottles, number of dirty bottles and APC respectively within 43 days. Therefore, washing performance was not much shown for that period of time. Twenty nine days from the initial charge of caustic soda can be taken as the proper caustic drain out period according to the results obtained. Statistically, total caustic strength (%) and effective caustic strength (%) have a significant difference at 95% confident intervals.Under the practical situation, mean differences of total caustic strength (%) and effective caustic strength (%) are negligible compared to the standard value. Therefore, Total caustic strength (%) and effective caustic strength (%) have not significant (P > 0.05) difference.

5. References

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