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Dilution of caustic soda solutions

Scope

This Technical Information Paper presents information necessary for calculating how to dilute strong caustic soda solutions to produce a solution of the desired, lower concentration.

Safety precautions

Caustic soda is a highly corrosive material, which can cause severe burns to the eyes and skin. Eye contact of only a few seconds can cause permanent damage, even blindness. In all cases of bodily contact with caustic soda, begin washing the exposed area **immediately** with large quantities of flowing water. The dilution of caustic soda is a hazardous activity. Personnel engaged in the dilution of caustic soda should wear close-fitting chemical worker's goggles, rubber gloves, rubber apron or suit, and a face shield. When diluting caustic soda, **always** add caustic soda to water with constant agitation. **Never** add water to caustic soda. Dilution water should be warm (27-38 degrees C), but neither hot nor cold. The addition of caustic soda to liquid will cause a rise in temperature. If caustic soda becomes concentrated in one area, or is added too rapidly, or is added to hot or cold liquid, a rapid temperature increase can result in dangerous mists or boiling and splattering which may cause an immediate **violent eruption**.

Dilution of caustic soda

Often it is necessary to calculate the amount of water or dilute caustic soda solution necessary for the dilution of a strong caustic soda solution to a desired concentration. The following examples are provided to aid with problems of this nature.

Dilution concentration are made by one of the following formulas:

$$V = [100H(A-B)] / [R(B-C)]$$

or

$$W = [100(A-B)] / (B-C)$$

where

V = volume of weak liquor or water required per 100 volumes of original strong solution

W = weight of weak liquor or water required per 100 parts by weight of original strong solution

A = NaOH in original strong solution, %

B = NaOH desired in the diluted solution, %

C = NaOH in the diluting weak liquor, %

H = specific gravity of original strong solution

R = specific gravity of the diluting weak liquor

Sample calculation

Assume that it is desired to prepare a 23% NaOH solution from a stronger liquor of 49°Be at 15.55°C. From appropriate concentration tables, it is found that a caustic soda liquor of 49°Be corresponds to a 47.9% NaOH and a specific gravity of 1.510 at 15.55°C.

Substituting in formula 1:

$$V = [100 \times 1.510 (47.9 - 23.0)] / [1.000 (23.0 - 0.0)]$$

V = 163.5 parts of water to be added to each 100 parts by volume of original strong solution

How to use the chart for diluting and mixing caustic soda solutions

Use of the chart on page 4 simplifies the calculation of problems such as:

1. How much water is needed to dilute a strong caustic soda solution to a weaker one?
2. How many gallons of strong solution are needed to bring a weak solution to a higher concentration?
3. What is the strength of a solution formed by mixing equal volumes of water and a caustic soda solution?

The left-hand line of the chart, zero percent, is of course water. The decreasing heights from left to right of the vertical lines for percentage concentration reflect the greater weight per gallon of stronger solutions. The chart does not take into consideration differences initial temperatures of solutions and water as well as volumetric changes caused by heat of dilution since these conditions usually have relatively small effects on final volume.

Problem 1

How many gallons of water should be added to dilute 1,000 gallons of 50 percent caustic soda solution to 19 percent? (The latter concentration has the lowest freezing point and can withstand storage temperatures down to approximately -18°F.)

Solution:

Draw a line from zero percent on the weak solution scale at top to 50 percent on the strong solution scale at the bottom. From the point where the drawn line intersects the 19 percent vertical line, read 70 gallons of weak solution needed at right and 30 gallons of strong solution needed at the left.

Multiply the percentage ratio,

$$\frac{70 \text{ gallons weak solution}}{30 \text{ gallons strong solution}} \times 1,000 \text{ gallons strong solution} = 2,333 \text{ gallons weak solution}$$

The answer is the number of gallons of water to be added.