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Hardness Removal by Freezing with a Dry Gas

Mohd Shareef [1], Abdul Samad M Kamdod[2], Abdullah Bin Mohammed[2]

Department of Mechanical, Muffakhamjah College of Engineering and Technology, Hyderabad, Telangana, India. [1]

Dept. of Civil Engineering, Muffakhamjah College of Engineering and Technology, Hyderabad, Telangana, India. [2]

Abstract: The water contaminants such as calcium and magnesium salts are of great concern since they lead to water hardness. In this method of research the water containing calcium and magnesium ions was to be removed by cooling with dry gas a cheaper process up to about 0^0C in a 1 liter bottle keeping it in inverted shape a such that funnel portion goes down and bottom portion goes up in a refrigerator. It has been observed that more than 67% percentage of the hardness have been removed after measuring in the laboratory.

Key Words: Total hardness, Cooling process, dry gas.

I. INTRODUCTION

Both water reuse and desalination have been incorporated successfully to provide additional fresh water production for communities using conventional water treatment and fresh water resources [1-5]. Water reuse has been used to provide water for uses such as irrigation, power plant cooling water, industrial process water, and groundwater recharge and has been accepted as a method for indirect drinking water production [6-8]. Desalination has become an important source of drinking water production, with thermal desalination processes developing over the past 60 years and membrane processes developing over the past 40 years [9]. Removal of hardness from water is a treatment or pretreatment practiced in a wide variety of installations including chemical industries, power plants, laundries, individual households, and drinking water treatment plants. Many industrial unit operations and unit processes require near-complete removal of hardness to avoid scaling in heat-transfer equipment, fouling in membranes, and high consumption of detergents and sequestering chemical in cooling and washing water.

Therefore, removal of hardness from water is of relevance to produce or treat water in order to eliminate or decrease problems associate with water hardness [10-13]. Hard water is said to cause serious health problems such as urolithosis, cardiovascular disorder, kidney problems, anencephaly and cancer [14]. Additionally, WHO reports that excess intake of calcium is associated with kidney stones and that of magnesium leads to diarrhea and laxative effect due to change in bowel habit [15]. Because of the challenges raised by hardness in water, immediate measures to soften water are inevitable. Currently, there are various techniques that have been put in place to solve the issue. Ion exchange [16], electro-based techniques [17] and membrane filtration [18] are among the techniques having so far been applied. However there is a high cost of installation with the use of these processes.

The objective of the research described in this paper is the removal of hardness contaminated water by cooling uses dry gas a cheaper process. The freezing method uses only about the 85% of the energy required in evaporation processes. A low temperature operation avoids scale formation and corrosion.

II. METHODOLOGY

1. Separation of calcium and magnesium by freezing:
Take 1 liter of water containing calcium and magnesium ions in a bottle and keep it in freezer till it attains a temperature of zero degree and keep the bottle in inverted shape such that funnel portion goes down and bottom portion goes up. When it becomes ice take it out from freezer and remove ice containing fluoride of one fourth portion from nozzle.

2. Measurement of calcium, magnesium and total hardness:
Measure Ca-Hardness and Total Hardness by titration as described below.

Use a different sample for each measurement.

Total Hardness: Take 100 ml of the sample and add 2 ml buffer solution in it and add 2- 3 drops of Black T. Titrate it with standard EDTA solution (with continuous stirring) until the last reddish colour disappears. At the end point the solution turns blue. Note down the volume used [19].

Calculate Hardness as follows: Hardness (in mg/L as $CaCO_3$) = (V× N × 50 ×1000) / (SV) Where: V = volume of titrant (mL); N = normality of EDTA; 50 = equivalent weight of $CaCO_3$; SV = sample volume (mL) [19].

Ca-Hardness: Take 50 ml of the sample and add 1 ml Sodium Hydroxide solution (8%) in it and add pinch of Mercurex Powder. Titrate with standard EDTA solution until the light pink colour of solution converts into light blue color. Note down the volume consumed [19].

Calcium Hardness in mg/L = (V x N x 50 x 1000) / SV.

Magnesium Hardness:
Magnesium Hardness = Total Hardness – Calcium Hardness [19].

III. RESULTS AND DISCUSSIONS

Table 1: Hardness obtained after experiment

Hardness reading	Initial Hardness in ppm	Final Hardness in ppm	Hardness removed in ppm	%removal
Values	658	212	446	67.7%

From above table l, it was shown that approximately 67.7% of the hardness can be removed with freezing method by dry gas as a coolant.

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IV. CONCLUSION

Hardness can be removed from this method has more advantages over process of removing hardness through boiling of water as we have problems of formation of scales in boilers and needs very careful attention. And in this process of hardness removal at low temperature avoids scale formation and corrosion problems. However it is effective method for washing ice crystals to overcome this we must avoid small size by increasing crystallizing time or supplying nucleation sites.

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