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SHMP and SBS Mix for Brackish Water Treatment for 50 Days

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ABSTRACT:
Managing or concentrating brine is one of RO desalination's biggest challenges. This concentration is used to make minerals. After salt crystallization, remove the RO handle's anticoagulants. Anticipants can be used to control calcium reverse osmosis precipitate sulphate and carbonate. Calcium phosphate control hasn't been well studied. Anticipants are used to prevent calcium phosphate build up on RO blocks, although their mechanism is unknown.
Most RO desalination plants use phosphorus-based anticalins to minimize scale. These anticalins lower transmembrane weight, salt entry, and saturation stream. Phosphorus anticalins in brine disposal should be considered when building a desalination plant.
SHMP is a well-respected anti-scale agent for RO films. It's dosed into feed water from a vessel containing sodium hexametaphosphate. Sodium hexametaphosphate-containing devices were prone to bacterial contamination. After 36 days, there were too many bacteria in the cosmetics applicator to count (TNTC).
Sodium hexametaphosphate can convert polyphosphate to orthophosphate. Temperature, concentration, and nutrients that help bacteria grow all affect conversion. A solution of sodium hexametaphosphate was tested for free phosphate. Hydrogen sulphide (H2S) can occur in raw water, hence chlorine was avoided. Sodium metabisulfite disinfected sodium hexametaphosphate tanks and injection lines (SBS).
Sterilization and phosphate reduction were studied. The SBS process was affected by sodium hexametaphosphate. SBS-sodium hexametaphosphate solution interaction affects how well and how much this RO system operates.

Keywords: Anticipant, Sodium metabisulfite (SBS), sodium hexametaphosphate (SHMP), reverse osmosis (RO)

INTRODUCTION

Living things need water. Only 3% of the world's pure water is available to everyone. As the world's population expands, so does demand for safe drinking water, creating a demand for better ways. Less than 1% of the world's water is available, ensuring its purity. In the coming decades, fresh water will be scarce. Water pollution reduces the amount of available water. Several organizations worldwide certify water purifying methods. Clean water techniques have downsides that must be addressed. Nearly 67% of the water is lost during the purifying process, but it can be recovered. Effective water treatment and conservation education are needed.

RO has a prominent role in freshwater delivery. Inorganic scaling is tricky in RO desalination. To reduce scaling in RO systems, improve scaling layer materials, pre-treat hard water, adjust antiscalants, and standardize operation. Antiscalants are the cheapest and simplest layer scaling modulation approach. This research explored antiscalants and their usage in RO layer scaling control. Antiscalants, which reduce RO film scaling, have many downsides. These include bacterial mobility, ineffective dosage regulation, concentration difficulties, and fouling. The search for eco-friendly, high-potency antiscalants is growing. Antiscalants must be optimized with pretreatment treatments to prevent scaling.

The desalination industry chooses membrane filtration over thermal desalination for its inherent benefits and energy efficiency (Ashfaq, Al-Ghouti, Qiblawey, Zouari, Rodrigues & Hu, 2019). Layer filtration suffers from natural, inorganic, colloidal, and natural film fouling despite its benefits (Ashfaq, Al-Ghouti, Al Disi & Zouari, 2020). Depending on the feedwater content, these foulants often occur together (Ashfaq, Al-Ghouti, Qiblawey, Rodrigues, Hu & Zouari, 2019b). Animal feedwater contains natural, inorganic, microbiological, and colloidal foulants of all kinds (Ashfaq et al., 2020). The intuitive between these foulants must be investigated to better understand membrane fouling in general. Organic foulants reduce nucleation time, which

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boosts scaling. Liu, Xiu, and Das 2019 studied biofouling and scaling. According to another study, reverse osmosis bacteria enhance biofouling by secreting carbohydrates and EPS (Butt, Rahman & Baduruthamal, 1997). Biofouling in the desalination sector is especially problematic and frequent in the Middle East, where saltwater temperatures are perfect for microbial development (Al-Ahmad, Abdul Aleem, Mutiri & Ubaisy, 2000). Microorganisms develop too fast to avoid biofouling (Ashfaq, Al-Ghouti, Qiblawey, Zouari, et al., 2019).

Researchers (Mangal et al., 2021) examined the efficiency of eight antiscalants in reverse osmosis without acids. Calcium phosphate scaling is a controversial topic. Some groups claim considerable calcium-phosphate scaling, whereas others report a lower rate under the same settings (temperatures, phosphate and calcium concentration, pH). Calcium phosphate in reverse osmosis membranes decreased flow. 85% of needs were met by synthetic concentrate. Antiscalants of 33.3% concentration covered TW30-1812-50 RO membrane with calcium phosphate granules. Inorganic fouling and mineral scaling plague reverse osmosis systems (Ashfaq et al., 2020). Calcium sulfate, carbonate, strontium sulfate ($SrSO_4$), and barium sulfate were utilized as non-alkaline scaleants ($BaSO_4$). Calcium fluoride and silica are also harmful scals (SiO_2). Antiscalants reduce inorganic fouling or scaling in reverse osmosis facilities (Ashfaq et al., 2020). Antiscalants ensure excellent recovery rates, maximum energy consumption, and long-term plant life for RO systems (Ashfaq et al., 2020). According to a study (Saleem & Zaidi, 2020), polyacrylic acid (PAA) and polymaleic acid (PMA) are the principal antiscalant components. The research publication (Van Driessche, Stawski, & Kellermeier, 2019) did not study antiscalant and biofoulant interactions in reverse osmosis systems (Van Driessche, Stawski & Kellermeier, 2019). The metabolic processes of bacteria can directly establish supersaturation conditions for minerals and bacterial cells, and EPS can serve as a nucleation template. As scalants, minerals in reverse osmosis plants can interact with microbes to generate membrane fouling. Al-Roomi and Hussain (2016) categorized antiscalants by phosphorus content. Phosphate- and phosphonate-based antiscalants were available. Finch and Rashchi (2000) described a method for assessing the characteristics of P–O orthophosphate compounds such as sodium hexametaphosphate and sodium tripolyphosphate. They're more active than phosphates since they're close to the carbon-phosphorus covalent bond (Nowack 2003). Phosphonates include polyphosphate-like structures. Phosphonates and phosphates can create complexes, making them useful complex specialists. Rashchi and Finch (2000) observed that phosphate speeds scaling by creating soluble metal complexes in solution. Hydrolysis of phosphates to orthophosphate is simple in the presence of calcium particles, which increases biofouling. Literature provided this information. Phosphonates have more applications than phosphates because they slow biofouling (Matin et al. 2019). Ton and colleagues Chemical composition classifies mineral scaling. Mineral scaling is mainly silica-based or metal-based. Calcium sulphate and strontium sulphate ($SrSO_4$) are crystallized to form metal-ion-based scales (Martin et al., 2019). When the salt concentration exceeds the solvent-soluble salt concentration, particles collide. Micronuclei arise from particle clusters. Micronuclei generate nucleation centres, and aligned particles form a core. Crystal growth from cores is called scale arrangement.

Topçu et al. (2017) classify silica-based scaling as metal or silica. The silica-based scaling procedure is limited by silica polymerization and colloidal silica aggregation. Temperature, pH, ionic quality, and silica concentration are factors. Removing water from silica molecules forms Si–O–Si anhydrides. $Si(OH)_4$ starts as a dimer, then oligomers, colloidal polymers, and $(SiO_2)_n$ polymers. Multivalent cations reduce the solubility of silica derivatives. Thus, metal silicates precipitate.

FOULING

Fouling hinders the removal of pollutants in inverse osmosis water purification plants. Switch osmosis film fouling reduces efficiency. Most water toxins are organic matter, colloidal particles, and suspended solids (Winter, 1995). Switch osmosis fouling includes biofouling, inorganic, natural, and particulate. Pretreatments make biofouling difficult. Pretreatment can remove other fouling components besides biofouling. Pretreatment in switch osmosis removes membrane-clogging components.

Researchers use electrical conductivity and dissociated material properties to estimate membrane fouling. Potential Fouling Water Quality Parameters (PFWQPs) Standard pre-treatment can remove PFWQP's turbidity, suspended solids, and dissolved elements. Pharmaceutical companies still want PFWQP to remove endocrine-affecting compounds, microorganisms, and colloidal particles. Pretreatments save money by removing contaminants from water. This research will study foulants and reverse osmosis pre-treatment options. Ahmed et al. investigated fouling at Bahrain's Ras Abu Jarjur switch osmosis plant in 1989. Experiments were done to solve the H_2S problem in the groundwater. According to the research team, SHMP was the primary source of normal interaction in SHMP tanks. Orthophosphate was converted into SHMP to reduce toxicity. SHMP's conversion to orthophosphate as a polyphosphate affects pH, concentration, and temperature. H2S in the water hindered chlorination.

SHMP tanks and lines were sterilized with sodium metabisulfite (SBS). To prevent SHMP from reversing into orthophosphate, the optimal amount of SBS has been studied. SBS in SHMP tanks must be estimated using Micron Observe Channel (MGF) conditions and turn-around osmosis.

pH affects antiscalants' solubility and ionic properties (Prihasto et al., 2009; Qin et al., 2005; Tong et al. 2019). Soluble carbonate salts are pH-dependent. Carbonates become bicarbonates as pH drops and sluggishness rises (Prihasto et al., 2009). Tong and colleaguesIn another study, pH affected reverse osmosis scaling (Qin et al. 2005). In a nickel-plating company, they studied the scaling process and found that moo bolster pH evolved into moo fouling. Ton et al., 2019; Milne et al., 2014).Thus, pH-based silica removal was studied (Bush et al. 2018). When the pH is greater than 10 or less than 5, acidification and alkalization prevent silica scaling. Silica solubility is reduced by acidic conditions and polymerization in H3SiO4 and H2SiO4 (Bush et al. 2018). 2019 (Tong and colleagues).Increasing pH deprotonates ionic scalants. Scaling compounds affect antiscalant effectiveness (Ang et al. 2016).

Rahardianto et al. (2008) found that pH did not affect antiscalant performance in reverse osmosis with high gypsum scaling. Antiscalant ionization at pH values above 6.0 was thought to be the cause. Ruiz-Agudo and colleagues (2016) found that increasing pH strengthens the bond of a commercial antiscalant (allyl sulfonic acid/maleic acid copolymer) with phosphonate groups and Ba2+ ions. The acidic counterpart deprotonated faster at pH 10 than at pH 6. The effect of pH on BSA was studied again by adding Ca2+ ions and modulating PASP (Yang, Liu, and Li 2010). pH 7.0 reduced fouling compared to BSA's isoelectric point, pH 4.9. Electrostatic repulsion prevented BSA deposition at neutral pH. The water-soluble BSA–Ca–PASP complexes stabilize the BSA–Ca complexes on the film's surface (Yang, Liu, and Li 2010).

INHIBITOR

Ituen et al. (2017) used inhibitors to study surface layer disintegration and scaling. The researchers studied disintegration and edge inhibitors like phosphonate and phosphine. Researchers studied polycarboxylic acid's destructiveness. Phosphorus-free and phosphorus-containing disintegration and scale inhibitors exist. Phosphorus-free inhibitors are used worldwide due to their low cost. The nonbiodegradable inhibitors pollute the environment and cause film fouling. Effective, environmentally friendly scale inhibitors are in high demand. Current inhibitors are ineffective due to molecular chelation (hydroxic, carboxylic, and acylamido).

Because they have many bundles, living organisms produce organic materials that disintegrate and scale.

Extracellular polymeric substances (EPS) are high-molecular-weight polymers that form a layer on solids (Wang et al., 2018). Insulating EPS film prevents oxygen and chloride from reaching metals. Scaling is slowed by Ca-binding proteins and humic acid-like materials. There are two types of EPS: those that are hard to dissolve and those that are easily removed (s-EPS). The s-EPS has better proton transfer, biosorption of solids, and biodegradability than the others. Scale inhibitors and anti-corrosion agents can use s-EPS' low cost and biodegradability.

B. cereus EPS can be inoculated on carbon steel, stainless steel, conveyor belts, and floors. The B. cereus biofilm in EPS-rich seawater slowed SS corrosion (S. Li et al. 2019). s-EPS from B. cereus interacts with calcium carbonate to inhibit mineral formation. Scale is rarely prevented by S-EPS. Biomineralization induced by B. cereus s-EPS was studied. 316L stainless steel corrosion in seawater was studied. One of the most promising candidates to prevent bio-functional erosion and scaling in seawater is "s-EPS."

They found that phosphonate-, sulphonate-, and carboxylic-based scale inhibitors (A/S) interact with carbon-containing materials such as zeolites. Antiscalants and edge inhibitors inhibit scale. Using edge inhibitors boosts efficacy. Above pH 6.0, EDTA (tetra sodium salt of ethylene diamine) is used. Minerals that scale make antiscalant salts. While A/S don't suspend, they prevent the formation of pearls. Dispersants help speed up suspension in some scale inhibitors. When water hardness is under 100 ppm, antiscalants can soften it. A/S was designed to flush the RO/NF system after shutting it down. This kept salts from accumulating on the reactor-side of the membrane. Antiscalants alone or with acid feeds are options. Like LSI, A/S is improved with a corrosive agent. Even though some A/S manufacturers say a 2.7 LSI is acceptable when using their item, 1.0 is more than adequate. The dose of A/S ranges from 2 to 10 ppm depending on RO water's scale-forming potential, item water recovery, and A/S manufacturer proposals. With a better LSI, the RO/NF system would be more effective and cost less. Greater improvement is due to higher salt concentration in the feed–reject channel. The sparingly soluble salts can exceed their solvency limits more quickly. When adding a second-pass reverse osmosis plant to increase production and purify water, long-term performance recovery is possible.

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The lack of orthophosphoric destruction (OPD) is determined by SHMP hydrolysis (sodium hexametaphosphate). Metallic sulfate and calcium carbonate benefit from it. It is the most common obstacle because it is difficult and cheap. 2–5 ppm for sulfate and calcium is within this range, according to our calculations. Based on submersion control, SHMP precipitates 15% calcium sulfate. SHMP hydrolyzes more slowly than organophosphates. In comparison to SHMP, organophosphates inhibit scaling and spread faster. Polyacrylic acids (PAA) outperform SHMP in scaling retardation and distribution.

PAA's high atomic weight prevents scaling. Al or cationic polyelectrolyte precipitation and sleet foul the layers. When combined with organophosphates, PAA and atomic weight (6,000–25,000 Da), moo and atomic weight (2,000–5,000 Da) produced good dispersive and inhibitory inhibitors. Inhibitors are mixed. Antiscalants must be dosed precisely to prevent fouling; too much or too little can cause it. Antiscalants in high doses form hard ion complexes that cause biofouling. Microorganisms eat organic materials.

The successful evaluation of inhibition performance can guide the selection of antiscalants and their quantities for effective procedure deployment. Both inactive and energetic point-by-point operations are evaluated for scale restraint execution. The static jar test (Yu et al., 2006), bubble, turbidity, and conductivity methods use the relentless composition and precipitation technique (Goh et al., 2018). Inactive jolt test is the most common inactive strategy because it's easy to use. As solute concentration changes, clear restraint is measured. Antiscalant effects can be seen with X-ray diffraction and electron microscopy. These methods are also used to detect morphological changes in crystals, such as distortion. Due to this, the inactive jostle test and practical applications have different conditions. As a result, the results contradict many commonsense assumptions and aren't entirely relevant. There are also stark contrasts between real-world application conditions and inactive strategies. Despite not being useful in everyday situations, this strategy is good for pre-evaluation. Al-Roomi et al. (2015) and Al-Roomi and Hussain (2015) worked extensively on energetic strategies that were found to provide valid results for the real-world relevance of antiscalants by recreating viable conditions, respectively. A lab-scale test of active RO's ability to prevent scaling RO unit mimics the RO handle. A change in substrate flux can be used to determine scaling resistance with antiscalant expansion or no expansion. An electron microscope can be used to analyze the scale and thickness of a surface's film. These variables affect antiscalants in RO (Thompson et al. 2017). By performing RO diversion tests, operational parameters like the nourishment spacer, crossflow speed, and counting weight can be changed. The results of dynamic RO simulations are better.

Currently, AFCs are used to reduce suspended solids and adsorb biological phenomena, despite their plans to remove hydrocarbons from feed water. AFCs are used. Layout of a salty RO plant. In Kah et alwork, .'s the RO desalination process depends on feed water quality and membrane surface life (2011). Rate of generation decay is influenced by pre-treatment and operation and support strategy. If Devin (2012) is right, the decline will be closer to the desired value. Pretreatment system coordinates are used to advance RO Piece execution. No matter what, the RO membrane cleaning program is the most important step. Many follow the manufacturer's rules.

New information revealed that the manufacturer's cleaning rules were not always enforced. New cleaning regimens were created using RO-friendly chemicals. A 72-hour soak in 5000 ppm SBS followed by a flush with essential water is standard for a rapid decline in RO Square generation.

Free phosphate SHMP could be a source of oxygen-consuming microorganisms. When used as an antiscalant, it can increase the bacterial stack on the RO block. Because it doesn't eliminate bacterial action, adding cartridge watch channels to the RO shock treatment line may protect against inorganic foulants in SBS tanks. In the MGF vessel, cartridges were often arranged. Although these components were damaged by the swell, they have been cleaned.

Regular dual media filter sterilization, ACF restoration, and MGF and well collector pipe sterilization. SBS for regular RO membrane sterilization and 5) routine SHMP tank sterilization are all recommended protocols. ACFs quickly absorb H2S gas.

2. MATERIALS AND METHODS

The Skid Unit for Testing

This test skid compares small-scale, realistic RO conditions. The brackish RO desalination test skid used water from high-salt deep wells with 2 to 5 ppm dissolved sulfur. The test setup included three filtration steps and RO blocks (Figure 1). Regular sterilization of the Dual Media Filters (DMF), MGF, and well collector pipes used in this investigation eliminated bacterial and biological growth colonies. ACF restoration can go as high as 4000 ppm. With SBS, RO membranes were shock-treated and sterilized. Regularly sterilized SHMP tanks The guidelines were strictly followed. To avoid oxidation, the hydrogen sulfide gas stripping system in the post-treatment

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zone was pressurized and lacked pre-chlorination. Broken sulfides that oxidize to natural sulfur can cause plant fouling. This is a typical high-brackish RO test skid.

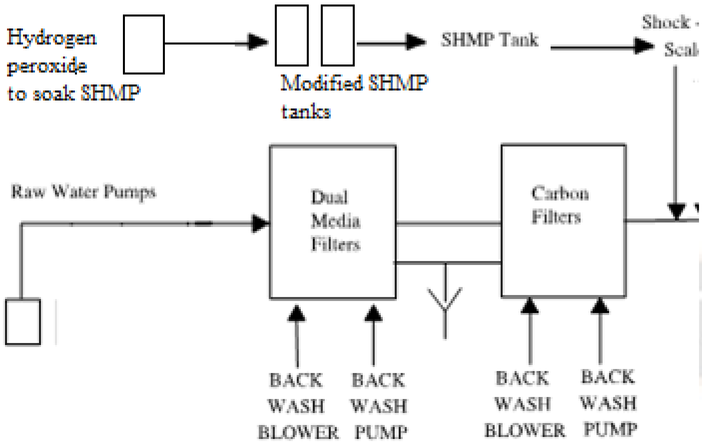

Figure 1: Layout of test skid used to simulate RO conditions

Pre- Treatment System

Pretreatment involves filtering raw water pump feedwater. Dual Media Filters were the first filtration point and were chlorinated off-line. Before returning to the system, raw water is filtered through activated carbon filters (AFCs). injected sulphuric acid and AFCs. After dosing pretreatment chemicals, SHMP dosed the in-line mixer. This procedure controlled alkaline and non-alkaline scaling. Feedwater was Micron Guard-filtered before entering the membrane. Polypropylene filters with 1–5-micron pores and 10-micron pores are used to remove fouling substances. Heavy-duty pumps were used to pump the bolster water into the RO Blocks.

The overall recovery rate is 68 to 72% and could reach 80%. The treated water was then reinjected into the system. This allowed the gas stripping towers to expel the released H2S. After degasification, Cl2 is added to the water. Third-arrangement brine tagging was rejected. This removed H2S from gas stripping towers. Once in production, the product will be chlorinated for disinfection.

No one complained about the test skid's performance. Dechlorinated water contained 10 and 7% SHMP. Dual Media Filters and ACFs had bacterial growth early on. The vessel was disinfected with hydrogen peroxide (H2O2), and an additional vessel for sodium hexametaphosphate (SHMP) solution was made to prevent re-infection. The hydrogen sulfide gas smell and rising DO were alarming. The best arrangement was investigated. Early changes to the plants' pretreatment framework yielded the results. Each treatment plan must demonstrate restrained algal growth and direct bacterial action.

Thus, the following protocols were developed and implemented for continuous sterilization of DMF using 1000 ppm: daily Cl2 injection into two DM/F, pressurized air with backwashing, and a longer rinse duration to ensure complete Cl2 removal before the filter was placed on-line; a shorter MGF filter component replacement (day cycle) was used to further clean the items. 10000ppm sodium bisulfite was used. SBS was used to control oxygen consumption and eliminate the need for offline chlorine sterilization of SHMP vessels. Micron guard cartridge filters were installed in the RO shock treatment line. During maintenance outages, MGF vessels were pressurized and sterilized with chlorine.

SHMP and SBS

SHMP tanks supply the unit with SHMP solution in various percentages to maintain the stream's sterilized antiscalant and zero bacterial and biological material. Sodium bisulfite was added to a 7% SHMP solution to mimic the SHMP vessel, and free phosphate, EC, pH, and TBC were determined. Salt and differential pressure will cause RO Blocks to fail, reducing production and allowing salt passage. Aerobic bacteria were removed from SHMP tanks entering the system using a modified method when foulants affected conditions and MGF cartridge elements began to deteriorate, along with high P and low flow. Daily additions of 0.25 percent SHMP solution improved water quality, stabilized flow rate, and lowered P. MGF vessels will remain operational for 16 weeks after the shutdown, resulting in progress. This may be due to anaerobic bacteria in the untreated water and an infection during element installation that kept them clean for four weeks with a faint odor. To keep the MGF vessel clean and eliminate odors at its bottom, soak it in H2O2 for four hours before installing elements. MGFs used to last longer than four weeks. Low flow, high SDI, and high differential pressure shortened service time.
After 24 hours in 5000 to 6000 ppm chlorine, these components were rinsed with water. Newly installed elements were measured for SDI, P, and flow rates.

4.0 Behavior of SHMP Solution

SHMP concentrations ranged from 10% to 75% in chlorine-free water. Figure 2 illustrates SHMP yields in raw brackish water. Mix solution contains 25% unique polyphosphate solution that returns to orthophosphate at 10%. Free phosphate returned to a high level in the mixed solution (7%), and no further increase was observed. The stronger the solution, the more pH and electrical conductivity readings fluctuated. TBC levels are rising rapidly (Ten ppm and seven percent). TBC seems unrelated to free phosphate. According to these findings, even at high SHMP concentrations, bacteria can grow.

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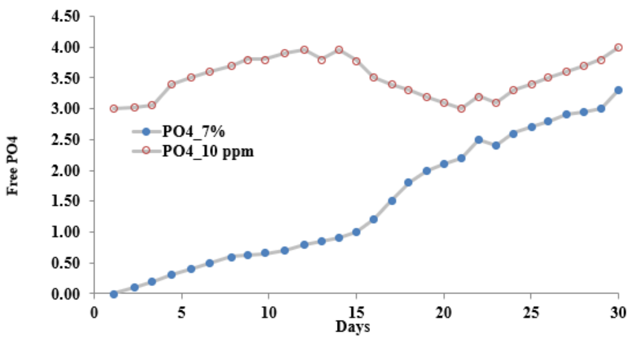

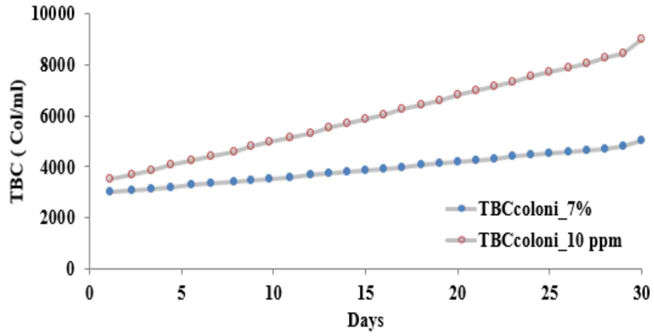

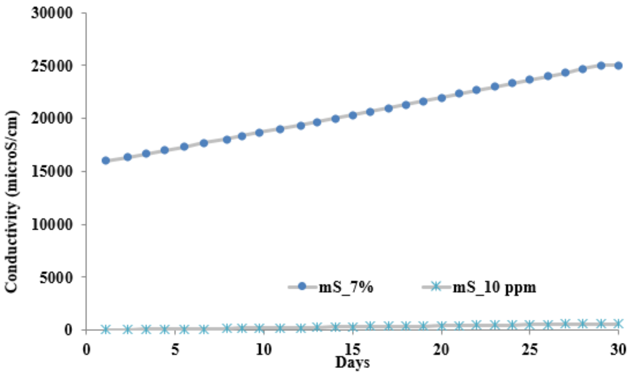

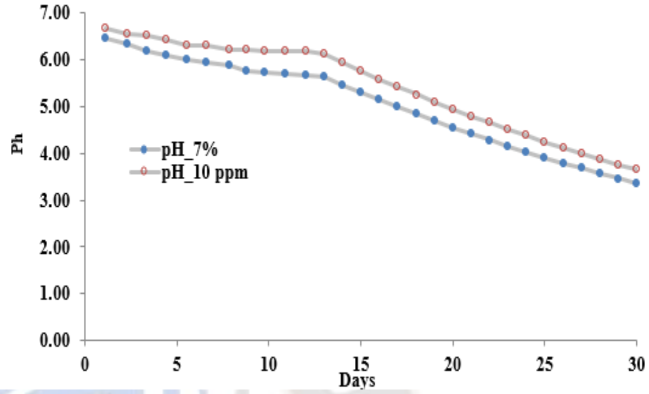

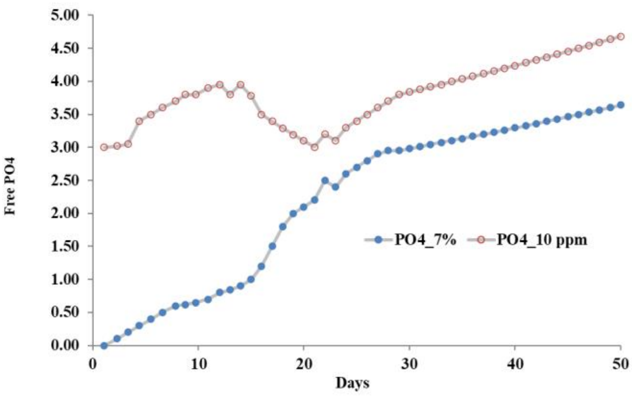

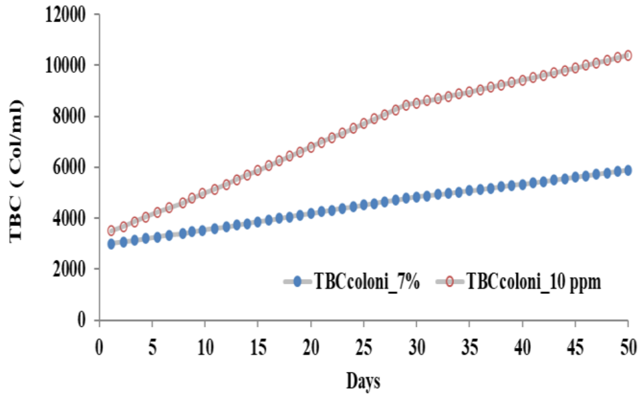

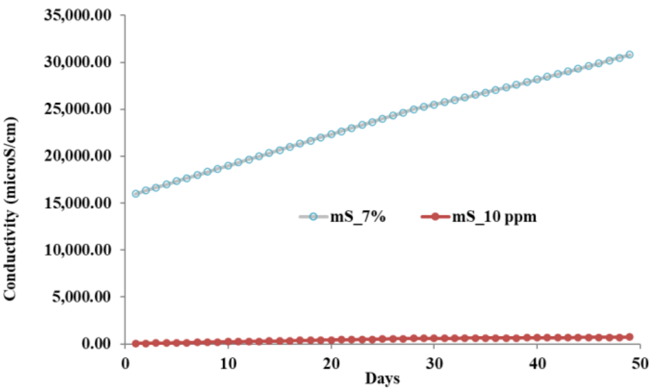

Figure 2: Behaviour of SHMP in Raw Brackish water

SBS

Low concentrations of SBS, less than 0.1 percent, may not sterilize SHMP continuously (Figure 3). SHMP tanks need 0.25 percent SBS for sterilization. This study found that increased SBS concentrations lowered pH within a few days and lowered pH to 4 or lower within 5 to 6 days. SBS concentrations increase conductivities. 0.25 percent SBS is best for sterilizing a solution while minimizing its effect on SHMP (Figure 3).

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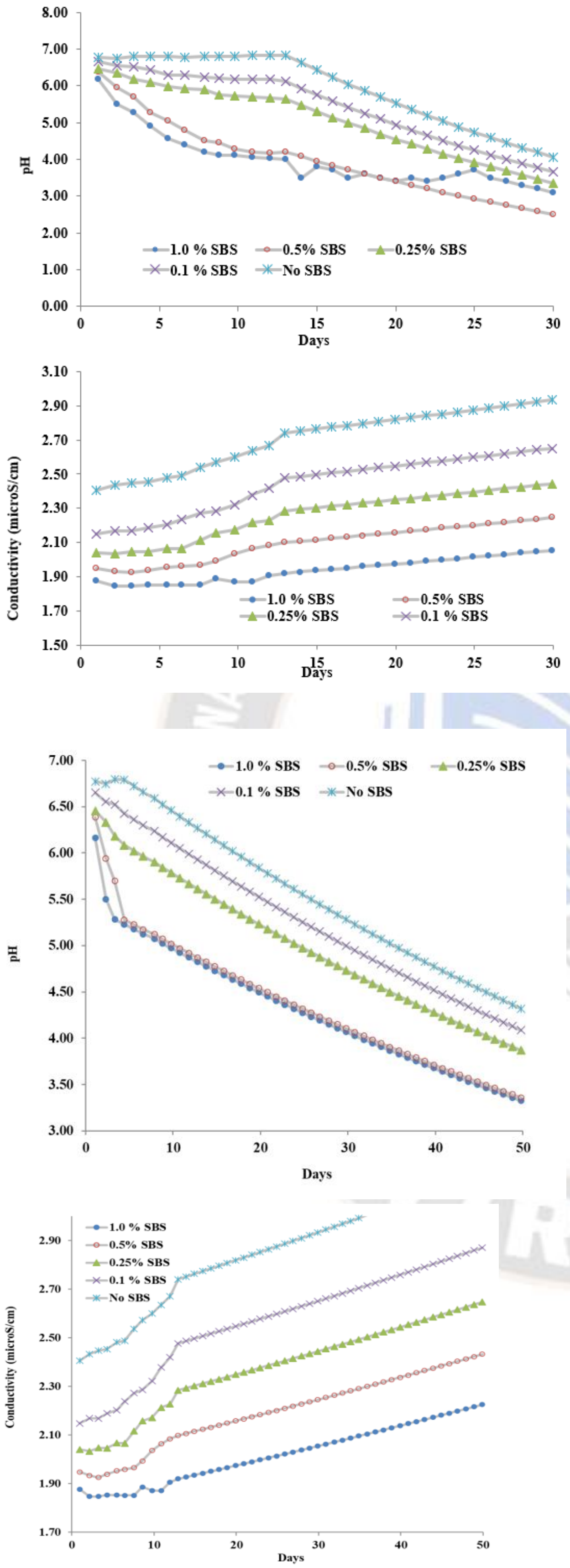

Figure 3 conductivity and pH

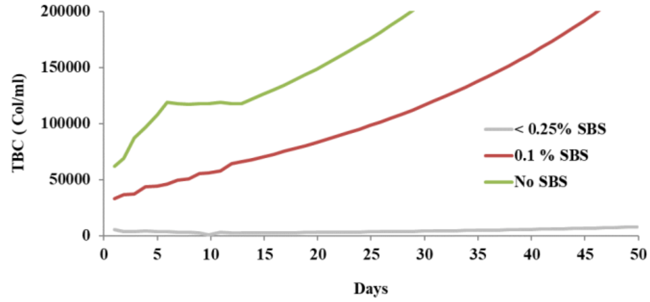

Figure (4) presentation of TBS in Col/ml of adding 0.25% SBS and 0.1 SBS during the 50 days trial

The reverse osmosis desalination process is low-cost, simple, and easy to use. It's a crucial research area for improving water desalination. (2007) Desalination by reverse osmosis can use brackish water (BW) as feed in addition to seawater. (2013). Reverse osmosis membranes can discard inorganic salts. Brackish water treatment has gained popularity in recent years. (2011). Reverse osmosis is only economically viable when BW is purified to over 70%. The concentration of salts only slightly soluble in water is proportional to the BW recovery rate. The membrane salts precipitate, worsening the scaling. 2009 (Jawor & Hoek))Because BW feeds contain near-saturated mineral salts (BaSO4, CaSO4, and CaCO3), the membrane may foul. (2012) According to Zhao, Zou, and Mulcahy, even a small amount of water can cause these slats to precipitate. (2012) (Pérez-González et al.)

Two distinct processes contribute to the formation of scales in water purification membranes: surface crystallization and bulk crystallization. Common is surface crystallization (crystals precipitate in the solution).

Antony, et al. Surface characteristics and procedures determine scale formation on membranes. (2010). At low supersaturation levels, crystals form due to the thermodynamically favored heterogeneous nucleation process. When the solubility product of ionic salts in a solution is equal to or less than the ionic product, membranes scale. Scaling can also occur when ionic salt solubility is greater than that of the ionic product. In addition to supersaturation, precipitation kinetics also affects scaling. Au, Kim, Rahardianto, and Cohen(2007). High CO32-, Ca2+, and SO42-ion concentrations cause scaling in BW RO systems. CaSO4 and CaCO3 salts cause fouling. (2015) Ochando-Pulido, Victor-Ortega, Martnez-Ferez. Scales form in BW, surface water, and some groundwater due to CaCO3 salt. 2010 (Amjad/Koutsoukos). Other factors that contribute to fouling include BaSO4 and SrSO4, both of which are found in concentrations below 0.5 mg/L (Hegab and Zou 2015), and

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silica, which is present in groundwater and forms hard scales on membranes. According to Greenberg, Hasson, and Semiat (2005), the fouling layer forms when salt buildup near the membrane exceeds salt removal from the environment.

(2013). Membrane fouling reduces permeate water flux. Due to increased hydraulic resistance, water must pass through a denser layer.

(2005). The deposited layer on the membrane prevents salt diffusion in the opposite direction, which lowers the reverse osmosis propelling force and increases osmotic pressure. (Herzberg and Elimelech, 2007). Depending on membrane fouling, the decrease in flux can be irreversible or reversible. 2008 (Kanani, Sun, Ghosh) As scaling continues, the membrane's water-diffusion capacity decreases. Keeping the flux stable requires increasing the system's pressure, which requires more energy. Butt, Rahman, and Baduruthamal. Regular cleaning reduces the membrane's durability and raises its maintenance costs. According to Lu et al. (2006), the RO plant's budget has increased by 15%. Fouling can affect the morphology and geometry of spacers. Radu and van Loosdrecht (2013): Spacers aid in scaling. (2012). Scales form despite the feed water's low saturation level because the growth of crystal nuclei is boosted near the spacer.

Calcium carbonate scales are a common issue in the water transportation, thermal desalination, gas and oil, and reverse osmosis industries.

CaCO3 salt and the membrane's outermost layer form strong bonds. Muryanto et al. In RO systems, CaCO3 salt fouling is worst for the final stream of concentrate through the membrane. Scaling ion concentration, temperature, pressure, and pH affect how much CaCO3 precipitates out. Mpelwa/Tang (1999). When scaling ions are present in high concentration, supersaturation can occur. Temperature increases precipitation because less CaCO3 is soluble in water. (2018). Lowering the pressure increases CO2 loss, which speeds CaCO3 precipitation and boosts precipitation. Alkaline conditions accelerate precipitation in this line because CaCO3 solubility decreases with pH. 2016; Sousa, Signorelli, Bertran.

Extensive research has been done worldwide to reduce scaling to increase RO system efficiency and cost-effectiveness. Industrial plants can reduce scaling by modulating operations, the RO system, and feed water. Pretreatment lowers the pH and mineral salt concentration of feed water. Inhibitors are another method of scale control. 1999 (Lee, Kim, and Lee). Inhibitors are organic compounds that bind to crystal growth sites to stop growth. (2011). Antiscalants can only prevent salt crystallization when the salt concentration is close to its maximum solubility. (2000). Electrostatic repulsion between similar-charged compounds prevents accumulation. 2001 (Rieger, Hadicke). Small amounts of ppm scale added to feed water can prevent fouling. This happens without any chemical reaction between salt and antiscalants. Chen, Zhu, and Wang (2010) antiscalants affect polyvalent cations by forming stable complexes. 2007 (Eriksson, Merta, Rosenholm)

Antiscalants prevent membrane clogging. Using reverse osmosis of BW, the effect of scale inhibitor and pH on salt crystal shape and size was investigated. The results suggested that antiscalants affected the crystals. Smaller crystals also caused a decrease in flux. The investigation confirmed this. (1991). Divalent anions and cations (Mg2+) as antiscalants slowed CaCO3 precipitation. Delaying crystallization by one order and switching from calcite to aragonite achieved this. Antiscalants caused both effects. Tarabara and Wang (2007)

Companies use PAM, PAA, polymaleic anhydride, and inorganic polyphosphates as chemical additives (antiscalants). These substances stop crystal growth, preventing scale.

Their 2017 book Antiscalants sold commercially can be categorized by their primary functional groups: polycarboxylates, phosphonates, or phosphates. Scale inhibitors alter the morphology of crystal nuclei by retarding their growth (Ketrane et al. 2009). (2018). Low-cost, high-efficiency inorganic polyphosphates are widely used. Due to the cleavage of long-chain polyphosphates into smaller chain molecules, hydrolysis of linear polyphosphates is slow at low temperatures and pH values of 7. Low temperatures and pH slow linear polyphosphate hydrolysis. (Unknown date, Temperature and Concentration Effects of Five Scale Inhibitors on Calciumcarbonate Precipitation from Hardwater) SHMP is a cyclic polyphosphonate scale inhibitor. SHMP contains six phosphates. This compound prevents scale formation on reverse osmosis membranes for desalinating water (Rahman 2013). Abd-El-Khalek, Abd-El-Nabey 2013. During scaling inhibition, cationic ions and anions like carbonate, inhibitor, and bicarbonate interact. This interaction inhibits Parameters must interact well for inhibition to work. SHMP hydrolysis in the dosing tank produces Ca3(PO4)2, which amplifies scaling. SHMP hydrolysis equation.

$$PO_3{}^- + H_2O \rightarrow H_2PO_4{}^- \rightarrow HPO_4{}^{2-} \rightarrow PO_4{}^{3-}$$

$$3Ca^+ + 2PO_4{}^{3-} \rightarrow Ca_3(PO_4)_2$$

SHMP de Morais et al. studied the inhibition efficacy of CaCO3 scale and the effect of pH at extreme pressure and temperature. In the absence of SHMP, CaCO3 formed cubic orthogonal (calcite) and needle-shaped (aragonite) crystals. 2019-Sergeeva, Vikulina, Volodkin Changing pH in the presence of SHMP caused different-shaped crystals below pH 6.5. The effective interaction between Ca ions and SHMP increased scaling inhibition by 75%. Above pH 6.9, crystal morphology remained unchanged.

Table 1: The Analysis of High Brackish in Reverse Osmosis Plant Chemically

Item as ppm	Raw Water
Dissolved O_2	0.12
TS	3.12
TBC	2
TDS	12674
Total Hardness	2249
HCO_3	187
Ca	617
PO_4	0.35
Na	3170
K	136
Mg	293
Sr	22
Ba	0.27
NO_4	0.08
Ma	<0.03
Cu	0.03
Zn	0.07
S_2O_3	1193
Cl	6836
SO_4	610
Oil	<0.10

From table (1) that shows chemical analysis of highly brackish water used in this study with an average temperature for raw water to reverse osmosis brine plus final product to be 30 ^oC. The total organic carbon for the raw water is always as 0.88 ppm while the rest is remained as not detected. The turbidity was showing Raw Water (0.16), RO Brine(0.25) and Final Product (1.7) while the silt density index (SDI) Raw Water (2.55), RO Brine(4.5) and Final Product (3.7). The conductivity are Raw Water (19245), RO Brine(46230) and Final Product 393). The pH for the Raw Water (6.85), RO Brine(6.35) and Final Product (8.30)

5.0 DISCUSSION

Ashfaq et al. This study analyzed seawater containing antiscalants and calcium sulfate in a reverse osmosis system. Researchers studied the relationship between scaling ions in seawater and scale inhibitors by analyzing microscopic images of antiscalants. Antiscalants were the only source of energy and carbon. Energy dispersive x-beam electron microscopy was used to look for calcium sulfate. Only a few Pseudomonas strains isolated from salt water could use antiscalants for energy. The line bends vary depending on the antiscalant type. The scaling collaboration's final results showed that organisms caused or prevented calcium sulfate precipitation on switch osmosis film surfaces. No precipitation was observed on the microorganism-free control switch osmosis layers under study conditions. The proximity of scaling components in seawater appears to reverse assimilation, causing biofouling. Biodegradation of antiscalants and calcium sulfate precipitation accelerate mineral scaling. Pseudomonas can biodegrade antiscalants to get carbon and energy. Biodegradation rate was important for many antiscalants. Each solution-tested strain accelerated calcium sulfate biodegradation. Switch osmosis controls without bacterial colonies did not precipitate. Microorganisms pose two risks to switch osmosis desalination systems. Antiscalants biodegraded, reducing their scaling-controlling activity, and calcium sulfate precipitated on RO layers. Microorganisms make switch osmosis membranes susceptible to biofouling and mineral scaling. Similarly, cooperation between two foulants must be considered when changing fouling control strategies. An investigation is being conducted to examine these partnerships from different angles and create film parts that can handle scaling and organic fouling.

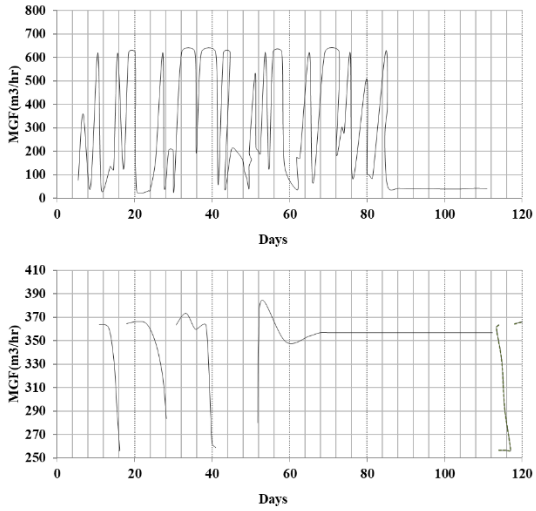

Figure 5 pattern of flow in MGF in m^3 per hours for 120 days

Rebuilt parts were considered. Reusing components up to 12 times saved money. According to online tests that used 10 micron cartridge components alongside 5 micron and 1 micron cartridge components in channel lodgings, 1 micron channels accelerated and collected more flotsam and jetsam. This, in an invert osmosis plant with nutrient-rich crude water. Using nutrient-rich water would help with generation consistency and layer fouling. On the chemical manufacturer's moo press substance, a press sulfide arrangement, SHMP and H2SO4 measurements were recently taken. One shipment turned brown and was taken out of service and maintenance within a week. Regularly cleaning MGF vessels with H2O2, maintaining a low iron content in SHMP and H2SO4, and adding SBS to SHMP tanks to prevent aerobic bacterial growth have improved the system's performance.

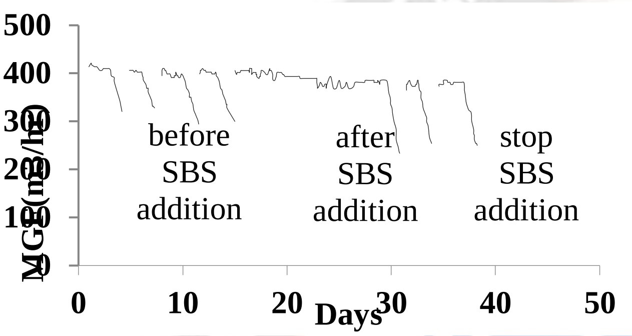

Figure 6 shows time in days versus the use of SBS addition and the decline when SBS addition is stopped

Most water treatment plants use SBS, a well-known bactericide, in their Shock Treatment Systems. This is the framework for shocking all the pieces for 30-60 minutes. Sodium bisulfite is prepared daily in the stunning vessel at 30,000 ppm and dosed to each block daily or on randomized days. Micron Guard Filter Cartridges have been added to the RO Squares shock treatment system to protect against foulants. Foulants are removed using 10- to 5- to 1-micrometer filters.

6.0 CONCLUSION

This study examines sulfuric acid and sodium hexametaphosphate (SHMP) in RO permeators. The study sought a reliable and practical anti-scale agent. The experiment used a reverse-osmosis-prepared slide of a living plant. For each exam, the records were clustered 2:1:1. The briny brackish water was pumped into modules, and their brine was pumped into a third module. The paper analyzes the chemical tests' results. Experiments in the plant yielded fruitful results, likely due to the advanced MGF. Due to adequate distance from contaminants sucking oxygen from dosing lines and SHMP, the reverse osmosis membrane was protected. A concentration of 0.2% SBS was optimal for both microorganism control and preventing SHMP conversion back into orthophosphate. Future work will need to reduce free phosphate. During annual maintenance, a modern line from the SHMP's dosing system was displayed. This study found that 5-micron cartridge channels can replace cartridge channels (10 micron). Fouling was a major problem in the RO plant, which will be studied further. These studies are future.

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