

Desalination of Salt Water by Collision with Surface Coated with Nano Particles

Hesham Muhammad Ibrahim

Abstract—This paper introduces and proves new concept of salt dissolving in water as very tiny solid sodium chloride particles of nanovolumes, from this point of view salt water can be desalinated by collision with special surface characterized by smoothness upon nano level, high rigidity, high hardness under appropriate conditions of water launching in the form of thin laminar flow under suitable speed and angle of incidence to get desalinated water.

Keywords—Desalination by collision, nano coating, water desalination, water repellent surface.

I. INTRODUCTION

FRESH water determines where life to be, wherever it exists the people gather around, the construction and civilization start, otherwise they travel to another place where they can find, it is the least existent but it is the dearest missing, sometimes it is the secret of life and sometimes the key for destruction.

"The map of the world is changed due to water resources, the Mongols conquered the world in the Middle Ages as Central Asia is subjected to drought causing tremendous destructions to the world and emigrations along the history are numerous due to water lack, the most famous goes back to the brothers of the prophet Joseph from Canaan to Egypt"[1].

The known fresh water sources which were sufficient yesterday, today they aren't as the population increases and the vaporization rate of fresh water also increases due to global warming, it is an alarm bell for the wises to do something before the cataclysm comes.

Desalination of water is necessary but the high cost causes overall rise in goods prices so we want to make this process by cheaper way, desalination of water by collision to prevent collision of nations and to give chance to the civilization to continue and the green color to be dominant.

II. GLANCE ABOUT BIONICS

"Bionics is the application of biological methods and systems found in nature to the study and design of engineering systems and modern technology, classical example is the development of dirt-and water-repellent paint (coating) from the observation that the surface of the lotus flower plant is practically unstick for anything (the lotus effect)"[2].

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Fig. 1 The lotus leaf is water repellent

The nano coating is similar to the nano structure of the lotus leaf, under electron microscope it seems like regularly arranged cones which prevent the water drop to penetrate the coated surface finding no way but to slide away from the surface without getting it wetted, this water repellent material is a good advantage in our research to collect desalinated water easily.

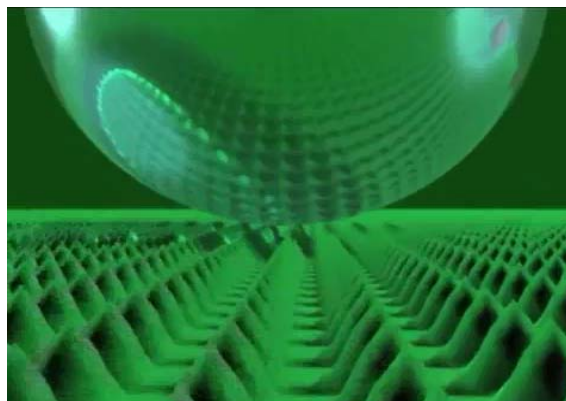


Fig. 2 The nanostructure of lotus makes it hydrophobic

III. ESSENCE OF THE IDEA

Collision of some water containing beads with any vertical rigid surface which conserves kinetic energy like Porcelain (ceramic material), the beads rebound back due to their rigidity and the water remains as sliding drops on the surface till leave it with some difficulty due to the surface protrusions.

The same concept will be applied on salt water but instead of beads are salt particles but these salt particles whose volumes are more than 1nm find these protrusions in the Non-nano coated surface from their perspective as blind wide holes where the majority enter them and rebound back with great difficulty.

But what if the surface is coated with nano particles these protrusions are blocked which enables salt particles to rebound back readily and the remaining desalinated water to be ejected and collected easily but why salt is considered like solid beads even though it is dissolved in water?

IV. THE SALT IS SOLID AFTER DISSOLVING IN WATER

This is the key of our research that must be taken well into consideration, salt doesn't convert to liquid after dissolving in water but it crumbles into small particles so tiny particles to the level of nano but it is still solid, this can be simply proved by this simple experiment.

A. Procedures

1. Get some of salt and put them in water.
2. Stir the solvent well.
3. Heat the solution till water is completely evaporated.

B. Observation

You will find the salt as a hot cake at the bottom of the container.

C. Conclusion

If salt is converted to liquid by dissolving in water so by giving it heat, it must be nearer to vapor state or at least remains at its liquid state but it appears in solid state which means it was solid and remains solid and wasn't liquid which may be converted to vapor as it is far away from vapor state as its boiling point is "1413 °C"[3] and even far away from liquid state as its melting point is "801 °C"[3].

Another proof is nano filtration "Nano filtration (NF) is a cross-flow filtration technology which ranges somewhere between ultra filtration (UF) and reverse osmosis (RO). The nominal pore size of the membrane is typically about 1nanometer"[4].

Nano filtration is a good example that salt dissolves physically in water not chemically, this technique is like strainer upon nano level which prevents particles whose volumes are larger than the pore size and this what already happens, the nano membrane lets water pass and prevents solid salt particles, this means that no chemical bond between them.

V. NEITHER DISSOCIATION NOR CHANGE IN CHEMICAL COMPOSITION

Salt dissociation in water to form NaOH and HCl is completely wrong idea and the proof is simple, "Zinc replaces Hydrogen in Hydraulic acid but don't replace hydrogen in water unlike sodium which replaces hydrogen in both cases"[5]so putting Zinc in salt water should release Hydrogen gas from reaction with HCl but nothing happen as there is no HCl, added to that sodium released from dissociation should release Hydrogen from water but also this doesn't happen, "to detect NaOH ,CuSO₄ is used to get blue precipient of copper(II) hydroxide"[6]but no precipitation happens.

If salt dissociates to Na⁺ and Cl⁻ in water or subjected to any change in chemical composition by form or another, it loses its taste since its chemically known that any change in chemical composition of any compound changes its properties but salt

keeps its taste, so it is crumbled into too many tiny particles to fill the spaces in water molecules so we can taste its flavor.

After proving the salt dissolves in water as tiny solid sodium chloride particles in water, they can be dealt as beads in water, in case the water containing beads is collided with smooth surface they rebound back and the water adhere to the wall as sliding drops, the same idea is to be applied on the dissolved salt in water but getting down to the nano level under appropriate conditions to get the desired result, but let's first speak about mass and volume of salt particles relative to water.

VI. SALT MASS AND VOLUME ROLE IN COLLISION

The molar mass of salt is 58.4430 g/mole which is approximately three times that of water which is 18.0153 g/mole which means if both of them are launched together by the same velocity, the salt will have three times momentum and kinetic energy of water, so if they are collided with a given surface the salt particles are easier to rebound back with kinetic energy and momentum three times of water without consideration of other factors.

Respecting volume, nano filtration is a good proof that volume of salt particles are more than volume of water molecules, the nano membrane of pore size 1nm lets water get through it but prevents salt, so it is impossible for salt particles to penetrate or adhere to the nano coated collision surface as their volumes are more than the volume of nano protrusions.

Nano coating prevents water to penetrate the surface and get it wetted so it is easier to prevent salt particles, it becomes clear now that mass and volume play important role in facilitating the separation process from water molecules.

VII. COLLISION NEEDS SMOOTH SURFACE

Every surface is not 100% smooth, it is full of protrusions, it is important to fill them with healthy nano particles so as not to let these protrusions absorb kinetic energy only, but also not to keep the salt particles adhered to them, you can simply spray salt water at any surface and wait for a while to let water evaporate where you can see the salt grains is adhered to the surface.

When the salt water is collided with an ordinary vertical surface having theses protrusions, it becomes difficult for the salt to rebound back because of them, to close the image, imagine a 25 cm² surface with 36 nails mounted regularly, when you launch a rigid ball whose diameter is slightly less than 1 cm it can penetrate the space between nails, but what about if you increase the number of nails to 146 on the same 25 cm² area, it becomes more difficult for the ball to penetrate the surface as there is no spacing between the nails equal to the ball diameter finding no way but to rebound back.

The same idea for salt particle whose volume is more than nano volume spacing so we want to fill the material surface with nano particles to ensure that neither the salt won't adhere to the surface nor its kinetic energy will be absorbed and rebound back swiftly.

VIII. VANDER WAALS FORCE

"Van der Waals forces include attractions between atoms, molecules, and surfaces, as well as other intermolecular forces, they differ from covalent and ionic bonding in that they are caused by correlations in the fluctuating polarizations of nearby particles"[7].

Vander Waals force makes the salt particles adhere to the surface, when you close two objects together, they are supposed to be stuck to each other due to Vander Waals force but the protrusions prevent them to be close enough to achieve this principle and what is close makes small Vander Waals force which cannot hold the two objects together, remember the glue material which fills these protrusions makes the two surfaces close enough to each other to be stuck by the same principle.

It is predicted also the salt particles at nano levels will be subjected to Vander Waals force due to the trap the protrusions make around the salt particles which leads to increase in the area of contact and enhance the attraction force, so we should overcome this force by nano coating to decrease area of contact to decrease the Vander Waals force and give salt particles the ability to rebound back easily.

IX. WATER MUST BE LAUNCHED AS LAMINAR FLOW

Launching water with large amounts as the firemen do is useless since the kinetic energy of salt particles after collision will be absorbed by the subsequent water as it will acts as a damper absorbing the rebounded salt particles giving them no chance to separate from water.

To illustrate this point take this example, if we have a large amount of liquid dough having beads and collide them with wall as one package, after collision the beads will be damped by the large volume of dough having no chance to rebound back but if you take small amount and launch them, the beads will have more chance to be collided with the wall surface and rebound easily, the less the amount of dough the more the number of beads can leave it.

The same principle in our case, water must be launched as thin laminar flow to leave more chance for the salt particles to liberate from it easily as the way for rebounding will be open without any obstacle from subsequent water or damping from it especially when the launcher is moving away as shown in Fig. 7.

X. RIGIDITY IS NEEDED

Rigidity here refers to Stiffness which is defined as "the resistance of an elastic body to deformation by an applied force along a given degree of freedom (DOF) when a set of loading points and boundary conditions are prescribed on the elastic body"[8].

Rigid material with high young's modulus like porcelain is required to make elastic collision where both momentum and kinetic energy are conserved and not to convert it to any other form of energy so that salt particles can rebound back for a great extent with approximately the speed they were launched with and also to decrease cost by decreasing the launch velocity.

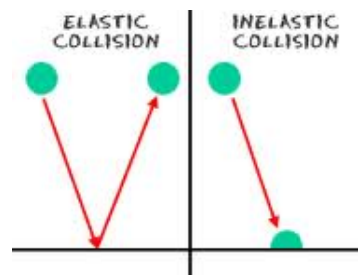


Fig. 3 The difference between elastic and inelastic collisions

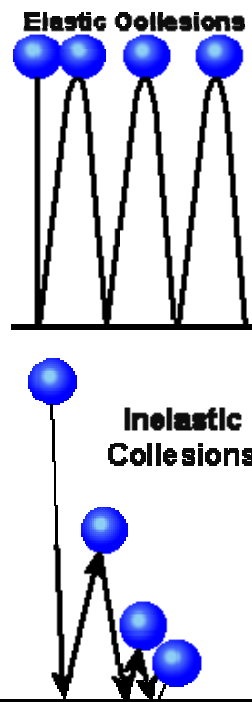


Fig. 4 Kinetic energy conservation of elastic collision relative to inelastic one

When a material is coated by nano particles, it becomes super rigid material, there is no porosity, no hole above nano level to penetrate which can absorb the kinetic energy, if a bullet is fired on some types of nano coated material, it rebounds back to the shooter, be careful.

XI. SAFETY DEPENDS ON HARDNESS

"Hardness is the measure of how resistant solid matter is to various kinds of permanent shape change when a force is applied"[9], on sea shores rockets are subjected to crashing waves making it eroded over time, rockets like granite have hard numbers lie between six and eight on Moh's scale making it resist erosion longer.

Nano coating increases hardness as there is no hole above nano level, this gives no chance to water to penetrate the material causing corrosion, surface of collision characterized by high hardness is needed to avoid erosion over long time to decrease cost of changing the material subjected to collision or coating it with new nano particles.

It is required that the material has high hardness even if the matter isn't related to the cost or the efficiency but the it is related to the safety from the unknown repercussions from nano particles corrosion at high velocities of water launching, what will be the effects of the nano particles on the human health, the soil if it is used in agriculture and the environment?, tests should be done before introducing this idea to mankind.

XII. THE VELOCITY OF LAUNCH

Increasing the velocity increases both the momentum and kinetic energy before and after collision and allows salt to be separated from water easily, optimum velocity is the minimum one to achieve the needed efficiency but to increase the velocity more than these optimum one won't increase cost only, but also may cause decay to the material over long time and the problem of protrusions appears again, the most important is to make test on the produced water to see its safety on environment and human health.

It is well known that the angle of incidence is equal to the angle of reflection, launching the salt water perpendicularly at angle 0^0 is a big fault as the reflected particles will be collided with the subsequent water, so it is preferable to be at 20^0 while launching water 50 cm apart from surface and at the same time the ejector is moving away from collision surface as in Fig. 7 to get the desired desalinated water.

XIII. PROTOTYPE OF THE MACHINE

Taking into consideration the previous factors, the surface of collision coated with nano particles are mounted vertically as shown in Fig. 5 and the water is launched on it, the desalinated water slides down to the grooved beam swiftly due to nano coating then to the container on the right and the salt particles are rebounded back, the ejector is designed to follow its track automatically being programmed as milling computerized numerical control (CNC) machine and the track of the ejector is shown in Fig. 6, by the way multi ejectors could be used to increase the productivity.

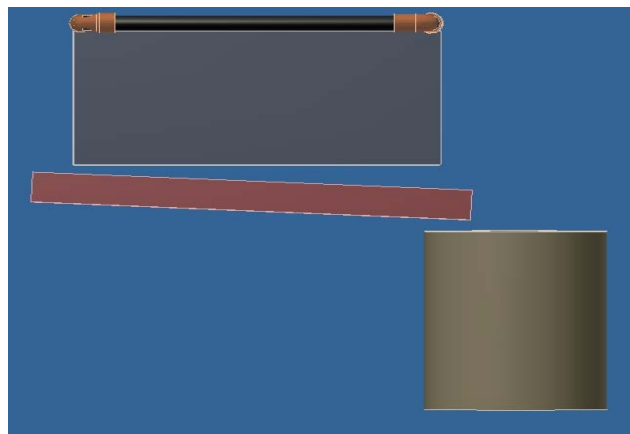


Fig. 5 Simple prototype of the desalination machine

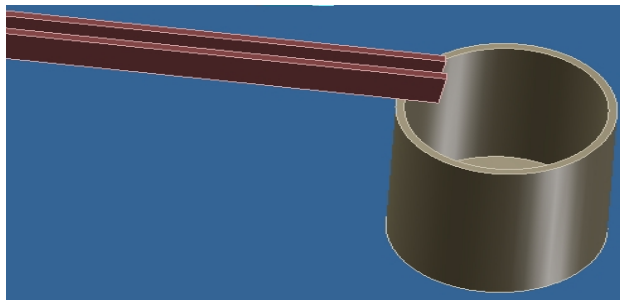


Fig. 6 Groove pours water in the collecting container

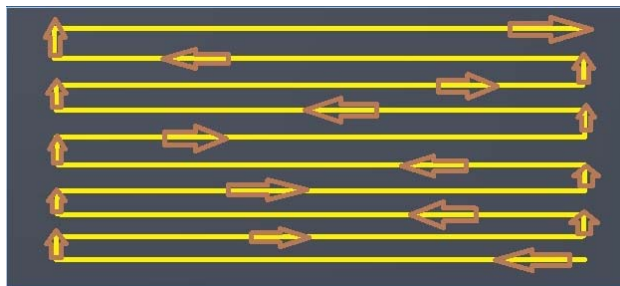


Fig. 7 The path the ejector tracks

Open design of the machine let the rebounded salt particles of nano volumes be volatile in the air which may cause harmful effects on the eyes or the skin of the operators or to be breathed by their lungs and affect their respiratory systems over long time, on the other hand closed design makes another problem as the other surfaces except the collision surface will make another secondary collision for the rebounded particles and may be with the launching water again.

The u-shaped is to be hung on it black leather curtains so as to absorb the kinetic energy of the rebounded salt particles and at the same time prevent it from getting out of the machine.

XIV. TO BE CLOSE TO THE PERFECTION

After the salt water is launched and collided back, some water and salt particles are suspended in air, these particles will obstacle the new launched salt water and damp it, so it is preferable that the air is pure from any suspensions, this can be done by air suction after every complete launch cycle.

Material coated with nano particles is important for two reasons, first to increase productivity by ejecting desalinated water from its surface like the way the water leaves the lotus flower smoothly which can be collected easily by also nano coated grooved beam, secondly the material keeps itself dry so that we can ensure elastic collision as if material preserves drops of water they will acts as damper for collision.

XV. CENTRIFUGAL FORCE WORKS WELL

Centrifugal force is "The apparent force, equal and opposite to the centripetal force, drawing a rotating body away from the center of rotation, caused by the inertia of the body"[10].

REFERENCES

Its formula is $F = m\omega^2 R$

(1)

F: centrifugal force

M: mass of the object

R: radius of rotation

ω : angular velocity

as the mass of the object increases, its centrifugal force at fixed radius and angular velocity increases.

If we have a plastic -non rigid- container containing salt water subjected to centrifugal force, it is expected that the ratio of salt to water is higher at the edges and decreases towards the center due to the heavy mass of salt relative to water, let's do the procedures of the experiment and see what happen.

A. Procedures

1. Get a cylindrical container its area to volume ratio is high (wide and small height) having salt water.
2. Take a glass of water of this salt water.
3. Put in the container an insulated DC motor with a fan upside and the motor downside.
4. Operate the fan for 30 seconds in clockwise direction.
5. Take a glass of water from the top of this salt water.

B. Observation

Waves of water collide with the container surface, after the experiment water at the top is found to be sweeter than before and sweeter than the bottom of the container.

C. Conclusion

Salt is collided with the container surface and separate from water molecules towards the bottom of the container helping in that salt water is denser and stay at the bottom, the taste is obvious as the successive trials of collisions increase the probability of the separation even the conditions are not ideal.

Apply the ideal conditions to obtain the ideal results by increasing the fan angular velocity, the surface to be coated with nano particles and to be subjected to the previous mentioned conditions.

Without complete ideal conditions, the less desalinated water at the top of the container can be easily desalinated completely by any other method of desalination even if the vaporization method is used as the boiling point at a given pressure decreases as the salinity decreases.

XVI. CONCLUSION

New application of nano technology is opened to get things separated from each other by collision with surface coated with nano particles.

ACKNOWLEDGMENT

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- [1] Scientific American Magazine, Casualties of Climate Change: Sea-level Rises Could Displace Tens of Millions, <http://www.scientificamerican.com/article.cfm?id=casualties-of-climate-change>, January 10, 2011.
- [2] Bionics, <http://en.wikipedia.org/wiki/Bionics>, October 17, 2012.
- [3] Sodium chloride, http://en.wikipedia.org/wiki/Sodium_chloride, October 18, 2012.
- [4] Nanofiltration, <http://en.wikipedia.org/wiki/Nanofiltration>, October 24, 2012.
- [5] Reactivity series, http://en.wikipedia.org/wiki/Reactivity_series, October 24, 2012.
- [6] Forensic-science, http://www.bbc.co.uk/schools/gcsebitesize/science/edexcel_pre_2011/patterns/forensicsciencerev1.shtml, October 24, 2012.
- [7] Van der Waals force, http://en.wikipedia.org/wiki/Van_der_Waals_force, October 19, 2012.
- [8] Rigidity, <http://en.wikipedia.org/wiki/Stiffness>, November 17, 2011.
- [9] Hardness, <http://en.wikipedia.org/wiki/Hardness>, October 18, 2012.
- [10] Centrifugal force, <http://www.thefreedictionary.com/centrifugal+force>, October 24, 2012.