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Assessment of different materials as a condensation nucleus

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ABSTRACT

Condensation nuclei are one of the main factors in building the structure of the cloud during its formation stages, so it is the basic structure around which water vapor gathers by a specific mechanism to form a cloud droplet. However, this cloud soon disappears due to a defect in one of the conditions for its formation, and the fact is that the nuclei of condensation here are either few or increased due to convection currents caused by the winds, which are various materials present in the atmosphere. These materials are classified into liquefied and non-liquefied. according to the nature of those materials, which have the ability to attract water vapor molecules around them, So, the aim of this research was to study and discover some materials that may have the ability to be used in artificial seeding. A group of samples were collected such as carbon generators, Himalayan salt, pollen grains, Refrigerated helfa and analyzed by FT-IR and SEM devices, as well as examining the surface tension in unite Newton meter of each material separately. It was found that some of the analyzed materials were appeared as chemical compounds that behaved as liquefies. It was concluded that the most effective substance is K_2CO_3 which is present in pollen grains (4.296%), as well as CaO (26) %, Na_2O in Himalayan salt (38.0%) and Refrigerated helfa which recorded the highest value for SiO_2 (4.761%). The effectiveness of the surface tension was represented in the refrigerated helfa, where the surface tension decreased from 51.67 mN/m to 43.95 mN/m when adding each 0.5 g to the solution. Also, in the refrigerated helfa, the surface tension decreased from 55.3 mN/m to 47.89 mN/m when adding 0.5 g each time. In the case of the Himalayan salt, when the same amount of solution was added, the surface tension decreased from 68.3 mN/m to 49.44 mN/m when the solution was added gradually from 0.5 to 2 g for every 0.5.

Key words: Carbon generators, Himalayan salt, Pollen grains, Refrigerated helfa.
Article type: Research Article.

INTRODUCTION

Clouds consist of small droplets of water or ice crystals that form when water vapor cools in the atmosphere and condenses around particles known as condensation nuclei, which are dust and salt particles such as sodium, silicates, magnesium and carbon (AL-Saleem 2019). Without these particles no raindrops or snowflakes could form and there would be no precipitation. Cloud seeding is a type of weather modification that aims to change the amount or type of precipitation that falls from clouds by dispersing materials in the air. it acts as cloud condensation nuclei or icy nuclei, and the usual goal is to increase precipitation (rain or snow) or the need to pour it down in a certain place or at a certain time (Mielke 1971). In mid altitude clouds, the usual seeding strategy was based on the fact that equilibrium vapor pressure is lower on ice than over water. The formation of ice particles in super cooled clouds allows these particles to grow at the expense of liquid droplets. If sufficient growth occurs, the particles become heavy enough to fall into clouds. This process is known as static seeding (Dong 2020). The latent heat from freezing in tropical cumulus clouds (convection) can be exploited to activate the seeding process. This "dynamic" seeding strategy assumes that additional latent heat adds additional buoyancy, strengthens uplift currents, ensures convergence of low atmospheric levels, and ultimately leads to rapid growth of properly selected clouds (Guo 2006). In 1998, the American Meteorological Association judged that "precipitation from extremely cold orographic clouds (clouds that develop over mountains) increased seasonally by about 10%-15%. The supposed chain of events begins with the introduction of particles that will act as nuclei for condensation into regions of clouds containing super cooled liquid water, resulting in the nucleation of ice crystals, followed by the growth of ice particles to sizes large enough for snowfall to fall on the ground (French 2018). Studies based on general circulation models named ECHAM and CESM on cirrus clouds indicate a greater surface temperature decrease in CESM, which reduce about 70% of the global temperature increase due to carbon dioxide, and only 30% in ECHAM. Seeding significantly reduces climate damage from increased CO_2 by about 50% in ECHAM and by 85% in CESM over study areas (Gasparini 2020) . After seeding, we observed an elevation in the cloud cover area of the thin cloud, a decrease in the concentration of the number of ice crystals, and a drop in the radius of ice crystals. The analysis of the respective radiated contributions suggested that the ice crystal radius drops with decreasing main factor limiting the seeding effectiveness (Gasparini 2016) . It was found that cloud seeding produces snowfall when the temperatures inside the clouds range between -20 and -9 ℃, and that seeding with materials such as silver iodide (its crystalline structure is similar to that of ice) will stimulate snow nucleation (Vonnegut 1971) . Jeff Tilley (Director of Weather Modification at the Desert Research Institute in Reno) claimed in 2016 that current research and new technology revealed results that support cloud seeding as an effective and reliable technique for extracting water from clouds at reasonable prices for many regions (Kumar 2017). The most common chemicals used for cloud seeding include silver iodide, potassium iodide, dry ice (solid carbon dioxide) and liquid propane (which expands into a gas) have also been employed, which can produce ice crystals at higher temperatures than silver iodide. After promising research, the use of hygroscopic materials (such as table salt) is becoming more popular (Hill 2012). In addition, silver iodide can cause temporary incapacitation or possible residual injury to humans and other mammals with intense or chronic exposure according to an NFPA 704 health hazard rating (Mat Lazim 2023). The toxicity of silver and silver compounds (from silver iodide) was shown to be of low order in some studies. These findings likely result from the minute amounts of silver generated by cloud seeding, which are about 1% of industry emissions into the atmosphere in many parts of the world, or individual exposure from tooth fillings (Fajardo 2016). Therefore, the researchers began to study the possibility of using new materials in the seeds to activate the nucleation process inside the clouds to avoid the dangerous effects of silver iodide. For example, a comparative study on the dynamic and micro-physical effects of cloud seeding by silver iodide (AgI) and liquid carbon dioxide (liquid CO_2) was conducted using a 3D cloud model with the seeding processes. The model results show that seeding by liquid CO_2 and AgI at -15 to -20 ℃ has nearly the same dynamic effect on simulated clouds. In addition, the initial seeding carried out by liquid carbon monoxide in the super cooling zone (water with a temperature of 0 to -5 °C) enables a much stronger dynamic effect and more precipitation to be produced by creating many new cells with convection (Yuan 2021). The performance of the new aerosols (shell structured TiO) was compared against pure NaCl that had been traditionally used to improve precipitation. These aerosols showed significantly better performance as the sedimentation enhancer than pure NaCl. It has been observed that in an unsaturated environment with a relative humidity less than 75%, the use of aerosols enhancers leads to the precipitation process by 15% more than NaCl, and by 30% more than the normal state (Lompar 2018). The National Institute of Meteorology conducted 54 cloud seeding experiments with silver iodide and calcium chloride using aircraft from 2008 to 2018. The cloud type was most likely to be seeded with Nimbostratus (Ns)-Stratus (St; 58%) in the cloud seeding experiment with silver iodide. Altostratus clouds (As)-Stratocumulus clouds (Sc) were the most likely (44%) in the calcium chloride cloud seeding experiment. By using atmospheric research aircraft, the amount of precipitation increased from 43% to 63% in the cloud seeding experiment with silver iodine, and from 29% to 75% in calcium chloride one (Cha 2019) . The traditional methods of seeding may have negative effects on the environment and be very expensive. Therefore, laboratory experiments have proven the efficiency of cloud seeding with charged particles compared to traditional methods. The electrostatic interaction between the charged particles and neutral water droplets in the cloud will accelerate the cohesion process and accelerate the formation of precipitation, which depends on whether it is a solid or a liquid on the temperature. The double-charged ions take advantage of the principle of attracting particles with different charges to harvest a greater number of water droplets (Zheng 2020). Studies have been conducted in which aerosols have been used in the cloud seeding of supercooled liquid clouds. Cloud particle size distributions after the cloud seeding indicate the formation of large ice crystalline particles and a large particle size distribution range. In other words, many number of large ice crystal particles have formed after cloud seeding, which can grow further into precipitation through the collision and coalescence process. The satellite image also clearly shows the precipitation formation after the cloud seeding experiment. This study indicates that aerosol cloud seeding can work efficiently for supercooled liquid clouds (Zhao 2022). However, there have been several detailed ecological studies that showed negligible environmental and health impacts. So a ground-based aerosol generator (NAG-07M) was used within the boundary layer of the atmosphere; samples were measured using a probe (AVA3240-10S), and calculations were made by a 3D SeedDisp model. In addition, it was found that the effective silver iodide concentration was at a height of 1200 m. Also, the correlation coefficient between the concentration of silver iodide particles measured by the probe and calculated by the model was shown to exceed the value of 0.7 (Kadhim, 2021). The environmental importance of this research was to find alternative elements or compounds that act as cloud condensation nuclei, i.e., using artificial seeding instead of the traditional condensation nuclei by silver iodide powder.

MATERIALS AND METHODS

In this research, a new technique was used to detect condensation nuclei, which is one of the most important causes of cloud formation, through which the cloud droplet grows. Three types of powders were used: Refrigerated helfa powder, Himalayan salt, generator powder and pollen; and the samples were analyzed by FT-IR and SEM,

Fig. 1. FT-IR device

Fig. 2. SEM device

the devices which can detect the elements and compounds present in the sample through a high-precision analysis and defining the proportions of them in one sample (Table 1).

Table 1. The proportions (%) of chemical compounds and elements in the samples.

Sample	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	CaO (%)	Na_2O (%)	K_2CO_3 (%)	MgO (%)	MnO (%)	TiO_2 (%)	P_2O_5 (%)
Refrigerated helfa	4.761	1.392	1.128	26	4.722	0.131	2.152	0.008	0.072	0.33
Carbon generators	0.67	0.249	0.792	0.891	0	0	0	0.011	0.06	0.197
Himalayan salt	0.387	0.217	0	0.071	Na = 38.5	0.067	0.819	0	0.017	0.028
Pollen grains	0.685	0.214	0.357	3.658	0.032	4.296	0.38	0.031	0.061	4.866

Table 2. The proportions of chemical compounds and elements in the samples.

S (ppm)	Cl (ppm)	Ba (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Mo (ppm)	Nb (ppm)	Ni (ppm)	Pb (ppm)	Rb (ppm)	Sr (ppm)	V (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)	As (ppm)
SO_3=37%	23306	2133	N	N	45	644	299	44	116	291	1612	25	718	1031	660	12
42890	107	5837	17	N	129	839	375	182	223	444	1302	28	1064	479	841	25

2802	59.50%	512	N	N	5	544	272	N	79	241	670	10	603	94	536	6
6911	3080	5285	14	N	127	842	375	175	219	422	1301	27	1056	434	840	26

Note: ppm = parts per million.

Through the above Table, we noticed that the proportions of chemical compounds and elements in one sample are different, as well as their presence in the rest of the samples. Since the proportions of the chemical elements are one part per million, they can be considered negligible. In order to examine the effectiveness of these compounds, which can be effective condensation nuclei, a desiccator device was used. It is a device that removes moisture from the sample or chemical compound using silica gel (Fig. 3).

Fig. 3. desiccator device.

It is heated in the oven for a period of not less than an hour to determine the susceptibility of these compounds contained within the samples in Table 1 to act as condensation cores. The compounds, in the form of powders, were prepared by taking 1 g of each compound, and tested in laboratory conditions at a relative humidity of 95% and a temperature of 21 °C. The first compound (Al_2O_3) was heated at a temperature of 115 °C in the oven for an hour, and then the sample was placed in the desiccator device to monitor its weight. After an hour, it was found that the weight of the sample became 0.95 g, and when the process was repeated for the second time, it was found that the sample weighed less. Also to 0.94 g, upon re-trying for the third time, it was found that the weight of the sample was fixed to the same weight. However, after leaving the sample in the air and on a sensitive balance, the sample started increasing for each period of time, which indicates that Al_2O_3 is a good factor for removing air moisture. The results also showed that 1 g MgO in the same conditions and at the same oven temperature (115 °C), and after an hour, the weight of the eye had become 0.9 g. In addition, once the experiment was repeated for the second time, the weight of the sample had been fixed to remain the same weight. When the sample was left exposed for a period of time, it was noticed that the weight of the sample remained constant. So that this material was ineffective by moisture. The results also showed that 1 g titanium dioxide (TiO_2) after conducting the experiment did not exhibit any changein the weight of the sample. As the experiment was repeated again to obtain a correct reading, we found that 1 g remained the same weight, which indicates that the titanium oxide is not hygroscopic and ineffective. Potassium carbonate (K_2CO_3) was also used to detect its ability to liquefy and draw moisture. Where 1 g was taken from the sample, and after drying in a desiccator device, the weight of the eye became 0.7 g of its true weight, indicating that the sample lost from its weight (0.3 g) by moisture. Once the process was repeated for the second time, the eye maintained its weight, so that, most of the samples exhibited a clear and consistent difference in the attic of moisture loss, given the difference in values from one sample to another. Noteworthy, when the sample was left in the dish for more than 2 h, it was noticed that the sample began to turn into a liquid substance, which indicates the liquefaction of the compound that record the highest percentage of pollen powder. Each of the compounds (Fe_2O_3, CaO and Na_2O) were inactive in moisture, since after checking these compounds, it was noticed that their weight did not change even after repeating the process. According to the results, 1 g MnO, after heating the sample for 1 h, was placed in the dryer, and it was found that the sample lost 0.1 g of its weight and remained constant at the same weight. We noticed that many chemical compounds

(Table 1) are weak in humidity area and ineffective despite losing a little moisture. The chemical compound (SiO_2) recorded the highest value in the refrigerated helfa powder (4.761%). However, it was only a percentage of the rest of the other compounds that could be considered sand, which is a non-fluidizing substance. In the case of P_2O_5, this compound was not examined for lack of its availability and it was also inactive despite the high percentage of pollen powder (4.8%). Table 3 depicts some chemical compounds and their dissolution efficacy.

Table 3. The solubility rates of some chemical compounds

Chemical compounds	**SiO_2**	**Al_2O_3**	**Fe_2O_3**	**CaO**	**Na_2O**	**K_2CO_3**	**MgO**	**MnO**	**TiO_2**	**P_2O_5**
solubility rates in water	0.012 g 100 mL^{-1}	Insoluble	Insoluble	react	react	112 g 100 mL^{-1}	Acid	Insoluble	Insoluble	Hydrolysis

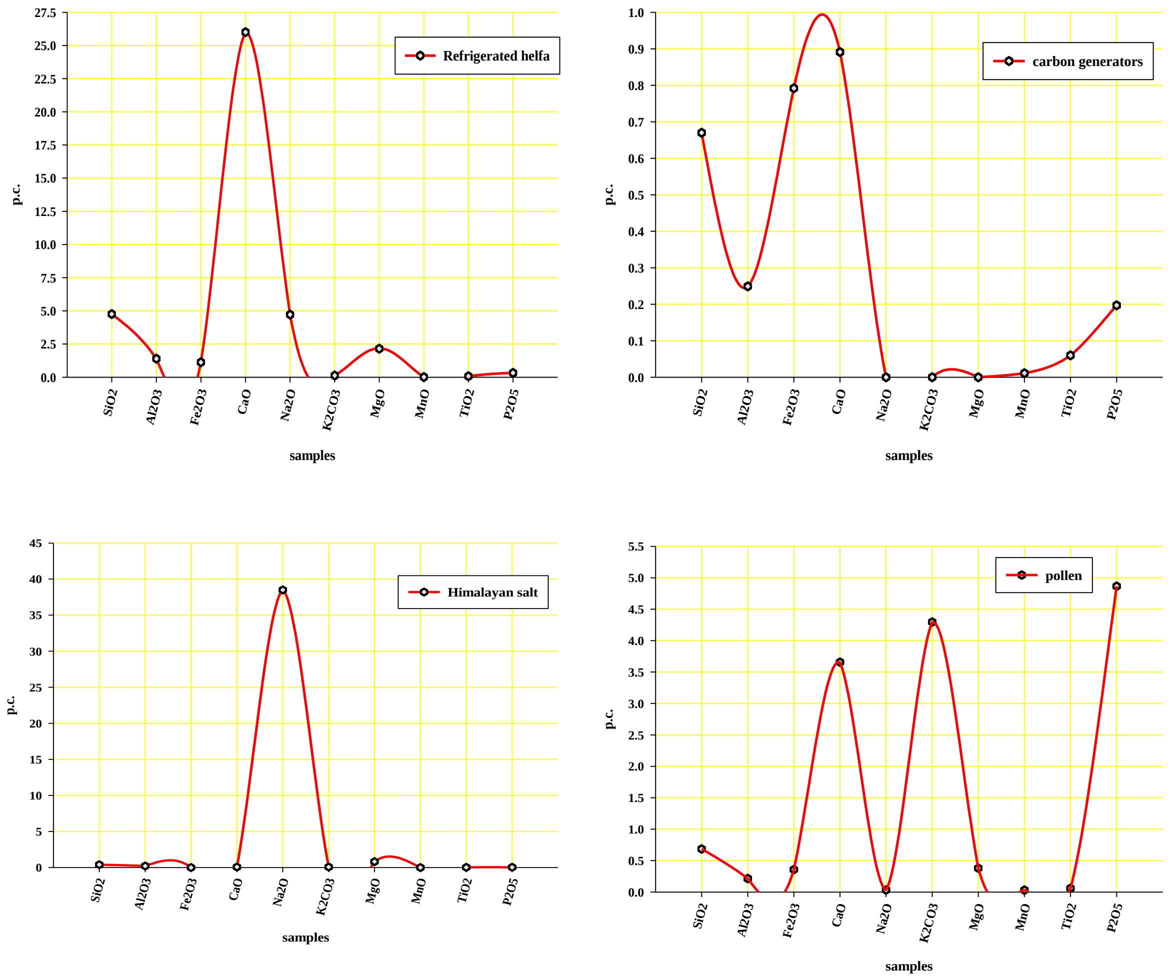

Fig. 4. Curves for the percentage of samples to powders.

By noting the values of the compounds in the table, which were examined to determine whether this substance is perfect, i.e., it is effective in atmospheric humidity, we found that it is well effective in the compound (K_2CO_3) found in the pollen grains, but through Fig. 1, we found that the highest value was recorded in the cooled sample of the compound (CaO) with a value of 26% and that the lowest value of the compound (MnO) was 0.008%. In the case of the car exhaust sample, it was recorded to a value of 0.891% for the calcium oxide, while the lowest value was 0% for each of the compounds (MgO, K_2CO_3, Na_2O). In the case of Himalayan salt sample, the highest share of Na_2O was 38.5%, while the lowest value (0%) was for each of the two compounds (Fe_2O_3 and MnO). In addition, the highest rate of P_2O_5 was about 4.866%. In the case of pollen sample, the lowest value of MnO was 0.031%. It turns out that these values, even if they are high or low, do not depend on the amount of this substance or compound, but rather on the amount of its effectiveness in the atmosphere.

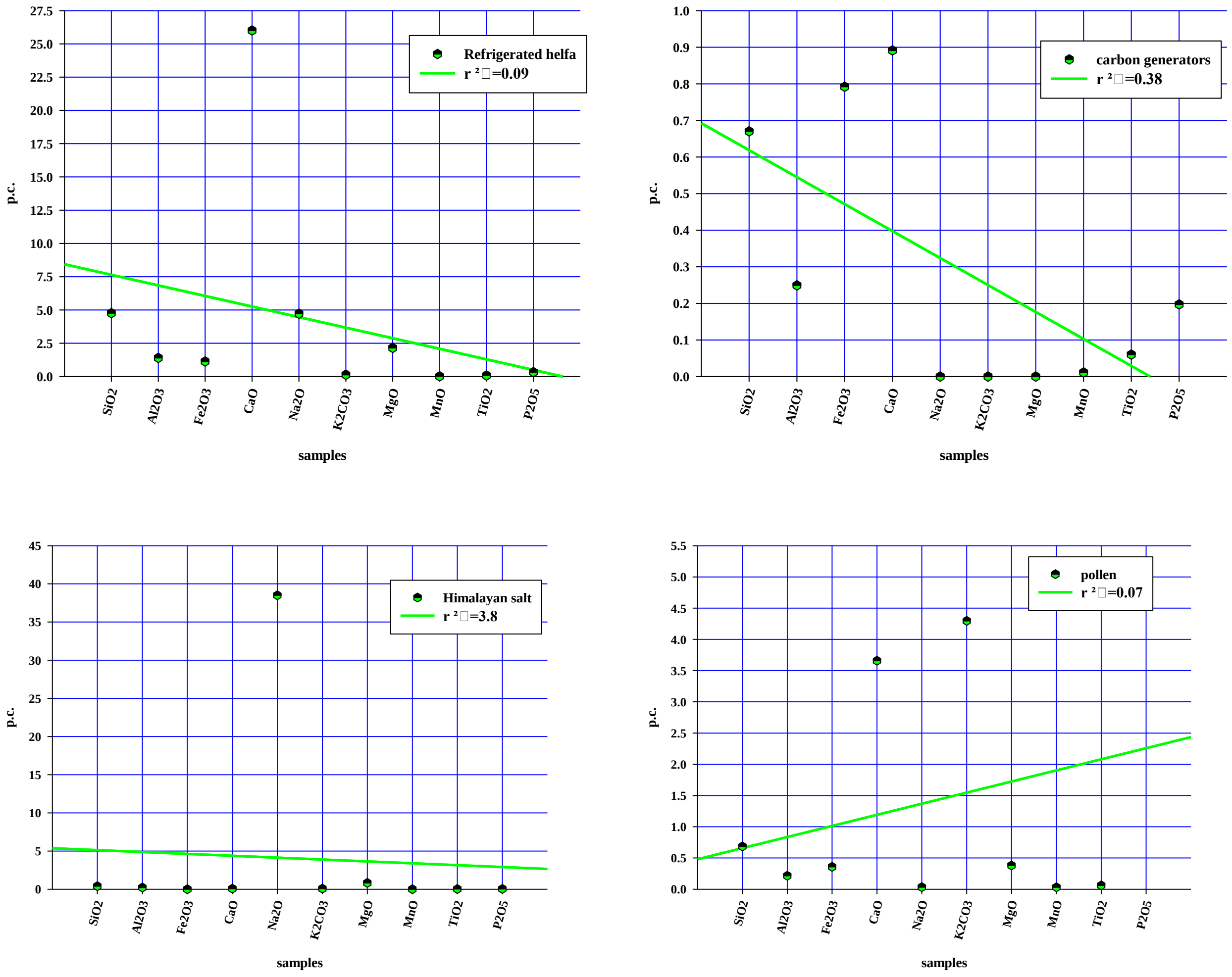

Fig. 5. represents the correlation coefficient values.

Surface tension is an effect that makes the surface layer of any liquid act as a flexible sheet, and that effect allows insects to walk on water as well as metals such as needles and tin foil from floating on the water in a flat manner. However, if these surfaces are not flat, the question here is why liquids tend to make their surfaces spherical in shape. In the matter of the clouds physics, and when the droplet is formed, it is formed in a way that tends to a spherical shape, and this droplet, by its nature, needs growth. In order to grow, appropriate conditions should be provided for its growth, and one of these conditions is the weakness of the surface tension of the droplet through an external influence that affects the droplet. The surface tension force is very important for droplet growth in terms of the influential external environment. The greater the influence of the external environment, the greater the effect on the surface tension force. In order to overcome this force, it was necessary to examine the study samples used in this research. By knowing the surface tension for each of them separately and for the added quantities that were examined in the laboratory and which were calculated through the following equations:

The saturation vapor pressure over a curved surface is higher than that over a flat surface and is given by:

$$e_s(r,T) = e_s(r=\infty,T)\exp\left(\frac{2\sigma}{rR_v\rho_L T}\right) \text{...} \quad \textbf{(1)}$$

where $e_s(r = \infty,T)$ is the saturation vapor pressure over a flat surface, $e_s(r,T)$ is the saturation vapor pressure over a curved surface, r is the radius of the droplet, σ is the surface tension (in force per unit length) and liquid water density, ρ_L, at temperature, T, and R_v is the gas constant for water vapor. The surface tension of water is approximately 7.5e^{-2} N/m for typical conditions. For a cloud to grow, the vapor pressure should be greater than the e_s. We can determine the critical radius for a droplet to grow given a supersaturation, S, defined as:

$$S = \frac{e}{e_s(r=\infty,T)} \text{...} \quad \textbf{(2)}$$

Setting $e = e_s(r,T)$ which gives the threshold for neutral conditions above which the droplet will grow and combining equations 1 and 2 yields:

$$\ln\left[\frac{e_s(r_c,T)}{e_s(r=\infty,T)}\right] = \ln\left[\frac{e}{e_s(r=\infty,T)}\right] = \ln[S] = \left(\frac{2\sigma}{r_c R_v \rho_L T}\right)$$

Therefore, the critical radius, r_c, is:

$$r_c = \left(\frac{2\sigma}{R_v \rho_L T \ln[S]}\right) \text{...} \quad \textbf{(3)}$$

Given a supersaturation, S, for a droplet to be stable, it should grow to at least a radius of r_c. Note that the larger S is, the smaller r_c. So very small droplets indeed require higher supersaturations to grow. For S = 1.01, or a supersaturation of 1%, r_c is 0.121 microns. Droplets larger than this will grow. Droplets smaller than this will evaporate.

Heterogeneous nucleation (Solution effect)

Water condenses onto existing particles of atmospheric aerosol termed cloud condensation nuclei CCN. These particles support condensation at supersaturation values well below those required for homogeneous nucleation - primarily because of their size. Hygroscopic particles, like sodium chloride and ammonium sulfate are even more effective. In the presence of moisture, NaCl and $(NH_4)_2SO_4$ absorb vapor and readily dissolve. The resulting solution has a saturation vapor pressure below that of pure water, since e_s is proportional to the absolute concentration of water molecules on the surface of the droplet. Consequently, a droplet containing dissolved salt favors condensation more than would a pure water droplet of the same size. Aerosols are categorized as hydrophobic, neutral and hygroscopic depending on how they interact with water. Water condenses onto condensation or hygroscopic nuclei. The effect is that when some of the solute is added to the water liquid, the solute molecules replace some of the liquid water molecules in the surface layer. This reduces the number of water vapor molecules at the surface and these molecules bind water more tightly to water than water does to itself. The net effect is to reduce the saturation vapor pressure required to create equilibrium where the number of water molecules leaving the surface is equal to the number of gas phase molecules striking and sticking to the surface.

For a plane surface, according to Raoult's law:

$$\frac{e'}{e_s(r=\infty,T)} = \frac{n_0}{n+n_0} \text{...} \quad \textbf{(4)}$$

where e' is the equilibrium vapor pressure over a solution consisting of n_0 molecules of water and n molecules of the solute. When $n < n_0$, we can further write:

$$\frac{e'}{e_s(r=\infty,T)} = 1 - \frac{n}{n_0} \text{...} \quad \textbf{(5)}$$

For solutions in which the dissolved molecules are dissociated, the formula 5 should be modified by multiplying n by the factor i, which is the degree of ionic dissociation. For sodium chloride and ammonium sulfate which are important CCNs, i~2 and can be used in the absence of more detailed information about *i*. The number of effective ions, *n*, in a solute of mass, m_s, is given by:

$$n = iN_a \frac{m_s}{M_s} \text{...} \quad \textbf{(6)}$$

where N_a is Avagadro's number, m_s is the molecular mass of the solute. Likewise, the number of water molecules in a mass, *m*, of water is:

$$n_0 = N_a \frac{m}{M_w} \text{...} \quad \textbf{(7)}$$

Therefore

$$\frac{e'}{e_s(r=\infty,T)} = 1 - \frac{iN_a \frac{m_s}{M_s}}{N_a \frac{m}{M_w}} = 1 - \frac{iM_w m_s}{M_s m} = 1 - \frac{3iM_w m_s}{4M_s \pi r^3 \rho_L} = 1 - \frac{b}{r^3} \text{........................} \quad \textbf{(8)}$$

where $b = \frac{3iM_w m_s}{4M_s \pi \rho_L}$ and ρ*L* is the mass density of liquid water. Equation 8 is called Raoult's law.

Kohler Curve

Plugging equation 8 into 1 yields:

$$\frac{e_s'(r,T)}{e_s(r=\infty,T)} = \left[1 - \frac{b}{r^3}\right] \exp\left(\frac{2\sigma}{rR_v \rho_L T}\right) = \left[1 - \frac{b}{r^3}\right] \exp\left(\frac{a}{r}\right) \text{...................................} \quad \textbf{(9)}$$

When *r* is not too small, this may be approximated as:

$$\frac{e_s'(r,T)}{e_s(r=\infty,T)} = \left[1 + \frac{a}{r} - \frac{b}{r^3}\right] \text{..} \quad \textbf{(10)}$$

The *a*/*r* term is a *curvature* term representing the increase in the saturation vapor pressure due to the curvature of the surface and the b/r^3 term is the *solution* term. *a* ~ $3.3 \times 10^{-7}/T$ (in m) and b ~ 4.3×10^{-6} im_s/M_s (in m^3).
The equation below shows these curves for a cloud condensation nucleus, *M*, of 10^{-19} kg of NaCl (table salt) and a temperature of 273 K.
Finding the point where the slope is zero yields the peak super saturation, *S**, for Equation 9 and corresponding radius, *r**, given by:

$$S^* = 1 + \sqrt{4a^3/27b} \text{ ....} \textbf{(11)}, \quad r^* = \sqrt{3b/a} \text{ ....} \textbf{(12)}$$

By investigative the samples, it was found from Table 4 that these materials exhibit a positive behavior, and it is known that the positive behavior comes through the effect of that substance on the surface tension of the droplet, as the greater the effect of the substance through an increase in salt weakens the surface tension of the droplet.
From Table 4 we notice that the first substance, pollen, when adding 0.5 g, the surface tension factor was 51.67 mN/m. Surface tensile modulus down to 2 g, indicates that by the increased pollen substance, it behaves positively in weakening the surface tension of the droplet. So it is likely an effective substance in the growth of the droplet, which can act as condensation nuclei, and this is the objective of the research. The results showed that the refrigerated helfa has good behavior and can be effective in cloudy conditions. When adding 0.5 g to the solution, we noticed that the surface tension was 55.35 mN/m, and when adding 1 g, the value of the tensile modulus decreased to 52.49 mN/m and then to 49.40 mN/m. Once adding 1.5 g up to 2 g, the tensile value became 47.89 mN/m. In the case of carbon generators, its behavior was completely different, as it behaved in the opposite way.

At 0.5 g, it was found that the surface tension was 67.17 mN/m, and when the quantity was increased, the value of the tension increased to become 70.08 mN/m in 1 g. So, this substance cannot be considered effective in cloudy conditions. Some salts are effective according to the Kohler curve. Himalayan salt in 0.5 g was the value of the surface tension modulus 68.30 mN/m, while its value decreased to 62.11 mN/m when adding 1 g. The value of the tensile modulus continued to decrease to reach 49.44 mN/m by elevating the amount of salt to 2 g, where we noted that the increase is ± 6 ≤. So, Himalayan salt is the most effective.

Table 4. value surface tension in Newton meter (mN/m) unit.

Samples	Wight /gm	Density (kg/l)	Surface tension (mN/m)
pollen grains	0.5	0.9811	51.67
pollen grains	1	0.9790	43.95
pollen grains	1.5	0.9794	46.27
pollen grains	2	0.9811	42.03
Refrigerated helfa	0.5	0.9692	55.35
Refrigerated helfa	1	0.9807	52.49
Refrigerated helfa	1.5	0.9475	49.40
Refrigerated helfa	2	0.9480	47.89
carbon generators	0.5	0.9459	67.17
carbon generators	1	0.9465	70.08
Himalayan salt	0.5	0.9476	68.30
Himalayan salt	1	0.9942	62.11
Himalayan salt	1.5	0.9856	56.42
Himalayan salt	2	0.9772	49.44

CONCLUSION

1- The compound K_2CO_3 is an effective substance in atmospheric conditions that can be used as new condensation nuclei.
2- Himalayan salt has a correlation coefficient of 3.4, since it contains Na, which can be used as a substitute in artificial seeding.
3- The Refrigerated helfa powder can also act as a condensation core, since it contains effective compounds that make it well in weather conditions.
4- These materials may be non-fluidized, but they can act as condensing nuclei, such as pollen and generator exhaust.
5- In addition to the materials that are scattered and enter the cloud drop industry, the rest of the materials can do the same work, since the atmosphere contains a lot of suspended materials.
6- The surface tensile modulus of Himalayan salt becomes weaker as the amount of salt increases, so it is more likely to act as effective condensation cores.

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