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(At what temperature) can salt evaporate?

materials

Related to my previous question, can sodium chloride evaporate, and if so, at what temperature? Since salt is a solid, and apparently all substances can at various temperatures exist as liquids and vapors as well as solids, salt should also have a melting and a vaporization points. At what temperatures are these points if they occur, and if they don't occur, why? (This is assuming the pressure is 1000 mb)

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George A. Solodun 203 • 2 • 7 asked Mar 8 '17 at 16:39

edited Mar 9 '17 at 4:00

1

Remember in asking "what temperature?" you have to assume a fixed pressure. For example, if you put the salt in a vacuum, it would evaporate at a lower temperature than an 1.0 atm. – **khaverim** Mar 8 '17 at 17:09

1000 mb = 1 bar, or one atm. In astronomy (my proffession) we use bars, not atm's. – **George A. Solodun** Mar 8 '17 at 17:22

Do you mean evaporate or vaporize (boil)? Those are different things. – **jpmc26** Mar 8 '17 at 22:10

@jpmc26 I mean evaporate, as seawater does. – **George A. Solodun** Mar 9 '17 at 3:56

2

Note 1 atm = 1.01325 bar; they're not the same – **khaverim** Mar 9 '17 at 12:59

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3 Answers

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All substances may have a melting and boiling point. I say "may" because in some instances there can be decomposition, for example, before reaching either temperature.

Sodium chloride has a melting and boiling point. Check Wikipedia:

https://en.wikipedia.org/wiki/Sodium_chloride

The sidebar lists the melting point at 801 °C (1,474 °F; 1,074 K) and the boiling point at 1,413 °C (2,575 °F; 1,686 K). The values are relatively high being consistent with the ionic nature of NaCl.

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Pedro O'Verde 342 • 1 • 3 answered Mar 8 '17 at 17:05

1

Some substances do not have a stable liquid at 1 atmosphere. They sublimate rather than melt. – **Jon Custer** Mar 8 '17 at 18:58

1

True. In fact, dry ice is a good example. At 1 atm the solid goes directly into the gas phase. – **Pedro O'Verde** Mar 8 '17 at 19:11

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3

At any temperature there is a certain fraction of a liquid to evaporate, because the temperature in the liquid is not homogeneous across its molecules. You know that from a puddle drying out, even the temperatures are below the boiling point of water. This fraction gives rise to a gas pressure above the liquid called the vapor pressure Check Wiki link. As also stated in the article, such a pressure exists even above a solid, though much smaller. So in that sense, a partial evaporation of salt takes place at any temperature. A much higher evaporation rate at room temperature can be seen in sprays of saline solution, for example at the coast, or in so called graduation towers.

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matchmo 31 • 2 answered Mar 8 '17 at 21:14

1

What is the vapor pressure of sodium chloride at room temperature? Does it correspond to a significant number of particles per liter of gas? – **Tanner Swett** Mar 8 '17 at 23:26

@TannerSwett See answer by Bernard J. Sandman. – **Karsten Theis** Oct 22 at 1:20

add a comment

3

The vapor pressure of sodium vapor is approximately 1.08 E-27 Pascals or 1.08 E-32 Bar at 25 C or 298.15 K, slightly above room temperature. Vapor pressure is so low that the saturated vapor density is 2.55 E-35 grams/cu. cm. with 99.99 % ClNa and 0.01% Cl2Na2 dimer fraction in the vapor. There are only 2.63 E-10 molecules of ClNa Vapor with 3 E-14 moles of Cl2Na2 dimer molecules per liter of gas at this temperature. One molecule of sodium chloride will occupy 3.80 billion liters at this temperature, which is 3,800,000 cubic meters. Therefore, the pressure is so low at 25 C that it will take many times the current age of the universe, 13.8 billion years, just to sublimate one atomic layer of sodium chloride.

Calculations. 1.08 E-32 Bar/83.14462618/298.15K*58.449 molecular weight vapor = 2.55E-35 grams/cm^3. Used NIST 2018 Constant for R molar gas constant 8.314462618 J/(mol-K)*10 = 83.14462618 to get R into correct units when using bar and g/cm^3. 2.55E-35 grams/cm^3 * 1000 cm^3/liter*6.02214076E23 (2018 NIST Avogadro Constant)/58.4426 (molecular weight of salt) = 2.63 E-10 molecules per liter. This is assuming ClNa monomer vapor at room temperature. There is only about 1 part per 10,000 dimers Cl2Na2 at this temperature and can be neglected. However at temperatures above 500 K, the saturated sodium chloride vapor starts to dimerize and polymerize. In addition to monomers, Sodium Chloride however has a significant fraction of dimers and even some higher polymers such as Cl4Na4 in the vapor at its boiling point of approximately 1727 K (1454 C).

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Bernard J. Sandman 39 • 1 answered Oct 21 at 21:51

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