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Solubility of agcl in water

Because the solubility of an ionic compound depends on the product of the concentrations of the ions, this solubility can be greatly affected if there are already some of those ions present in the solution. For example, imagine we have a 0.1 molar solution of sodium chloride. This solution has a $[Na^+] = [Cl^-] = 0.1$ M. Now we try to dissolve some AgCl into this same solution. Silver chloride is fairly insoluble. It has a solubility in pure water of about 2 mg/L. That corresponds to a molar solubility of 1.3×10^{-5} moles/L. Given as a K_{sp} this is 1.8×10^{-10} . However, now the amount of silver chloride that will dissolve will be less. This is because there is a common ion in the solution, chloride. The chloride concentration is already 0.1 M. Therefore the silver concentration will be even less than it would be in the solution of pure water. The silver ion concentration will be reflective of the amount of silver chloride that dissolves since this is the only source of silver ions. In order to find the solubility product constant for silver chloride, you need to determine the equilibrium concentrations of the dissolved ions. As you know, silver chloride is considered insoluble in water, and so when you dissolve this salt, an equilibrium is established in aqueous solution between the undissolved solid and the dissolved ions. $AgCl(s) \rightleftharpoons Ag^+(aq) + Cl^-(aq)$ Now, you are told that when you dissolve silver chloride in water, only 1.9×10^{-4} g per 100 mL of water will dissociate into ions to give a saturated solution of silver chloride. To convert this mass to moles, use the molar mass of silver chloride, $1.9 \times 10^{-4} \text{ g} \times \frac{1 \text{ mole } AgCl}{143.3 \text{ g}} = 1.326 \times 10^{-6} \text{ moles } AgCl$ So, you know for a fact that at the temperature at which you're performing your experiment, only 1.326×10^{-6} moles of silver chloride for every 100 mL of water will dissociate to produce ions. Since every mole of silver chloride that dissociates produces 1 mole of silver(I) cations and 1 mole of chloride anions, you can say that, at equilibrium, your solution will contain 1.326×10^{-6} moles of silver(I) cations and 1.326×10^{-6} moles of chloride anions per 100 mL of water. To calculate the molarity of the ions, scale up the volume to $1 \text{ L} = 10^3 \text{ mL}$ of water, which, for all intents and purposes, will be equal to the volume of the solution. $10^3 \times 1.326 \times 10^{-6} \text{ moles } Ag^+ = 1.326 \times 10^{-3} \text{ moles } Ag^+$ The calculation is the same for the chloride anions, which means that, at equilibrium, your solution contains $[Ag^+] = [Cl^-] = 1.326 \times 10^{-3} \text{ M}$ By definition, the solubility product constant for silver chloride is equal to $K_{sp} = [Ag^+][Cl^-]$ Plug in your values to find—I'll leave the value without added units! $K_{sp} = (1.326 \times 10^{-3})^2 = 1.758 \times 10^{-6}$ Based on the values you have for the volume of water, the answer should be rounded to one significant figure, but if you go by the number of sig figs you have for the mass of silver chloride, you can round the answer to two sig figs. $K_{sp} = 1.8 \times 10^{-10}$ Seawater contains approximately 2-100 ppt of silver, and the surface concentration may be even lower. River water generally contains approximately 0.3-1 ppb of silver. The phytoplankton concentration is 0.1-1 ppm (dry mass), leading to a 104-105 bio concentration factor in seawater. In oyster tissue concentrations of approximately 890 ppm (dry mass) were found. Dissolved in water silver mainly occurs as Ag^+ (aq), and in seawater as $AgCl_2^-$ (aq). In what way and in what form does silver react with water? Silver does not react with pure water. Is it stable in both water and air. Moreover, it is acid and base resistant, but it corrodes when it comes in contact with sulphur compounds. Solubility of silver and silver compounds Under normal conditions silver is water insoluble. This also applies to a number of silver compounds, such as silver sulphide. Some other sulphur compounds are more or less water soluble. For example, silver chloride has a water solubility of 0.1 mg/L, maximum. Silver nitrate has a water solubility of 2450 g/L. Silver fluorides are generally water soluble, but other silver halogens are not. Why is silver present in water? Silver mainly occurs in argenite and stephanite, from which it is released through weathering. In soils it is mainly present in sulphide minerals. Naturally occurring pure silver is extremely rare and is probably formed through the following reaction mechanism: $3 Ag_2S + 2 H_2O \rightarrow 6 Ag + 2 H_2S + SO_2$ Besides gold, silver is the most bendable of all metals. It is known for its high thermal and electrical conductivity, its reflective power and its white colour. It is applied for example in copper, nickel and tungsten alloys. Amalgam is a silver alloy with a high mercury content. In electronics, silver is applied for outlets. Commonly known are applications in jewellery, coins and cutlery. Objects are often provided with a silver layer, including mirrors. Silver compounds play an important role in photo and film production, and are applied in developing chemicals. It serves as a catalyst in many chemical processes. Silver oxides are applied in battery production. Colouring agents for food stuffs, preservatives and disinfectants may contain silver. Silver is added to the atmosphere as AgI to prevent hail. It is generally a by-product of metal refinery, and may be recycled. The 110mAg isotope is applied in nuclear physics. What are the environmental effects of silver in water? Silver is not a dietary requirement for organisms. It may even be lethal to bacteria, and it inhibits fungi reproduction. This is mainly caused by Ag^+ ions. At oral silver uptake by warm-blooded organisms, about 10% is absorbed. Mammal flesh contains approximately 4-24 ppb (dry mass) of silver. Mammals take up silver mainly through plant feed. Plants may absorb silver, although it has no biological use. Values of between 0.03 and 0.5 ppm (dry mass) were measured in the past. Fungi and green algae may even obtain a silver content of 200 ppm (dry mass). Soils do not contain great amounts of silver. However, areas rich in minerals may contain higher amounts. In mining areas soil silver amounts of up to 44 ppm were found. In normal air-dried soil concentrations do not exceed 100 ppb. In water silver and silver compounds are toxic to micro organisms. Fish contain approximately 11 ppm of silver. Silver toxicity to fish is reduced by water. Depending on water hardness, the lethal concentration for freshwater fish lies between 4 and 280 ppm. Freshwater plants tolerate between 30 and 7,500 ppb silver, depending on the species. The lethal concentration for daphnia is approximately 0.25 ppb, and for amphipods at 4,500 ppb. Naturally occurring silver concentrations in soil and surface water do not normally cause any environmental problems. LD50 values were determined for various silver compounds. For silver oxide the LD50 for rats at oral intake is 2820 mg/kg, and for silver nitrate the LD50 for mice at oral intake is 50 mg/kg. For dogs 2.3 g of silver nitrate is lethal. Silver difluoride is extremely toxic, and it is also excellently water soluble. Silver toxicity has a very broad spectrum. Silver is not known to be carcinogenic. However, when it is directly implanted under the skin of animals it can cause cancer. Silver has two stable and twenty four instable (radioactive) isotopes. What are the health effects of silver in water? Silver is not a dietary requirement for humans. The body of an adult contains approximately 2 mg of silver. Our daily intake of silver is 20-80 µg, of which approximately 10% is absorbed. These amounts are not health threatening. In larger amounts, some silver compounds may be toxic, because silver ions have a high affinity for sulphur hydryl and amino groups, and therefore complexation with amino acids, nucleic acids and other compounds occurs in the body. We know the mechanism of toxicity, so we also know a number of detoxification methods. The toxic mechanism is relatively small at oral uptake, because of the low absorption capacity of the body for silver. Silver that ends up in the body is generally deposited in connective tissue, skin and eyes and causes a gray to black colouring. Within 50 years, one is able to accumulate approximately 9 mg of silver. The drinking water guideline for silver is 0.05 mg/L, if a guideline is fixed at all. This is mainly because silver may bind to sulphur in food in boiling water. Silver oxide is harmful upon swallowing, because it irritates the eyes, respiratory tract and skin. Silver nitrate is much more harmful, because it is a strong oxidant. It causes corrosion and at oral uptake it leads to vomiting, dizziness and diarrhoea. At silver salt uptake the body may protect itself by converting them to insoluble silver chlorides. Silver is a bactericide, and may therefore be applied in water disinfection. Which water purification technologies can be applied to remove silver from water? Ionic silver may be removed from water by ion exchange. Some silver compounds may precipitate by coagulation. Two other efficient methods include active carbon filtration and sand filtration. Silver is applied in water purification for swimming pool water disinfection. Only small amounts are applied that are not a health hazard. Literature and the other elements and their interaction with water This example problem demonstrates how to determine the solubility of an ionic solid in water from a substance's solubility product. The solubility product of silver chloride (AgCl) is 1.6×10^{-10} at 25 °C. Calculate the solubility of barium fluoride (BaF2) is 2×10^{-6} at 25 °C. Calculate the solubility of both compounds. The key to solving solubility problems is to properly set up your dissociation reactions and define solubility. Solubility is the amount of reagent that will be consumed to saturate the solution or reach the equilibrium of the dissociation reaction. AgCl The dissociation reaction of AgCl in water is: $AgCl(s) \rightleftharpoons Ag^+(aq) + Cl^-(aq)$ For this reaction, each mole of AgCl that dissolves produces 1 mole of both Ag^+ and Cl^- . The solubility would then equal the concentration of either the Ag^+ or Cl^- ions. $s = [Ag^+] = [Cl^-]$ To find these concentrations, remember this formula for solubility product: $K_{sp} = [A][B]$ For the reaction $AB \rightleftharpoons cA + dB$: $K_{sp} = [Ag^+][Cl^-]$ Since $[Ag^+] = [Cl^-]$: $K_{sp} = [Ag^+]^2 = 1.6 \times 10^{-10}$ $[Ag^+] = \sqrt{1.6 \times 10^{-10}}$ $[Ag^+] = 1.26 \times 10^{-5}$ M solubility of AgCl = $[Ag^+]$ solubility of AgCl = 1.26×10^{-5} M BaF2 The dissociation reaction of BaF2 in water is: $BaF_2(s) \rightleftharpoons Ba^{2+}(aq) + 2 F^-(aq)$ The solubility is equal to the concentration of the Ba ions in solution. For every mole of Ba^{2+} ions formed, 2 moles of F^- ions are produced, therefore: $[F^-] = 2[Ba^{2+}]$ $K_{sp} = [Ba^{2+}][F^-]^2$ $K_{sp} = [Ba^{2+}](2[Ba^{2+}])^2$ $K_{sp} = 4[Ba^{2+}]^3$ $2 \times 10^{-6} = 4[Ba^{2+}]^3$ $[Ba^{2+}]^3 = \frac{2 \times 10^{-6}}{4}$ $[Ba^{2+}]^3 = 5 \times 10^{-7}$ $[Ba^{2+}] = \sqrt[3]{5 \times 10^{-7}}$ $[Ba^{2+}] = 7.94 \times 10^{-3}$ M solubility of BaF 2 = $[Ba^{2+}]$ solubility of BaF 2 = 7.94×10^{-3} M The solubility of silver chloride, AgCl, is 1.26×10^{-5} M at 25 °C. The solubility of barium fluoride, BaF2, is 3.14×10^{-3} M at 25 °C.

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