

How To Prepare Super Saturated Solution Of Copper Sulphate ? Explain The Experiment Please Answer Me I

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PREPARING A SUPER SATURATED SOLUTION OF COPPER SULPHATE IS A FASCINATING CHEMISTRY EXPERIMENT THAT DEMONSTRATES THE CONCEPTS OF SOLUBILITY, SATURATION, AND SUPERSATURATION. SUCH SOLUTIONS ARE HIGHLY CONCENTRATED AND CONTAIN MORE DISSOLVED SUBSTANCE THAN THEY WOULD UNDER NORMAL EQUILIBRIUM CONDITIONS. THIS ARTICLE WILL GUIDE YOU STEP-BY-STEP ON HOW TO PREPARE A SUPER SATURATED SOLUTION OF COPPER SULPHATE, EXPLAIN THE UNDERLYING SCIENCE, AND PROVIDE INSIGHTS INTO THE EXPERIMENT'S PROCEDURE, SAFETY PRECAUTIONS, AND APPLICATIONS. WHETHER YOU ARE A STUDENT, TEACHER, OR CHEMISTRY ENTHUSIAST, UNDERSTANDING THIS PROCESS ENRICHES YOUR KNOWLEDGE OF SOLUTIONS CHEMISTRY.

UNDERSTANDING COPPER SULPHATE AND ITS PROPERTIES

WHAT IS COPPER SULPHATE?

COPPER SULPHATE, ALSO KNOWN AS CuSO_4 , IS A CHEMICAL COMPOUND WIDELY USED IN AGRICULTURE, CHEMISTRY LABS, AND INDUSTRY. IT APPEARS AS BLUE CRYSTALLINE SOLIDS AND IS HIGHLY SOLUBLE IN WATER. ITS COMMON FORM, COPPER SULPHATE PENTAHYDRATE ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$), CONTAINS FIVE WATER MOLECULES PER FORMULA UNIT, GIVING IT A VIVID BLUE COLOR.

SOLUBILITY OF COPPER SULPHATE

THE SOLUBILITY OF COPPER SULPHATE IN WATER VARIES WITH TEMPERATURE:

- AT 20°C , APPROXIMATELY 23.1 GRAMS PER 100 ML OF WATER.
- AT 60°C , APPROXIMATELY 48 GRAMS PER 100 ML OF WATER.
- AT BOILING POINT ($\sim 100^\circ\text{C}$), IT DISSOLVES ALMOST COMPLETELY.

THIS TEMPERATURE DEPENDENCE IS CRUCIAL WHEN PREPARING SUPER SATURATED SOLUTIONS, AS HEATING INCREASES SOLUBILITY, ALLOWING MORE COPPER SULPHATE TO DISSOLVE THAN WOULD BE POSSIBLE AT ROOM TEMPERATURE.

WHAT IS A SUPER SATURATED SOLUTION?

A SUPER SATURATED SOLUTION CONTAINS MORE DISSOLVED SOLUTE THAN THE NORMAL SATURATION LIMIT AT A GIVEN TEMPERATURE. IT IS FORMED BY DISSOLVING SOLUTE AT AN ELEVATED TEMPERATURE AND THEN CAREFULLY COOLING IT. UNDER PROPER CONDITIONS, THE EXCESS SOLUTE REMAINS DISSOLVED TEMPORARILY, CREATING A METASTABLE STATE. THIS SOLUTION IS UNSTABLE AND CAN CRYSTALLIZE SUDDENLY WHEN DISTURBED OR WHEN A SEED CRYSTAL IS INTRODUCED.

MATERIALS AND EQUIPMENT NEEDED

- COPPER SULPHATE CRYSTALS OR POWDER (ANALYTICAL GRADE)
- DISTILLED OR DEIONIZED WATER

- BEAKER (PREFERABLY HEAT-RESISTANT, 250 mL OR LARGER)
- HOT PLATE OR WATER BATH
- STIRRING ROD OR MAGNETIC STIRRER
- THERMOMETER
- FILTER PAPER OR FUNNEL (OPTIONAL)
- DROPPER OR PIPETTE
- SAFETY GOGGLES AND GLOVES
- HEAT-RESISTANT CONTAINER OR FLASK
- COOLING SETUP (E.G., ICE BATH OR REFRIGERATOR)

STEP-BY-STEP PROCEDURE FOR PREPARING A SUPER SATURATED COPPER SULPHATE SOLUTION

1. MEASURE THE WATER

- POUR ABOUT 100 mL OF DISTILLED WATER INTO THE BEAKER.
- USE A THERMOMETER TO MONITOR WATER TEMPERATURE.

2. HEAT THE WATER

- PLACE THE BEAKER ON A HOT PLATE OR WATER BATH.
- HEAT THE WATER GRADUALLY UNTIL IT REACHES NEAR BOILING TEMPERATURE ($\sim 100^{\circ}\text{C}$).
- DO NOT LET IT BOIL VIGOROUSLY; GENTLE HEATING IS SUFFICIENT.

3. DISSOLVE COPPER SULPHATE

- GRADUALLY ADD COPPER SULPHATE CRYSTALS OR POWDER TO THE HOT WATER WHILE STIRRING CONTINUOUSLY.
- CONTINUE ADDING UNTIL NO MORE DISSOLVES, AND THE SOLUTION BECOMES SATURATED.
- AS THE SOLUTION APPROACHES SATURATION, THE CRYSTALS WILL DISSOLVE MORE SLOWLY.

4. ENSURE COMPLETE DISSOLUTION

- KEEP THE SOLUTION STIRRED AND MAINTAINED AT HIGH TEMPERATURE UNTIL ALL COPPER SULPHATE DISSOLVES COMPLETELY.
- CONFIRM THAT THE SOLUTION IS CLEAR AND FREE OF UNDISSOLVED PARTICLES.

5. FILTER THE SOLUTION (OPTIONAL)

- TO REMOVE ANY IMPURITIES OR UNDISSOLVED PARTICLES, FILTER THE HOT SOLUTION USING FILTER PAPER AND A FUNNEL.
- THIS STEP ENSURES A PURE SOLUTION, IMPORTANT FOR PRECISE EXPERIMENTS.

6. COOLING THE SOLUTION

- REMOVE THE SOLUTION FROM HEAT CAREFULLY, MAINTAINING IT IN A CONTAINER THAT CAN WITHSTAND TEMPERATURE CHANGES.
- ALLOW THE SOLUTION TO COOL SLOWLY AT ROOM TEMPERATURE WITHOUT DISTURBANCE.
- ALTERNATIVELY, PLACE THE CONTAINER IN AN ICE BATH TO ACCELERATE COOLING.

7. ACHIEVING SUPER SATURATION

- AS THE SOLUTION COOLS, IT REMAINS SUPERSATURATED—MORE COPPER SULPHATE STAYS DISSOLVED THAN AT ROOM TEMPERATURE.
- TO TEST SUPER SATURATION, CAREFULLY INTRODUCE A SMALL CRYSTAL OF COPPER SULPHATE OR A FINE SEED CRYSTAL INTO THE SOLUTION.
- IF THE SOLUTION IS SUPER SATURATED, CRYSTALLIZATION WILL OCCUR SUDDENLY, FORMING A VISIBLE MASS OF CRYSTALS.

UNDERSTANDING THE SCIENCE BEHIND THE EXPERIMENT

SOLUBILITY AND TEMPERATURE RELATIONSHIP

THE CORE PRINCIPLE IN PREPARING A SUPER SATURATED SOLUTION IS LEVERAGING THE TEMPERATURE-DEPENDENT SOLUBILITY OF COPPER SULPHATE. HEATING INCREASES SOLUBILITY, ALLOWING MORE SOLUTE TO DISSOLVE. COOLING THE SOLUTION REDUCES SOLUBILITY, BUT THE EXCESS SOLUTE REMAINS DISSOLVED TEMPORARILY IN A SUPER SATURATED STATE.

METASTABILITY OF SUPER SATURATED SOLUTIONS

SUPER SATURATED SOLUTIONS ARE UNSTABLE AND CAN RAPIDLY CRYSTALLIZE WHEN DISTURBED OR WHEN A SEED CRYSTAL IS INTRODUCED. THIS SUDDEN CRYSTALLIZATION DEMONSTRATES THE PRINCIPLE OF NUCLEATION, WHERE THE FORMATION OF STABLE CRYSTAL NUCLEI TRIGGERS RAPID CRYSTAL GROWTH.

APPLICATIONS OF SUPER SATURATED COPPER SULPHATE SOLUTIONS

- CRYSTALLIZATION EXPERIMENTS DEMONSTRATING CRYSTAL GROWTH.
- QUALITATIVE ANALYSIS AND TEACHING SOLUBILITY PRINCIPLES.
- INDUSTRIAL APPLICATIONS LIKE ELECTROPLATING AND FUNGICIDES.

SAFETY PRECAUTIONS

- ALWAYS WEAR SAFETY GOGGLES AND GLOVES WHEN HANDLING COPPER SULPHATE, AS IT CAN BE TOXIC IF INGESTED OR IF IT COMES INTO CONTACT WITH SKIN.
- CONDUCT THE EXPERIMENT IN A WELL-VENTILATED AREA.
- BE CAUTIOUS WHILE HANDLING HOT WATER TO PREVENT BURNS.
- DISPOSE OF COPPER SULPHATE SOLUTIONS RESPONSIBLY, FOLLOWING LOCAL REGULATIONS.

TIPS FOR SUCCESS IN PREPARING SUPER SATURATED COPPER SULPHATE

- USE PURE, DRY COPPER SULPHATE CRYSTALS TO ENSURE CLARITY.
- HEAT THE SOLUTION GRADUALLY TO AVOID BOILING OVER.
- DO NOT DISTURB THE SOLUTION DURING COOLING.
- COOL SLOWLY AT ROOM TEMPERATURE FOR BETTER SUPER SATURATION STABILITY.
- USE A SEED CRYSTAL CAREFULLY TO INITIATE CRYSTALLIZATION IF NEEDED.

CONCLUSION

PREPARING A SUPER SATURATED SOLUTION OF COPPER SULPHATE IS AN INSIGHTFUL EXPERIMENT THAT BEAUTIFULLY ILLUSTRATES THE PRINCIPLES OF SOLUBILITY, TEMPERATURE DEPENDENCE, AND NUCLEATION. BY CAREFULLY HEATING THE SOLUTION TO DISSOLVE MAXIMUM COPPER SULPHATE AND THEN COOLING IT SLOWLY, YOU CREATE A METASTABLE ENVIRONMENT WHERE THE EXCESS SOLUTE REMAINS DISSOLVED TEMPORARILY. THIS PROCESS NOT ONLY DEEPENS UNDERSTANDING OF SOLUTION CHEMISTRY BUT ALSO PROVIDES A FOUNDATION FOR NUMEROUS PRACTICAL APPLICATIONS IN SCIENCE AND INDUSTRY. REMEMBER TO FOLLOW SAFETY PRECAUTIONS AND PRECISE PROCEDURES FOR THE BEST RESULTS.

FAQs

1. **CAN I PREPARE A SUPER SATURATED SOLUTION AT HOME?** YES, WITH PROPER PRECAUTIONS, HEATING, AND COOLING, YOU CAN PREPARE IT AT HOME OR IN A SCHOOL LAB.
2. **WHAT HAPPENS IF I DISTURB THE SUPER SATURATED SOLUTION?** CRYSTALLIZATION OCCURS RAPIDLY, FORMING CRYSTALS AND RELEASING EXCESS SOLUTE.
3. **HOW CAN I TELL IF MY SOLUTION IS SUPER SATURATED?** IT REMAINS CLEAR AND DISSOLVED UNTIL DISTURBED OR SEEDED, THEN CRYSTALS FORM SUDDENLY.
4. **IS COPPER SULPHATE SAFE TO HANDLE?** IT IS TOXIC; HANDLE WITH CARE, WEAR PROTECTIVE GEAR, AND DISPOSE OF IT RESPONSIBLY.

FREQUENTLY ASKED QUESTIONS

WHAT ARE THE STEPS TO PREPARE A SUPER SATURATED SOLUTION OF COPPER SULPHATE?

TO PREPARE A SUPER SATURATED SOLUTION OF COPPER SULPHATE, FIRST DISSOLVE A LARGE AMOUNT OF COPPER SULPHATE CRYSTALS IN HOT WATER UNTIL NO MORE DISSOLVES, THEN SLOWLY COOL THE SOLUTION WITHOUT DISTURBANCE. THIS PROCESS RESULTS IN A SOLUTION THAT CONTAINS MORE DISSOLVED COPPER SULPHATE THAN IT CAN AT ROOM TEMPERATURE, CREATING A SUPER SATURATED STATE.

WHY DOES COOLING A HOT COPPER SULPHATE SOLUTION CREATE A SUPER SATURATED SOLUTION?

COOLING A HOT COPPER SULPHATE SOLUTION CAUSES THE DISSOLVED COPPER SULPHATE TO BECOME SUPERSATURATED BECAUSE THE SOLUBILITY DECREASES WITH TEMPERATURE. IF COOLED SLOWLY AND UNDISTURBED, THE EXCESS DISSOLVED MATERIAL REMAINS IN SOLUTION TEMPORARILY, FORMING A SUPER SATURATED SOLUTION.

WHAT SAFETY PRECAUTIONS SHOULD BE TAKEN WHILE PREPARING A SUPER SATURATED COPPER SULPHATE SOLUTION?

WHEN PREPARING A SUPER SATURATED COPPER SULPHATE SOLUTION, WEAR GLOVES AND SAFETY GOGGLES TO HANDLE CHEMICALS SAFELY, WORK IN A WELL-VENTILATED AREA, AND AVOID INHALING DUST OR FUMES. ADDITIONALLY, HANDLE HOT SOLUTIONS CAREFULLY TO PREVENT BURNS.

How can you demonstrate the super saturation of the copper sulphate solution in the experiment?

You can demonstrate super saturation by carefully placing a small crystal of copper sulphate into the cooled, supersaturated solution. If the solution is truly super saturated, the crystal will rapidly grow as the excess copper sulphate crystallizes out, showing the excess dissolved material.

What is the role of temperature in preparing a super saturated copper sulphate solution?

Temperature plays a crucial role because dissolving more copper sulphate at high temperature creates a solution that can hold more dissolved substance. Cooling the solution slowly without disturbance maintains the supersaturation condition, as the excess dissolved copper sulphate does not crystallize immediately.

Can a super saturated solution of copper sulphate be stored indefinitely?

No, a super saturated solution is thermodynamically unstable and may crystallize spontaneously if disturbed or if a seed crystal is introduced, causing the excess copper sulphate to crystallize out. Therefore, it cannot be stored indefinitely without crystallization.

Explain the scientific principle behind the formation of a super saturated copper sulphate solution.

The scientific principle is based on the solubility of copper sulphate decreasing with temperature. Heating increases solubility, allowing more copper sulphate to dissolve. Cooling slowly without disturbance traps extra dissolved copper sulphate in solution, creating a super saturated state that is unstable and prone to sudden crystallization.

Additional Resources

How To Prepare Super Saturated Solution Of Copper Sulphate? Explain The Experiment

Preparing a super saturated solution of copper sulphate is a fascinating and educational experiment that demonstrates the principles of solubility, saturation, and crystallization. A super saturated solution of copper sulphate is a solution that contains more dissolved copper sulphate than would normally be possible at a given temperature. This state is achieved through careful heating and cooling processes, allowing the solution to hold excess solute without crystallizing immediately. Understanding how to prepare such a solution not only deepens your knowledge of chemistry but also provides insight into various industrial and laboratory applications.

Understanding the Concept of Super Saturation

Before diving into the step-by-step process, it's essential to understand what a super saturated solution is. Normally, a solvent can only dissolve a certain maximum amount of solute at a specific temperature, known as the saturation point. When the solution is heated, its capacity to dissolve solute increases. If you dissolve more solute than the maximum at a higher temperature and then carefully cool the solution, it can remain in a metastable state—supersaturated or super saturated—containing more dissolved solute than normally possible.

Key points:

- Super saturated solutions are unstable and can crystallize rapidly if disturbed.
- They are used in crystal growing experiments and some industrial processes.
- Copper sulphate is a common compound used in such experiments due to its vivid blue color and high solubility.

MATERIALS NEEDED

TO PREPARE A SUPER SATURATED SOLUTION OF COPPER SULPHATE, GATHER THE FOLLOWING MATERIALS:

- PURE COPPER SULPHATE PENTAHYDRATE ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) – THE SOLUTE
- DISTILLED OR DEIONIZED WATER – THE SOLVENT
- BEAKER (PREFERABLY 250 ML OR 500 ML)
- GLASS ROD OR STIRRING ROD
- BUNSEN BURNER OR WATER BATH (FOR HEATING)
- THERMOMETER – TO MONITOR TEMPERATURE
- FILTER PAPER AND FUNNEL (FOR FILTERING, IF NECESSARY)
- HOT PLATE OR STOVE (IF A WATER BATH IS NOT AVAILABLE)
- ICE BATH OR COLD WATER – FOR COOLING
- SAFETY EQUIPMENT – GLOVES, GOGGLES, LAB COAT

STEP-BY-STEP GUIDE TO PREPARING A SUPER SATURATED SOLUTION

1. MEASURE THE WATER

BEGIN BY MEASURING A SPECIFIC VOLUME OF DISTILLED WATER, TYPICALLY BETWEEN 100 ML TO 200 ML, DEPENDING ON YOUR EXPERIMENT'S SCALE. USE A GRADUATED CYLINDER FOR ACCURACY.

2. HEAT THE WATER

POUR THE WATER INTO THE BEAKER AND GENTLY HEAT IT USING A BUNSEN BURNER OR HOT PLATE. BE CAUTIOUS TO AVOID BOILING OVER OR SPLATTERING. THE GOAL IS TO HEAT THE WATER TO A TEMPERATURE WHERE ITS CAPACITY TO DISSOLVE COPPER SULPHATE INCREASES SIGNIFICANTLY—USUALLY AROUND 60°C TO 70°C.

3. ADD COPPER SULPHATE GRADUALLY

WHILE STIRRING WITH A GLASS ROD, SLOWLY ADD COPPER SULPHATE CRYSTALS INTO THE HEATED WATER. CONTINUE ADDING UNTIL NO MORE CRYSTALS DISSOLVE AND A SMALL AMOUNT OF UNDISSOLVED CRYSTALS REMAINS AT THE BOTTOM OF THE BEAKER. THIS INDICATES THAT THE SOLUTION HAS REACHED ITS SATURATION POINT AT THAT TEMPERATURE.

TIP: TO ENSURE YOU REACH THE TRUE SATURATION POINT, KEEP ADDING COPPER SULPHATE UNTIL YOU SEE SOME CRYSTALS REMAIN UNDISSOLVED, CONFIRMING THE MAXIMUM SOLUBILITY AT THAT TEMPERATURE.

4. DISSOLVE THE COPPER SULPHATE COMPLETELY

MAINTAIN THE TEMPERATURE AND CONTINUE STIRRING UNTIL ALL THE CRYSTALS THAT CAN DISSOLVE AT THAT TEMPERATURE ARE FULLY DISSOLVED. IF NECESSARY, GENTLY REHEAT THE SOLUTION TO HELP DISSOLVE ANY REMAINING CRYSTALS.

5. FILTER THE SOLUTION (OPTIONAL)

POUR THE HOT SOLUTION THROUGH FILTER PAPER AND A FUNNEL INTO ANOTHER BEAKER TO REMOVE ANY IMPURITIES OR UNDISSOLVED PARTICLES. USE CAUTION TO AVOID LOSING SOLUTION DURING FILTRATION.

6. ALLOW THE SOLUTION TO COOL SLOWLY

THIS IS THE CRITICAL STEP IN PREPARING A SUPER SATURATED SOLUTION. CAREFULLY COOL THE SATURATED SOLUTION TO ROOM TEMPERATURE OR BELOW, WITHOUT DISTURBING IT. TO FACILITATE THIS, YOU CAN PLACE THE BEAKER IN A WATER BATH OR AN ICE BATH, ENSURING THE COOLING IS SLOW AND UNIFORM.

THE SLOW COOLING PROCESS ENCOURAGES THE SOLUTION TO BECOME SUPER SATURATED—HOLDING MORE COPPER SULPHATE THAN IT WOULD AT ROOM TEMPERATURE.

How To Verify Super Saturation

AFTER COOLING, THE SOLUTION APPEARS CLEAR AND HOLDS MORE DISSOLVED COPPER SULPHATE THAN THE MAXIMUM SOLUBILITY AT THAT TEMPERATURE.

TO TEST SUPER SATURATION:

- GENTLY DISTURB THE SOLUTION BY TAPPING OR INSERTING A SMALL CRYSTAL OF COPPER SULPHATE.
- IF IT RAPIDLY CRYSTALLIZES AND FORMS A SOLID MASS, THE SOLUTION WAS SUPER SATURATED.
- CRYSTALLIZATION INDICATES THE EXCESS SOLUTE HAS BEGUN TO COME OUT OF SOLUTION DUE TO DISTURBANCE.

CRYSTALLIZATION EXPERIMENT: VISUALIZING SUPER SATURATION

OBJECTIVE: TO OBSERVE CRYSTAL GROWTH FROM A SUPER SATURATED SOLUTION.

PROCEDURE:

1. CAREFULLY PLACE A SMALL CRYSTAL OF COPPER SULPHATE INTO THE SUPER SATURATED SOLUTION.
2. OBSERVE THE RAPID CRYSTALLIZATION PROCESS, WHERE THE EXCESS COPPER SULPHATE CRYSTALLIZES OUT, FORMING BEAUTIFUL BLUE CRYSTALS.
3. RECORD THE TIME TAKEN FOR CRYSTALS TO APPEAR AND GROW.

NOTE: THIS EXPERIMENT VIVIDLY DEMONSTRATES THE UNSTABLE NATURE OF SUPER SATURATED SOLUTIONS.

SAFETY PRECAUTIONS

- ALWAYS WEAR GLOVES, GOGGLES, AND A LAB COAT WHEN HANDLING CHEMICALS AND HEATING SOLUTIONS.
- PERFORM HEATING IN A WELL-VENTILATED AREA, AWAY FROM FLAMMABLE MATERIALS.
- BE CAUTIOUS WHILE HANDLING HOT LIQUIDS TO PREVENT BURNS.
- DISPOSE OF CHEMICALS RESPONSIBLY ACCORDING TO LOCAL REGULATIONS.

APPLICATIONS OF SUPER SATURATED COPPER SULPHATE SOLUTIONS

SUPER SATURATED SOLUTIONS OF COPPER SULPHATE ARE USED IN VARIOUS FIELDS:

- CRYSTAL GROWING: PRODUCING LARGE, WELL-FORMED COPPER SULPHATE CRYSTALS FOR EDUCATIONAL DEMONSTRATIONS.
- INDUSTRIAL PROCESSES: USED IN ELECTROPLATING AND AS A FUNGICIDE.
- EDUCATIONAL DEMONSTRATIONS: TEACHING CONCEPTS OF SOLUBILITY, SATURATION, AND CRYSTALLIZATION.

CONCLUSION

PREPARING A SUPER SATURATED SOLUTION OF COPPER SULPHATE INVOLVES PRECISE CONTROL OF TEMPERATURE AND CAREFUL HANDLING. BY DISSOLVING EXCESS COPPER SULPHATE AT ELEVATED TEMPERATURES AND THEN SLOWLY COOLING THE SOLUTION, YOU CREATE A METASTABLE STATE WHERE THE SOLUTION CONTAINS MORE DISSOLVED SOLUTE THAN NORMALLY POSSIBLE. THIS EXPERIMENT NOT ONLY ENHANCES UNDERSTANDING OF FUNDAMENTAL CHEMISTRY PRINCIPLES BUT ALSO PROVIDES A VISUALLY APPEALING DEMONSTRATION OF CRYSTAL GROWTH AND SOLUTION STABILITY.

WITH PATIENCE, CAREFUL OBSERVATION, AND ADHERENCE TO SAFETY PROTOCOLS, ANYONE WITH A BASIC CHEMISTRY SETUP CAN SUCCESSFULLY PREPARE AND OBSERVE A SUPER SATURATED COPPER SULPHATE SOLUTION, DEEPENING THEIR APPRECIATION

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