

Chemical Engineer's Solutions Suite

Platform: Windows

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[Table of Contents](#)

[Back to Product List](#)

CHEMICAL ENGINEER'S SOLUTIONS SUITE

File Edit Bookmarks Help
Contents Go Back History Search << >>

ANALYSIS OF A SATURATED SOLUTION

Calculation Procedure:

1. Compute the precipitate when the solution is cooled

When a solid is dissolved in water (or any other solvent liquid), the resulting solution is termed saturated when at a given temperature the solvent cannot dissolve any more of the solid. Most solvents dissolve (hold) more solids at higher temperatures than at lower temperatures. Thus, when the solution temperature is lowered or a portion of the solvent is evaporated, the solution becomes supersaturated and solid material may precipitate. This is the basis of crystallization, a chemical engineering operation frequently used to produce a pure solid.

Referring to Fig. 1, obtain these solubilities: at 80°C
KClO₃ solubility = 10.5 g per 100 g of H₂O.

The weight of the water at 80°C (176°F) = (1000 g/kg). Now, the weight of KClO₃ that any solvent can dissolve at this temperature, is (solubility of KClO₃ at the given temperature) × (weight of water) = (10.5 g/100 g of water) × (1000 g) = 105 g (368.8 kg) of KClO₃ dissolved by the water at 80°C.

at 30°C (86°F) with the same quantity of water but the solubility is only 4.5 g per 100 g of water. (8103)(4.5 g per 100 g) = 3651.15 g (8103)(10.5 g per 100 g) = 851.15 g (386.8 kg) of KClO₃ dissolved at 30°C (86°F).
When the temperature of the water (solvent) is reduced, the weight of KClO₃ dissolved at 80°C (176°F) - weight of KClO₃ dissolved at 30°C (86°F) = weight of KClO₃ precipitated.

Note that the same procedure can be followed for any other solid dissolved in any other solvent. The only difference is the solubility data used.

2. Compute the precipitate when a portion of the solvent is evaporated

Since half the solvent (water in this case) is evaporated, the weight of water is now 500 g (110.23 kg).
Using the solubility of KClO₃ as before, except that the weight of water is now 500 g, the weight of KClO₃ dissolved at 80°C (176°F) = (10.5 g/100 g of water) × (500 g) = 52.5 g (11.67 kg) of KClO₃.
The weight of KClO₃ precipitated = 105 g (368.8 kg) - 52.5 g (11.67 kg) = 52.5 g (11.67 kg).

Fig. 1 - Solubility of KClO₃.

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Temperature °F
32 50 68 86 104 122 140 158 176 194 212

Temperature °C
0 10 20 30 40 50 60 70 80 90 100

Solubility g KClO₃/100 g H₂O
0 10 20 30 40 50 60

Source of data: Perry

Temperature °F	Temperature °C	Solubility g KClO ₃ /100 g H ₂ O
32	0	3.3
50	10	4.0
68	20	4.4
86	30	4.5
104	40	5.0
122	50	6.0
140	60	7.5
158	70	9.5
176	80	10.5
194	90	12.5
212	100	17.0

The Chemical Engineer's Solutions Suite includes topics such as chemical mixing, batch processing, pumps, piping, steam transmission, energy savings, waste heat, gas and vapor disposal, separators, and storage tanks

Chemical Engineer's Solutions Suite



TABLE OF CONTENTS (page 1 of 1)

Chemical Engineering

Analysis of a Saturated Solution
Ternary Liquid System Analysis
Determining the Heat of Mixing of Chemicals
Chemical Equation Material Balance
Batch Physical Process Balance
Steady-State Continuous Physical Balance with Recycle and Bypass
Steady-State Continuous Physical Process Balance
Crusher Power Input Determination
Cooling-Water Flow Rate for Chemical-Plant Mixers
Liquid-Liquid Separation Analysis

Process Plant Engineering

Designing Steam Tracing for Piping
Steam Tracing a Vessel Bottom to Keep the Contents Fluid
Designing Steam-Transmission Lines without Steam Traps
Saving Energy Loss from Storage Tanks and Vessels
Saving Energy Costs by Relocating Heat-Generating Units
Energy Savings from Vapor Recompression
Effective Stack Height for Disposing Plant Gases and Vapors
Excess-Air Analysis to Reduce Waste-Heat Losses
Sizing Vertical Liquid-Vapor Separators
Sizing a Horizontal Liquid-Vapor Separator
Sizing Rupture Disks for Gases and Liquids
Time Needed to Empty a Storage Vessel without Dished Ends
Determining the Friction Factor for Flow of Bingham Plastics
Time Needed to Empty a Storage Vessel with Dished Ends
Checking the Vacuum Rating of a Storage Vessel
Designing Prismatic Pressure Vessels
Minimum-Cost Pressure Vessels

[Back to Product List](#)