# Iron chloride test, Formation of verdigris (Item No.: P7172900)



# Task and equipment

## Information for teachers

### Learning objectives

- Formic acid and acetic acid exhibit some reactions typical for carboxylic acids, and can so be distinguished from other • acids.
- Typical reactions are the red colouration on the addition of iron(III) chloride and the formation of verdigris.

### Notes on setup and procedure

Preparation: Provide the following solutions: Formic acid, 50% (140 ml) Acetic acid, 10% (11 ml) Acetic acid, 50% (132 ml) Sodium carbonate solution, 10% (11 g) Sodium formate solution, 10% (11 g) Sodium acetate solution, 10% (11 g) Iron (III) chloride solution, 10% (11 g). All of the quantities given refer to the quantity of substance which should be added to 100 ml water. The concentrations stated can be varied slightly.

#### Remarks on the students experiments:

The addition of iron(III) chloride solution should be stopped when a red colouration is shown. Ensure that the test tubes are carefully heated, as the solutions have a tendency towards delayed boiling.



# Hazard and precautionary statements



### Teacher's/Lecturer's Sheet

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Formic acid:	
H226:	Flammable liquid and vapour.
H314:	Causes severe skin burns and eye damage.
P260:	Do not breathe dust/fume/gas/mist/vapours/spray.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P301 + P330 + P331:	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
P309 + P310:	IF exposed or you feel unwell: Immediately call a POISON CENTER or doctor/physician.
Acetic acid:	
H226:	Flammable liquid and vapour.
H314:	Causes severe skin burns and eye damage.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P301 + P330 + P331:	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P307 + P310:	IF exposed: Immediately call a POISON CENTER or doctor/physician.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
Sodium carbonate:	
H319:	Causes serious eye irritation.
P260:	Do not breathe dust/fume/gas/mist/vapours/spray.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
Iron(III) chloride:	
H302:	Harmful if swallowed.
H315:	Causes skin irritation.
H318:	Causes serious eye damage.
H317:	May cause an allergic skin reaction.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P301 + P312:	IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.
P302 + P352:	IF ON SKIN: Wash with soap and water.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
P310:	Immediately call a POISON CENTER or doctor/physician.
P501:	Dispose of contents/ containers to be collected by a licensed contractor in accordance with national and local regulations.

#### Hazards

- Formic acid and acetic acid are corrosive! Wash splashes off the skin with copious water!
- Wear protective glasses!
- Copper compounds are poisonous. Do not swallow them!

#### Notes

Short-chain carboxylic acids react with  $Fe^{3+}$  ions to form red-coloured complexes of the type  $[Fe_3(OH^-)_2(HCOO^-)_6]^{1+}[HCOO]^{1-}$ , which decompose to brown iron(II) oxyhydrate on heating. Verdigris is basic copper acetate  $Cu(CH_3COO)_2 \cdot Cu(OH)_2$ . Naturally occurring verdigris forms in the presence of  $CO_2$ , CO and moisture in the air with basic copper carbonate as intermediate. The verdigris formation is not very specific, as the other short-chain carboxylic acids also form similarly structured copper compounds.

### **Remarks on the method**

It could be useful to show in a parallel demonstration experiment that pure acetic acid does not give a red-colouration. Working in groups is recommended for this experiment, so that the time until the formation of verdigris can be utilized. One group can carry out the iron chloride test while a second group starts the experiment on verdigris formation.

### Waste disposal



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## **Teacher's/Lecturer's Sheet**

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- Pour all liquids in the container for acidic and alkali waste.
- Either recycle copper foil or put strips coated with verdigris in the heavy metals waste.

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# Iron chloride test, Formation of verdigris (Item No.: P7172900)

# Task and equipment

#### Task

### How can acetic acid and formic acid be recognized?

Examine acetic acid and formic acid for some specific reactions.





# Equipment



Position No.	Material	Order No.	Quantity
1	Test tube rack for 12 tubes, holes d= 22 mm, wood	37686-10	1
2	Graduated cylinder, 10 ml, plastic	36636-00	1
3	Test tube brush w. wool tip,d25mm	38762-00	1
4	Glass beaker DURAN®, short, 150 ml	36012-00	2
5	Test tube, 180x18 mm,100pcs	37658-10	(3)
6	Test tube,180x20 mm,DURAN, PN19	36293-00	1
7	Test tube holder, up to d 22mm	38823-00	1
8	Tweezers, I = 130 mm, straight, blunt	64610-00	1
9	Glass beaker DURAN®, short, 250 ml	36013-00	1
10	Crucible tongs,200mm,stainl.steel	33600-00	1
11	Scissors, I = 110 mm, straight, point blunt	64616-00	1
12	Pipette with rubber bulb	64701-00	1
13	Protecting glasses, clear glass	39316-00	1
14	Erlenmeyer flask 100 ml, narrow neck, PN 19	36418-00	1
	Butane burner f.cartridge 270+470	47536-00	1
	Butane catridge CV 300 Plus, 240 g	47538-01	1
	Formic acid 98-100% 250 ml	30021-25	1
	Iron-III chloride, 250 g	30069-25	1
	Copper foil, 0.1 mm, 100 g	30117-10	1
	Sodium acetate trihydrate, 250 g	30149-25	1
	Sodium carbonate, anhyd. 1000 g	30154-70	1
	Sodium formate 250 g	30156-25	1
	Water, distilled 5	31246-81	1
	Acetic acid 99100%, pure 1 l	31301-70	1
	Indicator paper, pH1-14, roll	47004-02	1



# Set-up and procedure

### Set-up

#### Hazards

- Formic acid and acetic acid are corrosive! Wash splashes off the skin with copious water!
- Wear protective glasses!
- Copper compounds are poisonous. Do not swallow them!



## Procedure

Number the test tubes from 1 to 3.

Pour 5 ml of 10% acetic acid into an Erlenmeyer flask and add sodium carbonate solution until no further evolution of gas is seen. Check with a strip of indicator paper if the acid has been neutralized, add more sodium carbonate solution if necessary.

Fill a test tube one third full with the neutralized solution (Fig. 1), add a few drops of iron(III) chloride solution (Fig. 2) and shake gently to mix the liquids. Heat the solution to boiling (Fig. 3).









Fill another test tube one third full with sodium acetate solution. Again add a few drops of iron(III) chloride solution and heat the liquid.

Cut 3 strips out from the copper foil, each about 1 cm wide and 5 cm long. Fill 50% formic acid in a beaker to a height of approx. 3 cm, and the same amount of 50% acetic acid in two other beakers (150 ml and 250 ml). Put one strip of copper foil in the beaker containing the formic acid, and another in the 150 ml beaker containing acetic acid (Fig. 4).



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Heat the third strip of copper foil to glowing and then put it directly into the 250 ml beaker (Fig. 5). Allow the three beakers to stand somewhere with free access of air for about 2 weeks. Note your observations during this time.



### Waste disposal

- Pour all liquids in the container for acidic and alkali waste.
- Either recycle copper foil or put strips coated with verdigris in the heavy metals waste.

# **Report: Iron chloride test, Formation of verdigris**

#### **Result - Observations**

Note the observations you make in general form.

a) Reaction with iron(III) chloride.

b) Reaction with copper foil.

### Result - Table 1

Summarize your observations in the table.

Reactants	Reaction
Neutralized acetic acid + iron(III)-chloride	red colouration <sup>1</sup>
Sodium acetate + iron(III)-chloride	a brown precipitate is formed on heating 1
Sodium formate + iron(III)-chloride	a brown precipitate is formed on heating 1
formic acid + copper foil	a green coating is formed
acetic acid + copper foil	the solution is coloured green 1



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#### **Evaluation - Question 1**

Draw conclusions from your observations.

a) Reaction with iron(III) chloride.

b) Reaction with copper foil.

### **Evaluation - Question 2**

Formulate the equations for the reactions which took place.



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#### **Evaluation - Question 3**

Enter the properties of formic acid which have been observed up to now in the general data sheet, look up missing entries in your text book to fill it in completely.

Name of substance:	Formic acid
	HCOOH 1
	colourless 1
	liquid 1
	8.4 °C
	100.5 °C
	biting smell; colours indicators like other acids; reacts with metals formic hydrogen; 1
	corrosive; inhibits bacterial growth;
	the salts (formates) form red-coloured compelexes with iron(III) chloride
	ants; stinging nettles; fir-needles; 1
	is formed by the oxidation of formaldehyde or the thermal decomposition of oxalic acid
	preservative 1



#### **Student's Sheet**

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# **Evaluation - Question 4**

Enter the properties of acetic acid which have been observed up to now in the general data sheet, look up missing entries in your text book to fill it in completely.

Name of substance:	Acetic acid
	CH <sub>3</sub> COOH 1
	colourless 1
	liquid 1
	16.6 °C
	118 °C
	biting smell; colours indicators like other acids; reacts with metals formic hydrogen; 1
	corrosive; inhibits bacterial growth;
	the salts (acetates) form red-coloured compelexes with iron(III) chloride
	constituent of wood vinegar; 1
	formed by the oxidation of acetaldehyde and the dry distillation of wood
	vinegar 1



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