
Iron

For water and seawater

1,10-Phenanthroline, FerroZine, TPTZ and
Titration Methods

Introduction

Natural waters contain variable, but minor, amounts of iron, despite its universal distribution and abundance. Iron in ground waters is normally present in the ferrous (Fe^{2+}), or soluble state, which oxidizes easily to ferric (Fe^{3+}) iron on exposure to air. Iron can enter a water system from leaching of natural deposits, iron-bearing industrial wastes, effluents of pickling operations, or from acidic mine drainage.

Iron in domestic water supply systems stains laundry and porcelain, causing more of a nuisance than a potential health hazard. Taste thresholds of iron in water, 0.1 mg/L for Fe^{2+} and 0.2 mg/L for Fe^{3+} , result in a bitter or astringent taste. Water used in industrial processes must contain less than 0.2 mg/L of total iron.

Three methods of colorimetric iron analysis are used in Hach procedures. The 1,10-Phenanthroline Method is the best-known test for iron. The Fe^{2+} procedure uses Ferrous Iron Reagent Powder containing 1,10-Phenanthroline as an indicator. Total iron determination or analysis uses FerroVer Iron Reagent. FerroVer Iron Reagent contains 1,10-Phenanthroline, combined with a reducing agent, to convert all but the most resistant forms of iron present in the sample to Fe^{2+} .

The FerroZine Method for total iron is more than twice as sensitive as the 1,10-Phenanthroline Method. Researchers at Hach have patented a process to manufacture high purity FerroZine Iron Reagent, ideal for iron measurement, in economical quantities. FerroZine is highly specific for iron, forms an intensely-colored stable complex and performs in the pH range of 3–7.5. The FerroZine Method requires boiling to dissolve rust.

The TPTZ Method for total iron has the advantages of simplicity, sensitivity and freedom from common interferences. Iron in the sample, including precipitated or suspended iron such as rust, is converted to Fe^{2+} by a reducing agent. A highly colored Fe^{2+} -TPTZ complex is formed.

Hach Methods also include a high-range titration procedure utilizing sulfosalicylic acid as the indicator and EDTA as the titrant.

Chemical reactions

1,10-Phenanthroline method

1,10-Phenanthroline, contained in Ferrous Iron Reagent Powder, reacts with Fe^{2+} to form a characteristic orange-colored complex. The intensity of color development is directly proportional to the amount of Fe^{2+} in the sample. Total iron also can be determined with FerroVer Iron Reagent. (When Environmental Protection Agency reporting is necessary, digestion of the sample is also required)

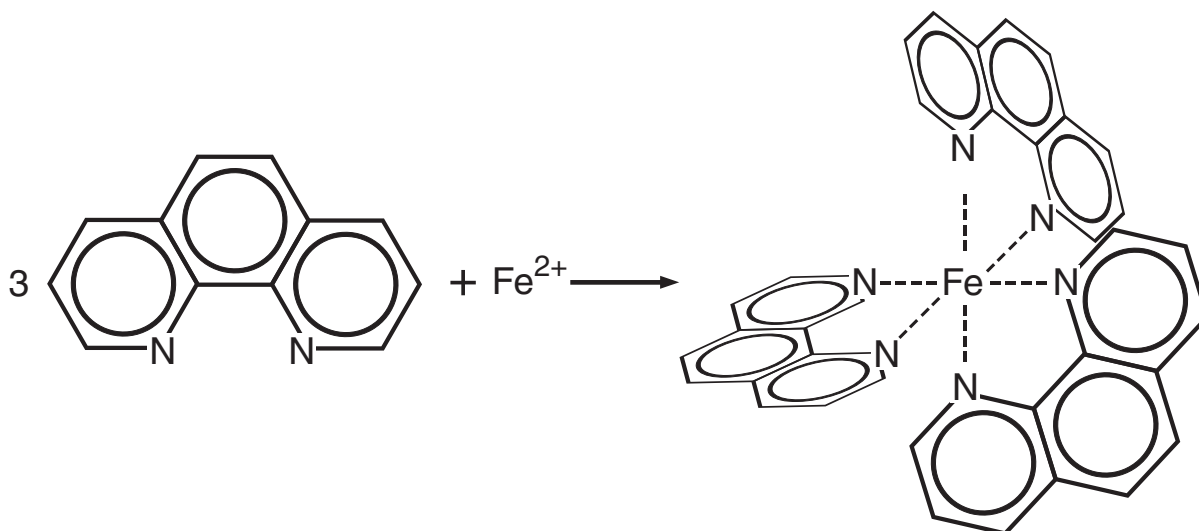


Figure 1 Chemical reaction for 1,10-Phenanthroline method

FerroZine method

Very low concentrations of iron can be determined using an ultra-sensitive iron indicator, FerroZine Iron Reagent, 3-(2-pyridyl)-5, 6-bis (4-phensylsulfonic acid)-1, 2, 4-triazine, monosodium salt. FerroZine Iron Reagent also can be used to analyze samples containing magnetite (black iron oxide) or ferrites. The test is performed by adding a solution of FerroZine Iron Reagent to the water sample. The sample is thereby buffered to a pH of 3.5 and a purple-colored complex directly proportional to the iron concentration is formed. A reducing agent is included to convert any Fe^{3+} to Fe^{2+} (which forms the colored complex).

Where:

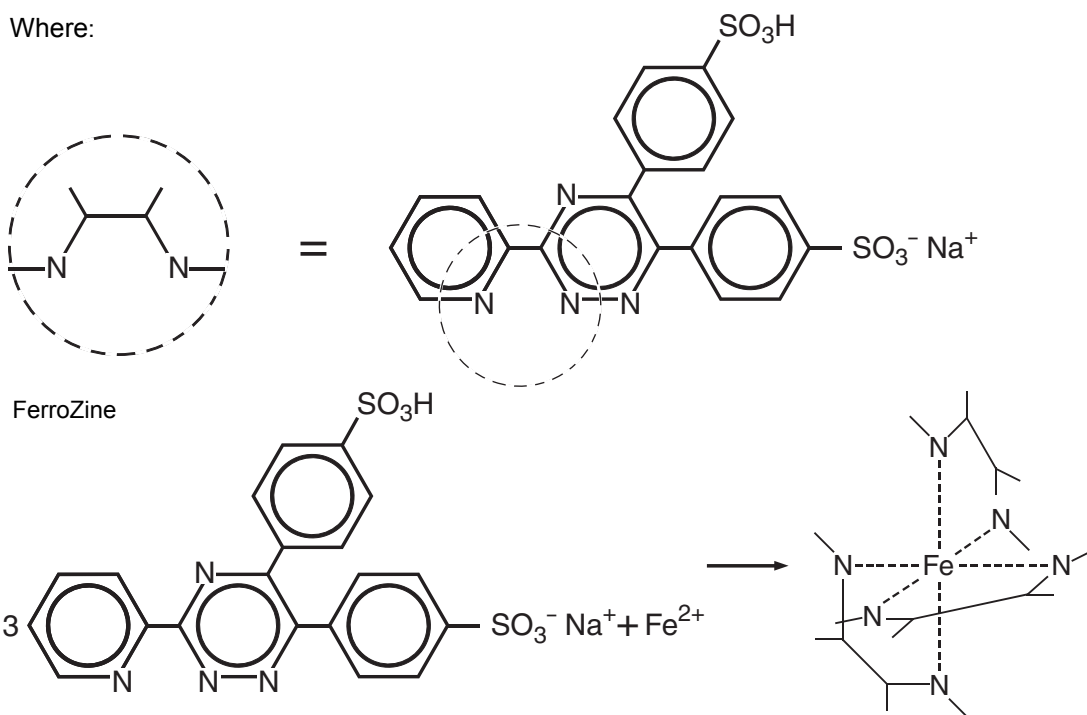


Figure 2 Chemical reaction for FerroZine method

Titration method

The Titration Method is intended for high iron concentrations, such as oil-field water determinations. In this method the iron present in the sample is oxidized to Fe^{3+} by an oxidizing agent. The Fe^{3+} is then detected with sulfosalicylic acid, which forms a wine red complex with Fe^{3+} . The solution is titrated with TitraVer (EDTA) to a colorless to yellow end point. A buffer is added to stabilize the Fe^{3+}

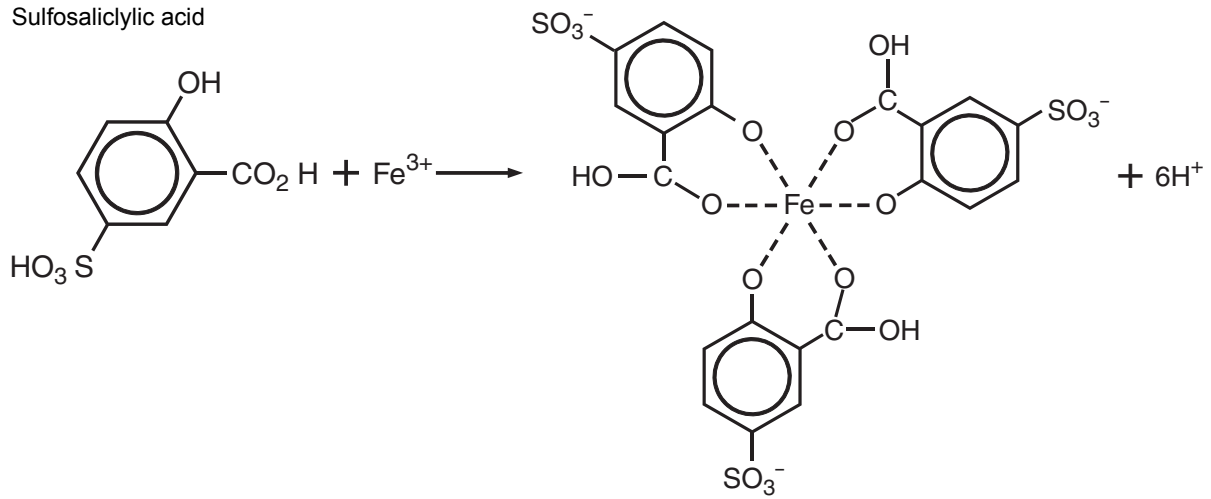


Figure 3 Titration method

TPTZ method

TPTZ, 2,4,6-tripyridyl-s-triazine, reacts with Fe^{2+} to form a deep blue-purple color. Reducing agents are added to convert iron in the sample to the Fe^{2+} form. TPTZ, reducing agents and pH buffers are combined in one simple reagent— TPTZ Iron Reagent Powder Pillows.

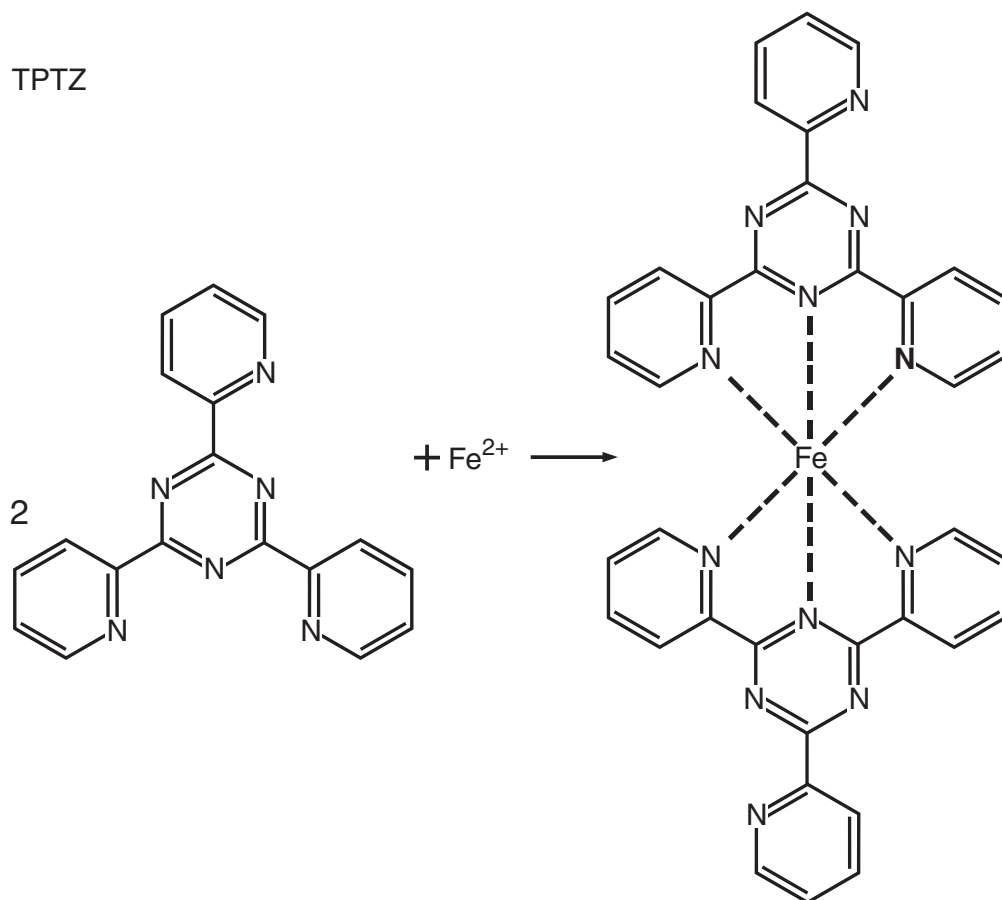


Figure 4 Chemical reaction for TPTZ method