**Title**
A process of smelting monazite rare earth ore rich in Fe

**International Patent Classification(s)**
- C22B 3/00 (2006.01)
- C22B 59/00 (2006.01)
- C22B 1/06 (2006.01)

**Application No:** 2008286599  
**Date of Filing:** 2008.04.08

**WIPO No:** WO09/021389

**Priority Data**

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<th>Number</th>
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<td>2007.08.29</td>
<td>CN</td>
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<tr>
<td>200710143582.9</td>
<td>2007.08.10</td>
<td>CN</td>
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**Publication Date:** 2009.02.19  
**Accepted Journal Date:** 2010.11.18

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**Related Art**
- CN 1721559
- CN 1804063
- RU 2151206
- CN 1075171
- CN 1009332
- CN 1405337
- FR 2826667
Title: A PROCESS OF SMELTING MONAZITE RARE EARTH ORE RICH IN Fe

Abstract: A process of smelting monazite rare earth ore rich in Fe in particular comprises the following steps: mixing Fe-rich monazite rare earth ore containing 8-40% Fe with concentrated sulphuric acid and adding the mixture into a calcining kiln; calcining at 231-600°C, wherein rare earth reacts with sulphuric acid to produce rare earth sulphate which dissolves in water or a solution with a H⁺ concentration less than 1.5mol/L and Fe is transformed into at least one of iron sulphate, iron phosphate and iron pyrophosphate; leaching the calcined ore with water or a solution with a H⁺ concentration less than 1.5mol/L and filtering to obtain a solution of rare earth sulphate containing Fe and P; neutralizing the solution to recover Fe and P and to obtain pure solution of rare earth sulphate; producing single or mixed rare earth compound by extracting and separating the pure solution directly, or producing mixed rare earth carbonates by precipitation process. The process could avoid the influence of Fe on extracting rare earth. The process is simple, continuous, easy to control, low in consumption of chemical engineering materials, high in recovery ratio of rare earth and suitable for large-scale production.

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(84) 指定国（除另有指明，要求每一种可提供的地区保护）：ARIPPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), 欧亚 (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), 欧洲 (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)。

本国际公布：—— 包括国际检索报告。
A metallurgical Process for
Iron-rich Monazite Rare Earth Ore or concentrate

FIELD OF THE INVENTION

The present invention relates to a metallurgical process for iron-rich monazite rare earth (RE) ore or concentrate, in particular to a metallurgical process for monazite rare earth ore containing 8-40% iron, which belongs to rare earth metallurgical production field.

BACKGROUND OF THE INVENTION

Monazite is a mineral of rare earth phosphate. Generally, monazite ore is easy to be sorted to obtain high grade concentrate. The content of monazite mineral in the concentrate may be more than 95% and the concentrate further contains a small quantity of other minerals, such as rutile, ilmenite, zirconite, quartz and the like. In industry, the caustic soda decomposition method at normal pressure is usually used for decomposing monazite concentrate [Rare Earth, 1978:P221-237, Volume 1, 1st edition, Metallurgical Industry Press; 1995:P365-373, Volume 1, 2nd edition, Metallurgical Industry Press]. In caustic soda decomposition, the monazite reacts with the caustic soda to produce insoluble rare earth hydroxide and soluble trisodium phosphate, which are separated each other by filtration. Through selective dissolution with hydrochloric acid and impurity removal, rare earth hydroxide converted into mixed rare earth chloride solution. The characteristics of this process are that it almost has no waste gas pollution, and phosphorus may be recovered in the form of trisodium phosphate. However, this process requires the grade of concentrate must be high enough. Some impurities, such as iron, silicon and the like in the concentrate, are easy to form colloid materials such as sodium silicate and iron hydroxide in caustic decomposition which are difficult to sedimentate, filter and separate.
Therefore, the excessive impurity will cause this process unable to run normally. For example, in the Australia Mt. Weld monazite ore, content of iron oxide in ore reaches more than 40wt%, and monazite and iron mineral are embed in each other and their particle size is fine. The sorting performance of the ore is very bad. Rare earth grade in the concentrate can only reach 40% with very low ore dressing recovery. So the caustic soda decomposition method is completely unsuitable for this iron-rich rare earth ore or concentrate in industry.

Some scholars also developed concentrated sulfuric acid decomposition method for monazite [Rare Earth, 1978:P237-241, Volume 1, 1st Edition, Metallurgical Industry Press] early. Monazite concentrate is mixed with concentrated sulfuric acid with the weight ratio of acid to concentrate being 1.7-2, and reacted for 2 to 4 hours at 200-230°C. After cooled, decomposition products are leached by water with 7-10 times of the weight of the concentrate. In the leaching solution, the concentration of rare earth is 55g/L, P_2O_5 is 25g/L, Fe_2O_3 is 2.5g/L, and the acidity is 2.5N. The acidity of the leaching solution is high, and contents of impurities, i.e. phosphorus and thorium in the solution are high. Rare earth and thorium are precipitated by sodium sulfate double salt precipitation, and then converted into hydroxide with caustic soda, and rare earth is selectively leached with acid. At last, rare earth and thorium are separated completely by solvent extraction. Due to multistep solid-liquid separation, the method is very complicated with discontinuous processes and low recovery of rare earth. And cost is high because acid is used in combination with alkali in the method. In addition, it is difficult to recover phosphorus which entered into waste water. And radiothorium is dispersed in the residue and waste water, so it is also difficult to recover thorium.

OBJECTS OF THE INVENTION

The object of the present invention is to provide a metallurgical process for iron-rich monazite ore or concentrate that has some characteristics such as short flowsheet, high rare earth recovery, low consumption of chemical raw materials, easy
adjustment of products and suitable for large-scale production.

SUMMARY OF THE INVENTION

Accordingly, the present invention provides a metallurgical process for iron-rich monazite ore or concentrate, wherein the iron-rich monazite rare earth ore or concentrate contains 8wt%-40wt% of iron, the metallurgical process including steps of 1) mixing the iron-rich monazite rare earth ore and concentrated sulfuric acid with the weight ratio of the acid to ore/concentrate being 1-2, 2) calcining the resulting mixture at the temperature of 231-600°C for 1 to 20 hours, wherein the iron-rich monazite rare earth ore reacts with sulphuric acid to produce rare earth sulphate which can be dissolved in water or a solution with a H⁺ concentration less than 1.5mol/L, and iron is transformed into at least one of salt-based iron sulphate, iron phosphate and iron pyrophosphate, and 3) leaching the calcined ore with water or a solution with a H⁺ concentration less than 1.5mol/L to obtain a water-leaching slurry of rare earth sulphate containing iron and phosphorus, in which the rare earth concentration REO is 20-55g/L, the H⁺ concentration is less than 1.5mol/L, decomposition rate of rare earth is over 95%.

DETAILED DESCRIPTION OF EMBODIMENTS

The iron-rich monazite ore, such as Australia Mt. Weld monazite ore in which iron oxide reaches more than 40wt%, is difficult to separate rare earth due to intergrowth of monazite and iron minerals and its fine particle size. Therefore the rare earth grade of the concentrate can only reach 40wt% with low recovery obtained in the ore dressing process. The caustic decomposition method is not applicable to such concentrate. The present invention provides a solution to solve the problem. The present invention comprises the following steps: mixing iron-rich monazite rare earth ore containing 8-40% iron with concentrated sulphuric acid and feeding the mixture into a calcining kiln continuously; calcining at the temperature of 231-600°C, wherein rare earth reacts with sulphuric acid to produce rare earth sulphate which dissolves in water or a solution with a H⁺ concentration less than 1.5 mol/L, and iron is transformed into at least one of iron sulphate, iron phosphate and iron pyrophosphate; leaching the calcined ore with water or dilute acid to obtain a slurry...
of rare earth sulphate containing iron and phosphorus; more than 95% of rare earth entering into the slurry in ion state; obtaining a solution of rare earth sulphate containing iron and phosphorus by filtration; and neutralizing the solution of rare earth sulphate with oxide, hydroxide, carbonate which contains magnesium, calcium, aluminum. When pH value of the solution is 3-5, iron ion present in the solution will combine with P to generate iron phosphate precipitate, avoiding the formation of rare earth phosphate precipitate. To ensure no loss of rare earth during recovery of phosphorus and iron by precipitation, the ratio of iron to phosphorus should be larger than 2, preferably larger than 3. Pure solution of rare earth sulfate obtained by neutralization precipitation and filtration is used to produce individual or mixed rare earth compound by solvent extraction directly, or prepare rare earth carbonate by carbonate precipitation.

The main reactions of monazite ore or concentrate and concentrated sulfuric acid at high temperature are listed as follows:
2REPO₄ + 3H₂SO₄ = RE₂(SO₄)₃ + 2H₃PO₄

Th₃(PO₄)₄ + 6H₂SO₄ = 3Th(SO₄)₂ + 4H₃PO₄

Fe₂O₃ + 3H₂SO₄ = Fe₂(SO₄)₃ + 3H₂O↑

When the reaction temperature reaches 300°C, the phosphoric acid generated by decomposition reaction dehydrates to form pyrophosphoric acid. And the pyrophosphoric acid reacts with thorium, iron and calcium to form pyrophosphate insoluble in water.

2H₃PO₄ = H₄P₂O₇ + H₂O↑

Th(SO₄)₂ + H₄P₂O₇ = ThP₂O₇ + 2H₂SO₄

2Fe₂(SO₄)₃ + 3H₄P₂O₇ = Fe₄(P₂O₇)₃ + 6H₂SO₄

2CaSO₄ + H₄P₂O₇ = Ca₂P₂O₇ + 2H₂SO₄

When the reaction temperature reaches about 328°C, sulfuric acid begins to decompose.

H₂SO₄ = SO₃↑ + H₂O↑

When the reaction temperature reaches 400°C, Fe₂(SO₄)₃ is decomposed into salt-based iron sulfate which is insoluble in water, and the pyrophosphoric acid further dehydrates.

Fe₂(SO₄)₃ = Fe₂O(SO₄)₂ + SO₃↑

H₄P₂O₇ = 2HPO₃ + H₂O↑

So it is important to control appropriate calcining temperature and time to obtain high rare earth decomposition rate when rare earth ore or concentrate is calcined with certain amount of concentrated sulfuric acid. When the calcining temperature is under 230°C, the decomposition ability of the ore or concentrate is weak. But if the calcining temperature is too high, sulfuric acid will be easily decomposed and then the ore will be easily over-calcined, the solubility of the rare
earth sulfate will worsen and leaching rate of rare earth will be reduced. Generally, the lower the calcining temperature is, the longer the calcining time is needed.

This process is also applicable to other rare earth ore containing phosphate such as xenotime and the like or their mixed rare earth ore.

The present invention specifically applies the technical solution as follows:

A metallurgical process for iron-rich monazite ore or concentrate, in which iron-rich monazite rare earth ore containing 8-40wt% iron is used as raw material. The metallurgical process comprises steps of:

1) mixing the iron-rich monazite rare earth ore or concentrate and concentrated sulfuric acid with the weight ratio of the acid to the ore/concentrate being 1-2 and then feeding the mixture into a calcining kiln continuously;

2) calcining the resulting mixture at the temperature of 231-600°C for 1 to 20 hours, wherein rare earth reacts with sulphuric acid to produce rare earth sulphate which dissolves in water or a solution with a H⁺ concentration less than 1.5 mol/L, and iron is transformed into at least one of iron sulphate, iron phosphate and iron pyrophosphate; and

3) leaching the calcined ore with water or a solution with a H⁺ concentration less than 1.5mol/L to obtain a water-leaching slurry of rare earth sulphate containing iron and phosphorus, in which the rare earth oxides concentration (REO) is 20-55g/L, the H⁺ concentration is less than 1.5mol/L, decomposition rate of rare earth is over 95%.

The present invention relates to a metallurgical process for iron-rich monazite rare earth ore or concentrate, taking Australia Mt. Weld monazite ore or concentrate as raw material, in which iron content is 15wt%-40wt%, REO is 18wt%-60wt%. The ore or concentrate and concentrated sulfuric acid (not less than 90wt%) are mixed with weight ratio of the acid to the ore/concentrate being 1.3-1.69 and are fed to rotary kilns continuously, and calcined at the temperature of 231-400°C for 2-12h.
The calcined ore or concentrate is leached with water or the solution with a H\(^+\) concentration less than 1.5 mol/L, and water-leaching slurry of rare earth sulfate containing iron and phosphorus is obtained, in which the decomposition rate of rare earth is over 97%.

The above calcined ore or concentrate is leached with water or the solution with a H\(^+\) concentration less than 1.0 mol/L, and the weight ratio of solid to liquid is 1:5-1:12. After filtration, a solution of rare earth sulfate containing iron and phosphorus is obtained, in which the rare earth concentration REO is 25-55 g/L and the acidity is 0.05-1.0 mol/L. Preferably, the ratio of solid to liquid is 1:7-1:10, the rare earth concentration REO in the solution of rare earth sulfate is 30-50 g/L and the acidity is 0.1-0.5 mol/L.

The above water-leaching slurry of rare earth sulfate containing iron and phosphorus or the solution of rare earth sulfate containing iron and phosphorus is neutralized with at least one compound of oxide, hydroxide and carbonate containing magnesium, calcium, Al to recover iron and phosphorus. After filtration, pure solution of rare earth sulfate is obtained in which iron is less than 0.05 g/L, phosphorus is less than 0.001 g/L, thorium is less than 0.1 mg/L, and pH is 3-5. Preferably, the water-leaching slurry of rare earth sulfate containing iron and phosphorus or the solution of rare earth sulfate containing iron and phosphorus is neutralized with at least one of magnesium oxide, magnesium hydroxide, magnesium carbonate, calcium oxide, calcium carbonate, calcium hydroxide and carbide slag. Iron and phosphorus are recovered in the form of iron phosphate. And the pure solution of rare earth sulfate is obtained in which iron is less than 0.005 g/L, phosphorus is less than 0.0005 g/L, thorium is less than 0.05 mg/L and pH is 3.5-4.5.

The above pure solution of rare earth sulfate is grouped or separated by solvent extraction with acidic organophosphorus extractants directly to prepare individual or mixed rare earth compound. Or all the rare earth is extracted with acidic organophosphorus or carboxylic acid extractants, and then stripped with
hydrochloric acid or nitric acid to prepare mixed rare earth chloride or nitrate, or further separated to prepare individual or mixed rare earth compound by solvent extraction.

The above pure solution of rare earth sulfate also can prepare mixed rare earth carbonate by precipitation process with ammonium bicarbonate, sodium carbonate or sodium bicarbonate. The mixed rare earth carbonate can be dissolved by hydrochloric acid or nitric acid, and then separated by solvent extracted with acidic organophosphorus or carboxylic acid extractants to prepare individual or mixed rare earth compound.

In the metallurgical process for iron-rich monazite rare earth ore or concentrate according to the present invention, the waste gas produced in the calcination is sprayed to recover the sulfuric acid, or absorbed with alkaline solution to achieve standard discharge.

ADVANTAGES OF THE INVENTION

The present invention is an effective metallurgical process for iron-rich low grade monazite rare earth ore or concentrate. All kinds of rare earth compounds are obtained through calcining with concentrated sulfate acid, water leaching, impurity removal and solvent extraction. The process could effectively avoid the influence of iron on extraction of rare earth. The process is simple, continuous, easy to control, low consumption of chemical raw materials, high rare earth recovery and suitable for large-scale production.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Example 1:

The iron-rich monazite concentrate is used as raw material, in which iron is 20.6 wt%, REO is 41.8 wt% and phosphorus is 7.5 wt%. The concentrate and concentrated sulfuric acid (93 wt%) are mixed with weight ratio of the acid to the concentrate being 1.4 and then fed to rotary kilns continuously. The resulting mixture is calcined
at the temperature of 240°C for 8 hours. The calcined ore is leached with water in which the ratio of solid to liquid is 1:9. A water-leaching slurry of rare earth sulfate is obtained in which the rare earth concentration is 44.6 g/L REO, the acidity is 0.2 mol/L, and the decomposition rate of rare earth is 95.5%. After filtration, a solution of rare earth sulfate containing iron and phosphorus is obtained. Then iron and phosphorus in the solution are recovered by neutralization with magnesium oxide and filtered. Pure solution of rare earth sulfate is obtained in which rare earth concentration REO is 44.3 g/L, iron is 0.03g/L, phosphorus is less than 0.001g/L, thorium is less than 0.05mg/L, and pH is 3.6.

All the rare earth is extracted from the pure solution of rare earth sulfate directly with unsaponified P₅₀₇. Then a solution of mixed rare earth chloride is obtained by stripping with hydrochloric acid. The solution of mixed rare earth chloride is grouped or separated by solvent extraction with P₅₀₇ or P₂₀₄ to produce individual rare earth compounds.

Example 2:

The iron-rich monazite ore is used as raw material, in which the content of iron is 27.3wt%, REO is 25.2wt% and phosphorus is 6.6wt%. The ore and concentrated sulfuric acid (90wt%) are mixed with weight ratio of the acid to the ore being 1.7 and then fed to rotary kilns continuously. The resulting mixture is calcined at the temperature of 320°C for 5 hours. The calcined ore is leached with water in which the ratio of solid to liquid is 1:6. A water-leaching slurry of rare earth sulfate is obtained in which rare earth concentration is 47.16g/LREO, the acidity is 0.43mol/L, and the decomposition rate of rare earth is 98.2%. The water-leaching slurry is neutralized with magnesium oxide and calcium oxide to recover iron and phosphorus. After filtration, pure solution of rare earth sulfate (iron is 0.01g/L, phosphorus is 0.0007g/L, thorium<0.03mg/L, pH is 4.0) and iron phosphate concentrate are obtained.

Pure solution of rare earth sulfate is precipitated with ammonium bicarbonate to
prepare mixed rare earth carbonate. Then the mixed rare earth carbonate is dissolved with hydrochloric acid. At last, individual rare earth compound is prepared by solvent extraction with \( P_{507} \) or \( P_{204} \) in rare earth chloride solution.

Example 3:

The Australia Mt. Weld monazite concentrate is used as raw material, in which the content of iron is 19.7wt%, REO is 41.3wt% and phosphorus is 7.8wt%. The concentrate and concentrated sulfuric acid (95wt%) are mixed with weight ratio of the acid to the concentrate being 1.5 and then fed to rotary kilns continuously. The resulting mixture is calcined at the temperature of 300°C for 8 hours. The calcined ore is leached with water in which the ratio of solid to liquid is 1:11. A water-leaching slurry of rare earth sulfate is obtained in which the rare earth concentration REO is 36.61g/L, the acidity is 0.15mol/L, and the decomposition rate of rare earth is 97.5%. After filtration, a solution of rare earth sulfate containing iron and phosphorus is obtained. The resulting solution is neutralized and precipitated with magnesium hydroxide to recover iron and phosphorus, and after filtration, pure solution of rare earth sulfate (iron is 0.008g/L, phosphorus is 0.0005g/L, thorium<0.01mg/L, pH is 4.3) and iron phosphate concentrate are obtained.

The pure solution of rare earth sulfate is grouped or separated by solvent extraction directly with mixed extractants of unsaponified \( P_{204} \) and \( P_{507} \) to produce individual rare earth compounds.

Example 4:

The xenotime containing 61wt% REO is added to iron-rich monazite ore (in which iron content is 37.3wt%, REO is 22.2wt % and phosphorus is 6.6wt %). And the weight ratio of the xenotime to monazite ore is 3:7. The ore and concentrated sulfuric acid (98wt%) are mixed with weight ratio of the acid to the ore being 1.9 and then fed to rotary kilns continuously. The resulting mixture is calcined at the temperature of 500°C for 6 hours. Then the calcined ore is leached with water in which the ratio of solid to liquid is 1:7. A water-leaching slurry of rare earth sulfate is
obtained in which rare earth concentration REO is 46.2g/L, the acidity is 0.15mol/L, and the decomposition rate of rare earth is 95.6%. The obtained water-leaching slurry is neutralized and precipitated with calcium oxide to recover iron and phosphorus. After filtration, pure solution of rare earth sulfate (iron<0.05g/L, phosphorus<0.001g/L, thorium<0.08mg/L, pH is 4) is obtained.

All the rare earth is extracted from the pure solution of rare earth sulfate directly with the mixed extractant of unsaponified P_{204} and P_{507}. Then a solution of mixed rare earth chloride is obtained by stripping from RE-loaded organic phase with hydrochloric acid. The solution of mixed rare earth chloride is grouped or separated by solvent extraction with unsaponified P_{507}, P_{272} or naphthenic acid to produce individual rare earth compounds.

Example 5:

Monazite concentrate is used as raw material, in which iron content is 23.5wt%, REO is 44.6wt% and phosphorus is 8.1wt%. The concentrate and concentrated sulfuric acid (95wt%) are mixed with weight ratio of the acid to the concentrate being 1.7 and then fed to rotary kilns continuously. The resulting mixture is calcined at the temperature of 380°C for 4 hour. The calcined ore is leached with dilute hydrochloric acid of 0.05mol/L, in which the ratio of solid to liquid is 1:10. The water-leaching slurry is obtained in which rare earth concentration is 42.4g/L, REO, the acidity is 0.12mol/L, and the decomposition rate of rare earth is 95.0%. The water-leaching slurry is neutralized and precipitated with magnesium oxide to recover iron and phosphorus. After filtration, pure solution of rare earth sulfate (iron is 0.005g/L, phosphorus is 0.0005g/L, thorium<0.01mg/L, pH is 4.5) is obtained.

The pure solution of rare earth sulfate is precipitated with sodium carbonate to prepare mixed rare earth carbonate. The mixed rare earth carbonate is dissolved with hydrochloric acid and separated by solvent extraction with P_{507} to produce individual or mixed rare earth compounds.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.
The reference to any prior art in this specification is not, and should not, be taken as an acknowledgment or any form of suggestion that the prior art forms part of the common general knowledge in Australia.
The claims defining the invention are as follows:

1. A metallurgical process for iron-rich monazite ore or concentrate, wherein the iron-rich monazite rare earth ore or concentrate contains 8wt%-40wt% of iron, the metallurgical process including steps of:

1) mixing the iron-rich monazite rare earth ore and concentrated sulfuric acid with the weight ratio of the acid to ore/concentrate being 1-2;
2) calcining the resulting mixture at the temperature of 231-600°C for 1 to 20 hours, wherein the iron-rich monazite rare earth ore reacts with sulphuric acid to produce rare earth sulphate which can be dissolved in water or a solution with a H⁺ concentration less than 1.5mol/L, and iron is transformed into at least one of salt-based iron sulphate, iron phosphate and iron pyrophosphate; and
3) leaching the calcined ore with water or a solution with a H⁺ concentration less than 1.5mol/L to obtain a water-leaching slurry of rare earth sulphate containing iron and phosphorus, in which the rare earth concentration REO is 20-55g/L, the H⁺ concentration is less than 1.5mol/L, decomposition rate of rare earth is over 95%.

2. The metallurgical process for iron-rich monazite ore or concentrate according to Claim 1, wherein in step 1), the iron-rich monazite rare earth ore used is Australia Mt. Weld monazite ore or concentrate in which iron content is 15wt%-40wt% and REO is 18wt%-60wt%; mixing the ore (or concentrate) and concentrated sulfuric acid no less than 90 wt% with weight ratio of the acid to ore/concentrate being 1.3-1.69; in step 2), the calcining temperature is 231-400°C, and the calcining time is 2-12 hours; in step 3), the calcined ore is leached with water, and in the obtained rare earth sulfate slurry containing iron and phosphorus the decomposition rate of rare earth is over 97%.

3. The metallurgical process for iron-rich monazite ore or concentrate according to either Claim 1 or Claim 2, wherein, in step 3), the calcined ore is leached with water or a solution with a H⁺ concentration less than 1.0mol/L, in which weight ratio of solid to liquid is 1:5-1:12, and after filtration, a solution of rare earth sulfate containing iron and phosphorus is obtained, in which the rare earth concentration REO is 25-55g/L, and the H⁺ concentration is 0.05-1.0mol/L.
4. The metallurgical process for iron-rich monazite ore or concentrate according to Claim 3, wherein, in step 3), the calcined ore is leached with water in which the weight ratio of solid to liquid is 1:7-1:10, and the obtained solution of the rare earth sulfate containing iron and phosphorus has rare earth concentration REO of 30-50g/L and H⁺ concentration of 0.1-0.5mol/L.

5. The metallurgical process for iron-rich monazite ore or concentrate according to any one of Claims 1 to 4, wherein the water-leaching slurry of the rare earth sulfate containing iron and phosphorus or solution of rare earth sulfate containing iron and phosphorus is neutralized with at least one compound of oxide, hydroxide, carbonate containing magnesium, calcium, aluminium to recover iron and phosphorus, then after being filtered, a pure solution of rare earth sulfate is obtained in which iron is less than 0.05g/L, phosphorus is less than 0.001g/L, thorium is less than 0.1mg/L, and pH is 3-5.

6. The metallurgical process for iron-rich monazite ore or concentrate according to Claim 5, wherein the water-leaching slurry of the rare earth sulfate containing iron and phosphorus or the solution of rare earth sulfate containing iron and phosphorus is neutralized with at least one of the magnesium oxide, magnesium hydroxide, magnesium carbonate, calcium oxide, calcium carbonate, calcium hydroxide and carbide slag to recover iron and phosphorus mainly in the form of iron phosphate, and in the obtained pure solution of rare earth sulfate, the iron content is less than 0.005g/L, phosphorus is less than 0.0005g/L, thorium is less than 0.05mg/L, and pH is 3.5-4.5.

7. The metallurgical process for iron-rich monazite ore or concentrate according to either Claim 5 or Claim 6, wherein the pure solution of rare earth sulfate is grouped or separated by solvent extraction directly using acidic organophosphorus extractants to produce mixed or individual rare earth compounds.

8. The metallurgical process for iron-rich monazite ore or concentrate according to either Claim 5 or Claim 6, wherein the pure solution of rare earth sulfate is extracted with acidic organophosphorus or carboxylic acid extractants to obtain all rare earth therefrom, then it is stripped with hydrochloric acid or nitric acid to produce mixed rare earth chloride or rare earth nitrate, or is further separated with solvent extraction method.
9. The metallurgical process for iron-rich monazite ore or concentrate according to either Claim 5 or Claim 6, wherein the pure solution of rare earth sulfate is precipitated with ammonium bicarbonate, sodium carbonate or sodium bicarbonate to produce mixed rare earth carbonate.

10. The metallurgical process for iron-rich monazite ore or concentrate according to Claim 9, wherein the mixed rare earth carbonate is dissolved with hydrochloric acid or nitric acid, and then is extracted and separated with acidic organophosphorus or carboxylic acid extractants to produce individual or mixed rare earth compounds.

11. The metallurgical process for iron-rich monazite ore or concentrate according to either Claim 1 or Claim 2, wherein, in step 2), the waste gas produced during the calcination is sprayed to recover the sulfuric acid, or absorbed with alkaline solution to achieve standard discharge.

12. A metallurgical process for iron-rich monazite or concentrate, according to Claim 1, substantially as hereinbefore described.