

Copper is one of the earliest found metals in the human history, its color is amaranth, relative density is 8.89, melting point is 1083°C. Copper and its alloy are good at electric conduction and heat conduction. They have strong resistant to corrosion, and can be processed easily. Considering of these advantages, the copper are widely used in electrical industry, mechanical industry, chemical industry and national defense industry.

## The brief introduction of manganese ore

All the copper ore can be divided into the copper sulphide and copper oxide. The copper sulphide ore include the chalcopyrite, chalcocite, bornite, covellite and malachite; The copper oxide ore contains the malachite, chrysocolla, tenorite, cuprite. Here is the characteristics of each kind of copper ore as below:

Name	Content	Density (g/cm <sup>3</sup> )	Color	Theoretical grade	Cutoff grade	Production grade	M Hardness
Chalcopyrite	CuFeS <sub>2</sub>	4.1~4.3	Yellow	34.5	≥0.2-0.3	≥0.4-0.5	3.5~4.0
Chalcocite	Cu <sub>2</sub> S	5.5~5.8	Lead color or black	79.8	≥0.2-0.3	≥0.4-0.5	2.5~3.0
Bornite	Cu <sub>5</sub> FeS <sub>4</sub>	4.9~5.0	Copper red or tarnish	63.3	≥0.2-0.3	≥0.4-0.5	3
Covellite	CuS	4.6~6.0	Blue	66.4	≥0.2-0.3	≥0.4-0.5	1.5~2.0
Malachite	CuCO <sub>3</sub> ·Cu(OH) <sub>2</sub>	3.7~4.1	Green	57.5	≥ 0.5	≥ 0.7	3.5~4.0
Chrysocolla	CuSiO <sub>3</sub> ·2H <sub>2</sub> O	2~2.2	Green	36.2	≥ 0.5	≥ 0.7	2~4.0
Tenorite	CuO	5.82~6.25	Steel grey or Iron Black	79.85	≥ 0.5	≥ 0.7	3.0~4.0
Cuprite	Cu <sub>2</sub> O	5.8~6.2	Dark Red	88.8	≥ 0.5	≥ 0.7	3.5~4.0

## The processing technology for the copper ore:

### Copper Sulphide Ore:

a. Flotation Technology ( Preferential flotation or mixed flotation)

## **Copper Oxide Ore:**

a. Flotation Technology:(Sulphidizing Flotation Technology, Fatty Acid Flotation Technology or Amine Flotation Technology)

b. Dump Leaching Technology: ( Acid leaching method or Ammonia leaching method)

c. Combined Processing Technology: ( Dump Leaching+ Flotation Processing)

## **For the sulphide copper ore and sulphured oxide copper ore processing, we can conclude these commonsense as below:**

I. All the minerals that don't contain iron element,such as chalcocite and covellite,they have the similar floatability, cyanide and lime restrain them weakly.

II. All the copper minerals that contain iron element,such as chalcopyrite and bornite ,when they are in the alkaliescent medium,the cyanide and lime cyanide their flotation.

III. Because xanthate series collector is anion, it mainly react chemisorption with the Cu ion , so the minerals that contains more Cu ion will have stronger reaction with xanthate.

## **Preferential flotation**

This method first select copper and then get the sulphur concentrate. The collector can be xanthate or together with the aero float. For the compact nubby iron pyrite which contains copper, the flotation reaction should be in the strongbasicitic medium (PH=11~12)when select copper, it can restrain vast iron pyrite,at the same time,we should control CaO is about 700~1000g/L.when it contains litter vast iron, we can conduct the copper ore flotation in the PH=8~9 medium.

## **Mixed flotation**

We can usually select the copper and sulphur mixed concentrate in the neutral medium(PH=7~8),so we should control dissociative CaO is about 100~150g/L.After that we can separate the copper and sulphur mixed concentrate.The separation methods are adding lime 、adding lime and cyanide、 the heating method.

①adding lime----improve medium's PH and make it to be strongbasicitic,and it can restrain iron pyrite.

②adding lime and cyanide----we can use this way when iron pyrite is very active and it's hard to be restrained by lime.

③the heating method---we can use the method when it is hard to separate copper and sulphur mixed concentrate,the high temperature will quicken the oxidization of iron pyrite's surface.

The above-mentioned methods also used in the preferential flotation and the oxide copper ore after sulfuration.

**For the oxide copper ore processing: For improving the recovery rate and making it is much easier to do the flotation processing, it is better to sulphur the oxide copper ore and make it into sulphide copper ore. This technolgy is very popular to use in the copper ore mining.Here is the common way for processing the oxide copper ore as below:**

I. Sulphidizing flotation method. Add sulfurization agent of sulfide ore to oxidation, and then to use common copper sulfide flotation prescription for flotation.

II. Fatty acid flotation method. Do with fatty acids of collector for flotation, must usually add carbonate, sodium silicate and phosphate inhibitor and the pulp of the gangue for the adjustment of the agent.

III. Amine flotation method.As with amine class of collector for flotation, suitable for dealing with malachite, blue copper, chlorine such as copper, including long exploratory experiment should add the gangue inhibitors.

IV. Acid leaching method or Ammonia leaching method: The process dissolving out copper material of copper and other useful composition with the chemical is known as "leaching". Extraction process with special effects of organic compounds (extraction solvent) from the leaching solution will be extracted from the copper selectively, to separate and impurities, and approved by the crafts that enrichment copper , get purity and concentration comply with the requirements of the electric product copper solution of the process known as "solvent extraction". Through the extraction and the opposite extraction,we can get the relative pure copper-bath ,and then use the insoluble anode electrodeposition technology ,which makes copper to separate out at the cathode.the process getting high quality cathode copper is known as "electrodeposition".

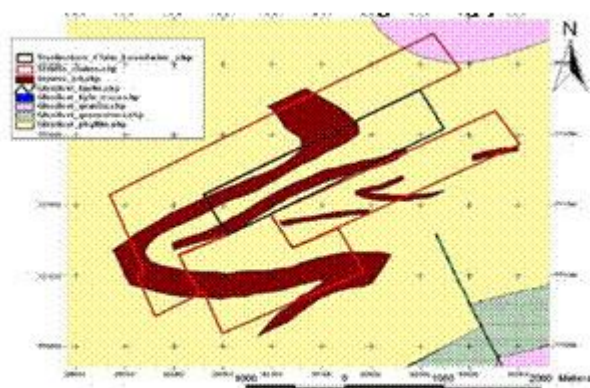
## The copper minerals floatability summary form

Minerals name	Medium adjustmet agent	Best PH	inhibitor	activating agent	collector	foaming agent	remarks
Native copper	CaO、NaCO3	alkalescence			ethyl xanthogenate	2# oil	gravity concentration

Chalcopyrite	lime, sulphurous acid, sulfuric acid	6.5~11	sodium sulfide	sulphurous acid	Xanthate Series	2# oil Synthesis is foaming agent	Low grade copper ore can use the Leaching-extracting-electrodeposition.
Bornite							
Chalcocite	as above	4~13	sodium sulfide, ferricyanide		As above	As above	
Covellite							
Malachite		<10		sodium sulfide	Xanthate series	As above	leaching-extraction+electrodeposition rescuing copper; dissociation+flotation.
Chessylite							
chrysocola	1.sulfuric acid 2. sodium carbonate	(1) 4~7 (2) 7~10		sodium sulfide	(1) Xanthate (2) aliphatic acid	As above	
precipitated copper	sodium carbonate, lime	<5 or ≥7.5	sodium sulfide, sodium chloride		ethyl-dixanthogen	As above	

## How to setup the Copper ore processing plant?

Frist, doing the geological prospecting to know the deposit, position and the trend of your mine and make sure it is with the the feasibility of developing or not.



Copper ore veins figure

Second, doing the dressing test is for choosing the suitable and economical mineral processing technology and recovering the Cu element inside the raw ore after detailed experimental study. The research report will be as the basis of the project feasibility study.

a. The raw ore more chemical elements analysis test: In order to know the nature of the crude ore, copper cobalt ores reference a experimental study of the report more than the crude ore element analysis results could be obtained more roughly element analysis results undressed ore chemistry in the list as below:

items	Cu	Co	Zn	Ni	Mn	TFe	TS
contents	1.38	0.05	0.68	0.04	0.06	40.66	35.58
items	SiO <sub>2</sub>	CaO	MgO	Al <sub>2</sub> O <sub>3</sub>	Au	Ag	Na <sub>2</sub> O
contents	6	1.03	2.46	0.28	0.24	9.75	0.02
items	As	TC					
contents	0.01	0.76					

Remark: the Au and Ag unit is g/t. From the above table , the main elements of the minerals is Fe, S, SiO<sub>2</sub>, MgO and Cu etc. Available for Cu elements, the second part of the main metal have Co, Zn, Au, Ag, etc.

b. The texture and structure and mineral composition of the ore; To know the valuable mineral of your ciorer ore like the chalcopyrite, Iron pyrite, zinc blende magnetite, spathic iron and the gangue dolomite, calcite, talc etc.

Item	chalcopyrite	iron pyrite	zinc blende	magnetite	spathic iron	dolomite	calcite
Content %	4.02	66.5	0.53	2.34	1.56	5.43	2.42
Item	talc						
Content %	2.13						

The raw ore's main mineral is metal minerals, metals mineral content is 82.56%, the main metal mineral have pyrite (account for 66.5% of the mineral content), chalcopyrite, sphalerite and magnetite. Other minerals in the crude ore for non-metallic minerals, the main non-metallic minerals are dolomite and calcite, siderite and talc, etc. Through the mine of ore analysis shows that the main available mineral in the raw ore is chalcopyrite.

c. The major metal mineral's embedded features and Main metal minerals particle size analysis

The main metal mineral particle size distribution will affect the floatability, is the main factors of influence the mineral separation, pyrite particle size distribution a broader, mainly distributed in the grain size chalcopyrite below 0.045 mm, the grain size also most of the units below 0.045 mm, and -0.045 mm size magnetite content account for more than 93%, pyrite particle size distribution is wide, and present "two

large head", that is, in a 0.045 mm and 0.4 mm grain distribution level + rate relatively large. The granularity of sphalerite and magnetite is extremely fine, we must grind it to fully disintegrate.

e. Grinding particle size analysis: Grinding cost is a high part of the concentrator, how to effectively reasonable control grinding fineness is direct reduce processing cost and improve the economic benefit of concentrator important factors. Because, grinding fineness, is to influence dressing indexes very important one of technical parameters, grinding fineness directly affect the size of the discretion of the concentrate grade and recovery of products.

minus 0.045mm ratio %		72	78	83	88	Remark
Rough concentrate grade %		6.50	7.00	6.80	5.70	
Rough concentrate recovery ratio %		38	48	46	37	

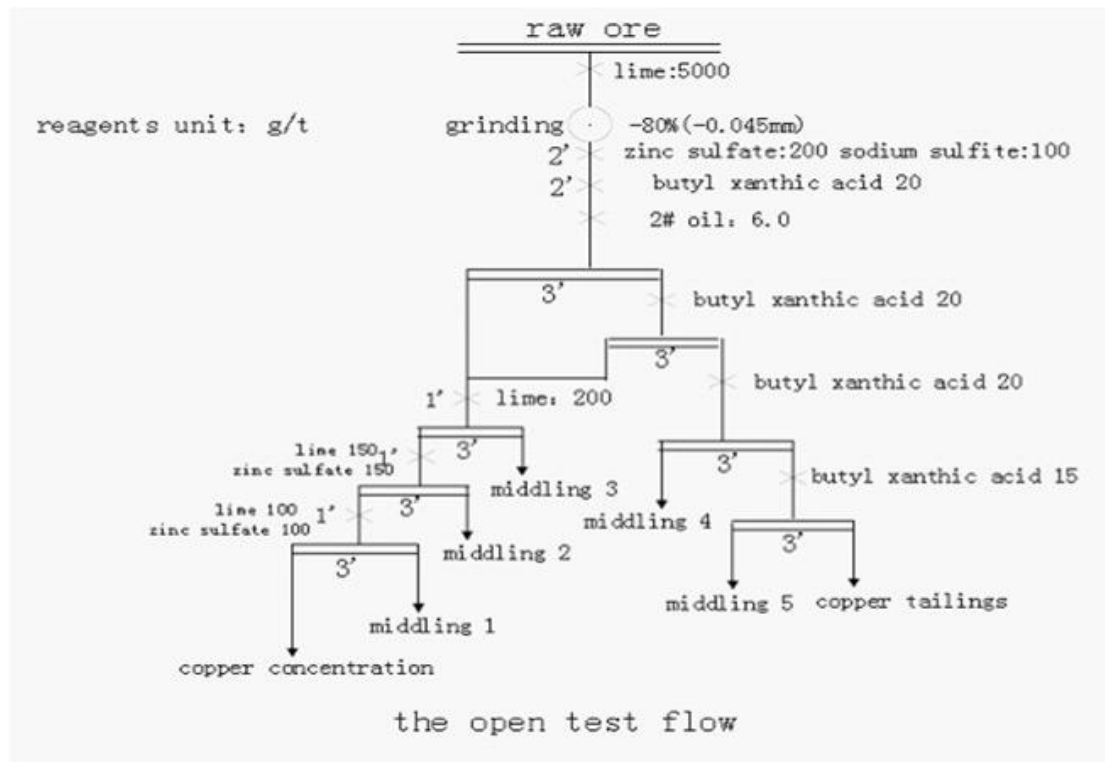
Grinding fineness test results are shown below, we can see that the grinding fineness for -0.045 mm at 80% is better .

f.Exploratory Test; Make exploratory Test for the ore and make foreshadowing for condition test; If your copper ore is rich in the Au, Ag or other value metal we can give you the advice to expand the production in the future.

g. Condition test; Base on the research, flotation concentration solution; collector type and dosage; depressant type and dosage; activator type and dosage; modifier type and dosage; PH value; flotation time; pulp density, etc for fixing the technological parameter of beneficiation flowsheet;

After doing the above condtion test we have got the flotation parameters: PH11-13, the lime dosage is 5000g/t,2#oil is 6.0g/t,butyl xanthic acid is 50g/t,PAC is 22.0 g/t, ZnS04 is 200.0g/t,Na2S03 is 100.0g/t, flotation time is 3 minutes.

h. Completely open closed-circuit test: Base on the above test, choose the beneficiation technology process and the process parameters. The test index should be with repeatability, stability and facticity.



The whole open process circuit flow results as below:

Items name	Rate of production %	Grade %	Rate of recovery %
Copper concentration	1.13	22.45	21.37
Middling 1	1.65	13.38	18.52
Middling 2	5.31	6.28	27.98
Middling 3	5.62	2.12	10
Middling 4	1.61	1.73	2.34
Middling 5	2.22	1.34	2.49
Tailings	82.4	0.25	17.3
Total	100	1.19	100

The whole process closed-circuit test

According to the open condition and procedure , put the middling1, 2, and 3 return to superior work link, middling4 and 5 return to rough beneficiation, then go on the closed-circuit test. Closed-circuit test results as the table below.

Items name	Rate of production/%	Grade/%	Rate of recovery/%
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Copper concentrate	6.25	16.75	79.95
Copper tailings	93.75	0.28	20.05
total	100	1.31	100

i. Product check: Make multi-element analysis for the concentrate and tailing; Make sedimentation performance test for the concentrate and tailing.

Beneficiation test conclusion:

I. we confirm the best rough beneficiation test conditions: the lime dosage is 5000g/t, 2#oil is 6.0g/t, butyl xanthic acid is 50g/t, PAC is 22.0 g/t, ZnSO<sub>4</sub> is 200.0g/t, Na<sub>2</sub>SO<sub>3</sub> is 100.0g/t, flotation time is 3 minutes.

II. We get the reasonable flotation flow, and the closed-circuit flow has the satisfying targets; We get copper concentrate containing copper 16.75%, concentrate rate of recovery is 79.95% from the run-of-mine which contains copper 1.38%.

j. Designing the beneficiation flow-sheet: Base on the above test, designing the most suitable beneficiation flow-sheet, technological parameter and reagent system.

k. Issuing Report Issuing report base on the above tests.

Please Note: If it is for the copper oxide ore dressing test, we should do the sulfidizing test to fix the sulphur dosage, temperature, and the sulfidizing time. If the sulfidizing+ flotation processing is not ideal, we will consider to use the dump leaching way to process the copper ore.

Third, choosing the suitable equipments base on the above test result.

Forth, build the foundation and doing the installation with our engineer. After receiving the deposit, we will send the technical drawing to you and send our engineer to supervise the foundation building and guide your staff to do the installation, then have a commissioning running. Meanwhile, they can train your staff at your site also.

## One project of Copper ore processing plant for your reference

**Here is one project of Copper ore processing plant for your reference. Please see the flow chart of crushing section and beneficiation sections.**

a. In the crushing section, crush the copper into size 0-10 mm or 0-15mm. It should be with the capacity 2-3 times larger than the grinding and beneficiation sections.



b. Crushed ore will be sent to the ball mill to grind it to the suitable particle size like 75 microns with passing rate D70. ( Of course it is should fixed by the dressing test. Sometime it will be not necessary to crush it into so fine size)

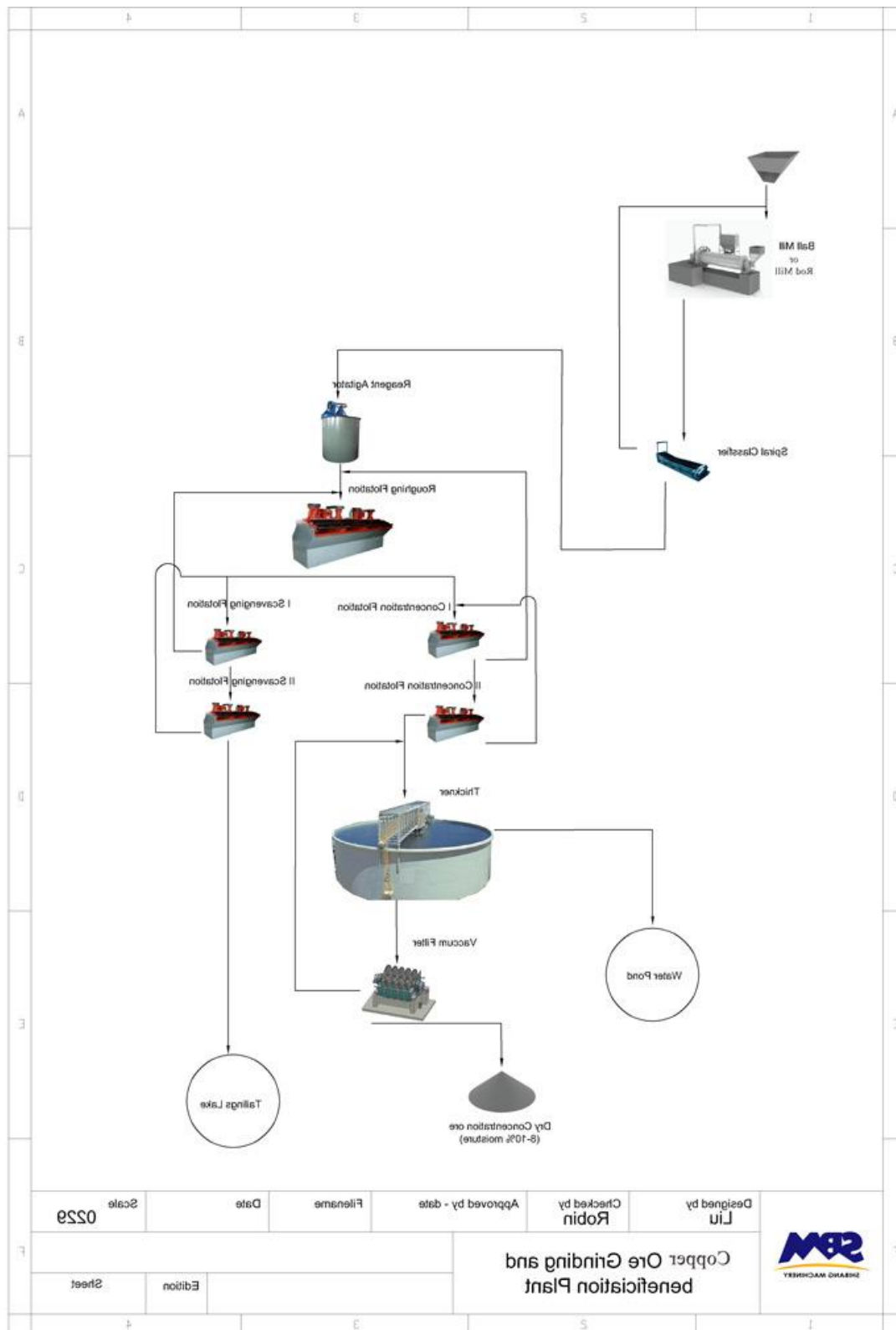
c. The copper ore after grinded by the ball mill will sent to the spiral classifier as slurry. The suitable particle size will be sent to the reagent agitator to adjust it into suitable pulp density. And over size copper ore will be returned to the ball mill to grind it again.

d. Then the slurry will send to the flotation machine to do the concentration. If your copper ore is copper oxide, you should add sulfurization agent of sulfide ore to oxidation, and then to use common copper sulfide flotation prescription for flotation.

e. The concentrates ore from the flotation system should be do the dewatering by thickner and vacuum filter to make it with moisutre around 8-10% and then you doing the package and sell it.

f. The tailings will send to the tailing lake by pump or you choose use the thickner and filter to do the deatering. Then drop the dy tailings in the tailings pile.

## **Appendix I. The flow chart of the crushing section for copper ore.**



**AppendixII. The flow chart of the grinding and beneficiation section for copper ore.**

