OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

20415

Workshop on Mineral Processing
of Lead and Zinc Sulphide Ores
for Selected Countries

THE MINERAL PROCESSING AND ENVIRONMENTAL PROTECTION IN THE FAN KOU LEAD-ZINC MINE

(DRAFT)

LUO LIANG SHI

FAN KOU LEAD-ZINC MINE

August 1993

THE MINERAL PROCESSING AND ENVIRONMENTAL PROTECTION IN THE FAN KOU LEAD-ZINC MINE

Luo Liang Shi and Luo Kai Xian
(Fan Kou Lead-Zinc Mine, 512325 Guangdong, China)

(一) GENERAL DESCRIPTION

The Fan Kou lead-zinc Mine where is located 48 km North area from Shao Guan City, Guang Dong province, is one of the largest lead-zinc mining and dressing enterprises under authority of the China National Nonferrous Metals Industry Corporation. This mine was completed and put into production in 1968, its original designed scale were 3000 tonnes ore perday. And its capacity has been enlarged to 4100 tonnes perday after technical innovation in 1989.

The Fan Kou Mine is an underground metallic mine, it is developed by using a shaft mine. There are a main shaft and two auxiliary shaft mine, and now the underground developing has been separated nine gallery to extract. Also a slope tunnel has been opened to fit active requirement of large trackless equipments which were used in underground stope. Now deep part prospecting has been researched and developed for the future. The filled mining is a mainly method in mining. The run-of-mine ore were hoisted by through the main shaft, then their would be transported to ore dressing plant by overhead cableway. Three kind of products of the lead concentrate, zinc concentrate and sulphate concentrate have been produced in ore dressing plant. The annual lead-zinc metalluge output have 120,000 tonnes and the sulphate concentrate have 400,000 tonnes. These concentrates are mainly supplied to the national metallurgy and smelting plant, and a few of them are exported to abroad.

A serial diffcult technical problems such as geohydrology, mining and mineral processing were always met while the mine was developing. In order to make full use the underground rich deposit source, the Fan Kou Mine have always persisted in researched and developed the science-technology, and every year several million yuan have been put into used as technical and research funds. Depend on mineself engineer and technican and combined with other researched or designed institute's and high college's, lots of technical diffcult problems have been overcome. An advance technical and flowsheet which able to fit the mine

have been successfully developed. At the same time, the Fan Kou Mine have introduced and used abroad advanced technology and equipments which were worth over several million US dollors from more than ten countries and areas.

After the advanced technicals and newly equipments have been put into application, the level of mining and mineral processing technology, the economic technical indices are up to the advanced level of developed countries. The mine's economic benefit have obviously been increased. Since 1989, average increase rate of the science- technology progress has up to 6%, it occupied 62.8% in total economics increased, every year the total profits and taxes can be achieved RMB100,000,000.00.

(二) THE ORE PROPETY

The Fan Kou ore deposit is mainly dispersed and existed over two large massive ore body of the JinXin Ridges and the Shi Ridges in the mine. The valuable metallic minerals have high contents due to the minerals are concentrated to aggregate body. The grade of ore for lead is in the range 3.5%--5% (Pb), for zinc is 9%--12%(Zn), and for silve is around 100g/t(Ag). The ores can be scaled three types of massive lead--zinc--pyrite ore, fine lead-zinc-pyrite ore and massive pyrite ore, the massive pyrite ores belong to the sulphide ores and their contents occupied 95.5% in the total deposit, and the sulphide ores have been opened as mainly mining ores in the Fan Kou Mine, The oxide rate of the lead is up to 5%(PbO) and the zinc is less than 1%(ZnO).

The mainly metallic minerals of ore have pyrite, sphalerite and galena, next metallic minerals have englesite, cerussite, arsenopyrite, proustite, argentitle, bournnite, copper and other. The metallic minerals have 60% in the total minerals. Also the ores have accompanied with the rare metals of the silve(Ag), cadmium(Cd), germanium(Ge), gallium(Ga), mercury(Hg) and etc.. The gangue minerals have quartz, calcite, dolomite and so on.

The metallic minerals has a very complicated dissemination characteristics. The corrodent replacement of minerals in each other existed very common and serious because of the ores were formed in different period.

The pyrite minerals most present and exist as in idiomorphic shape and half-idiomorphic shape, their partical size are coarsest, most of them are up to 0.1mm. About 15% fine pyrite minerals which their partical size are in the range of 0.1--0.018mm, and their present as star points dissemination between the galena and sphalerite minerals. The structure

of corrosion and relict of the pyrite minerals have been formed since the pyrite minerals had formed in earily period, their were corrodent replaced and interlocked by hydrothermal alternation of the sphalerite and galena minerals

The sphalerite minerals present a coarse partical size aggregate, their mainly dissemination size are in the range of 0.10--1.00mm. The sphalerite minerals were filled or replaced in the gaps of the pyrite or the sphalerite aggregate minerals. And winding contact boundary between the pyrite and sphalerite minerals were filled and replaced with the galena minerals.

In opposite case with the pyrite minerals, the galena minerals have the smallest dissemination size, most of them are in the range of 0.018 to 0.5mm. And dissemination size of the galena which have about 20% are less than 0.018mm. The anglesite and cerussite minerals were formed in gap or winding edge of the galena. As the galena formed in later period, the pyrite and the sphalerite minerals which formed in earily priod were corrodent replaced and interlocked by the galena, Therefore the relation of the galena, pyrite and sphalerite minerals were made in a very fine and close aggregation. So it is very diffcult to separate the galena, sphalerite and pyrite minerals.

(三) THE MINERAL PROCESS TECHNOLOGY

Three stages and one closed-circult process flowsheet of the crushing and screening have been used in the Fan Kou mineral processing plant. The coarse crusher is installed in underground, secondary and tertiary curshers are installed in the plant. The crushing product partical size is less than 15mm. The run-of-mine ore content lots of slimes due to the mine use the cemented filling mining method, first a washing and desliming stage need to be used in the plant.

There are two parallel system in the grinding and flotation section, the throughput of each parallel system have 2050 tonnes per day. there is a single system to treat the slime which output have 300 tonnes per day. The total throughput have 4400 tonnes perday. the selective flotation flowsheet has been used to separate all lead and zinc, then it can be produced lead concentrate and zinc concentrate. All tailings of lead and zinc after their were dewatered by through their passed into thickener, are concentrated to flotate the sulphide and then the sulphide concentrate can be obtained. All concentrates pulp were dewatered and filtered by using the thickener and the disc vacume filter, the concentrate moisture can be got in the range of 12-14% at least.

Each system has two parallel sets and each set is consisted of a ball mill Φ2700x3600mm and a Φ2000mm dio-sprial classifier in grinding circuit operation. The overflow fineness of classifier is 65%-0.074mm. The overflow of classifier are combined with the product of a ball mill Φ2700x3600mm which is a secondary grinding, their products fineness can be controled over 85% -0.074mm by a set of Φ 350mm hydrocyclone at least. An I/A automatical control system has been used to control the grinding and classifying in plant, and the partical size are measured and checked by the PSM-400 partical size analysis.

The flotation machine of JJF-8M^3, JJF-4M^3 and XJK-2.8M^3 have been used in the flotation section. To floate lead has used a stage of rougher and one stage of seavenger flowsheet, the lead coarse concentrate are sent to regrinding which used a Φ2100x3000 ball mill, its regrinding fineness is 85% -0.036mm, then the lead concentrate can be obtained by through five satges of cleaning. In order to reduce the galena minerals reground or overground, and to increase the "coarse effect", one stage of speed rougher and speed cleaner flotation have been added before the lead rougher flotation. Its froth concentrates are directly entered to the fourth lead cleaners stage, its tailings are combined with the lead coarse concentrate and sent to regrinding. The tailings of lead flotation are sent to separate zinc flotation, which have one stage of rougher, three stages of scavener and three stages cleaner, the zinc concentrate can be obtained at least.

Courier 30 on stream X-ray fluorescence analysis have been installed and used in the flotation section.

To floate lead flotation use a kind of combined collector and mixed depressant, to floate zinc flotation use the butyl xanthate and copper sulfate(CuSO4), the frother is a kind of pine camphor oil. The sulfuric acid and ethyl xanthate were used to floate sulphide flotation, the grade of sulphide concentrate can be obtained 43.5% and its recovery is 56%.

The principle flowsheet of lead and zinc selective separate flotation can be shown in Figure 1, and the metallurgical pertormance are shown in following table.

The separated technology of the Fan Kou ore was always a diffcult problem because of the ores were charactered by fine and close between the lead-zinc and the pyrite minerals, and pyrite mineral can easily floated, so that it was very diffcult to separact galena, sphterite and pyrite. In order to slove the problem of treatment of refractory ore, depand on the engineer and technican of mineself and learn from abroad

The Fan Kou Lead Zinc Separaction Flotation Flowsheet

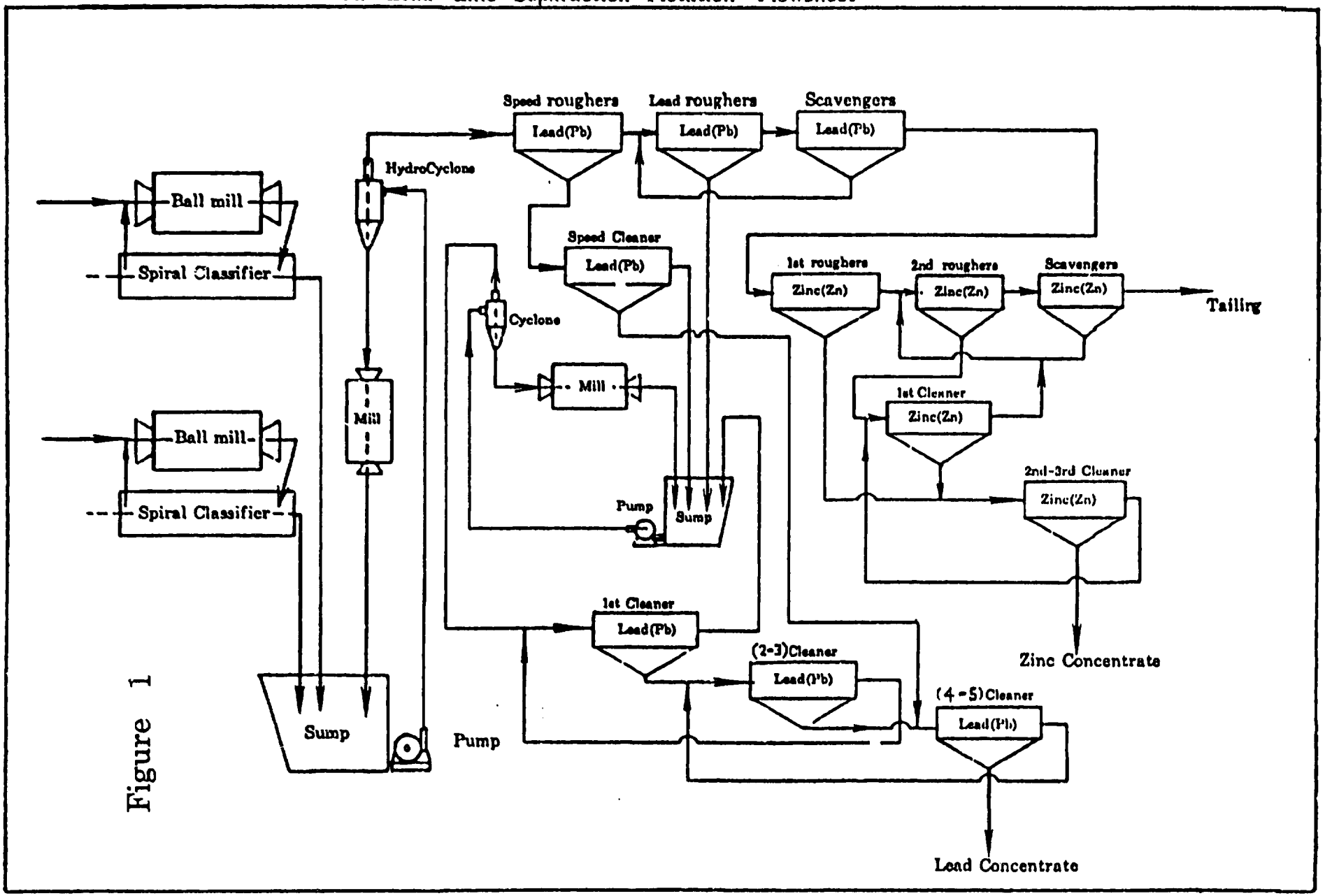


Figure 1

Table The metallurgical pertormance of FKM

PRODUCTION NAME	RATE (%)	GRADE (%)		RECOVERY (%)	
		Pb	Zn	Pb	Zn
Pb Concentrate	5.736	58.40	4.25	82.70	2.38
Zn Concentrate	16.364	1.35	54.10	4.97	93.41
Zn Taillings	77.900	0.64	0.55	12.33	4.21
Feed Ore	100.00	4.05	10.26	100.00	100.00

* Note: FKM means Fan Kou Mine

advance and treatment technology, the flowsheet of mineral process had been modified over ten times, till they have found the flowsheet of mineral process technology which able to fit the characters of the Fan Kou ores in practice, and the metallurical pertormance can be breaked through progress. Compare with initial peroid, now the grade of concentrate have increased 22.3% for lead concentrate and 10. 3% for zinc concentrate, and the recovery has increased 10% for lead and 6.3% for zinc concentrate. These progress have achieved to the advance level which have the same type of ores and their separated processing.

The mainly characters of the Fan Kou mineral processing technology can be summaried as following:

(1). In order to reduce the losses of matellic mineral in tailings, the run-of-mine ore must be fine ground and their clear particles of the minerals can be as possible as liberated. And it can be enlarged the floatablities difference between the galena and pyrite minerals by through the lead rougher concentrates were reground.

(2). By using the high alkaline medium, the pyrite mineral can be intensively suppressed. And combined with a newly type of DS depressant which has selective adsorped the harmful materials & ions in the pulp, a special depressed functional to the pyrite minerals can be produced. And the separated effection of the lead and pyrite can be increased.

(3). The dosages of reagent have obviously been reduced by using combined two kinds of collectors which has an "association effect".

(4). By through the characters of selectively floatabilities of part galena minerals, a newly process which was called "speed flotation" has been used, and overgrinding of the galena mineral can be provented. This also has lead a "coarse effect" in lead cleaning operation stage, and has improved the lead recovery.

(5). The influence of separate index by the slime hace been reduced by through slime and sand minerals were separated into two treatment system in practice

(四) THE ENVIRONMENTAL PROTECTION

The Fan Kou Mine has pay much attention to the environment and its protection, the polluted problems which had been met can be always solved depend on science-technology progress during developing production. In accordance with the mine pollute source which come from the tailings and waste water of mineral processing, a lot of pollution abatement methods have been used and the environmental pollution from the mineral processing have as possible as been reduced.

(1). The flowsheet and reagent regulation of the mineral processing have always been modified till their have obtained satisfactory result and a good environment. The initiate process of concentrate plant was designed to use the process of Pb-Zn bulk flotation-separation, and to depress the sphlerite and pyrite by using the cyanide and combine with sulphide zinc, the cyanide consumption is 300-500g/t. The content of cyanide ion in discharge tailings was up to 50mg/l. In order to solve the cyanide pollution, many steps of the comprehensive treatment and technology have been used. The Mine have successfully developed that bulk flotation was replaced by selective flotation, the cyanide was replaced by sodium carbonate (Na_2CO_3) and zinc sulfate ($ZnSO4$), it has successfully obtained the flotation with cyanide-free reagent. In later time, it was found some discharge materials come from collector were not as the National discharge standard, such as phenol in phosocresol, sulphide in PN-4. And these have been solved and replaced step by step through doing the research work and experiment. In recent time, a newly reagent DS which is neither smell nor toxicity and has special function to depress pyrite, has been successfully developed and used. It not only has increased the separated effect of lead and pyrite (Fe), but also has improved the environment.

A few of heavy metal ions from discharge waste water of the mine were treated and achieved their discharge standard by the comprehensive treatment method, such as the chemical neutralization method or plant

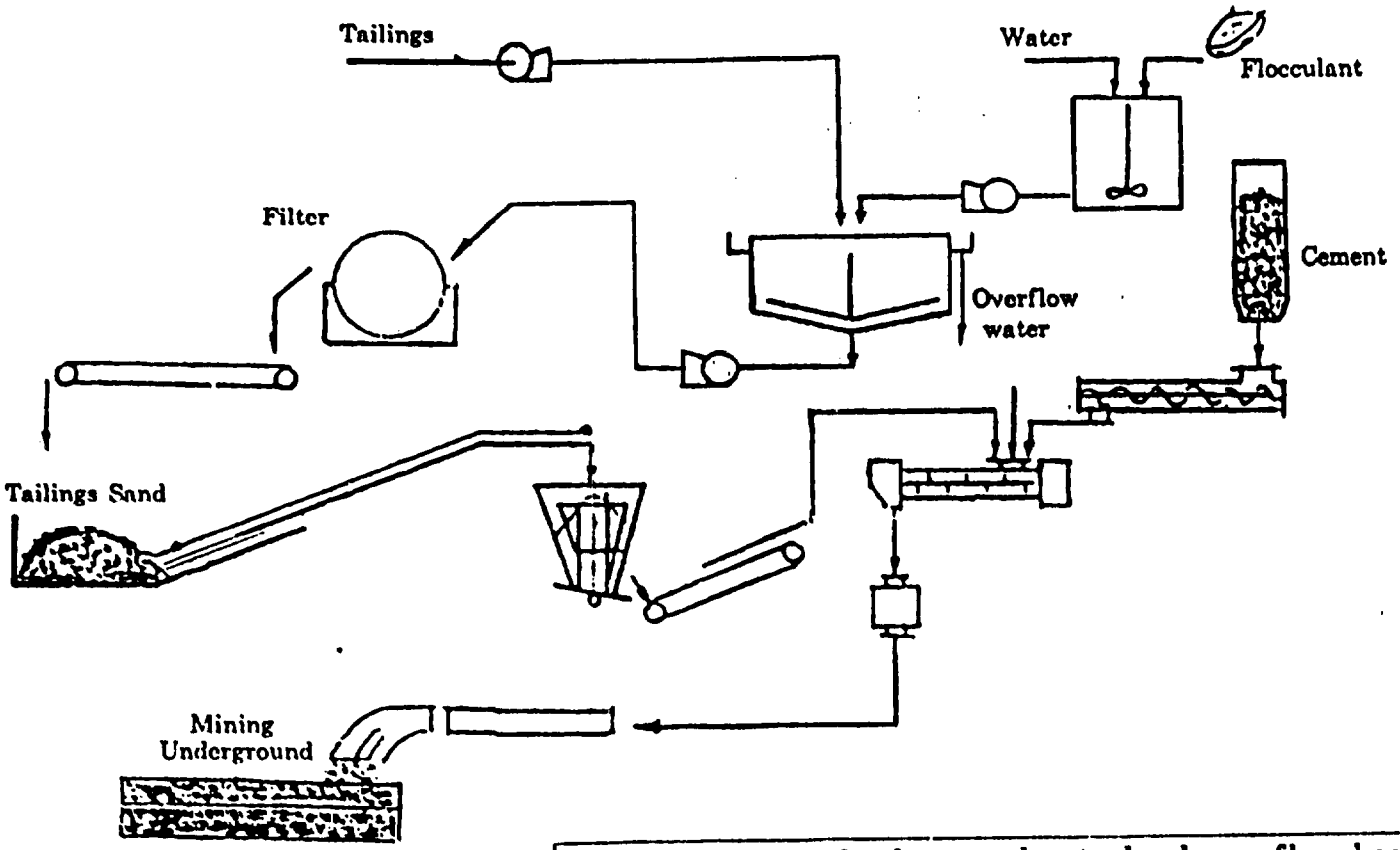
some plants which able to adsorbed some special ions. The waste water from underground which has high solid content have been settled by the thickener, then it can be discharged to irrigate farmland. Also it has been extended to reused in mining and mineral processing plant, so that the waste water discharge can be reduced.

(2). The tailings source has been made full used. The underground mine need great amount of filled materials to use as cemented filling in the underground. The Fan Kou Mine have persisted in developed and unlitited tailings and have as possible as exchanged the waste into valuable. In the early time, the tailings have been researched to sinter as cement, but it can not be used in practice because of that cement has a little high content of sulphide. Now mainly application of the tailings are used as filled materials in underground and permeate dosage material in cement plant.

When the tailings were used as the filled materials, it only can be used coarse fractions sand which has been classified from the tailings in initiate time. The unitlized rate of total tailings was only 30-40%, and rest of tailings which content lots of fine fractions sand have to be put into tailings pond. Since 1985, the full tailings which did not classified have been researched and tested by the Fan Kou Mine and combine with other research units. At least, a serial of technology and equipments of the recovery, preparation, transport of total tailings have been successfully developed and used after many test have been done in several years. A newly process of the cemented filling with high density and full tailings sand have been completed test and first successfully put into application in practice, and the unlitite rate of tailings sand were increased to 90%. The flowsheet of the cemented filling with high density and full tailings sand can be shown as Figure 2. Now the Fan Kou Mine still make hard work to developed and enlarged the unlitited rate and at least to approach the aim of not tailings mine.

(August 20, 1993)

Figure 2



Sketch map of the newly technology flowsheet of cemented filling with high density & all tailing