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KHD HUMBOLDT WEDAG AG

16560

Pyrites, Phosphates and Chemicals Ltd. India

Report

on

Upgrading of Saladipura Pyrite Ore

in India

for the United Nations Industrial Development Organisation (UNIDO)

- Purchase and Contract Service - Austria

UNIDO Project No. DP/IND/81/018

UNIDO Contract No. 85/99

KHD Project No. 9 2123 5 0156

KHD Order No. 9 8125 9 5023

630

TN 0103 0431/04
(HW 3002/4)
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KHD HUMBOLDT WEDAG AG

Abstract

The lumpy pyrite ore from the deposit Saladipura which was supplied by Messrs Pyrites, Phosphates and Chemicals Ltd. (PPC) to KHD Humboldt Wedag AG allows to be concentrated by jigging from 20.6 % sulphur content in the feed to 34 % sulphur content in the concentrate at a material recovery of 73 % after crushing it smoothly down to a fineness of 100 % minus 10 mm.

The detailed tests made the design of a jigging plant possible.

The investment costs of a complete jigging plant were established for a daily capacity of 600 t.

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Table of Contents

Enclosure

Flow-sheet No. 801-31-214 UD

Test report

1. Introduction

KHD Humboldt Wedag AG received three ore samples totalling 14 t from Messrs. Pyrites, Phosphates and Chemicals Ltd. (PPC) New Delhi, India, on December 9,1985 which were divided into low,- medium,- and high grade material. The main tests for establishing the process data and parameters required for the design of a plant were performed on the medium grade sample. The tests revealed that the lumpy pyrite ore from the deposit Saladipura allows to be concentrated by jigging from 20.6 % sulphur content in the feed to 34 % sulphur content in the concentrate at a valuable recovery of 73 % after crushing it smoothly down to a fineness of 100 % minus 10 mm.
The test report is attached hereto.

2. Design of a Jigging Plant

In agreement with the gentlemen of PPCL the plant was to be designed for the capacity of 600 t/day at 20 hours service. Based on the parameters and the hourly throughput of 30 t resulting from the tests, a flow-sheet system of the plant was made up and the respective machines were determined whereby a feed grain size of minus 10 mm was taken into account.

2.1 Process Description

Drawing No. 801-31-214 represents the process. The ore coming from the stockpiling plant is fed by the bucket elevator 1.01 into the intermediate bin arranged above the jig. The proportioning chute 1.02 feeds the feed material uniformly onto the Batac jig 1.03. The concentrate produced on the jig will be discharged via the bucket elevator 1.04 and partly dewatered. After dewatering the concentrate further on the hurdle 1.05 it will be conveyed by the belt conveyor 1.06 to the concentrate stockpile. The tailings delivered from the jig overflow are first dewatered on the hurdle 1.07 and then on a vibrating screen 1.08. Thereafter, they will be conveyed by the belt conveyor 1.09 to the tailings stockpile.

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The waste water with solids of minus 0.5 mm delivered from the dewatering hurdles and dewatering screen is supplied by the pump 1.10 to the thickener cyclone 1.11. The cyclone overflow is thickened in the thickener 1.12. The thickener underflow together with the cyclone underflow is pumped to the tailings pond 1.13. The clarified water produced from the thickener overflow is pumped back to the plant 1.14. This will lead to a quite low fresh water consumption of 10 m3/h only including 1.5 m3/h cooling water for the pumps. The total installed power of the plant is 195 kW. At 80 % motor capacity, the power consumption of this plant will be 156 kWh/h and 5.2 kWh/t respectively.

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1.2 Mechanical Equipment

As per drawing No. 801-31-214 UDthe below-listed machines were designed for a capacity of 30 t/h raw ore feed of 10 - 0 mm grain size.

Item	Qty	Mechanical Equipment	Weight kg
1.01	1	Bucket Elevator 315 mm wide 11,950 mm long	10,150
1.02	1	Bin Discharge Chute	395
1.03	1	Batac Jig, 1000 mm wide, 3,045 mm long	15,080
	1	Screw Compressor	1,020
	1	Compressed Air Tank, Volume 2000 l	540
	1	Compact Blower	510
	1	Silencer Hood including Valve, Manometer and Underpressure Indicator	220
1.04	1	Dewatering Bucket Elevator	10.150
1.05	1	Dewatering Hurdle	500
1.06	1	Belt Conveyor, 650 mm wide Center Distance 20 m	4,600
1.07	1	Dewatering Hurdle	500
1.08	1	Dewatering Screen USL 1.2 x 3.0 m	1,925
1.09	1	Belt Conveyor, 650 mm wide Center Distance 20 m	4,600
1.10	2	Pulp Pumps	1,000
1.11	1	Hydro-cyclone 300 mm dia	410
1.12	1	Thickener 5.2 m dia, 2.2 m high, mechanisms	2,000
		Steel Tank	9,000
1.13	2	Pulp Pumps	800
1.14	2	Water Pumps	300
			63,700 kg

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2.3 Investment Costs

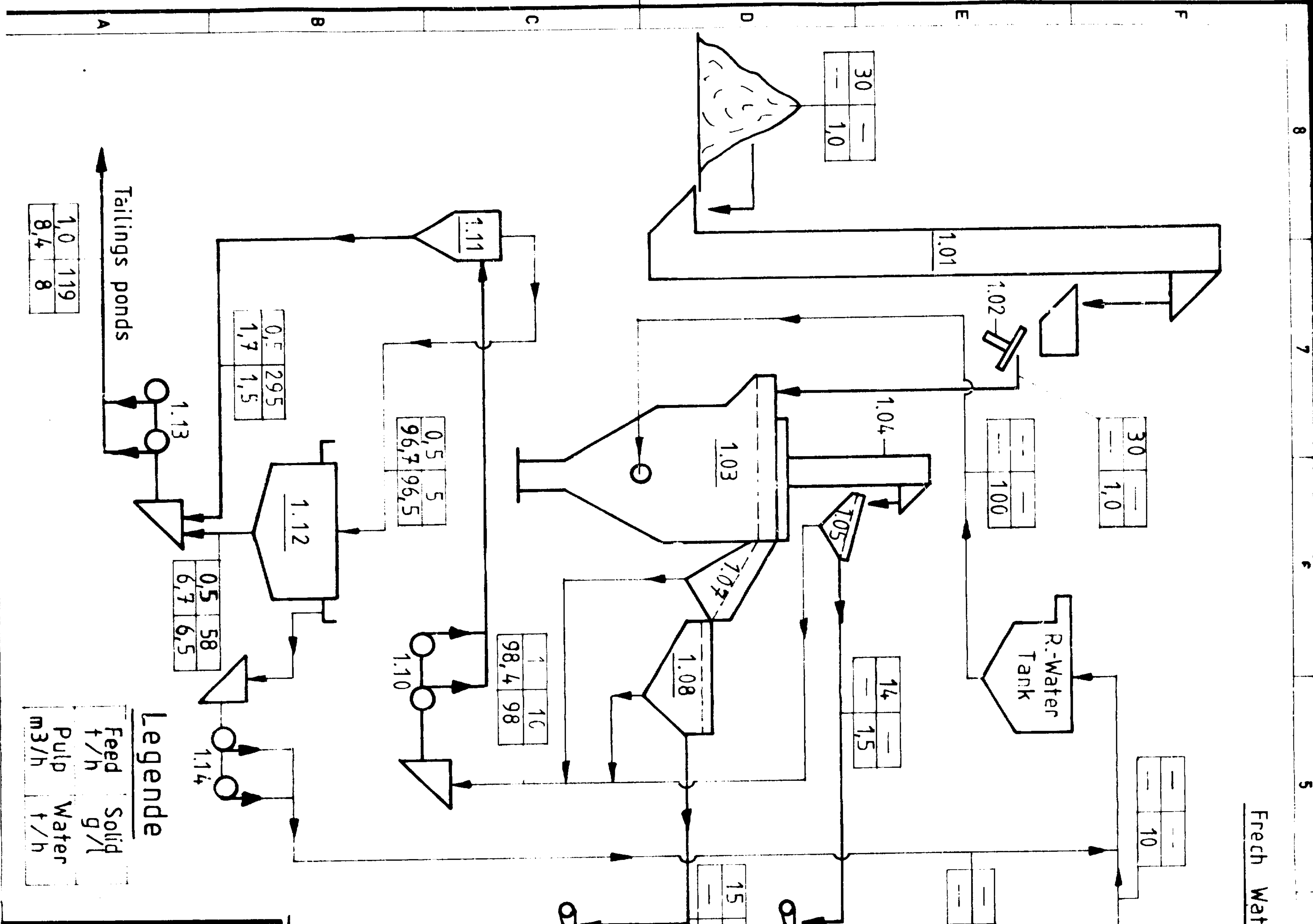
In order to establish the total investment, the costs of the mechanical equipment as listed above were drawn up.
The total investment for a plant of the size as planned will be estimated as follows:

		DM
Mechanical Equipment	100 %	1,730,000.--
Interior Equipment	15 %	259,500.--
Electrics	30 %	519,000.--
Steel Structure	30 %	519,000.--
Transport (fob)	6 %	104,000.--
Civil Work	40 %	692,000.--
Installation, Painting, Commissioning,	50 %	865,000.--
Engineering	15 %	259,500.--
Spare and Wear Parts for 2 years operation	15 %	259,500.--
Other	5 %	92,500.--
	Total	5,300,000.--

3. Prospect

The initial hand-jigging tests on a smaller sample from the deposit Saladipura with 25 % sulphur in the feed led to a promising result of a concentrate with 39 % sulphur at a valuable recovery of 75 %.
In the continuous tests on the larger but low-sulphur sample of 20% sulphur only in the feed, the above results could not be confirmed. Only a concentrate of 34 % sulphur at a valuable recovery of 73 % could be achieved.
The reason for this are the considerably finer intergrowth ratios of this coarse-grained ore. A further crushing of the ore won't lead to a better result as confirmed by the tests on the material crushed down to minus 5 mm because this will increase the percentage of minus 0.5 mm. In the jigging and dewatering process, some part of the valuable material minus 0.5 mm will disappear.
A jigging plant was designed for a feed rate of 600 t/day in line with the results of these tests.
The costs of the mechanical equipment will amount to 1,73million DM approximately and the investment costs of the entire plant to 5,3 million DM.
This designed plant would produce daily 280 t of concentrate with a sulphur content of 34 %.

SECTION 1



A
B
C
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E
F
8
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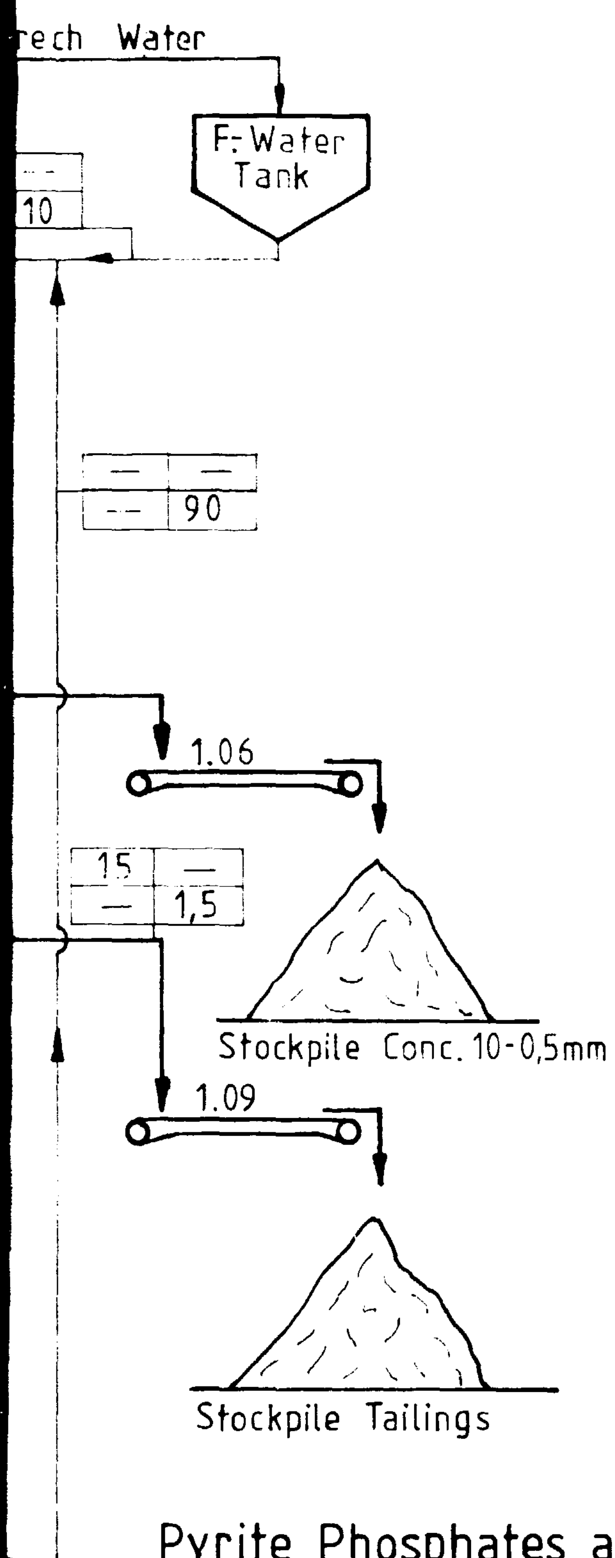
6
5
1.01
1.02
1.03
1.04
1.05
1.07
1.08
1.10
1.11
1.12
1.13
1.14
Tailings ponds
R.-Water Tank
Legende
Feed t/h
Solid g/l
Pulp m3/h
Water t/h

4 3 2 1



LEGENDE

1.01 1 BUCKET ELEVATOR

1.02 1 VIBRATING FEEDER

1.03 1 THICKENER

1.04 1 BATAC-JIG

1.05 1 FIXED-SCREEN FOR DEWATERING

1.06 1 BELT CONVEYOR

1.07 1 FIXED-SCREEN FOR DEWATERING

1.08 1 DEWATERING SCREEN

1.09 1 BELT CONVEYOR

1.10 2 PUMPS (1 X STAND-BY)

1.11 1 HYDROCYCLONE

1.12 1 THICKENER

1.13 2 PUMPS (1 X STAND-BY)

1.14 2 PUMPS (1 X STAND-BY)

9-2123-5-0156

Pyrite Phosphates and Chemicals, Delhi "India"

Maße ohne Toleranzangabe: spanend DIN 7168; spanlos DIN 7168; Brennschnitte s ≤ 20 B DIN 2310; s > 20 C DIN 2310; Schweißkonstr. B DIN 8570	Werkstückkanten nach DIN 6784 (−0,3 / +0,3)	Oberflächen Angaben ISO 1302, R_z nach DIN 4768
Fertigungstechn geprüft	Bearb: 12.08.87	Maßstab
Schweißtechn geprüft	Gepr	Rohteil Nr
	Norm	Modell-Nr
	Abt IM-AE	Gewicht / Werkstoff

Benennung: Flow sheet
Jigging-plant
SALADIPURA PYRITE

KHD HUMBOLDT WEDAG AG

Teile-Nr: 801-31-214 UD

Blatt 1 von 1 Bl

Mikr | Zust | Änderung | Dat/Na | Gepr | Urspr | Ers für | Ers durch

4 3 1

SECTION 2

KHD HUMBOLDT WEDAG AG

Cologne.

June 24, 1986
IT-YM 2 Wi/He -
phone ex-
tension 658

Report

on

continuous jigging- and flotation tests

for concentrating the pyrite ore

from deposit Saladipura

of Messrs. Pyrites, Phosphates and Chemicals Ltd, India

for the United Nations Industrial Development Organization (UNIDO) - Purchase and Contract Service -, Austria

UNIDO Project	DP/Ind/81/018
UNIDO Contract No.	85/99
KHD P.-No.:	9-2123-5-0156
KHD A.-No.:	9-8125-9-5023

TN 0103 0889
(HW 1630 E)
1 000 2 84

KHD HUMBOLDT WEDAG AG

KHD HUMBOLDT WEDAG AG

1. Summary

The lumpy pyrite ore from deposit Saladipura, made available by Messrs. Pyrites, Phosphates & Chemicals Ltd. (PPC), India, can - after heedful comminution to a fineness of 100 % less than 10 mm - be concentrated by jigging from a sulphur content in the feed of 20.6 % to a sulphur content of 34 % in the concentrate, at a recovery of valuable substances of 73 %. Subject to screening the accruing tailings on a 0.5 mm mesh screen and flotation of the screen throughs, the sulphur recovery is raised by approx. 4 points to more than 77 %. Enclosure 1 is a graph showing the dependency of the concentrate's sulphur content on the recovery of valuable substances for dressing this ore by jigging combined with flotating.

2. Test material

On December 09, 1985, the research- and development center of KHD Humboldt Wedag AG received three ore samples of a total quantity of 14 t, packed in 35 plate barrels, from the Pyrites, Phosphates and Chemicals Ltd. (PPC), New Delhi, India. The samples listed below were involved:

Sample identification	Total quantity (t)	Sulphur content (%)
pyrite ore Saladipura medium grade	10	20.63
pyrite ore Saladipura high grade	2	31.56
pyrite ore Saladipura low grade	2	17.16

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3. Test objective

The test objective was to concentrate the delivered, lumpy raw ore (sample medium grade) after comminution at maximum recovery from a sulphur content of the feed of 20.6 % to a sulphur content of more than 35 % by way of specific gravity sizing.

4. Test procedure and -results

Essentially, investigations and tests were only carried out for sample "Saladipura medium grade". If no statements to the contrary are made below, all information given refers to this type of ore.

4.1 Raw material testing

4.1.1 Medium grade

The total sulphur content of a representative sample was determined at 20.63 %. An X-ray emission semi-quantitive analysis yielded the following ranges of essay:

element resp. oxide	range of assay %
Na_2O	0.5 - 1.5
MgO	2 - 5
Al_2O_3	4 - 10
SiO_2	20 - 40
P_2O_5	0.1 - 0.3
S	15 - 30
Cl	0.3 - 1.0

element resp. oxide	range of assay %
K_2O	0.7 - 2
CaO	3 - 7
TiO_2	0.2 - 0.5
Cr	0.03 - 0.07
Mn	0.05 - 0.2
Fe	20 - 50
Ni	0.005- 0.02
Cu	0.04 - 0.1
Zn	0.5 - 1.5
Sr	0.005- 0.02
Zr	0.005- 0.02
Sn	0.05 - 0.2
W	0.02 - 0.05
Pb	0.2 - 0.5
Co	0.005- 0.02

The following mineral constituents were determined by way of the X-ray powder diffraction method:

mineral	portion
pyrite	main portion
quartz	secondary component
hornblende	minor contents
pyrrhotine	minor contents
feldspar	minor contents
mica	minor contents
sphalerite zinc	very small contents
chlorite	traces

The particle size distribution of the raw ore as delivered, determined by dry manual screening, is shown as a graph in enclosure 2

The bulk density was determined at 1.94 t/m^3 for this particle size range.

4.1.2 Low grade and high grade

The chemical analyses of the two samples yielded the following total sulphur contents:

low grade	17.16 % S
high grade	31.56 % S

To simplify matters the total sulphur content is below referred to as sulphur content.

4.2 Crushing

All three raw cre samples were, each, reduced to a fineness of 100 % less than 10 mm by means of a cone crusher, type CALIBRATOR 900/110, equipped with an SF-crushing tool.
The procedure has been detailed in enclosure 4.
The third crushing stage was meant to simulate a closed-circuit operation of CALIBRATOR - USK-screen - (10 mm) - CALIBRATOR.

The total, comminuted ore samples were each mixed and representative samples for the raw material tests and wet screen analyses were extracted. The particle size distribution figures obtained can be taken from enclosure 2.

It is clearly noticeable that the material is more difficult to crush upon a dropping pyrite content. The size fractions of ore sample "medium grade" were chemically analyzed. The results have been included in enclosure 3. A distinct sulphur concentration within a particle size range from 0.5 mm to 0.045 mm can be observed. This confirms the results of the selective comminution mentioned above.

4.3 Jigging tests

On the total, more than twenty continuous and several discontinuous jigging tests were carried out with the BATAC-laboratory jigging machine existing in the research- and development center. A detailed description of the test plant has been attached to the report as enclosure 5.

Essentially, the particle size range of the feed material, the pulsation characteristic, the mass throughputs and -distributions as well as the discharging facilities were varied during the tests.

4.3.1 Test result

At a recovery of valuable metals of less than 75 %, pyrite ore Saladipura sample "medium grade" was concentrated during the jigging tests from a sulphur content in the feed of 20.6 % to a sulphur content of approx. 33 %.

Since no sulphur content in the jigged tailings of clearly less than 9 % could be achieved with the adjustments selected, the recovery of valuable metals could not be increased.

The highest concentration achieved equalled 38 % S during continuous jigging and 42.6 % S during the intermittent jigging test.

4.3.2 Particle size range of the material fed to the jigging machine

The success of classification for particle size 10 - 0.5 mm was not dependent on the size range of the material fed to the jigging machine. Jigging without superfine grain of less than 0.5 mm yielded no improvement of result for fraction 10 - 0.5 mm compared to jigging of the non-classified raw ore of 10 - 0 mm size.

Regarding size less than 0.5 mm, a sulphur recovery of approx. 60 % only could be achieved.

4.3.3 Pulsation characteristic

During tests 2 - 5 the pulsation characteristic was changed by larger openings at the air discharge valves and higher air pressure. The results of these tests were not satisfactory. Therefore, the gap widths at the disc valves (outlet end) were significantly narrowed.
After mixing of all products larger than 0.5 mm from tests 2 - 5, a series of continuous jigging tests as well as intermittent jigging tests were carried out with this material. The products obtained were partly determined macroscopically only. It was shown that by a relatively weak pulsation, ensured by small outlet valve openings, low operating air pressure and short valve opening periods, improved jigging properties could be achieved.

4.3.4 Stratification test

This fact is also made evident by evaluation of jigging test 6 by way of stratification (enclosure 7.4 refers). At a material height of 110 mm, an approx. 50 - 60 mm thick heavy material layer of a sulphur content of 37 % was formed. Related to the sulphur content of the material, which at that time lay on the screen plate, this corresponded to a sulphur recovery of 83 %. Since, however, the horizontal velocity of the light material is significantly larger than that of the heavy material during jigging, the mass- and sulphur distributions stated in the balance can be evaluated qualitatively only. On the one hand it was shown that a heavy material layer is formed at a thickness of 50 - 60 mm at a sulphur content of 37 % resp. at a thickness of 20 - 30 mm at a sulphur content of 42.65 %. However, on the other hand it was observed that the topmost layer (light material) yet had a content of valuable substances of 9.4 % of S.

4.3.5 Number of jigging chambers

Although the results for jigging with only one discharge chamber do not substantially vary from those obtained with two discharge chambers, the two-stage design is preferable, since the desired product quality can be ensured better by the latter design. A three-stage arrangement with three discharge facilities has drawbacks, at least regarding the superfine grain, since already after two stages such large amounts of fine pyrite have been separated and jigged through the coarse pyrite, which served as ragging that the pore volumes between the coarse heavy material grains can no longer be filled completely with fine pyrite.

As to tests 12 and 13 the result was (enclosures 7.12 -7.16 refer) that in the heavy material less than 0.5 mm of the third stage, a high portion of low-sulphur particles existed.

A mere ragging chamber for jigging the superfine pyrite arranged downstream the one or two discharge chambers appears not to be appropriate for the same reasons. Moreover, the concentrate recovery of the ragging unit (enclosures 7.1 - 7.5 refer) was substantially lower than that of the jigging chamber with discharge facility.

4.3.6 Discharge facility

The discharge facility, type 1, outlined in enclosure 8, had been installed in the initial phase of the test jobs. Since the test objective could not be reached with regard to the recovery during tests 1 - 13, the discharge rate adjusted was varied twice. An inferior classification effect was obtained for variant 2. The third alternative confirmed the results obtained by the first variant. The respective advantages and drawbacks of the two facilities annul each other. Discharge facility, type 1, has the concentrate withdrawn from a small heavy material storage, the suction effect of the discharge gate is slight and particles of a lighter specific gravity, included in the heavy material storage, can principally move again up to the light material layer.

The drawback is that pulsation can only be adapted to the material layer height in the area of classification (thickness approx. 100 mm) or to the material layer height in the discharge area (thickness 100 mm to approx. 200 mm). In case of discharge facility, variant 3, the thickness of the ore layer over the total jig bed length is approximately constant. Thus, pulsation can be better adapted to the requirements of the ore, although the advantages offered by the heavy material storage cannot be utilized.

4.4 Stream classification

Since classification of the superfine grain and especially of the slime by means of a BATAC jigging machine was not very effective for this ore, a quantity of approx. 1000 kg of the crushed raw ore less than 10 mm was deslimed with the aid of a spiral-type classifier. The objective of this test was to achieve a cut point of approx. 0.2 mm. This could not be reached, since the solids content of the pulp in the spiral-type classifier above the coarse ore pieces, which immediately settled at the bottom, was very low. The raw ore feed rate, i.e. approx. greater than 3 mm, was too high and approx. less than 3 mm too small. Thus, a cut size of clearly under 0.1 mm was obtained and despite two classifying stages only 4.31 % of the ore could be separated as spiral-type classifier overflow of a sulphur content of 15.54 %. The coarse fraction served as feed material for the jigging test.

Regarding the semi-technical facility spiral-type classifier used, previous sizing on a screen of approx.3 mm mesh width, would have been reasonable, which was omitted, since the work expenditure for the required professional mixing of the products - percentage of residues retained on screen and spiral-type classifier coarse fraction - appeared to be excessively high.

4.5 Flotation

During the six flotation tests a 3-l Agitair-cell was applied, which at an agitator circumfarential speed of approx. 4.5 m/s had an air consumption rate of 60 - 110 l/h.

The solids contents of the flotation pulps were within a range between 320 and 400 g/l. The following reagents were applied:

dispersion agent	sodium silicate
pH-regulator	sulphuric acid
collecting reagent	potassium-amyl-xanthate
effervescing reagent	Flotol B
collecting - effervescing reagent	Phosocresol

4.5.1 Raw ore fraction less than 0.5 mm

The three exploratory flotation tests carried out with the raw ore fraction less than 0.5 mm evidenced good flotation properties of the pyrite. At concentrations of 26 % of S in the flotation feed to more than 40 % S in the froth products, sulphur recovery values of more than 85 % could be reached (<u>enclosures 10.0 - 10.6 re-</u>

fer). It is possible that the recovery of valuable substances can be improved by intermediate thickening after a flotation period of approx. 4 minutes.

The quantities of reagents listed below were on the whole admixed for flotating the raw ore fraction of a size less than 0.5 mm:

reagent	reagent admixture (g of reagent/t of solids)
sodium silicate	1100
sulphuric acid	1800
potassium-amyl-xanthate	210
Flotol B	90
Phosocresol	45

The quantities of collecting- and effervescing reagent stated are reduced, in case secondary flotation of the froth in accordance with the flowsheet (enclosure 10.0 refers) is omitted. Moreover, the reagent consumption rate can be lowered by recycling the flotation waste water.

4.5.2 Tailings and middlings

Apart from the raw ore fraction, the light materials of jigging tests 14 and 17 as well as the middlings of jigging test 17, i.e. size less than 0.5 mm, each, were subjected to flotation.

The jigged tailings less than 0.5 mm of test 17 required a higher expenditure due to the higher portion of slime. The consumption of sulphuric acid for pH-value regulation equalled 2.8 kg/t. The froth was twice subjected to secondary cleaning. At these conditions a sulphur concentration from 16.6 % of S to more than 45 % of S resp. more than 35 % of S could be achieved at a recovery of valuable substances of barely 50 % resp. approx. 75 %.

Flotation of the middlings from test 17 and the jigged tailings from test 14 showed approximately the same results as the tests carried out with the raw ore fraction.

4.6 Magnetic separation

Two exploratory tests for classifying the pyrite ore by means of DESCOS-separator, equipped with a supra-conducting magnetic system, yielded no successful classification effect. A clear concentration of pyrite could neither be observed in the magnetic material nor in the non-attracted material.

4.7 Sedimentation properties

The sedimentation properties of the pyrite ore were tested on the basis of the size fraction less than 0.5 mm (material discharged from CALIBRATOR). It is possible that after the long storage period the surface properties have changed and, thus, the effect of the flocculants applied.

A clear water could not be obtained from the small quantities of auxiliary sedimentation agents applied. During two tests the turbid 'clear' water was sucked off and filtered. The following solids contents were ascertained:

test	1	4	5
solids content of feed g/l	374	237	147
solids content of excess g/l	1.3	not named	0.4
degree of thickening reached (10 min) g/l	674	1412	1562
flocculant admixture rate g/m^3	0	1	0.5
flocculant type		Praestol 2900 TR	

The auxiliary sedimentation agent used (see tests 4 and 5, enclosure 12) caused a high sedimentation velocity. A sufficient final thickening degree was likewise achieved. The clear water, however, was contaminated to a non-tolerable degree by suspended matter. Prior to dimensioning the thickener, further sedimentation tests will have to be implemented with fresh pyrite ore by use of various flocculants, for which special attention has to be paid to the clear water.

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5. Combination of process steps jigging and flotation

Since no satisfactory classification results could be obtained for the superfine fraction of the ore by way of the BATAC-test, however the pyrite from deposit Saladipura has good flotation properties up to a size of 0.5 mm, various combinations of process steps jigging and flotation have been investigated.

On the one hand, the crushed raw ore of size 10 - 0 mm was subjected to wet screening at 0.5 mm, the oversize was continuously jigged and the screen throughs flotated. On the other hand the non-classified material was classified on the BATAC-jigging machine. The light product obtained as well as partly the middlings were classified at 0.5 mm and the fines were subjected to flotation.

Enclosures 12.1 - 12.6 include the results with the process flowsheets.

It was shown that both variants were identical. A concentration of the ore of 20.6 % of S in the feed to 33 - 36 % of S in the concentrate was reached at a sulphur recovery of more than 78 - 75 %. The dependency of the concentrate quality on the sulphur recovery has been shown as diagram in enclosure 1.

The tests have been carried out by us to the best of our knowledge and ability. A liability, especially for the process engineering results of machinery, plant components or plants delivered by us, is taken over by us only, if this has been agreed upon in writing.

KHD Humboldt Wedag AG Enclosures

i.V. Dr. Kellerwessel i.V. Dr. Imhof

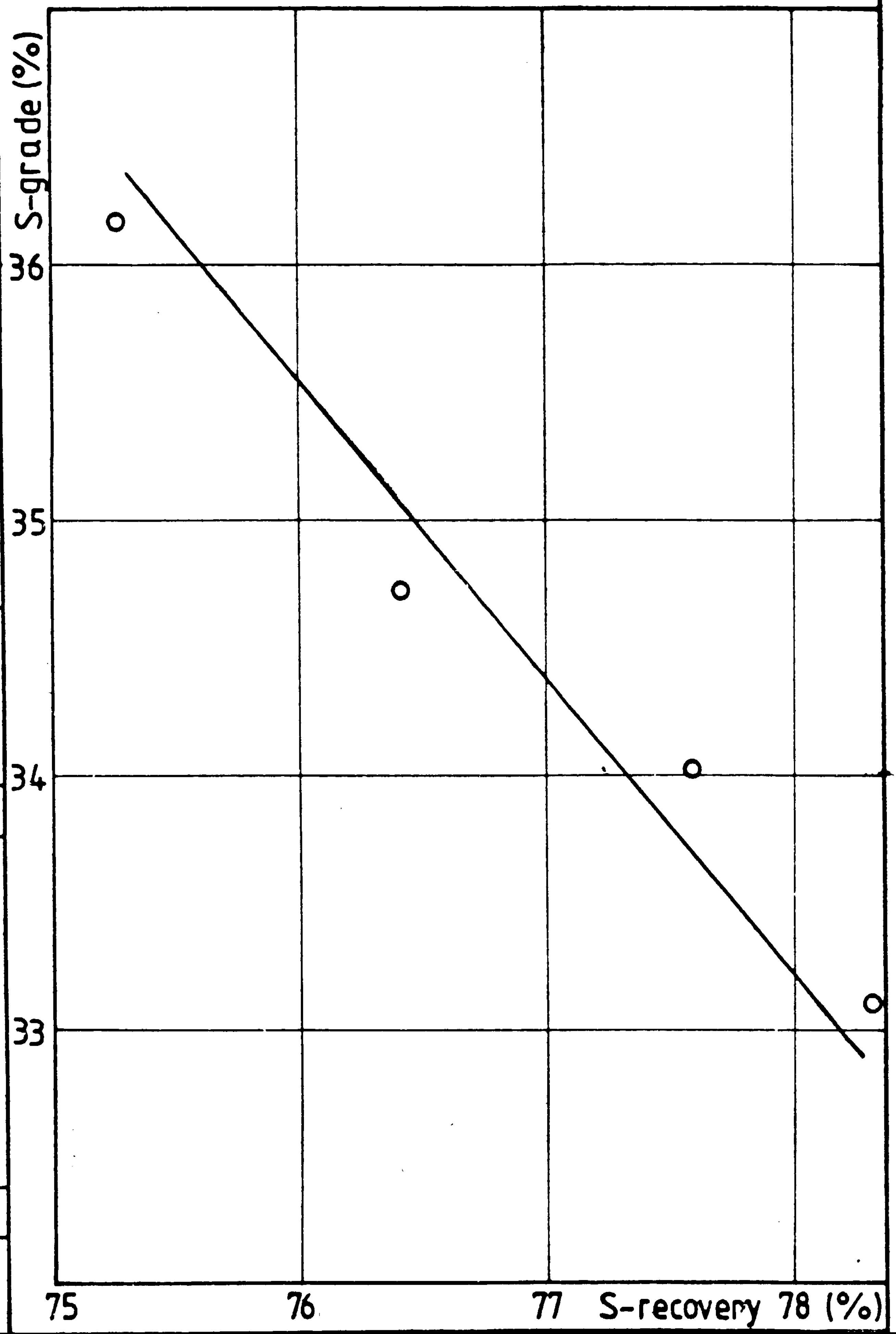
KHD HUMBOLDT WEDAG AG

Enclosures:

1.	*Function between concentrate sulphur grade and sulphur recovery*
2.	*Grading graph, sample "mg" as delivered*
	sample "mg" crushed
	sample "hg" crushed
	sample "lg" crushed
3.	*Particle size distribution with chemical analyses of the fractions sample "mg" crushed (CALIBRATOR-discharge)*
4.	*Flow sheet: crushing with cone crusher CALIBRATOR 900/100*
5.	*Description of the laboratory BATAC jig*
6.	*List of jigging tests*
7.1 - 7.18	*Flow-sheets and balances of the jigging tests*
8.	*Scheme of discharge gates*
9.	*List of flotation tests*
10.0 - 10.6	*Flow-sheets and balances of flotation tests*
11.	*Sedimentation curves*
12.1a- 12.6b	*Flow-sheets and balances of jigging combined with flotation*

function between
sulphur grade and sulphur recovery
(jigging tests combined with flotation tests)

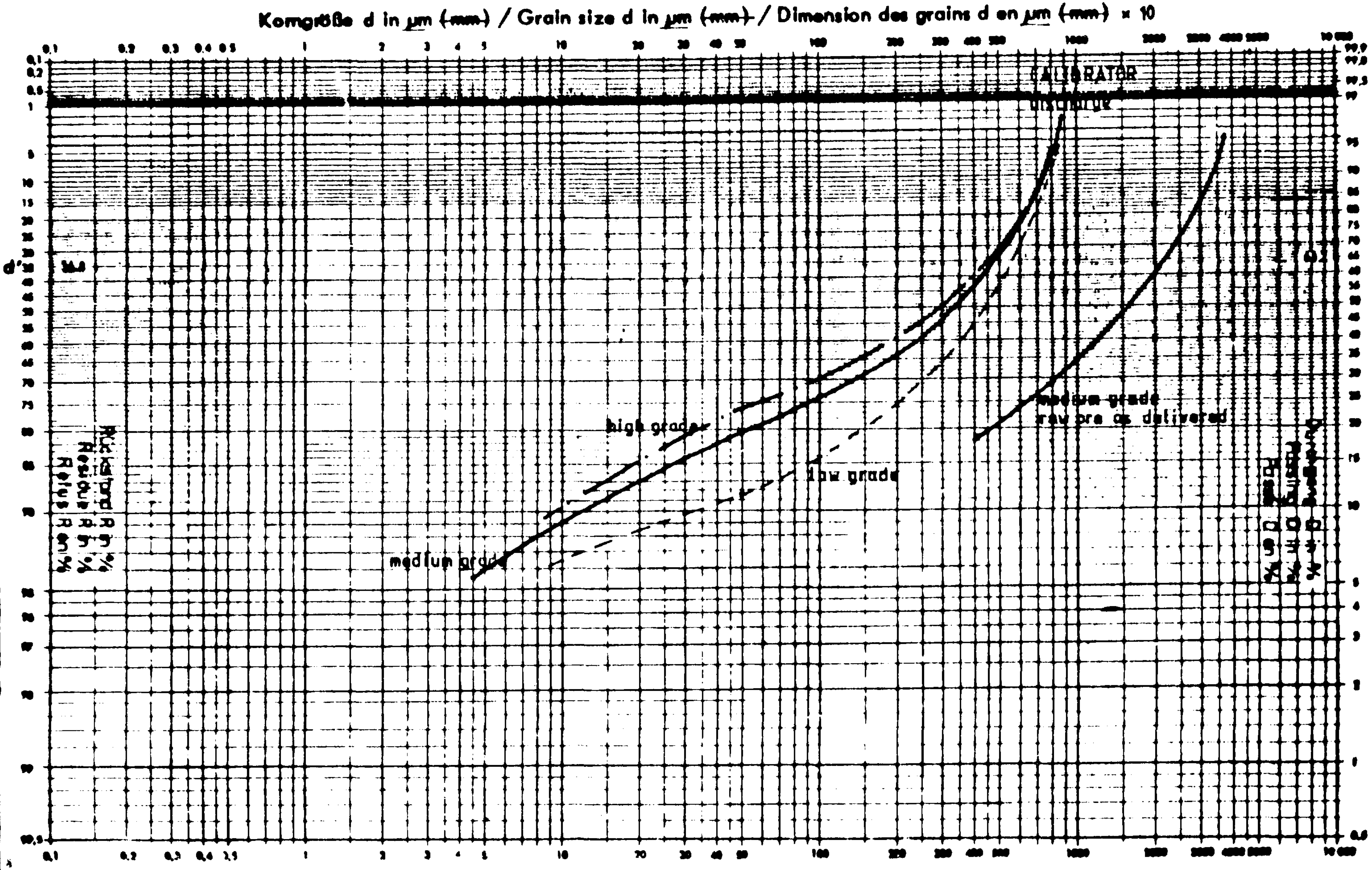
PPC
encl: 1



Stoff: Material: Produit: pyrite

Firma: Customer: Client: PPC

Maschine: Machine: Appareil: CALIBRATOR



Körnungsnetz / Grading graph

Diagramme granulométrique

encl. 2

Datum:
Date:

B A L A N C E
= = = = = = =

enclosure: 3
P.-A.-No.: 9-8125-9-5023
date: 05.03.1986

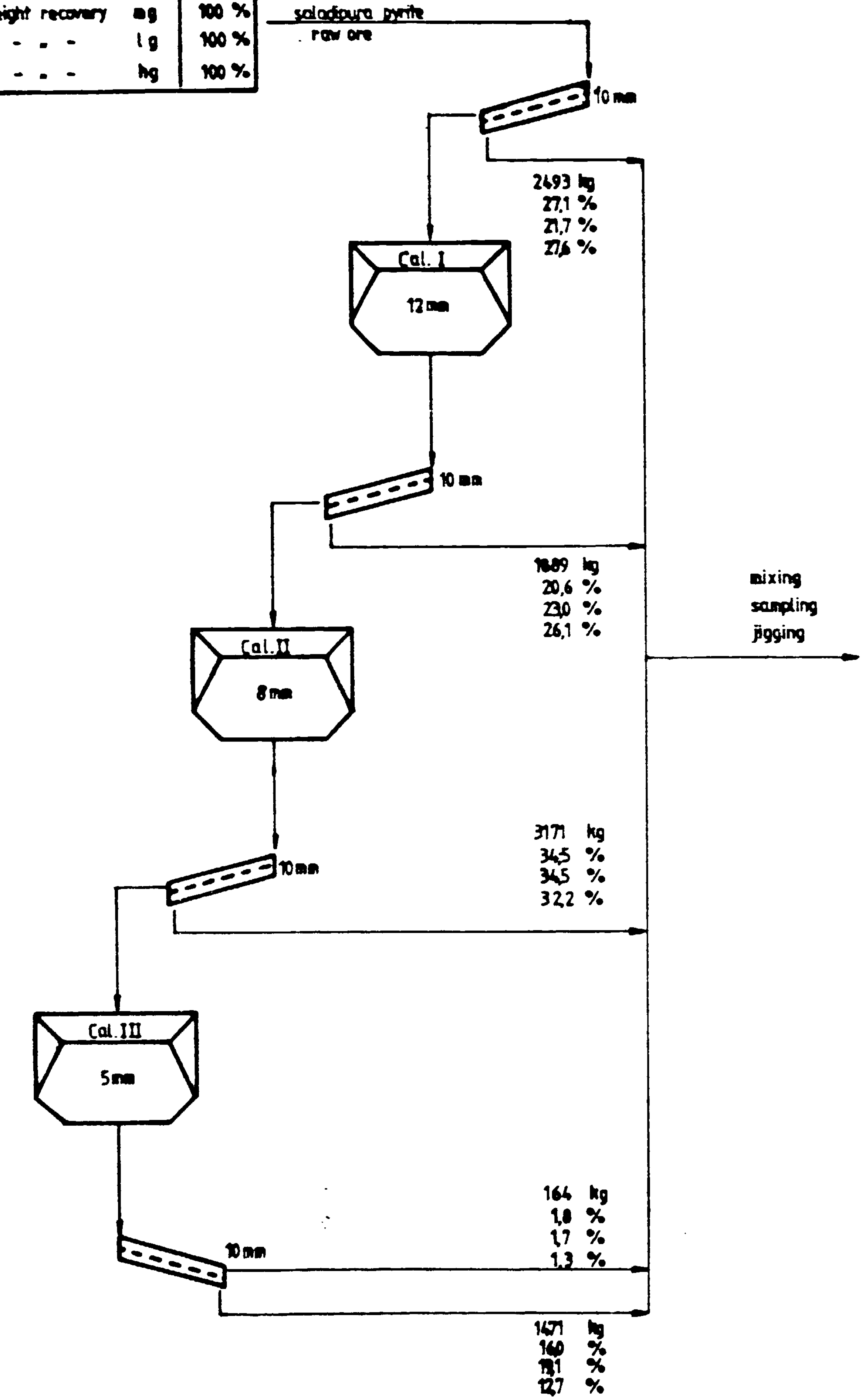
client: Pyrites, Phosphates & Chemicals (PPC)
material: pyrite ore "medium grade"

procedure: crushing of the raw ore
discharge of the CALIBRATOR cone crusher
particle size distribution
with chemical analysis of the fractions

particle size mm	weight recovery % raw ore	weight recovery % product	sulphur grade %	sulphur recovery % raw ore	sulphur recovery % product	sulphur content
+ 8.000	5.87	7.31	19.24	5.37	7.10	1.1294
8.000 - 5.600	25.00	31.13	19.71	23.42	30.97	4.9275
5.600 - 4.000	12.77	15.90	19.18	11.64	15.39	2.4493
4.000 - 2.800	13.38	16.66	19.49	12.40	16.39	2.6078
2.800 - 2.000	7.16	8.92	20.72	7.05	9.32	1.4836
2.000 - 1.000	9.66	12.03	20.13	9.24	12.22	1.9446
1.000 - .500	6.47	8.06	21.14	6.50	8.60	1.3678
+ .500	80.31	100.00	19.81	75.63	100.00	15.9098
.500 - .315	3.68	18.69	24.39	4.27	17.51	.8976
.315 - .200	3.06	15.54	28.48	4.14	17.00	.8715
.200 - .100	3.90	19.81	30.41	5.64	23.13	1.1860
.100 - .045	3.74	18.99	28.40	5.05	20.72	1.0622
- .045	5.31	26.97	20.89	5.27	21.64	1.1093
.500 - .000	19.69	100.00	26.04	24.37	100.00	5.1264
raw ore	100.00	---	20.63	100.00	---	21.0363

crushing with cone crusher CALIBRATOR 900/100	end. 4

mass of sample	mg	9188 kg
weight recovery	mg	100 %
- " -	lg	100 %
- " -	hg	100 %



Description of the laboratory BATAC jigs

The BATAC is a pneumatically pulsated jig with the air chambers situated underneath the screen plates. Separation is effected by water pulsation produced by the air pulsation and the hutch water stream.

If the jig is to upgrade fines, the sinks are discharged through an auxiliary bed (ragging) of granular material like baryte, hematite (granular feldspar is used for coal cleaning) and through the screen plates and drops into the hutch. From there it is discharged continuously by valves. Their openings are adjusted so that a free discharge of material is ensured. By changing the valve setting, the discharge rate is adapted to the specific requirements.

For coarse feed the jig is operated as gate discharge-type jig, the sinks will be discharged through a gate with variable opening of a gap.

The pressure of the jigging air is regulated by a pressure regulating system. The frequency and length of the stroke are adapted to the specific requirements by electronic valve controls. The frequency can be varied at choice.

Hutch water supply is adjusted manually by means of gate valves and measured by flow meters.

Further details are:

- the hutch, a solid steel frame design, the jigging chambers, being separated by partition walls, the side walls being manufactured of transparent perspex.

...

- the jig b made of perforated plates and/or screens clamped to the jig bed frames

- flow meters for measuring the hutch water in the chambers 1 and 2 and the flush water

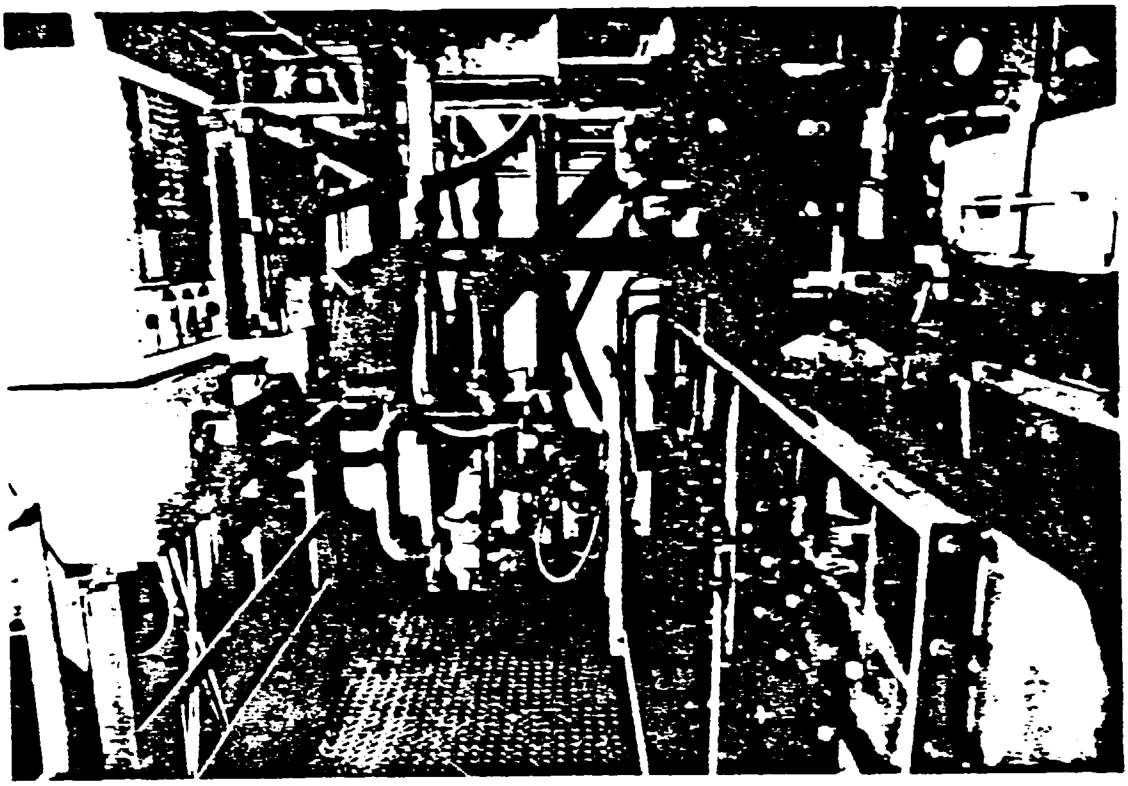
- the air distribution vessel, valves for the pulsation air and collecting pipes for the exhaust. The pulsation valves being operated with "control air", which again is electronically controlled.

- control panel, enclosure IP 44, with control unit for the electronic valve control and the general interlocking devices and switches for the drives of the jig

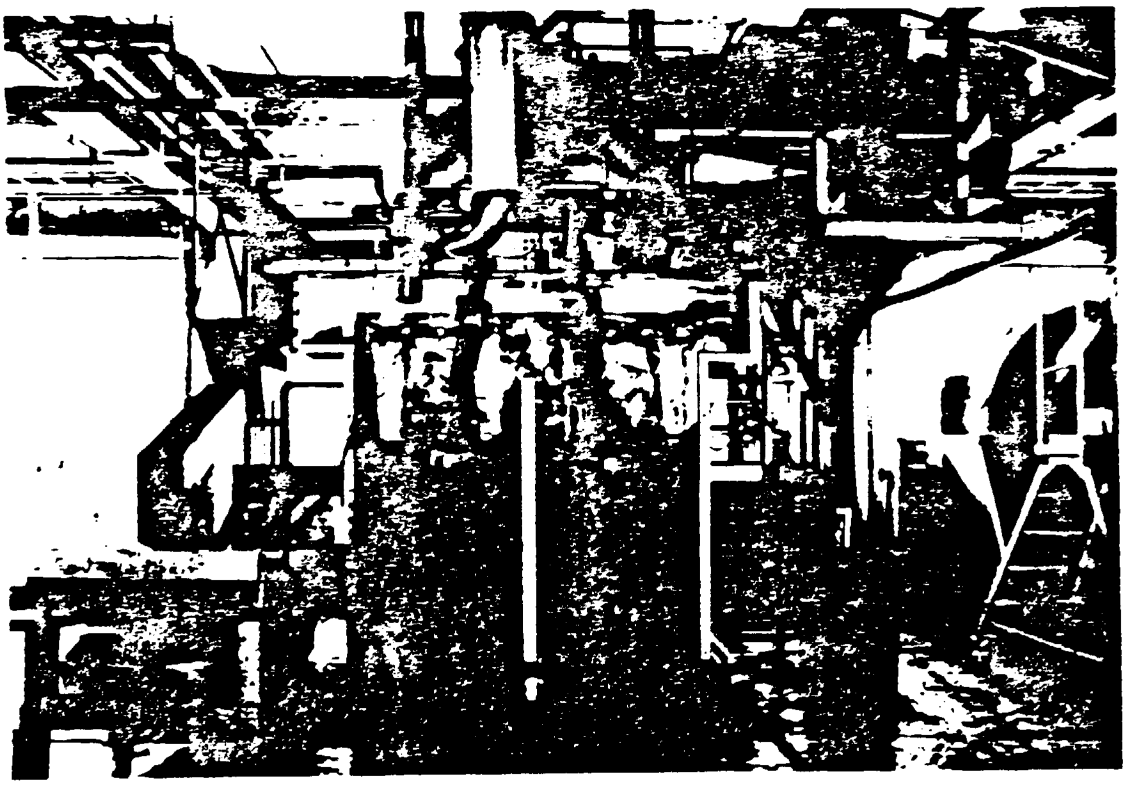
- the monitoring system for the air pulsation

Laboratory BATAC jig

throughput rate	up to 10 t/h
overall width	about 3.6 m
overall length	about 5.2 m
overall heigth	about 4.0 m
effective jigging area 2 x 0.5 m x about 1.0 m	about 1.0 m^2
pulsation air requirement	about 4 m^3/min
pulsation air pressure	up to 1,4 bar (abs)
control air requirement	about 4 m^3/min
control air pressure	4 bar (abs)
flush and hutch water requirement	up to about 25 m^3/h
hutch water pressure	about 2 bar (abs)



BAIAC jig, with control panel, flow meters and feeding device

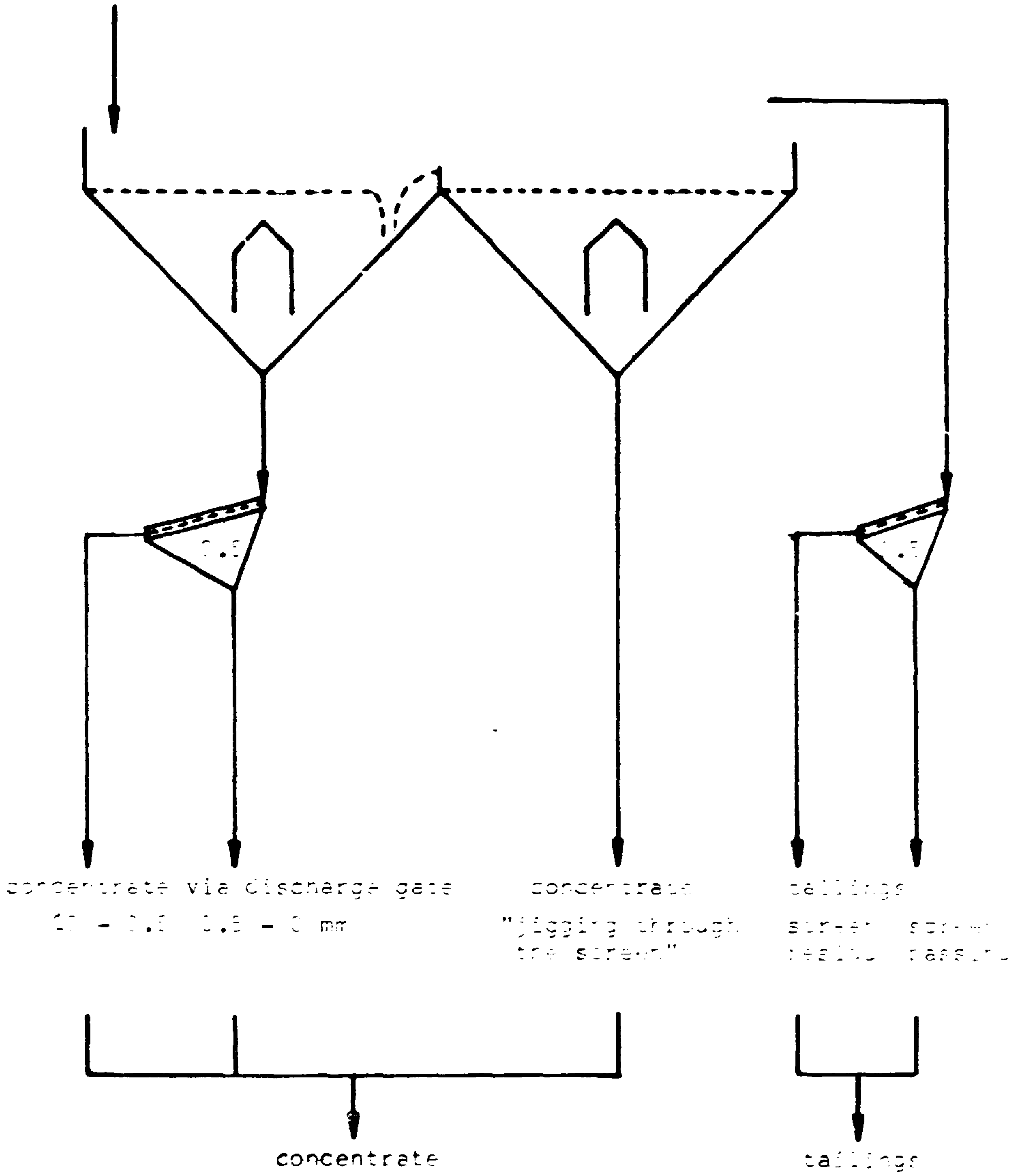


BATAC jig, hutch and air distribution vessel enclosure: 6

List of jigging tests

test no.	material	particle size	kind of discharge	pulsation	distribution concentrate weight-rec. %	S-grade %	S-rec. %	weight-rec. %	S-grade %	S-rec. %	S-grade anal. %	calc. %
1	raw ore	10 - 0	1. step: discharge gate, type 1 2. step: jigging through the screen	medium	40,5	35,07	68,05	59,5	11,21	31,95	20,63	20,87
2	"	"	"	high	53,4	31,56	75,96	46,6	11,45	24,04	"	22,19
3	"	"	"	"	59,0	29		41,0			"	
4	"	"	"	"	42,9	31		57,1			"	
5	"	"	"	"	45,0			55,0			"	
6	mixed material of test 2 - 5	10 - 0,5	"	medium	35,0	36,03	66,01	65,0	9,99	33,99	19,81	19,10
7	"	"	"	low	39,9	34,45	71,92	60,1	8,93	28,08	"	19,11
8,0	"	"	two discharge gate chambers, type 1	medium	40,7	36,36	67,95	59,3	11,77	32,05	"	21,78
8,1	"	"	"	"	36,1	37,91	61,06	63,9	13,66	38,94	"	22,41
8,2	"	"	"	"	47,7	36,15	74,93	52,3	11,03	25,07	"	23,01
8,3	"	"	"	"	38,7	35,38	67,61	61,3	10,70	32,39	"	20,25
9/10/12	coarse fraction of spiral classifier	10 - 0	three discharge gate chambers, type 1	low	47,18	35,16	72,83	52,82	11,72	27,17	20,63	22,78
9/11/13	"	"	"	"	46,43	32,33	73,59	53,55	10,06	26,41	"	20,41
9/10+11/12+13	"	"	"	"	46,86	33,95	73,13	53,14	11,00	26,87	"	21,75
14	raw ore	"	one discharge gate chamber, type 2	"	47,69	31,18	66,95	52,31	14,03	33,05	"	22,21
15	"	"	two discharge gate chambers, type 3	"	68,8	27,04	87,14	31,20	8,80	12,86	"	21,35
17	"	"	"	"	50,37	32,30	77,10	49,63	9,74	22,90	"	21,10

Flow - sheet jigging test 1 - 7



B A L A N C E
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enclosure: 7.2
P.-A.-No.: 9-8125-9-5023
date: 24 April 1986

client: Pyrites, Phosphates & Chemicals
material: pyrite ore (medium grade)
raw ore

procedure: jigging test 1

product	particle size mm	weight recovery raw ore %	weight recovery fraction %	grade %	sulphur recovery raw ore %	sulphur recovery fract. %	content
concentrate via discharge gate	10 - 0.5	35.50	87.65	36.92	62.79	92.27	13.1066
concentrate via discharge gate	0.5 - 0	2.00	4.94	18.41	1.76	2.59	.3682
conc. "jigging through the screen"	10 - 0	3.00	7.41	24.35	3.50	5.14	.7305
concentrate	10 - 0	40.50	100.00	35.07	68.05	100.00	14.2053
tailings (screen residue)	10 - 0.5	53.50	89.92	10.83	27.76	86.87	5.7941
tailings (screen passing)	0.5 - 0	6.00	10.08	14.59	4.19	13.13	.8754
tailings	10 - 0	59.50	100.00	11.21	31.95	100.00	6.6695
raw ore	10 - 0	100.00	---	20.63	100.00	---	20.8748

B A L A N C E

enclosure: 7.3
P.-A.-No.: 9-8125-9-5023
date: 24 April 1986

client: Pyrites, Phosphates & Chemicals
material: pyrite ore (medium grade)
raw ore

procedure: jigging test 2

product	particle size mm	weight recovery raw ore %	weight recovery fraction %	sulphur grade %	sulphur recovery raw ore %	sulphur recovery fract. %	content T
concentrate via discharge gate	10 - 0.5	43.20	80.90	31.06	60.47	79.61	13.4179
concentrate via discharge gate	0.5 - 0	7.60	14.23	34.64	11.86	15.62	2.6326
conc. "jigging through the screen"	10 - 0	2.60	4.87	30.92	3.62	4.77	.8039
concentrate	10 - 0	53.40	100.00	31.56	75.96	100.00	16.8545
tailings (screen residue)	10 - 0.5	40.80	87.55	11.22	20.63	85.82	4.5778
tailings (screen passing)	0.5 - 0	5.80	12.45	13.04	3.41	14.18	.7563
tailings	10 - 0	46.60	100.00	11.45	24.04	100.00	5.3341
raw ore	10 - 0	100.00	---	20.63	100.00	---	22.1886

B A L A N C E

enclosure: 7.4
P.-A.-No.: 9-8125-9-5022
date: 24 April 1986

client: Pyrites, Phosphates & Chemicals
material: pyrite ore (medium grade)
raw ore fraction 10 - 0.5 mm
(remixed material)
procedure: jigging test 6

product	particle size mm	weight recovery raw ore %	weight recovery fraction %	sulphur grade %	sulphur recovery raw ore %	sulphur recovery fract. %	sulphur content
concentrate	10 - 0.5	35.00	100.00	36.03	66.01	100.00	12.6105
tailings	10 - 0.5	65.00	100.00	9.99	33.99	100.00	6.4935
raw ore	10 - 0.5	100.00	---	19.81	100.00	---	19.1040

results of stratification after jigging test 6

product	layer	weight recovery raw ore %	weight recovery fraction %	sulphur grade %	sulphur recovery raw ore %	sulphur recovery fract. %	sulphur content
conc. 1	5	33.50	55.28	42.65	52.95	63.71	14.2878
conc. 2	4	17.30	28.55	35.45	22.73	27.35	6.1329
conc.3	3	9.80	16.17	20.45	7.43	8.94	2.0041
concentrate	3 - 5	60.60	100.00	37.00	83.10	100.00	22.4247
tail. 2	2	14.90	37.82	15.08	8.33	49.28	2.2469
tail. 1	1	24.50	62.18	9.44	8.57	50.72	2.3128
tailings	1 - 2	39.40	100.00	11.57	16.90	100.00	4.5597
raw ore +0.5 mm	1 - 5	100.00	---	19.81	100.00	---	26.9844

B A L A N C E
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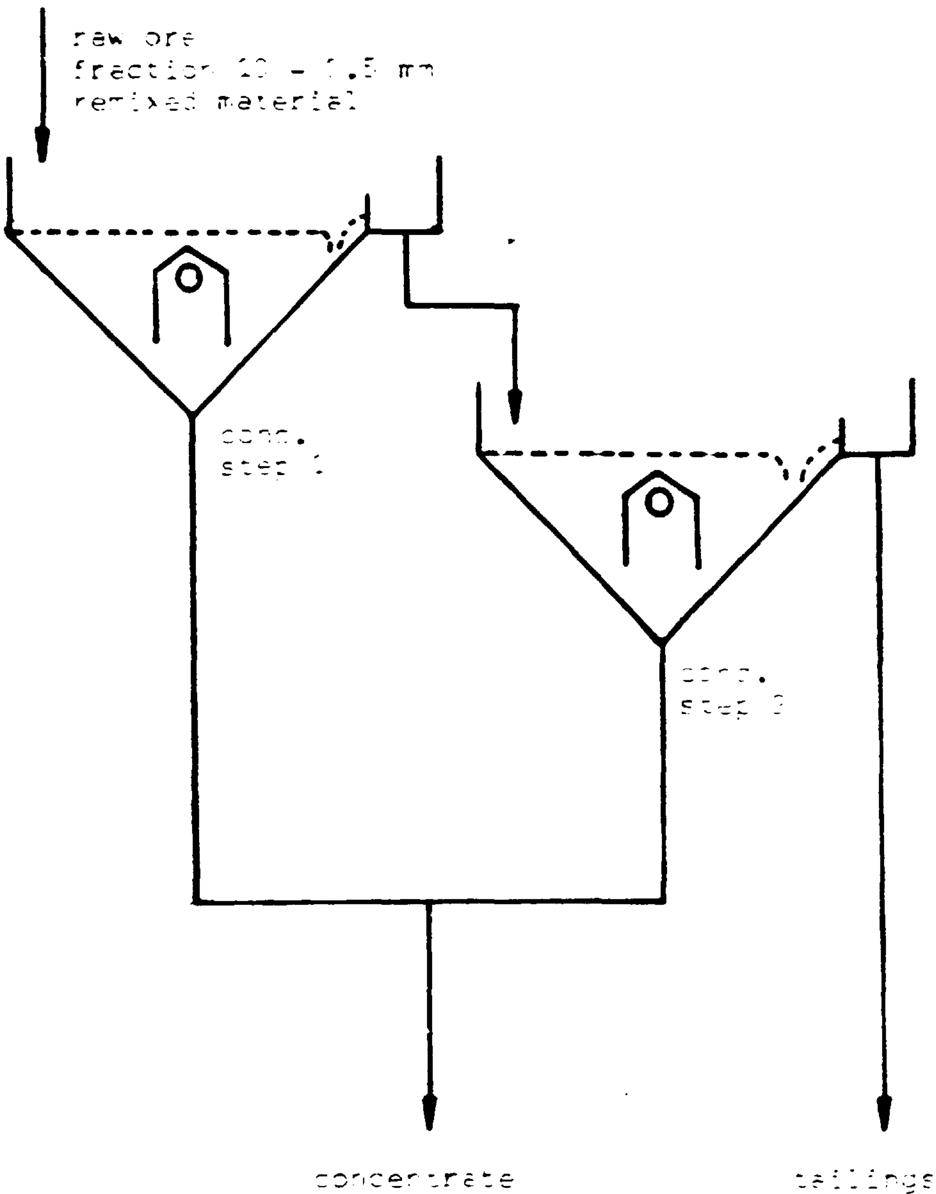
enclosure: 7.5
P.-A.-No.: 9-8125-9-5023
date: 24 April 1986

client: Pyrites, Phosphates & Chemicals
material: pyrite ore (medium grade)
raw ore (fraction 10 - 0.5 mm)
(remixed material)
procedure: jigging test 7

product	dewatering screen product	weight recovery raw ore %	weight recovery fraction %	sulphur grade %	sulphur recovery raw ore %	sulphur recovery fract. %	sulphur content
concentrate via discharge gate	residue	32.70	81.95	35.78	61.23	85.13	11.7001
concentrate via discharge gate	passing	3.50	8.77	35.87	6.57	9.13	1.2555
conc. "jigging through the screen"		3.70	9.27	21.32	4.13	5.74	.7888
concentrate		39.90	100.00	34.45	71.92	100.00	13.7444
tailings	residue	58.00	96.51	8.68	26.35	93.84	5.0344
tailings	passing	2.10	3.49	15.75	1.73	6.16	.3308
tailings		60.10	100.00	8.93	28.08	100.00	5.3652
raw ore fraction	10 - 0.5	100.00	---	19.81	100.00	---	19.1095

Flow - sheet:

jigging tests 8.2 - 8.3



B A L A N C E

enclosure: 7.7
P.-A.-No.: 9-8125-9-5023
date: 24 April 1986

client: Pyrites, Phosphates & Chemicals
material: pyrite ore (medium grade)
raw ore (fraction 10 - 0.5 mm)
(remixed material)
procedure: jigging test 8.0

product		weight recovery raw ore %	weight recovery fraction %	grade %	sulphur recovery raw ore %	sulphur recovery fract. %	content
concentrate	step 1	26.30	64.62	38.16	46.08	67.82	10.0361
concentrate	step 2	14.40	35.38	33.07	21.87	32.18	4.7621
concentrate		40.70	100.00	36.36	67.95	100.00	14.7982
tailings		59.30	100.00	11.77	32.05	100.00	6.9796
raw ore fraction 10 - 0.5 mm		100.00	---	19.81	100.00	---	21.7778

B A L A N C E

enclosure: 7.8
P.-A.-No.: 9-8125-9-5023
date: 24 April 1986

client: Pyrites, Phosphates & Chemicals
material: pyrite ore (medium grade)
raw ore (fraction 10 - 0.5 mm)
(remixed material)
procedure: jigging test 8.1

product		weight recovery raw ore %	weight recovery fraction %	grade %	sulphur recovery raw ore %	sulphur recovery fract. %	content T
concentrate	step 1	26.30	72.85	38.16	44.78	73.34	10.0361
concentrate	step 2	9.80	27.15	37.23	16.28	26.66	3.6485
concentrate		36.10	100.00	37.91	61.06	100.00	13.6846
tailings		63.90	100.00	13.66	38.94	100.00	8.7287
raw ore fraction 10 - 0.5 mm		100.00	---	19.81	100.00	---	22.4134

B A L A N C E

enclosure: 7.9
P.-A.-No.: 9-8125-9-5023
date: 24 April 1986

client: Pyrites, Phosphates & Chemicals
material: pyrite ore (medium grade)
raw ore (fraction 10 - 0.5 mm)
(remixed material)
procedure: jigging test 8.2

product		weight recovery raw ore %	weight recovery fraction %	grade %	sulphur recovery raw ore %	sulphur recovery fract. %	content
concentrate	step 1	26.30	55.14	38.16	43.61	58.19	10.0361
concentrate	step 2	21.40	44.86	33.69	31.33	41.81	7.2097
concentrate		47.70	100.00	36.15	74.93	100.00	17.2457
tailings		52.30	100.00	11.03	25.07	100.00	5.7687
raw ore fraction 10 - 0.5 mm		100.00	---	19.81	100.00	---	23.0144

B A L A N C E

enclosure: 7.10
P.-A.-No.: 9-8125-9-5023
date: 24 April 1986

client: Pyrites, Phosphates & Chemicals
material: pyrite ore (medium grade)
raw ore (fraction 10 - 0.5 mm)
(remixed material)
procedure: jigging test 8.3

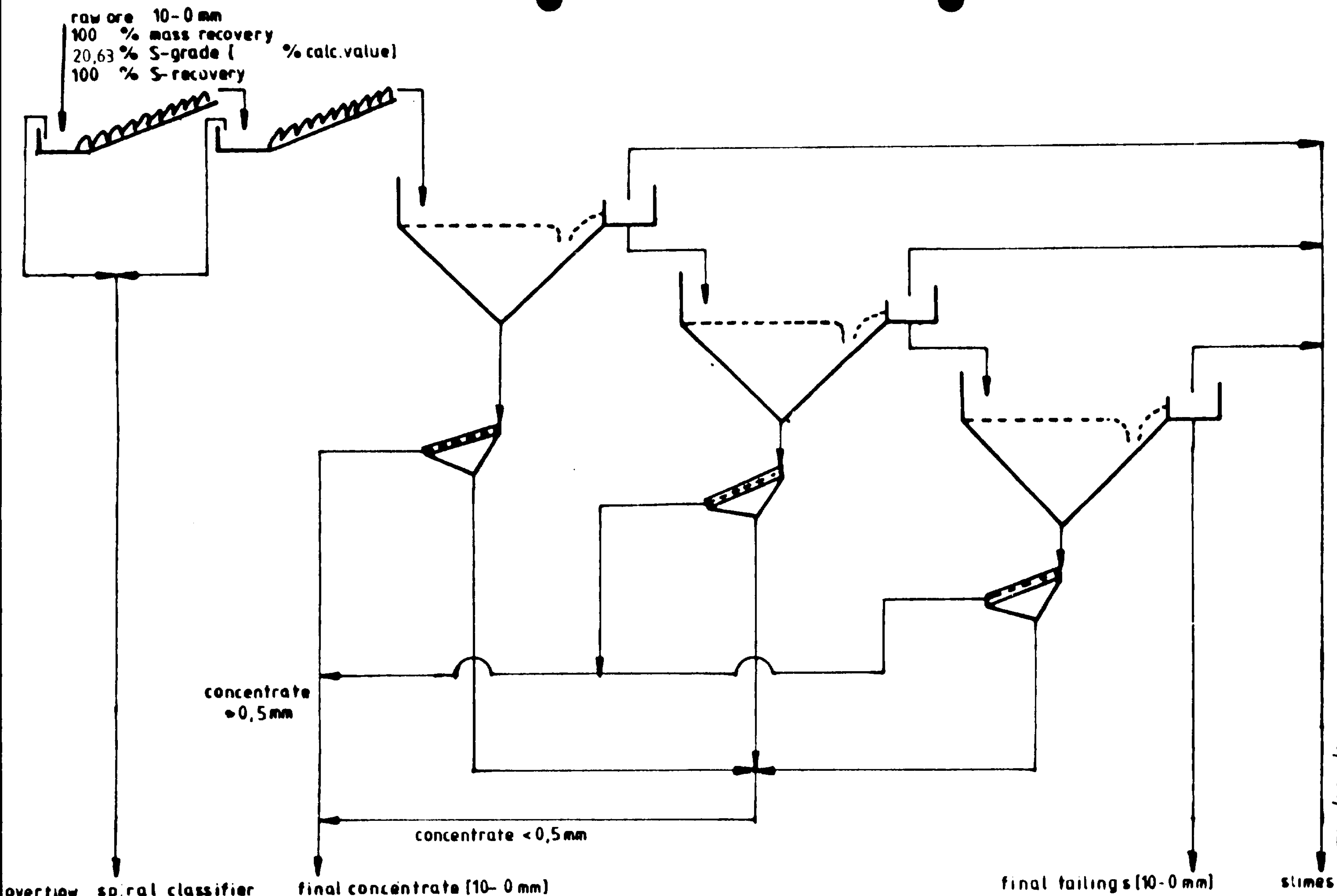
product		weight recovery raw ore %	weight recovery fraction %	grade %	sulphur recovery raw ore %	sulphur recovery fract. %	content
concentrate	step 1	26.30	67.96	38.16	49.56	73.29	10.0361
concentrate	step 2	12.40	32.04	29.49	18.06	26.71	3.6568
concentrate		38.70	100.00	35.38	67.61	100.00	13.6928
tailings		61.30	100.00	10.70	32.39	100.00	6.5591
raw ore fraction 10 - 0.5 mm		100.00	---	19.81	100.00	---	20.2519

PPL India

enclosure 7

sample: medium grade

jigging test no.: 9, 10, 12
9, 11, 13



B A L A N C E
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enclosure: 7.12
P.-A.-No.: 9-8125-9-5023
date: 05.03.1986

client: Pyrites, Phosphates & Chemicals (PPC)
material: pyrite ore "medium grade" 10 - 0 mm

procedure: jigging test 9, 10 & 12

product	particle size mm	weight recovery raw ore %	weight recovery fraction %	sulphur grade %	sulphur recovery % raw ore	sulphur recovery % fraction	sulphur content
concentrate step 1	+ 0.5	16.0700	16.07	37.90	26.74	26.74	6.0905
concentrate step 1	- 0.5	5.3400	21.41	34.69	8.13	34.87	1.8524
concentrate step 2	+ 0.5	11.4200	32.83	37.92	19.01	53.89	4.3305
concentrate step 2	- 0.5	1.7800	34.61	23.62	1.85	55.73	.4204
concentrate step 3	+ 0.5	11.4300	46.04	32.34	16.23	71.96	3.6965
concentrate step 3	- 0.5	1.1400	47.18	17.24	.86	72.83	.1965
concentrate	10 - 0.5	38.9200	38.92	36.27	61.98	61.98	14.1175
concentrate	- 0.5	8.2600	8.26	29.90	10.84	10.84	2.4694
concentrate	10 - 0	47.1800	47.18	35.16	72.83	72.83	16.5869
tailings	10 - 0	45.3200	92.50	10.81	21.51	94.34	4.8991
BATAC overflow	- 0.2	3.1900	95.69	19.44	2.72	97.06	.6201
spiral classifier	- 0.2	4.3100	100.00	15.54	2.94	100.00	.6698
tailings & slimes	10 - 0	52.8200	100.00	11.72	27.17	100.00	6.1890
raw ore	10 - 0	100.0000	---	20.63	100.00	---	22.7759

B A L A N C E

enclosure: 7.13
P.-A.-No.: 9-8125-9-5023
date: 05.03.1986

client: Pyrites, Phosphates & Chemicals Ltd., India (PPC)
material: pyrite ore (medium grade) 10 - 0 mm

procedure: jigging test 9, 10 & 12
particle size distribution
with chemical analyses of the fractions

product	particle size mm	weight recovery raw ore %	weight recovery product %	Sulphur grade %	Sulphur recovery % raw ore	Sulphur recovery % product	Sulphur content
	+ 5.60	19.2849	49.55	36.33	30.27	48.95	7.0062
	5.60 - 2.80	10.0025	25.70	38.48	16.63	26.89	3.8490
	2.80 - 1.00	5.6823	14.60	37.33	9.17	14.82	2.1212
	1.00 - .50	2.3624	6.07	33.84	3.45	5.59	.7994
	.50 - .20	.8601	2.21	34.86	1.30	2.09	.2998
	- .20	.7278	1.87	32.57	1.02	1.66	.2370
conc. +0.5 mm step 1, 2 & 3		38.9200	100.00	36.77	61.85	100.00	14.3127
	+ .50	.2553	4.78	31.53	.35	4.28	.0805
	.50 - .20	2.4030	45.00	33.44	3.47	42.71	.8036
	- .20	2.6817	50.22	37.19	4.31	53.01	.9973
concentrate -0.5 mm step 1		5.3400	100.00	35.23	8.13	100.00	1.8814
	+ .50	.3149	17.69	23.49	.32	17.90	.0740
	.50 - .20	.7198	40.44	19.34	.60	33.70	.1392
	- .20	.7453	41.87	26.83	.86	48.40	.2000
concentrate -0.5 mm step 2		1.7800	100.00	23.21	1.79	100.00	.4131
	+ .50	.1948	17.09	14.75	.12	14.62	.0287
	.50 - .20	.3837	33.66	11.28	.19	22.03	.0433
	- .20	.5615	49.25	22.17	.54	63.35	.1245
concentrate -0.5 mm step 3		1.1400	100.00	17.24	.85	100.00	.1965
	+ 5.60	18.4588	40.73	10.34	8.25	37.77	1.9086
	5.60 - 2.80	16.5917	36.61	12.17	8.73	39.96	2.0192
	2.80 - 1.00	8.7105	19.22	11.37	4.28	19.60	.9904
	1.00 - .50	1.1330	2.50	7.36	.36	1.65	.0834
	.50 - .20	.1903	.42	6.20	.05	.23	.0118
	- .20	.2357	.52	16.82	.17	.78	.0396
tailings		45.3200	100.00	11.15	21.83	100.00	5.0531
BATAC overflow (slimes)	- .20	3.1900	42.53	19.44	2.68	48.24	.6201
spiral classifier overflow	- .20	4.3100	57.47	15.44	2.88	51.76	.6655
slimes		7.5000	100.00	17.14	5.56	100.00	1.2856
raw ore	10.00 - .00	100.0000	---	20.63	100.00	---	23.1424

B A L A N C E

enclosure: 7.14
P.-A.-No.: 9-8125-9-5023
date: 05.03.1986

client: Pyrites, Phosphates & Chemicals Ltd., India (PPC)
material: pyrite ore (medium grade) 10 - 0 mm

procedure: jigging test 9, 10 & 12
particle size distribution
with chemical analyses of the fractions

product	particle size mm	weight recovery raw ore %	weight recovery fraction %	sulphur grade %	sulphur recovery % raw ore	sulphur recovery % fraction	sulphur content
concentrate +0.5 mm step 1, 2 & 3	- 0.2	.7278	5.84	32.57	1.02	8.22	.2370
concentrate -0.5 mm step 1	- 0.2	2.6817	21.54	37.19	4.31	34.56	.9973
concentrate -0.5 mm step 2	- 0.2	.7453	5.99	26.83	.86	6.93	.2000
concentrate -0.5 mm step 3	- 0.2	.5615	4.51	22.17	.54	4.32	.1245
tailings	- 0.2	.2357	1.89	16.82	.17	1.37	.0396
Batac overflow (slimes)	- 0.2	3.1900	25.62	19.44	2.68	21.50	.6201
spiral classifier overflow	- 0.2	4.3100	34.61	15.44	2.88	23.07	.6655
raw ore particle size fraction	- 0.2	12.4520	100.00	23.16	12.46	100.00	2.8841
concentrate +0.5 mm step 1, 2 & 3	0.5 - 0.2	.8601	18.87	34.86	1.30	23.11	.2998
concentrate -0.5 mm step 1	0.5 - 0.2	2.4030	52.73	33.44	3.47	61.92	.8036
concentrate -0.5 mm step 2	0.5 - 0.2	.7196	15.80	19.34	.60	10.73	.1392
concentrate -0.5 mm step 3	0.5 - 0.2	.3837	8.42	11.28	.19	3.34	.0433
tailings	0.5 - 0.2	.1903	4.18	6.20	.05	.91	.0118
raw ore particle size fraction	0.5 - 0.2	4.5569	100.00	28.48	5.61	100.00	1.2977
concentrate +0.5 mm step 1, 2 & 3	1.0 - 0.5	2.3624	55.45	33.84	3.45	74.99	.7994
concentrate -0.5 mm step 1	1.0 - 0.5	.2553	5.99	31.53	.35	7.55	.0805
concentrate -0.5 mm step 2	1.0 - 0.5	.3149	7.39	23.49	.32	6.94	.0740
concentrate -0.5 mm step 3	1.0 - 0.5	.1948	4.57	14.75	.12	2.70	.0287
tailings	1.0 - 0.5	1.1330	26.59	7.36	.36	7.82	.0834
raw ore particle size fraction	1.0 - 0.5	4.2604	100.00	25.02	4.61	100.00	1.0660
concentrate +0.5 mm step 1, 2 & 3	2.8 - 1.0	5.6823	39.48	37.33	9.17	68.17	2.1212
tailings	2.8 - 1.0	8.7105	60.52	11.37	4.28	31.83	.9904
raw ore particle size fraction	2.8 - 1.0	14.3928	100.00	21.62	13.45	100.00	3.1116
concentrate +0.5 mm step 1, 2 & 3	5.6 - 2.8	10.0025	37.61	38.48	16.63	65.59	3.8490
tailings	5.6 - 2.8	16.5917	62.39	12.17	8.73	34.41	2.0192
raw ore particle size fraction	5.6 - 2.8	26.5942	100.00	22.07	25.36	100.00	5.8682
concentrate +0.5 mm step 1, 2 & 3	+ 5.6	19.2849	51.09	36.33	30.27	78.59	7.0062
tailings	+ 5.6	18.4588	48.91	10.34	8.25	21.41	1.9086
raw ore particle size fraction	+ 5.6	37.7437	100.00	23.62	38.52	100.00	8.9148
raw ore	10 - 0	100.0000	---	20.63	100.00	---	23.1424

B A L A N C E

enclosure: 7.15
P.-A.-No.: 9-8125-9-5023
date: 05.03.1986

client: Pyrites, Phosphates & Chemicals (PPC)
material: pyrite ore "medium grade" 10 - 0 mm

procedure: jigging test 9, 11 & 13

product	particle size mm	weight recovery raw ore %	weight recovery fraction %	sulphur grade %	sulphur recovery % raw ore	sulphur recovery % fraction	sulphur content
concentrate step 1	+ 0.5	16.0700	16.07	37.90	29.85	29.85	6.0905
concentrate step 1	- 0.5	5.3400	21.41	34.69	9.08	38.92	1.8524
concentrate step 2	+ 0.5	8.1800	29.59	34.64	13.89	52.81	2.8336
concentrate step 2	- 0.5	1.3700	30.96	20.09	1.35	54.16	.2752
concentrate step 3	+ 0.5	14.7100	45.67	26.19	18.88	73.04	3.8525
concentrate step 3	- 0.5	.7800	46.45	14.52	.56	73.59	.1133
concentrate	10 - 0.5	38.9600	38.96	32.79	62.61	62.61	12.7766
concentrate	- 0.5	7.4900	7.49	29.92	10.98	10.98	2.2409
concentrate	10 - 0	46.4500	46.45	32.33	73.59	73.59	15.0176
tailings	10 - 0	46.0500	92.50	8.90	20.08	93.68	4.0985
BATAC overflow	- 0.2	3.1900	95.69	19.44	3.04	96.72	.6201
spiral classifier	- 0.2	4.3100	100.00	15.54	3.28	100.00	.6698
tailings & slimes	10 - 0	53.5500	100.00	10.06	26.41	100.00	5.3884
raw ore	10 - 0	100.0000	---	20.63	10 .00	---	20.4059

B A L A N C E
=============

enclosure: 7.16
P.-A.-No.: 9-8125-9-5023
date: 05.03.1986

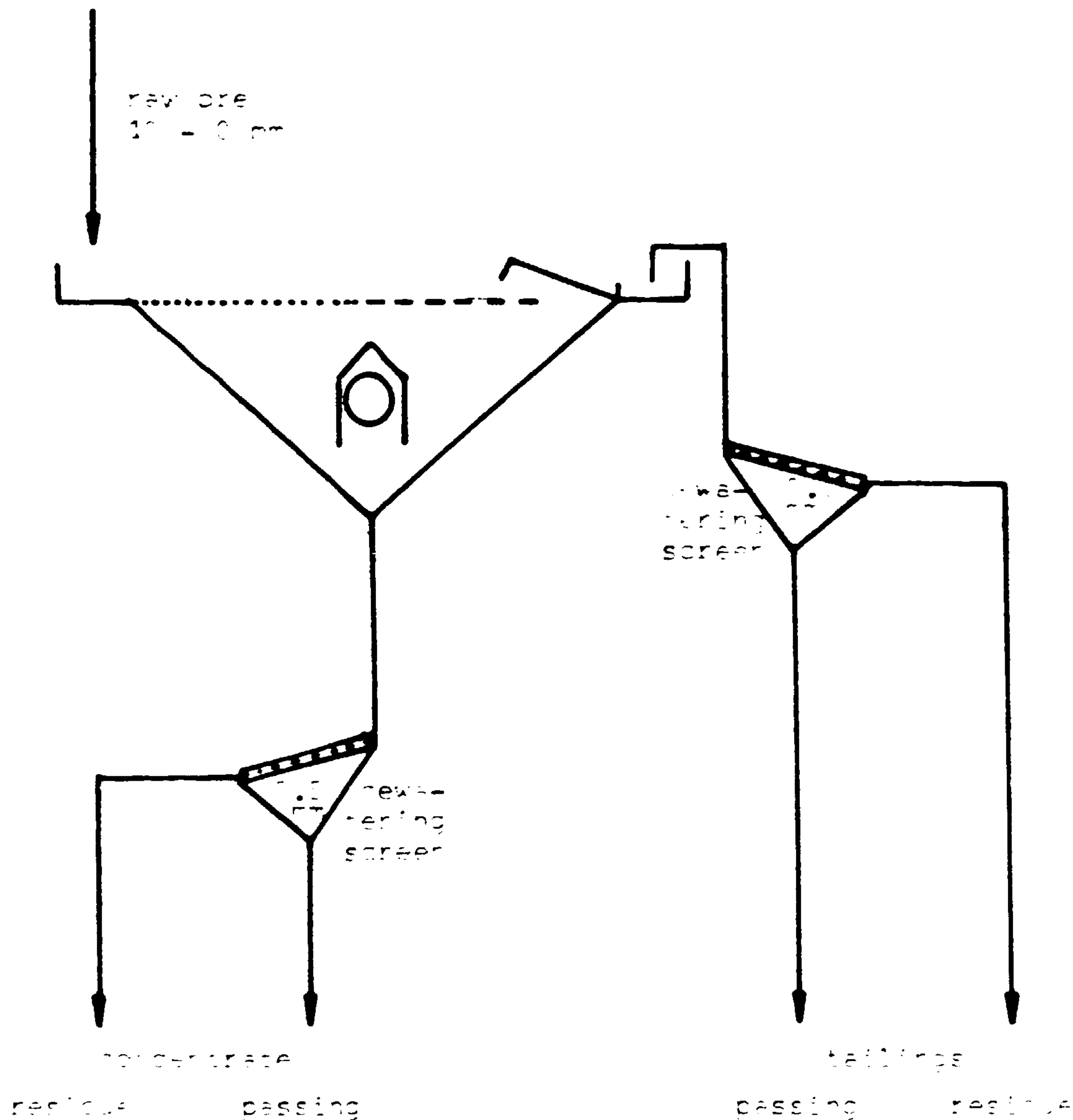
client: Pyrites, Phosphates & Chemicals (PPC)
material: pyrite ore "medium grade" 10 - 0 mm

procedure: jigging test 9, (10 + 11) & (12 + 13)

product	particle size mm	weight recovery raw ore %	weight recovery fraction %	sulphur grade %	sulphur recovery % raw ore	sulphur recovery % fraction	sulphur content
concentrate step 1	+ 0.5	16.0700	16.07	37.90	28.00	28.00	6.0905
concentrate step 1	- 0.5	5.3400	21.41	34.69	8.52	36.51	1.8524
concentrate step 2	+ 0.5	10.0200	31.43	36.76	16.93	53.45	3.6834
concentrate step 2	- 0.5	1.6000	33.03	22.31	1.64	55.09	.3570
concentrate step 3	+ 0.5	12.8400	45.87	29.31	17.30	72.39	3.7634
concentrate step 3	- 0.5	.9900	46.86	16.30	.74	73.13	.1614
concentrate	10 - 0.5	38.9300	38.93	34.77	62.23	62.23	13.5373
concentrate	- 0.5	7.9300	7.93	29.90	10.90	10.90	2.3708
concentrate	10 - 0	46.8600	46.86	33.95	73.13	73.13	15.9081
tailings	10 - 0	45.6400	92.50	9.98	20.94	94.07	4.5549
BATAC overflow	- 0.2	3.1900	95.69	19.44	2.85	96.92	.6201
spiral classifier	- 0.2	4.3100	100.00	15.54	3.08	100.00	.6698
tailings & slimes	10 - 0	53.1400	100.00	11.00	26.87	100.00	5.8448
raw ore	10 - 0	100.0000	---	20.63	100.00	---	21.7528

Flow - sheet:

jigging test 15



B A L A N C E

enclosure: 7.18
P.-A.-No.: 9-8125-9-5023
date: 24 April 1986

client: Pyrites, Phosphates & Chemicals
material: pyrite ore (medium grade)
raw ore

procedure: jigging test 15

product	particle size mm	weight recovery raw ore %	weight recovery fraction %	sulphur grade %	sulphur recovery raw ore %	sulphur recovery fract. %	content
concentrate (screen residue)	10 - 0.5	52.82	76.77	29.50	72.99	83.76	15.5819
concentrate (screen passing)	0.5 - 0	15.98	23.23	18.90	14.15	16.24	3.0202
concentrate	10 - 0	68.80	100.00	27.04	87.14	100.00	18.6021
tailings (screen residue)	10 - 0.5	29.30	93.91	8.31	11.41	88.65	2.4348
tailings (screen passing)	0.5 - 0	1.90	6.09	16.40	1.46	11.35	.3116
tailings	10 - 0	31.20	100.00	8.80	12.86	100.00	2.7464
raw ore	10 - 0	100.00	---	20.63	100.00	---	21.3486

Scheme of discharge gates

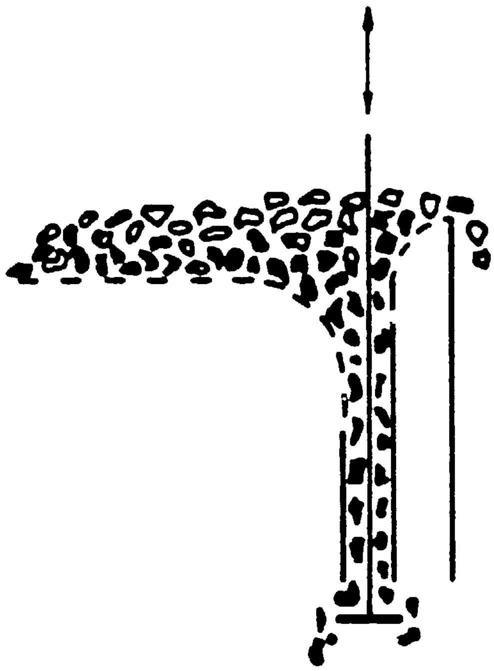
encl. 8

light particles (tailings)

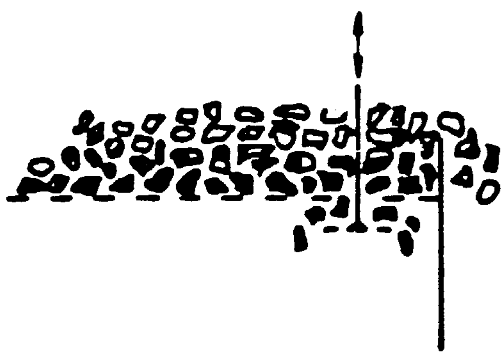
intergrown particles

heavy particles (pyrite)

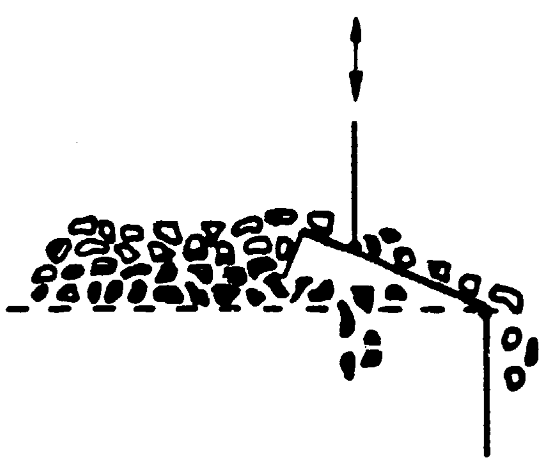
type 1



type 2



type 3



enclosure:9

List of flotation tests

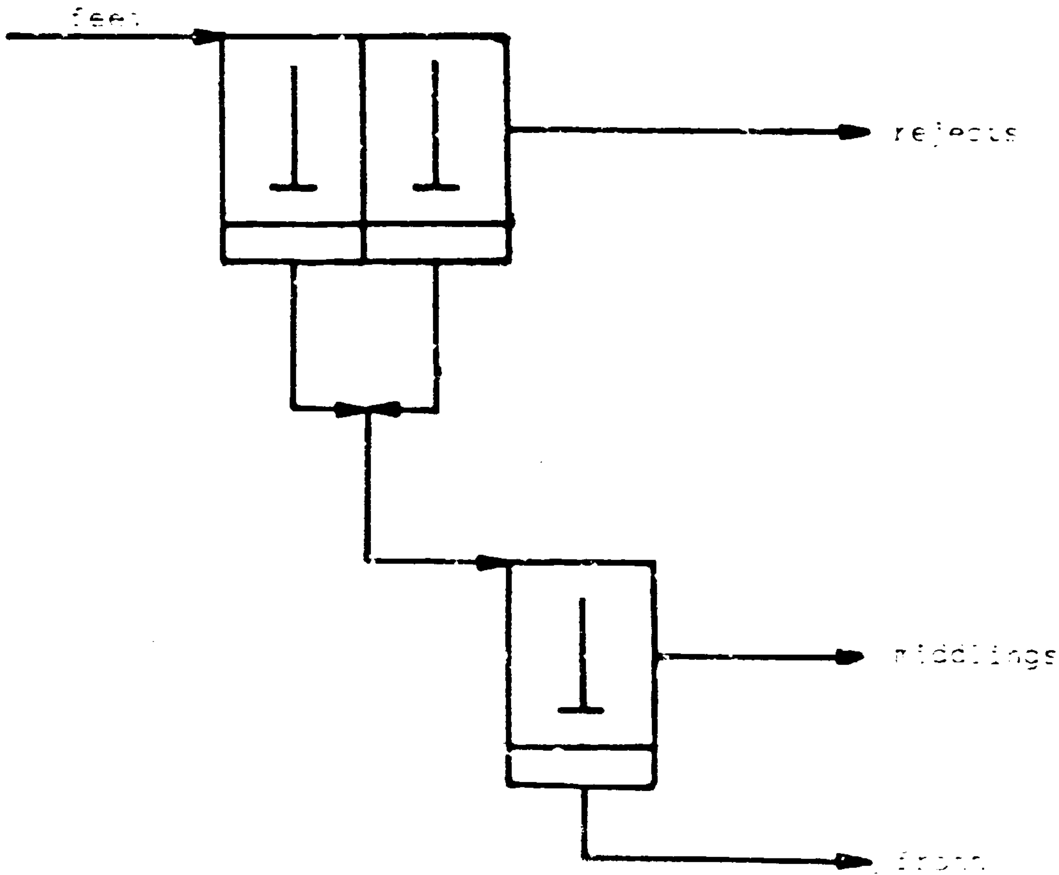
test no.	material	fraction	distribution concentrate mass-%	S-grade %	S-rec. %	rejects mass-%	S-grade %	S-rec. %	feed S-grade % anal.	calc.
1	raw ore	0,5 - 0	50,76	43,27	85,20	49,24	7,75	14,8	26,04	25,78
2	tailings of jig-test 14	"	49,71	37,74	86,83	50,29	5,66	13,17		21,61
3	" " " " 17	"	34,5	35,59	75,15	65,50	6,20	24,85	16,60	16,34
4	middlings" " " "	"	50,60	39,37	85,57	49,40	6,80	14,43	23,60	23,28
5	raw ore	"	52,20	41,51	85,48	47,80	7,70	14,52	26,04	25,35
6	"	"	55,30	40,54	87,14	44,70	7,40	12,86	26,04	25,72

Pyrites, Phosphates & Chemicals

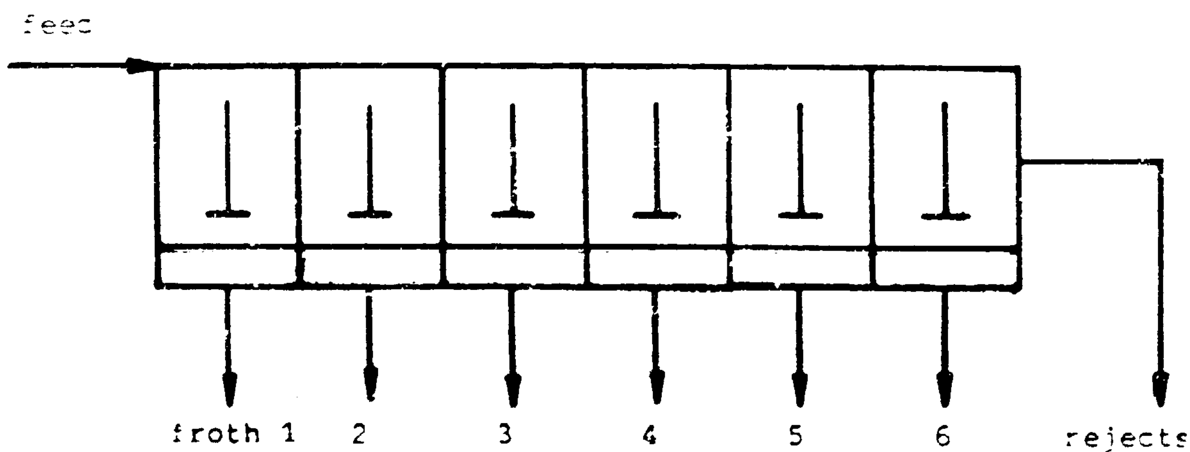
Flow - sheet: flotation tests

enclosure: 10.0

a) flotation test 1 - 5



b) flotation test 6



enclosure: 10.1
P.-A.-No.: 9-8125-9-5023
date: 21 April 1986

BALANCE

client: Pyrites,Phosphates & Chemicals Ltd., India

material: pyrite ore (medium grade)
raw ore fraction 0.5 - 0 mm

procedure: flotation test 1

product	flotation time min	weight recovery feed %	weight recovery prod. %	weight recovery raw ore %	sulphur grade %	sulphur recovery % feed	sulphur recovery % prod.	sulphur recovery % raw ore	sulphur content
froth	13	46.32	91.25	9.12	45.76	82.22	96.50	20.04	21.1960
middlings	5	4.44	8.75	.87	17.31	2.98	3.50	.73	.7686
concentrate		50.76	100.00	9.99	43.27	85.20	100.00	20.76	21.9646
rejects		49.24	100.00	9.70	7.75	14.80	100.00	3.61	3.8161
feed of flotation		100.00	---	19.69	26.04	100.00	---	24.37	25.7807

B A L A N C E

enclosure: 10.2
P.-A.-No.: 9-8125-9-5023
date: 21 April 1986

client: Pyrites, Phosphates & Chemicals Ltd., India
material: pyrite ore (medium grade)
tailings 0.5 - 0 mm of jigging test 14

procedure: flotation test 2

product	flotation time min	weight recovery feed %	weight recovery prod. %	weight recovery raw ore %	sulphur grade %	sulphur recovery % feed	sulphur recovery % prod.	sulphur recovery % raw ore	content
froth	15	39.03	78.52	1.06	41.89	75.67	87.15	2.00	16.3497
middlings	5	10.68	21.48	.29	22.58	11.16	12.85	.29	2.4115
concentrate		49.71	100.00	1.35	37.74	86.83	100.00	2.29	18.7612
rejects		50.29	100.00	1.37	5.66	13.17	100.00	.35	2.8464
feed of flotation		100.00	---	2.72	---	100.00	---	2.64	21.6076

B A L A N C E
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enclosure: 10.3
P.-A.-No.: 9-8125-9-5023
date: 21 April 1986

client: Pyrites,Phosphates & Chemicals Ltd., India
material: pyrite ore (medium grade)
tailings 0.5 - 0 mm of jigging test 17

procedure: flotation test 3

product	flotation time min	weight recovery feed %	weight recovery prod. %	weight recovery raw ore %	sulphur grade %	sulphur recovery % feed	sulphur recovery % prod.	sulphur recovery % raw ore	content
froth	13	17.60	51.01	.51	45.20	48.69	64.79	1.10	7.9552
middlings 1	6	11.00	31.88	.32	20.80	14.00	18.63	.32	2.2880
middlings 2	4	5.90	17.10	.17	34.50	12.46	16.58	.28	2.0355
concentrate		34.50	100.00	1.01	35.59	75.15	100.00	1.70	12.2787
rejects		65.50	100.00	1.91	6.20	24.85	100.00	.56	4.0610
feed of flotation		100.00	---	2.92	16.60	100.00	---	2.26	16.3397

B A L A N C E
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enclosure: 10.4
P.-A.-No.: 9-8125-9-5023
date: 21 April 1986

client: Pyrites, Phosphates & Chemicals Ltd., India
material: pyrite ore (medium grade)
middlings 0.5 - 0 mm of jigging test 17

procedure: flotation test 4

product	flotation time min	weight recovery feed %	weight recovery prod. %	weight recovery raw ore %	sulphur grade %	sulphur recovery % feed	sulphur recovery % prod.	sulphur recovery % raw ore	sulphur content
froth	15	43.20	85.38	1.27	42.70	79.24	92.61	2.58	18.4464
middlings	5	7.40	14.62	.22	19.90	6.33	7.39	.21	1.4726
concentrate		50.60	100.00	1.49	39.37	85.57	100.00	2.78	19.9190
rejects		49.40	100.00	1.45	6.80	14.43	100.00	.47	3.3592
feed of flotation		100.00	---	2.94	23.60	100.00	---	3.25	23.2782

B A L A N C E

enclosure: 10.5
P.-A.-No.: 9-8125-9-5023
date: 21 April 1986

client: Pyrites, Phosphates & Chemicals Ltd., India
material: pyrite ore (medium grade)
raw ore fraction 0.5 - 0 mm

procedure: flotation test 5

product	flotation time min	weight recovery feed %	weight recovery prod. %	weight recovery raw ore %	sulphur grade %	sulphur recovery % feed	sulphur recovery % prod.	sulphur recovery % raw ore	sulphur content
froth	16	43.20	82.76	8.51	44.70	76.18	89.12	18.56	19.3104
middlings	6	9.00	17.24	1.77	26.20	9.30	10.88	2.27	2.3580
concentrate		52.20	100.00	10.28	41.51	85.48	100.00	20.83	21.6684
rejects		47.80	100.00	9.41	7.70	14.52	100.00	3.54	3.6806
feed of flotation		100.00	---	19.69	26.04	100.00	---	24.37	25.3490

B A L A N C E
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enclosure: 10.6
P.-A.-No.: 9-8125-9-5023
date: 21 April 1986

client: Pyrites,Phosphates & Chemicals Ltd., India
material: pyrite ore (medium grade)
raw ore fraction 0.5 - 0 mm

procedure: flotation test 6

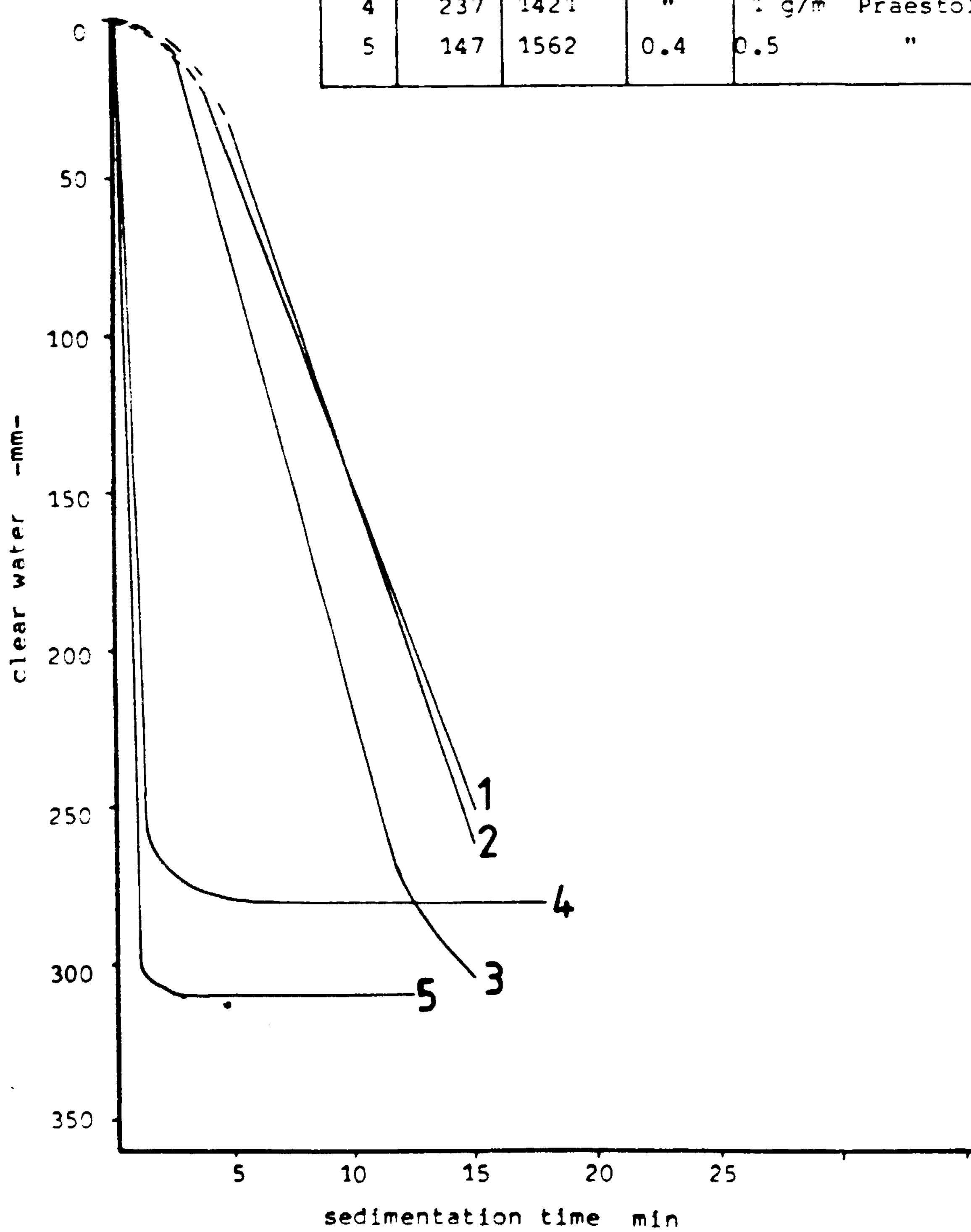
product	flotation time	weight recovery			sulphur				
	time	feed	prod.	raw ore	grade	recovery %			content
	min	%	%	%	%	feed	prod.	raw ore	
froth 1	2	18.40	33.27	3.62	45.70	32.69	37.51	7.97	8.4088
froth 2	2	14.20	25.68	2.80	43.70	24.12	27.68	5.88	6.2054
froth 3	2	7.40	13.38	1.46	42.40	12.20	14.00	2.97	3.1376
froth 4	4	4.90	8.86	.96	38.20	7.28	8.35	1.77	1.8718
froth 5	2	6.90	12.48	1.36	28.70	7.70	8.83	1.88	1.9803
froth 6	4	3.50	6.33	.69	23.20	3.16	3.62	.77	.8120
concentrate	16	55.30	100.00	10.89	40.54	87.14	100.00	21.24	22.4159
rejects		44.70	100.00	8.80	7.40	12.86	100.00	3.13	3.3078
feed of flotation		100.00	---	19.69	26.04	100.00	---	24.37	25.7237

SEDIMENTATION CURVES

PPC Saladipura pyrite ore

sample "mg" raw ore fraction -0.5 mm

test	solids content (g/l) feed	thicked product	clear water (after 10 min)	flocculant
1	374	674	1.3	
2	237	500	turbid	
3	147	417	"	
4	237	1421	"	1 g/m^3 Praestol 290[illegible]
5	147	1562	0.4	0.5 "



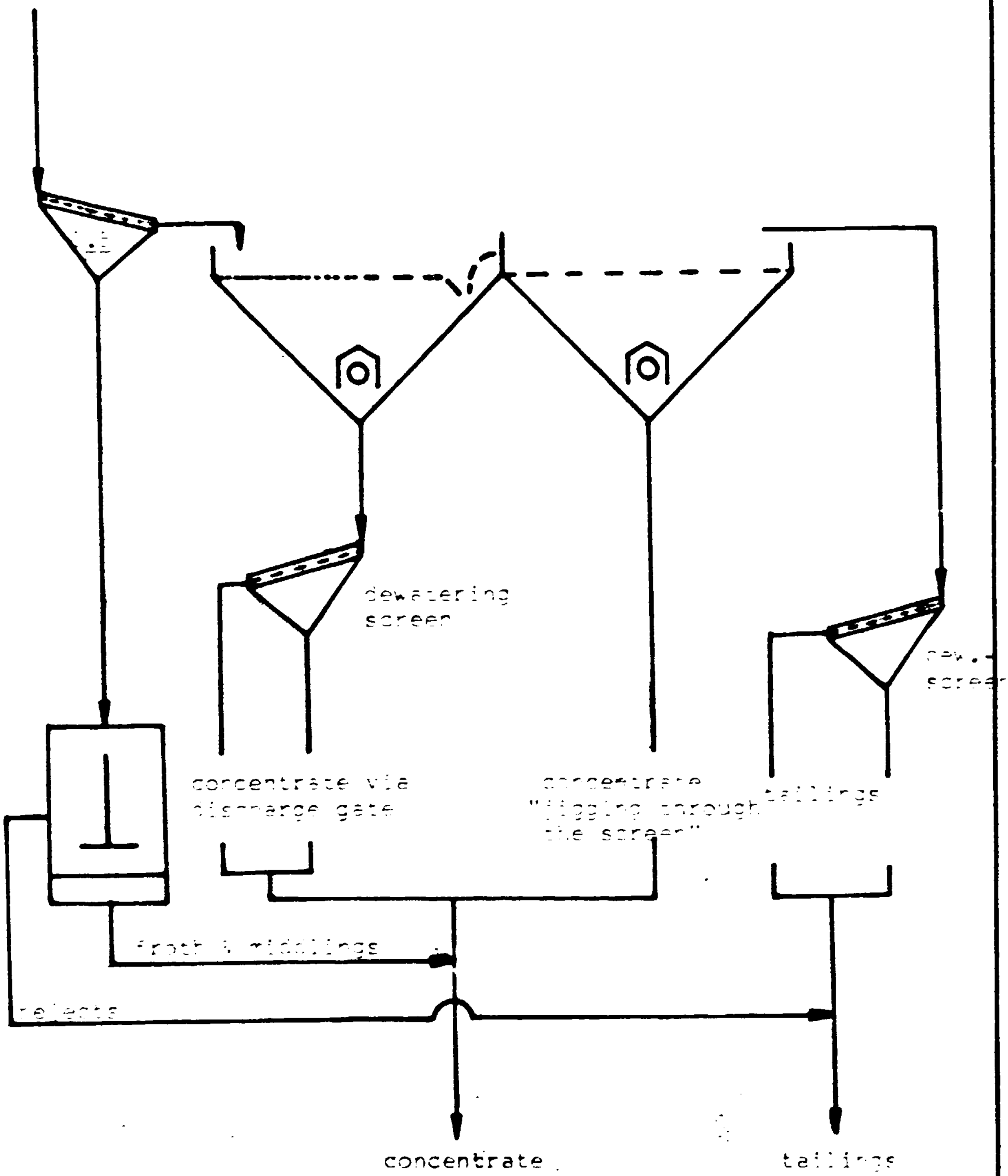
Pyrites, Phosphates & Chemicals

enclosure: 12.1a

Flow - sheet:

jigging test 7

combined with flotation test 5



B A L A N C E
=============

enclosure: 12.1b
P.-A.-No.: 9-8125-9-5023
date: 05.03.1986

client: Pyrites, Phosphates & Chemicals
material: pyrite ore (medium grade) 10 - 0 mm
fraction 10 - 0.5 mm : remixed material
fraction 0.5 - 0 mm :fraction of screen-sulphur-analysis

procedure: jigging test 7
combined with flotation test 5

product	particle size mm	weight recovery raw ore %	weight recovery fraction %	sulphur grade %	sulphur recovery % raw ore	sulphur recovery % fract	content
concentrate via discharge gate	+ 0.5	26.2614	81.95	35.78	46.20	85.13	9.3963
concentrate via discharge gate	+ 0.5	2.8109	8.77	35.87	4.96	9.13	1.0083
concentrate "jigging through the screen"	+ 0.5	2.9715	9.27	21.32	3.11	5.74	.6335
jig concentrate	+ 0.5	32.0438	100.00	34.45	54.27	100.00	11.0381
froth of flotation	- 0.5	8.5061	82.76	44.70	18.70	89.12	3.8022
middlings of flotation	- 0.5	1.7720	17.24	26.20	2.28	10.88	.4643
flotation concentrate	- 0.5	10.2781	100.00	41.51	20.98	100.00	4.2665
concentrate of jigging and flotation	10 - 0	42.3219	---	36.16	75.25	---	15.3046
jig tailings dewatering screen residue	+ 0.5	46.5798	80.76	8.68	19.88	80.32	4.0431
jig tailings dewatering screen passing	+ 0.5	1.6865	2.92	15.75	1.31	5.28	.2656
flotation tailings	- 0.5	9.4118	16.32	7.70	3.56	14.40	.7247
final tailings	10 - 0	57.6781	100.00	8.73	24.75	100.00	5.0335
raw ore	10 - 0	100.0000	---	20.63	100.00	---	20.3381

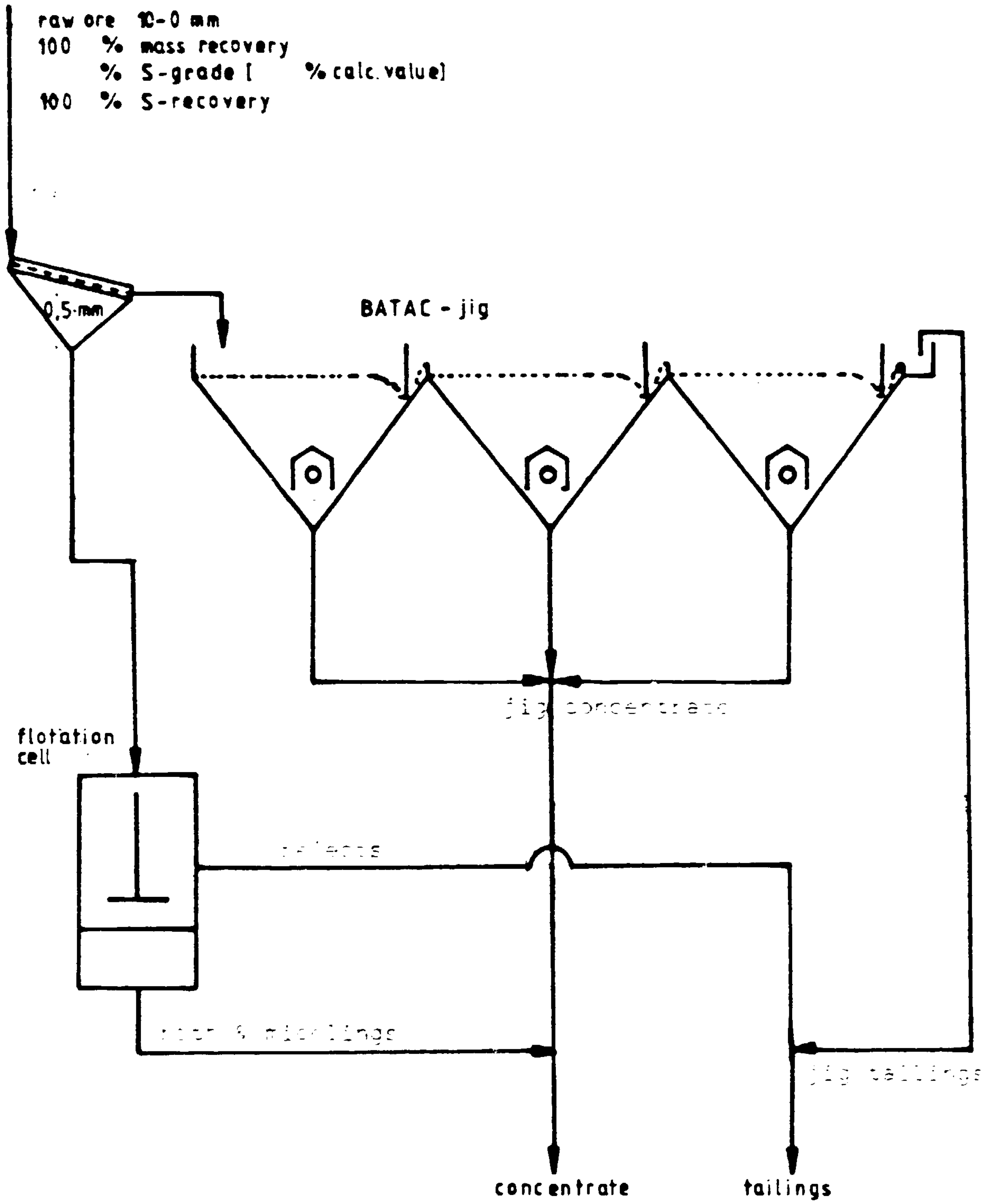
PPC INDIA

sample: mg

jigging test no.: 9, 10 + 12

flotation test no.: 5

enclosure: 12.2a



B A L A N C E
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enclosure: 12.2b
P.-A.-No.: 9-8125-9-5023
date: 05.03.1986

client: Pyrites, Phosphates & Chemicals Ltd., India (PPC)
material: pyrite ore (medium grade) 10 - 0 mm

procedure: jigging test 9, 10 & 12
combined with
flotation test 5

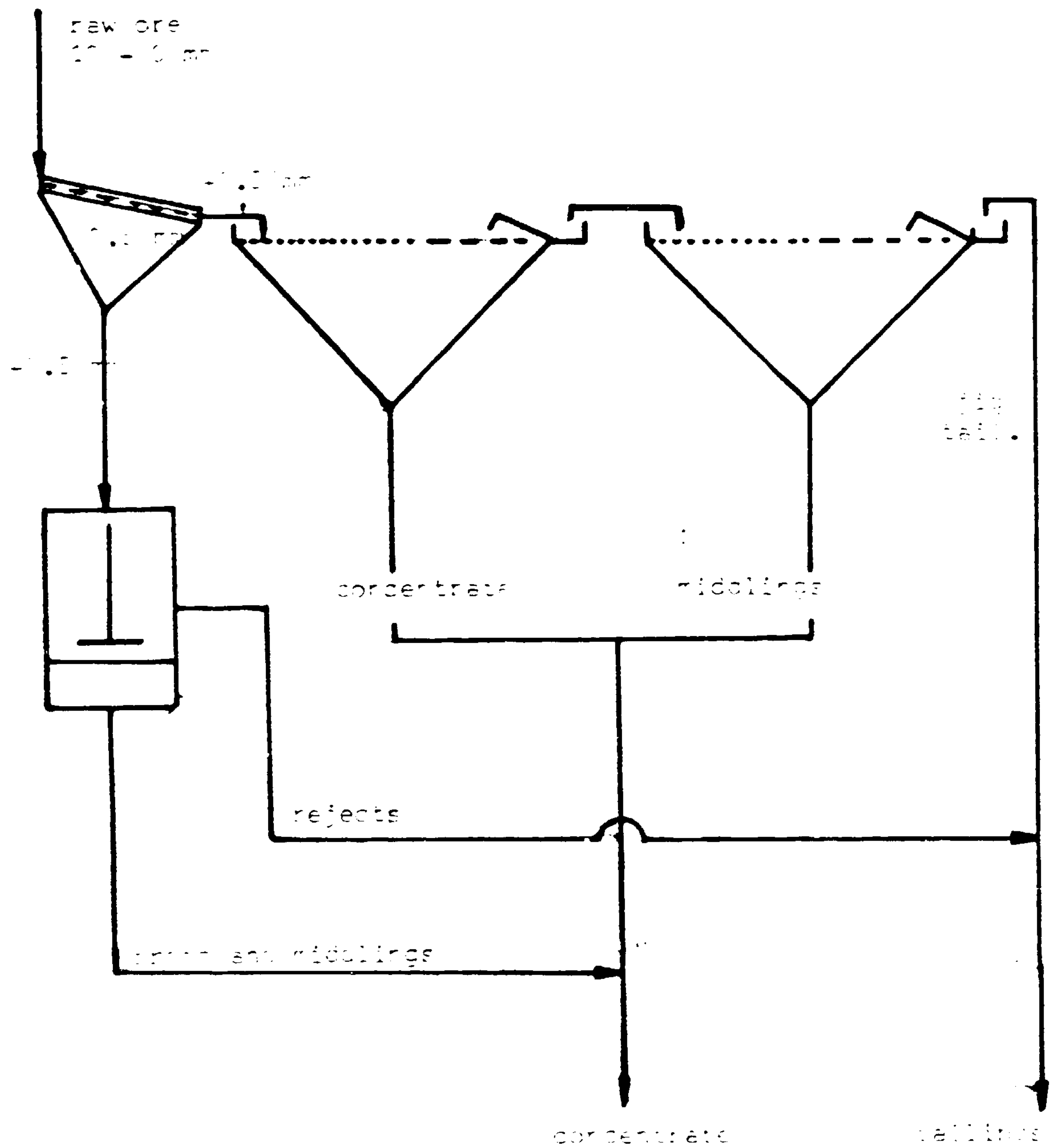
	particle size mm	weight recovery raw ore %	weight recovery product %	sulphur grade %	sulphur recovery % raw ore	sulphur recovery % product	content
jig concentrate	+ 0.5	38.10	81.06	36.64	59.95	79.04	13.9598
flotation froth	- 0.5	7.40	15.74	44.70	14.20	18.73	3.3078
flotation middlings	- 0.5	1.50	3.19	26.20	1.69	2.23	.3930
concentrate	10 - 0	47.00	100.00	37.58	75.84	100.00	17.6606
jig tailings	+ 0.5	44.90	84.72	11.14	21.48	88.91	5.0019
flotation rejects	- 0.5	8.10	15.28	7.70	2.68	11.09	.6237
final tailings	10 - 0	53.00	100.00	10.61	24.16	100.00	5.6256
raw ore	10 - 0	100.00	---	20.63	100.00	---	23.2862

KHD HUMBOLDT WEDAG

Pyrites, Phosphates & Chemicals

Flow - sheet: jigging test 17 combined with flotation test 5

enclosure: 12.3a



B A L A N C E

enclosure 12.3b
P.-A.-No.: 9-8125-9-5023
date: 05.03.1986

client: Pyrites, Phosphates & Chemicals Ltd.. India (PPC)
material: pyrite ore (medium grade) 10 - 0 mm

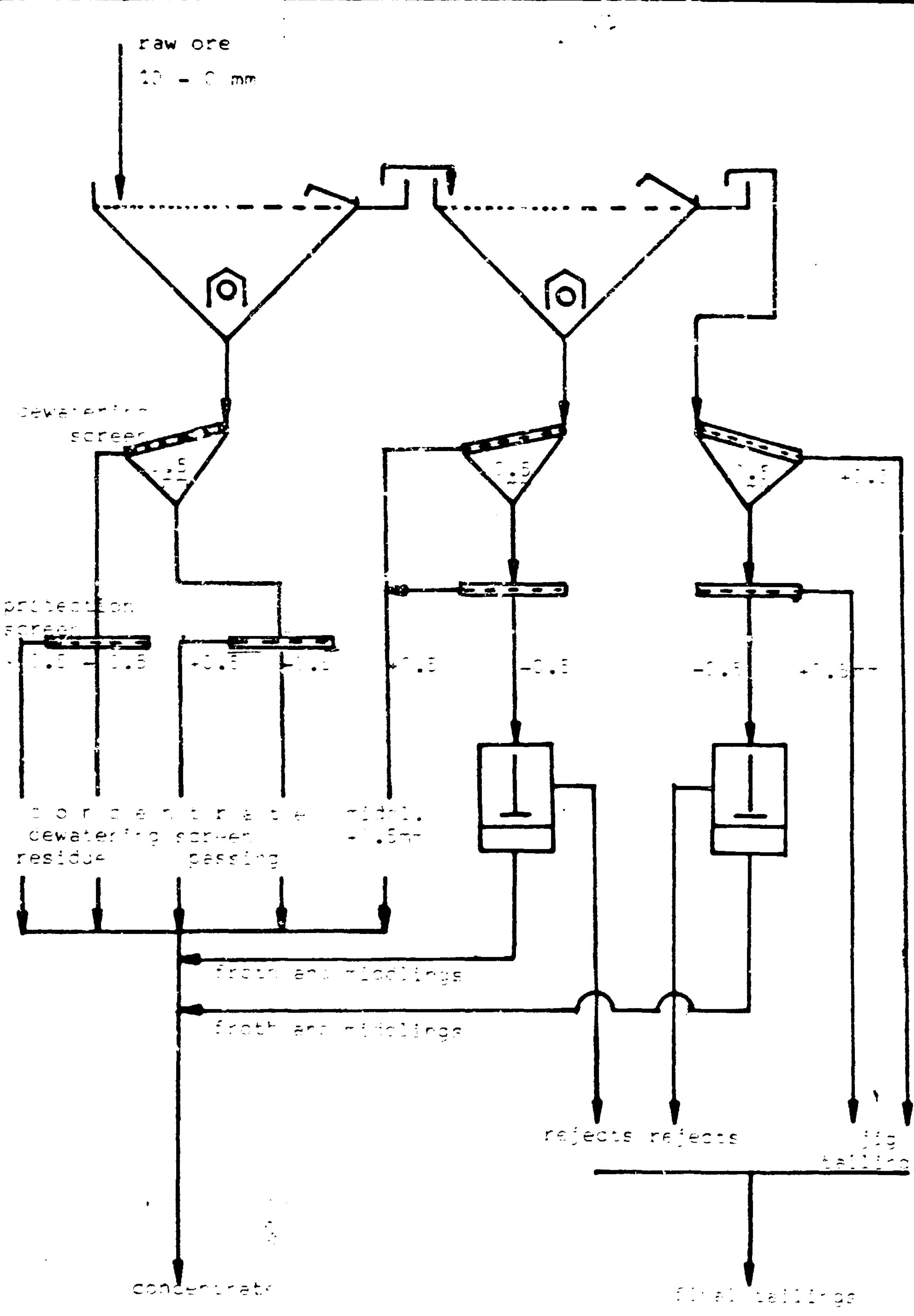
procedure: jigging test 17
combined with
flotation test 5

	particle size mm	weight recovery raw ore %	weight recovery product %	sulphur grade %	sulphur recovery % raw ore	sulphur recovery % product	sulphur content
jig concentrate	+ 0.5	37.86	82.45	33.28	60.38	79.02	12.5998
flotation froth	- 0.5	6.67	14.53	44.70	14.29	18.70	2.9815
flotation middlings	- 0.5	1.39	3.03	26.20	1.75	2.28	.3642
concentrate	10 - 0	45.92	100.00	34.72	76.41	100.00	15.9455
jig tailings	+ 0.5	45.45	84.04	9.30	20.26	85.88	4.2269
jig tailings	+ 0.5	1.26	2.33	10.10	.61	2.59	.1273
flotation rejects	- 0.5	7.37	13.63	7.70	2.72	11.53	.5675
final tailings	10 - 0	54.08	100 00	9.10	23.59	100.00	4.9216
raw ore	10 - 0	100.00	---	20.63	100.00	---	20.8671

Pyrites, Phosphates & Chemicals

Flow - sheet: jigging test 17 combined with flotation test 3 & 4

Enclosure: 12.4o



B A L A N C E

enclosure: 12.4b
P.-A.-No.: 9-8125-9-5022
date: 05.03.1986

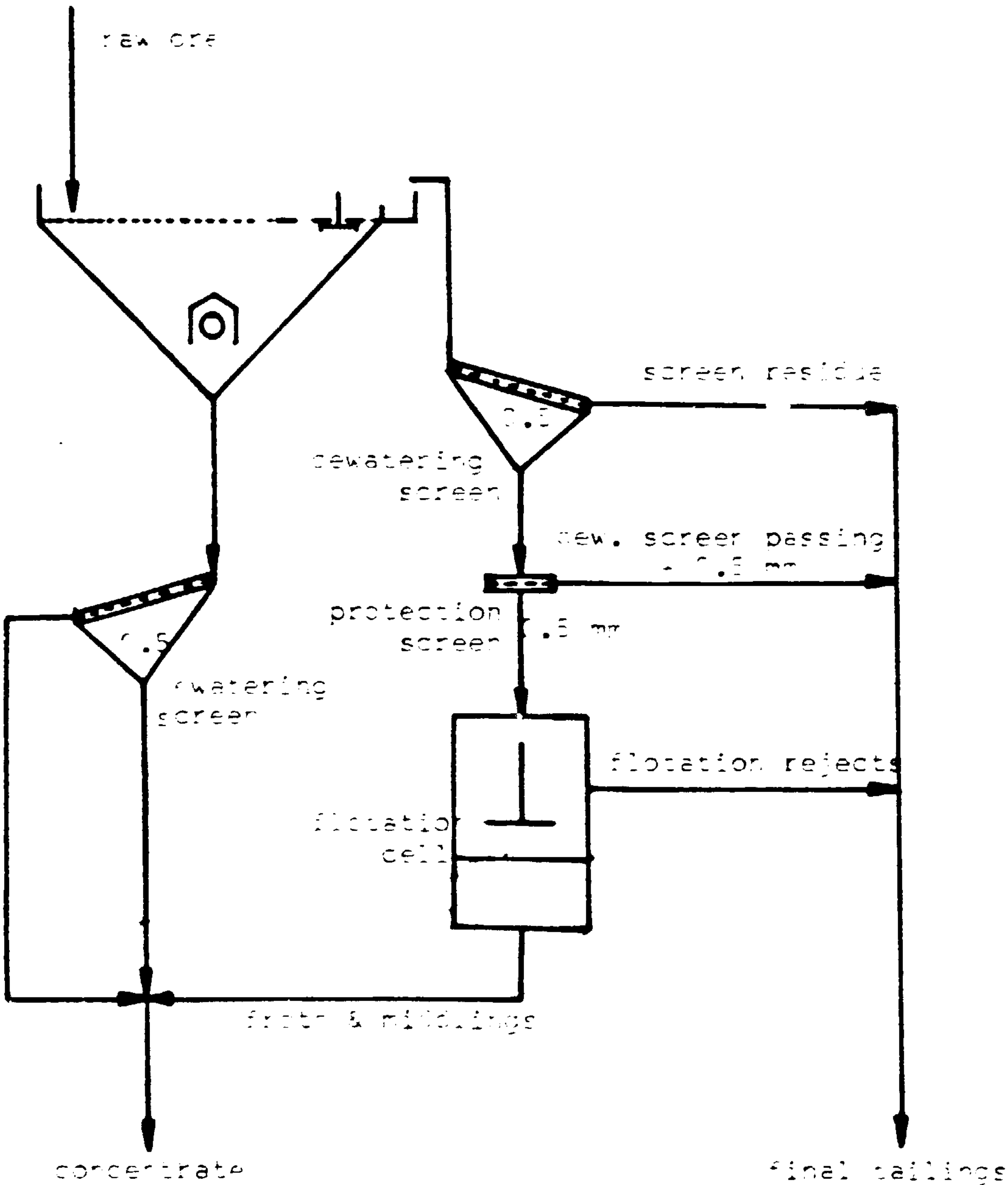
client: Pyrites, Phosphates & Chemicals Ltd., India (PPC)
material: pyrite ore (medium grade) 10 - 0 mm

procedure: jigging test 17
combined with
flotation test 3 and 4

product		particle size mm	weight recovery raw ore %	weight recovery product %	sulphur grade %	sulphur recovery % raw ore	sulphur recovery % product	sulphur content
jig concentrate	dewatering screen residue	+ 0.5	23.11	61.04	36.30	39.76	66.57	8.3889
jig concentrate	dewatering screen passing	+ 0.5	.50	1.32	30.20	.72	1.20	.1510
jig middlings	dewatering screen residue	+ 0.5	14.25	37.64	28.50	19.25	32.23	4.0613
jig concentrate and jig middlings		+ 0.5	37.86	100.00	33.28	59.72	100.00	12.6012
jig concentrate	dewatering screen residue	- 0.5	1.69	17.66	30.00	2.40	17.01	.5070
jig concentrate	dewatering screen passing	- 0.5	7.88	82.34	31.40	11.73	82.99	2.4743
jig concentrate and jig middlings		- 0.5	9.57	100.00	31.15	14.13	100.00	2.9812
flotation of tailings - 0.5 mm	froth	- 0.5	.52	51.49	45.10	1.11	65.17	.2345
flotation of tailings - 0.5 mm	middl.	- 0.5	.49	48.51	25.58	.59	34.83	.1253
flotation of tailings froth and middlings		- 0.5	1.01	100.00	35.63	1.71	100.00	.3599
flotation of middlings - 0.5 mm	froth	- 0.5	1.27	85.23	42.70	2.57	92.53	.5423
flotation of middlings - 0.5 mm	middl.	- 0.5	.22	14.77	19.90	.21	7.47	.0438
flotation of middlings froth and middlings		- 0.5	1.49	100.00	39.33	2.78	100.00	.5861
concentrate of jig and flotation		10 - 0	49.93	---	33.10	78.34	---	16.5284
jig tailings	dewatering screen residue	+ 0.5	45.45	90.77	9.30	20.03	92.47	4.2269
jig tailings	dewatering screen passing	+ 0.5	1.26	2.52	10.10	.60	2.78	.1273
flotation of jig tailings	rejects	- 0.5	1.91	3.81	6.20	.56	2.59	.1184
flotation of jig middlings	rejects	- 0.5	1.45	2.90	6.80	.47	2.16	.0986
final tailings		10 - 0	50.07	100.00	9.13	21.66	100.00	4.5711
raw ore			100.00	---	20.63	100.00	---	21.0996

Flow - sheet:

jigging test 14
combined with flotation test 2



B A L A N C E

enclosure:	12.5b
P.-A.-No.:	9-8125-9-5023
date:	24 April 1986

client: Pyrites, Phosphates & Chemicals
material: pyrite ore (medium grade) 10 - 0 mm

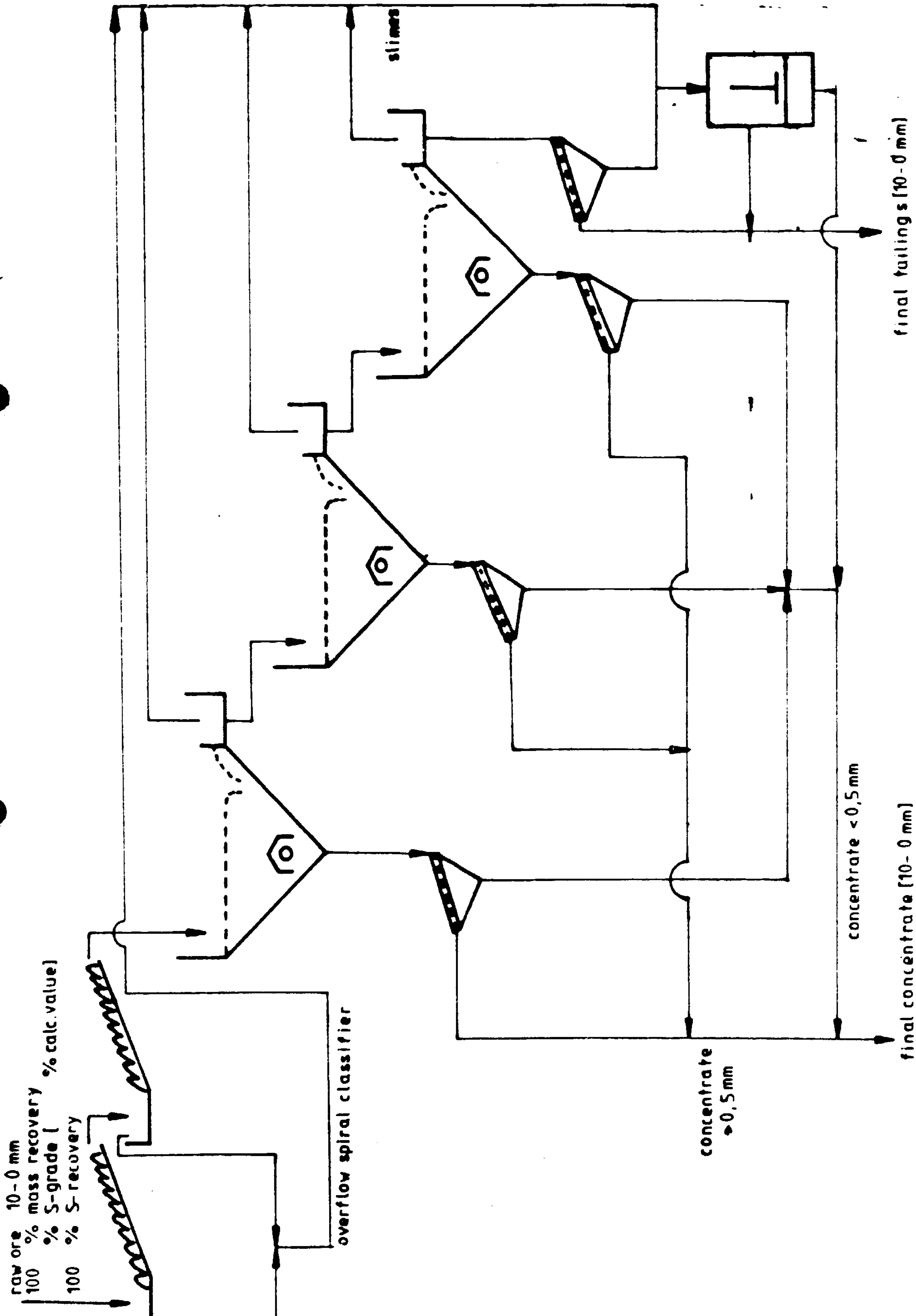
procedure: jigging test 14
combined with flotation test 2

product	particle size mm	weight recovery raw ore %	weight recovery fraction %	sulphur grade %	sulphur recovery % raw ore	sulphur recovery % fract	sulphur content
concentrate	10 - 0.5	38.1400	79.97	31.09	53.39	79.73	11.8577
concentrate	- 0.5	9.5500	20.03	31.56	13.57	20.27	3.0140
jig concentrate	10 - 0	47.6900	100.00	31.18	66.96	100.00	14.8717
froth of flotation	- 0.5	1.0600	78.52	41.89	2.00	87.15	.4440
middlings of flotation	- 0.5	.2900	21.48	22.58	.29	12.85	.0655
flotation concentrate	- 0.5	1.3500	100.00	37.74	2.29	100.00	.5095
conc. of jig & flotation	10 - 0	49.0400	---	31.36	69.25	---	15.3812
jig tailings screen residue	+ 0.5	48.5800	95.33	13.60	29.75	96.73	6.6069
jig tailings screen passing	+ 0.5	1.0100	1.98	14.41	.66	2.13	.1455
flotation tailings	- 0.5	1.3700	2.69	5.66	.35	1.14	.0775
final tailings	10 - 0	50.9600	100.00	13.40	30.75	100.00	6.8300
raw ore	10 - 0	100.0000	---	20.63	100.00	---	22.2112

sample: mg 12,6

jigging test no.: 9, (10+11), (12+13)

flotation test: 3



B A L A N C E

enclosure: 12.6b
P.-A.-No.: 9-8125-9-5023
date: 24 April 1986

client: Pyrites, Phosphates & Chemicals
material: pyrite ore (medium grade) 10 - 0 mm

procedure: jigging test 9, (10 + 11) & (12 + 13)
combined with flotation test 3

product	particle size mm	weight recovery raw ore %	weight recovery fraction %	sulphur grade %	sulphur recovery % raw ore	sulphur recovery % fract	sulphur content
jig concentrate step 1, 2 & 3	10 - 0.5	38.9300	83.08	34.77	62.41	85.09	13.5360
jig concentrate step 1, 2 & 3	- 0.5	7.9300	16.92	29.90	10.93	14.91	2.3711
jig concentrate	10 - 0	46.8600	100.00	33.95	73.35	100.00	15.9070
froth of flotation	- 0.5	1.3200	51.01	45.20	2.75	64.79	.5966
middlings of flotation	- 0.5	1.2675	48.99	25.58	1.50	35.21	.3242
flotation concentrate	- 0.5	2.5875	100.00	35.59	4.25	100.00	.9209
concentrate of jigging and flotation	10 - 0	49.4475	---	34.03	77.59	---	16.8279
jig tailings	10 - 0	45.6400	90.28	9.98	21.00	93.73	4.5549
flotation tailings	- 0.5	4.9125	9.72	6.20	1.40	6.27	.3046
final tailings	10 - 0	50.5525	100.00	9.61	22.41	100.00	4.8594
raw ore	10 - 0	100.0000	---	20.63	100.00	---	21.6873