

TOKYO CENTRAL LABORATORY MITSUI MINING & SMELTING CO., LTD.

Research Report No. 1031

MILLING TEST REPORT ON LEAD AND ZINC ORE
OF VANGORDA CANADA

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§ 1 SUMMARY

The main points of the milling test results performed on the newly arrived feed ore of lead and zinc of Vangorda Mine, Canada (arrived in December 1964), are as follows:

- 1) The assays of feed ore being 0.1% Cu, 3.8% Pb, 5.2% Zn, 21% Fe and 15.5% Ba. The grades of Pb and Zn are slightly higher than the last feed ore and about 26% of containing baryte is remarkable.
- 2) The work index is 7.4, and it seems to be comparatively easy to grind.
- 3) With regard to the floatability of minerals composing the feed ore, although the separation is rather easy for sphalerite, especially galena has a nature to impede the effective separation of pyrite from galena.
- 4) The flotation tests which had been carried out by differential, semi-bulk and bulk method proved that bulk method is most satisfactory, simplifying the system and showing the possibility to save the quantity of flotation reagent to be used.
- 5) Around - 150 mesh is supposed to be proper for feed size, the fine grinding is accompanied by the improvement of separation effect and the grade of zinc concentrate shows obviously a remarkable increase. But still further examination to be made to know whether the adoption of 2 stages grinding is more effective.
- 6) Although no special attention was paid to the flotation movement of pyrite and baryte, it has been recognized that the former is concentrated to Pb concentrate or bulk concentrate, while the latter is easily concentrated to the flotation tailing.
- 7) The result of milling treatment for the said feed ore are estimated from the aforementioned test results, as follows:

RESULTS OF MILLING TREATMENT

Feed ore	Quantity of concentrate	Grade (%)					Recoveries (%)					Treatment method
		Cu	Pb	Zn	Pb+Zn	Fe	Cu	Pb	Zn	Pb+Zn	Fe	
New feed ore (arrived in Dec., 1964)	14.3	0.6	20.4	35.6	56.0	8.4	63.0	78.2	92.3	170.5	5.6	Bulk flotation agent 3,840 g/t
Last feed ore (arrived in Feb., 1964)	12.3	0.9	20.4	28.8	49.2	12.5	65.7	82.8	79.7	162.5	7.1	Semi-bulk flotation agent 9,360 g/t
Noranda results (received in Feb., 1965)		1.8	21.5	32.4	53.9	10.2		90.2	87.0	177.2		Bulk flotation 2 stages grinding Grade of feed ore unknown.

§ 2 INTRODUCTION

Though the results of milling test on Pb and Zn ore of Vangorda, Canada has been reported by our Central Research Laboratory Report No. 1,001, we performed again the flotation test on the new feed ore in accordance with the recent request by Mining & Geology Dept. We would therefore like to submit a report of the results thus obtained

§3. FEED ORE FOR TEST

The assays of the feed ore are shown in Table 1.

The grades of Pb and Zn are slightly higher than the last feed ore, the grade of Ba being remarkably high.

Table 1. ASSAYS OF FEED ORE

	Composition (% g/k)													
	Au	Ag	Cu	Pb	Zn	Fe	S	As	Sb	Bi	Cd	Ba	CaO	SiO ₂
Now feed ore	0.8	58	0.13	3.85	5.25	21.17	24.46	0.08	0.01	tr.	0.01	15.46	1.91	5.92
Last feed ore	0.9	51	0.13	3.21	4.22	21.32	28.07	0.10	tr.	tr.	0.01	4.69	1.77	25.39

Without having particular confirmation of the mineral composition, paragenesis or isolation degree, we had proceeded with the test in the light of the microscopic test results obtained last time, and any problem would be examined every time when it comes out. It has been proven by X'ray diffraction that the aforementioned Ba mineral was baryte (BaSO₄). The work index is 7.40 (Kamioka ore 11.29, Nakatatsu ore 12.58), thus being comparatively easy to grind.

§4. TEST RESULTS

The points of treatment for this feed ore seems to be concerned with the depression and separation of pyrite and the effective recovery of galena, these two minerals would often show the same movement so that the adjustment of optional conditions should be done with the utmost care. As for the test, we performed the bulk-differential flotation as preliminary in order to get the flotability, and then we examined about the recovery of Pb-Zn bulk concentrate by semi-bulk flotation and bulk flotation.

1) Bulk differential flotation test.

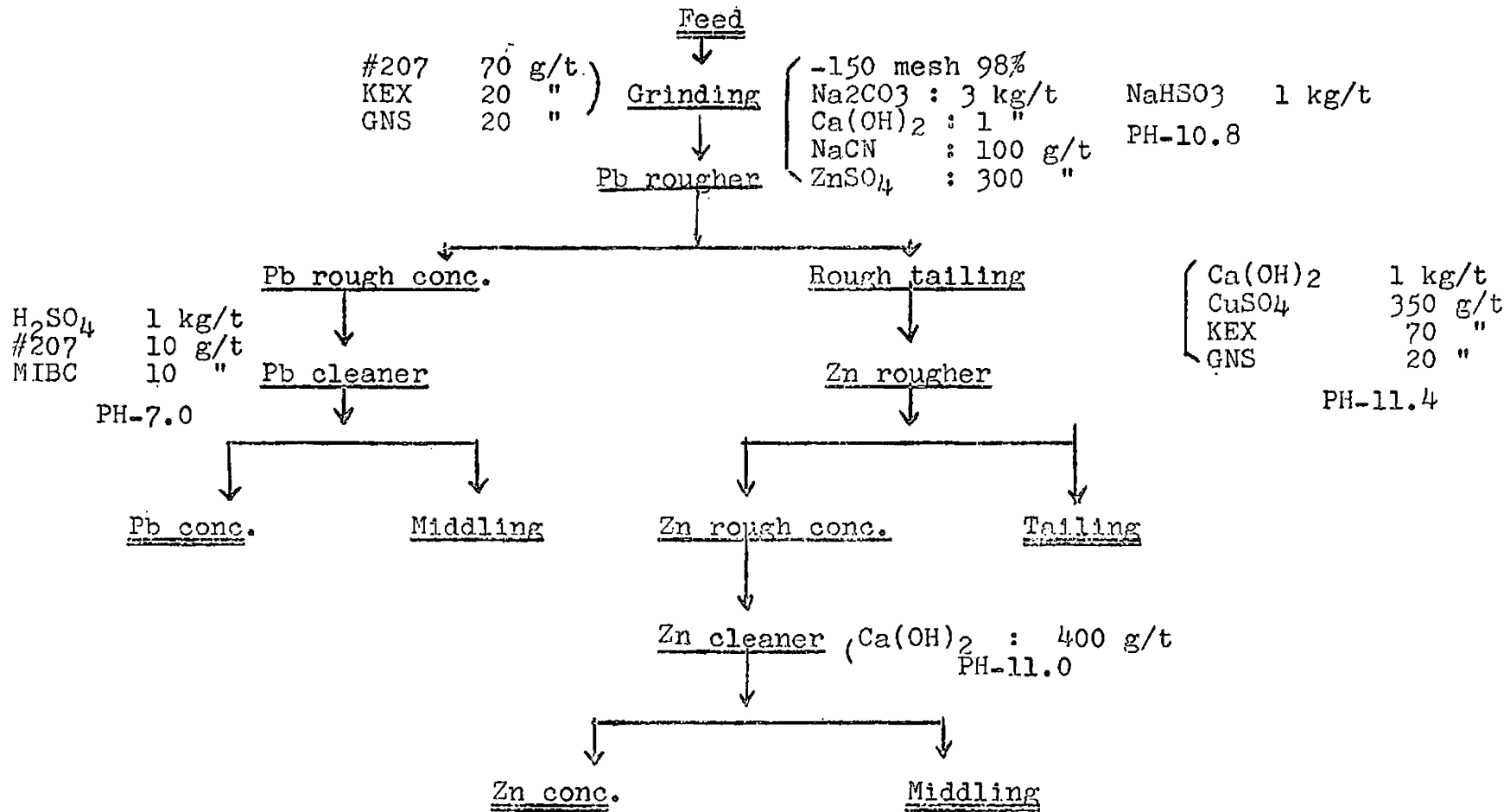
For Pb-Zn differential flotation by ordinary rule, it had been adjusted to around PH11 by means of soda ash and slaked lime; and after depressing Zn by using sodium syanide and Zn sulphate, Pb concentrate was recovered and finally Zn concentrate was recovered by activation with Cu sulphate. But the separation of Pb-Zn-Sp being unsatisfactory, both the quality of concentrates and recoveries were low. At the test, it has been noticed that it would bring a good effect on Pb recovery to use sulphate NaHSO_3 together with other reagents.

The examples of experiments are shown on Table 2.

Table 2. RESULTS AND CONDITIONS OF DIFFERENTIAL FLOTATION TEST

Kind of ore	Quantity of ore (%)	Grade (%)				Recoveries (%)				Remarks
		Cu	Pb	Zn	Fe	Cu	Pb	Zn	Fe	
(Feed)	100.00	0.13	3.86	5.60	21.33	100.00	100.00	100.00	100.00	
(Pb rough conc.)	15.43	0.21	21.31	10.49	16.85	24.51	85.01	28.89	12.18	
Pb concentrate	6.41	0.41	43.63	12.50	9.16	21.63	72.30	14.30	2.75	
Middling	9.02	0.06	5.45	9.06	22.31	2.88	12.71	14.59	9.43	
(Zn rough conc.)	14.43	0.43	1.83	25.47	19.43	48.36	6.84	65.60	13.14	
Zn concentrate	5.81	0.29	1.45	51.88	9.26	13.03	2.18	53.81	2.52	
Middling	8.62	0.53	2.09	7.66	26.29	35.33	4.66	11.79	10.62	
Tail	70.14	0.05	0.45	0.44	22.71	27.13	8.15	5.51	74.68	
(Pb-Zn mixed conc.)	12.22	0.35	23.58	31.22	9.21	34.66	74.48	68.11	5.27	Pb conc. + Zn conc.
										(Grade 55%(Pb+Zn) (Recoveries 143%("))
Pb conc.	7.3	0.4	43.1	12.5	9.3	21.9	81.4	16.3	3.2	
Estimated Zn conc.	6.7	0.3	1.4	50.5	9.5	15.5	2.3	60.2	3.0	
(Total)	14.0	0.4	23.1	30.6	9.4 -	37.4	83.7	76.5	6.2	(Grade 54%(Pb+Zn) (Recoveries 160%("))

(Test condition)



2) Semi bulk flotation test

When plenty of slaked lime is used for depressing pyrite, galena is apt to be depressed, so that the quantity of slaked lime is limited to the minimum, using the small quantity of sodium cyanide in order to depress pyrites, while making every effort to collect galena by adding errofloat collective agent ACC #31 and cresol acid, high floatable sphalerite is recovered simultaneously. As a result of semi-bulk flotation process as aforementioned, the recoveries of both Pb and Zn are improved though the grades of concentrates are somewhat lower because of high ferro grade.

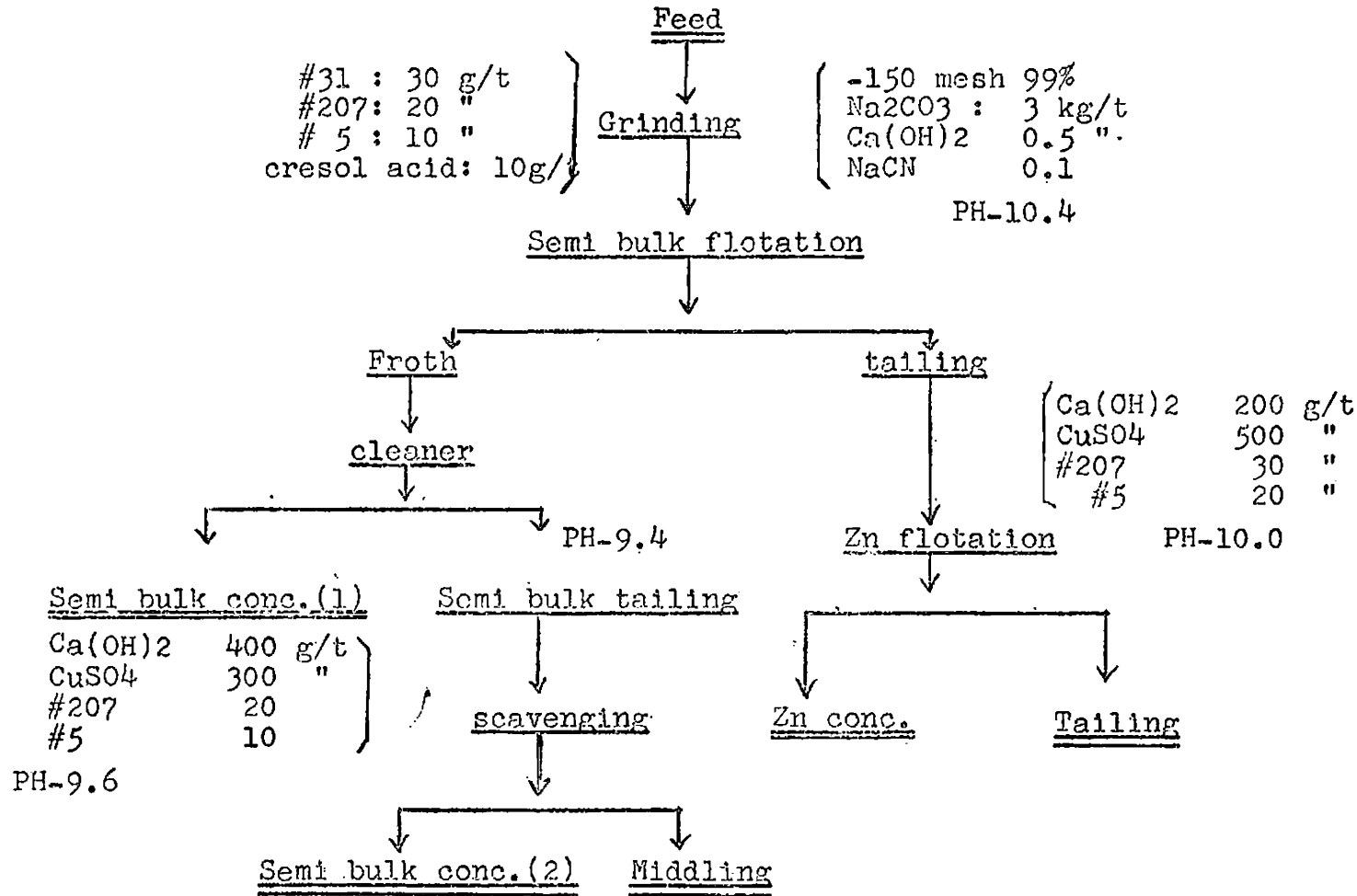
Table 3 represents the experimental examples.

Table 3. RESULTS AND CONDITIONS OF SEMI BULK FLOTATION TEST

(Test results)

Kind of ore	Q'ty of ore	Grade (%)				Recoveries (%)				Remarks
		Cu	Pb	Zn	Fe	Cu	Pb	Zn	Fe	
(Feed)	100.00	0.14	4.14	5.48	20.84	100.00	100.00	100.00	100.00	
Semi bulk conc. (1)	8.59	0.35	33.04	10.42	13.74	21.39	68.60	16.34	5.66	*1
(" Tailing)	17.96	0.34	5.15	7.49	20.47	43.94	22.36	24.56	17.66	
Semi bulk conc. (2)	3.59	0.68	11.48	29.01	13.94	17.36	9.96	19.02	2.41	*2
Middling	14.37	0.26	3.57	2.11	22.11	26.58	12.40	5.54	15.25	
Zn. conc.	5.19	0.15	1.57	47.89	9.16	5.54	1.95	45.39	2.28	*3
Tailing	68.26	0.06	0.43	1.10	22.71	29.13	7.09	13.71	74.40	
										*1+*2+*3
Pb Zn mixed conc.	17.37	0.36	19.18	25.46	12.41	44.29	80.51	80.75	10.35	Grade 45%(Pb+Zn) Recoveries 161%(")
Pb Zn mixed conc. (estimated)	18.1	0.4	19.1	25.2	12.5	46.3	83.4	83.0	10.8	Grade 44%(Pb+Zn) Recoveries 166%(")

(Test condition)



3) Bulk flotation test

After adjusting PH by using slaked lime together with soda ash and activating by using copper sulphate, Pb-Zn mixed froth was recovered, and subsequently a small quantity of slaked lime was added to remove Fe at the cleaning stage. Surmising from the result of the aforementioned bulk flotation process which was performed several times, though PH value; the adding quantity of slaked lime and the adjustment and selection of the kind of collective reagent may be essential for raising the separation effect of Pb-Zn-Sp, the feed size is considered to be more important.

Therefore the grindability of the new feed ore was newly examined, although it had been examined for the last feed ore.

Table 4 represents the result. The separation effect is improved with fine grinding and the increase of the grades of concentrate being especially remarkable.

Table 4 INFLUENCE OF GRINDABILITY

Grinding Time(min.)	Grindability	Kind of ore	Grade (%)				Recoveries (%)				(Pb+Zn)% Grade/recoveries
			Cu	Pb	Zn	Fe	Cu	Pb	Zn	Fe	
10	-150mesh 95.7%	Feed	0.13	3.86	5.57	21.31	100.00	100.00	100.00	100.00	22/184
		conc.	0.28	9.09	13.24	23.90	81.18	89.90	94.00	42.78	
		Tail	0.04	0.63	0.54	19.72	13.82	10.10	6.00	57.22	
20	-150mesh 98.0%	Feed	0.14	3.89	5.51	21.78	100.00	100.00	100.00	100.00	29/183
		conc.	0.39	11.82	17.65	20.52	84.39	89.27	94.11	27.69	
		Tail	0.03	0.59	0.46	22.31	15.61	10.73	5.89	72.31	
30	-150mesh 99.7%	Feed	0.14	3.94	5.47	21.04	100.00	100.00	100.00	100.00	30/185
		conc.	0.44	12.27	17.94	18.92	89.94	90.08	94.82	26.00	
		Tail	0.02	0.55	0.40	21.91	10.06	9.02	5.18	74.00	

The result of bulk flotation performed with -150 mesh for feed size is shown on Table 5. It is comparatively satisfactory: Zn-Pb mixed conc. 57% Pb+Zn, 8%Fe, recovery 153% Pb+Zn, and the treatment process would be simplified. Estimating the treatment result based on this experimental data, the grade of Pb-Zn bulk concentrate produced will be 56% Pb + Zn, 8% Fe, the recovery being 171% Pb + Zn.

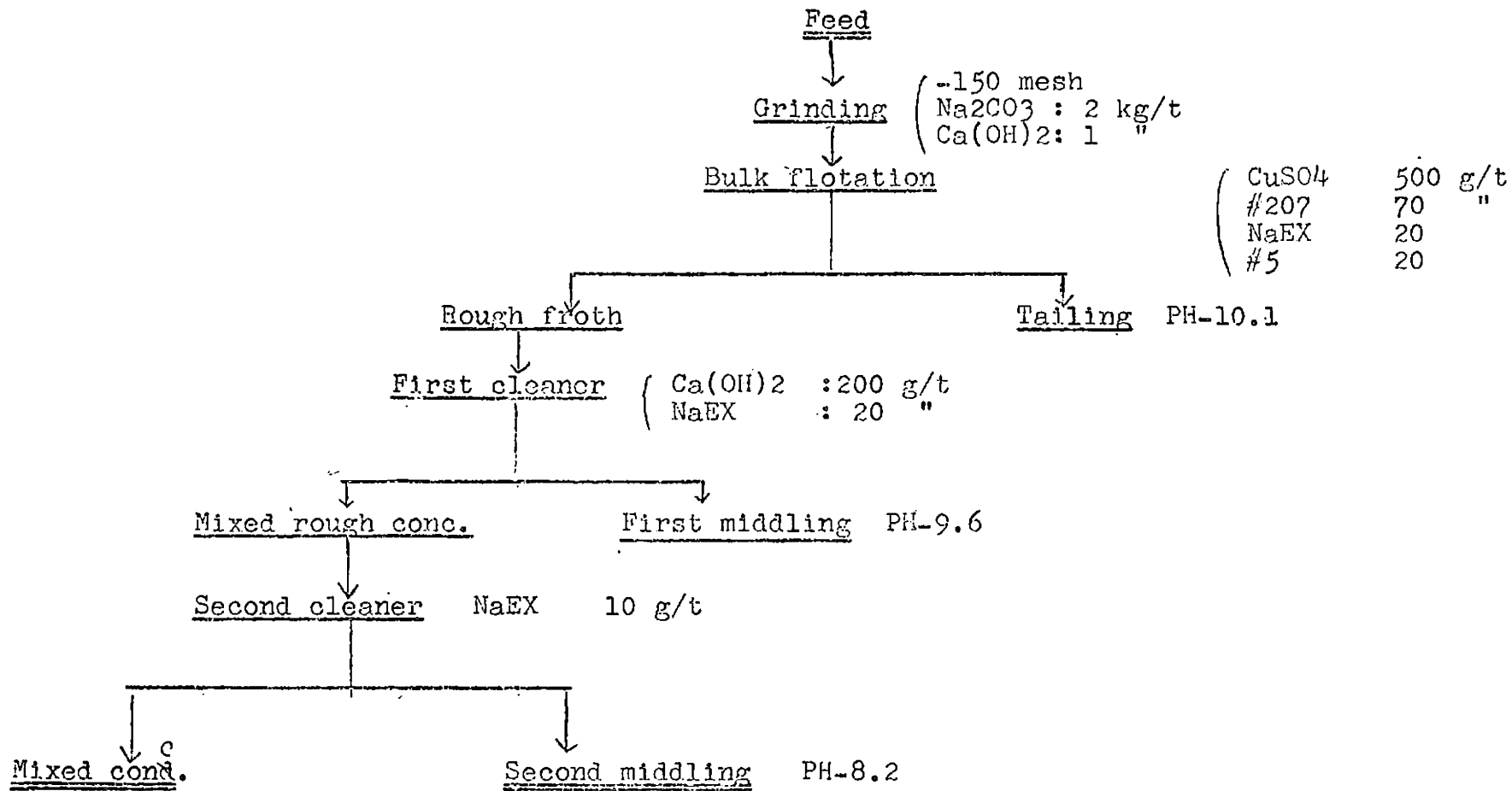
The result of the test which had been done under the two stages grinding and flotation condition similar to the aforementioned, is shown on Table 6. Though the grades of bulk concentrate are improved further more, the falls of recoveries are inevitable and still Pb recovery cannot be expected to rise.

Table 5 RESULT AND CONDITION OF BULK FLOTATION TEST

(Test result)

Kind of ore	Amount of ore (%)	Grade (%)				Recoveries (%)				Remarks
		Cu	Pb	Zn	Fe	Cu	Pb	Zn	Fe	
(Feed)	100.00	0.13	3.75	5.53	21.62	100.00	100.00	100.00	100.00	(Grade 57%(Pb+Zn) Recoveries 153%(")
(Rough froth)	27.80	0.39	12.57	18.92	18.78	83.59	93.07	95.04	24.16	
(Mixed rough conc.)	17.00	0.54	17.72	29.23	12.75	69.69	80.27	89.80	10.02	
First middling	10.80	0.17	4.45	2.69	28.29	13.90	12.80	5.24	14.14	
Mixed conc.	12.60	0.58	20.45	36.92	8.02	55.36	68.65	84.05	4.67	
Second middling	4.40	0.43	9.91	7.23	26.29	14.33	11.62	5.75	5.35	
Tailing	72.20	0.03	0.36	0.38	22.71	16.41	6.93	4.96	75.84	
Mixed conc. (estimated)	14.3	0.6	20.4	35.6	8.4	63.0	72.8	92.3	5.6	(Grade 56%(Pb+Zn) Recoveries 171%(")

(Test condition)



The relation between the conc. grades and the recoveries or Fe grades as a result of bulk flotation test is shown on Figure 1. Compared with the results of Noranda Co., the grade of concentrate is by no means inferior, the effect of Fe elimination being sufficient, though the insufficiency of recoveries is observed.

Figure 1. RELATION BETWEEN GRADE AND RECOVERIES

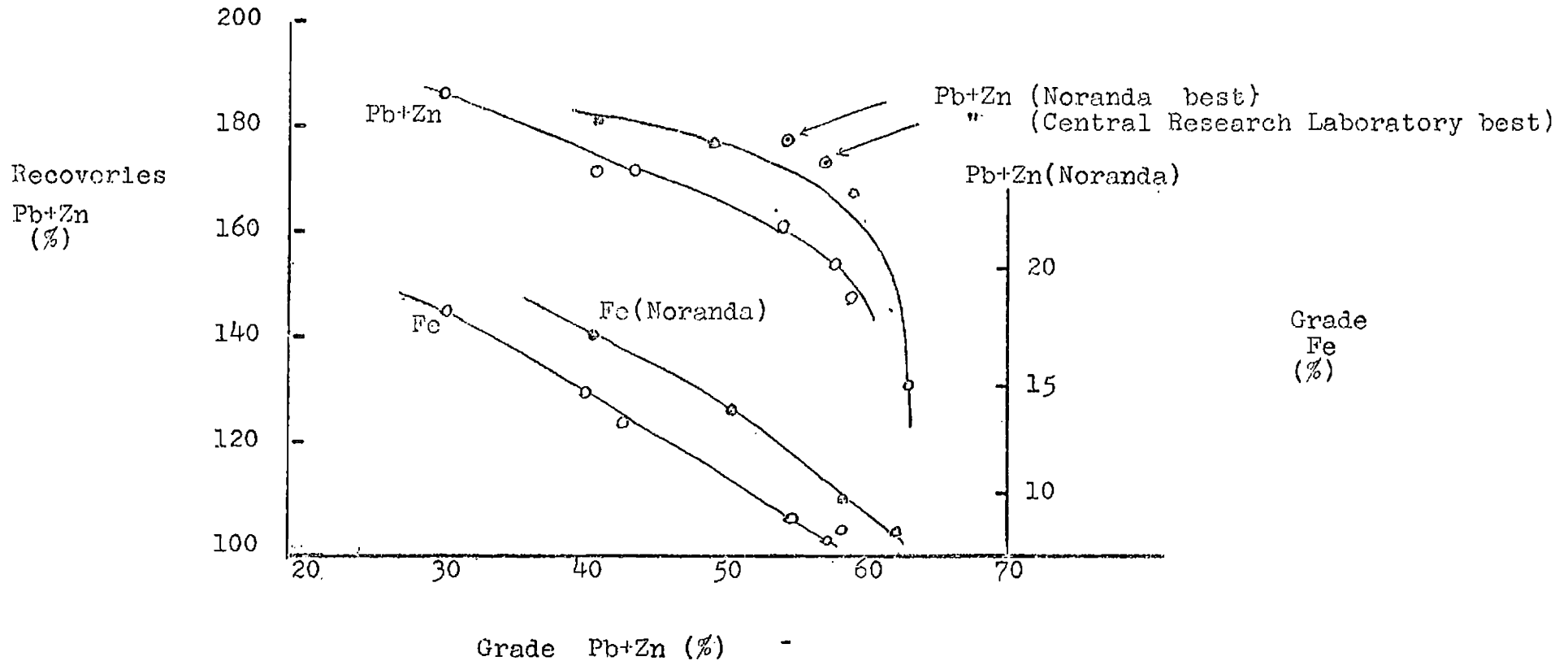
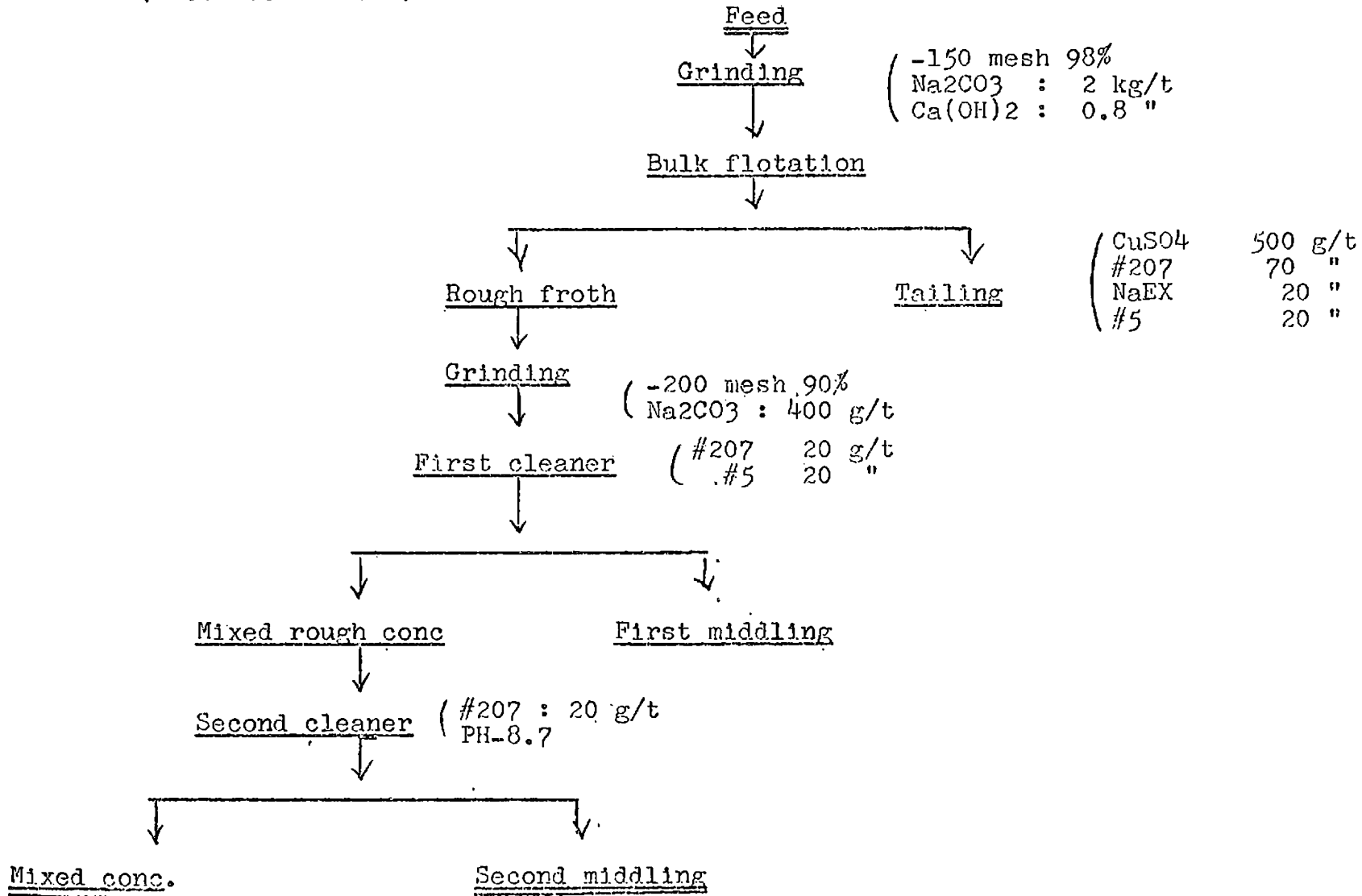


Table 6 RESULT OF BULK FLOTATION BY TWO STAGES GRINDING

(Test result)

Kind of ore	Q'ty of (%)	Grade (%)				Recoveries (%)				Remarks
		Cu	Pb	Zn	Fe	Cu	Pb	Zn	Fe	
(Feed)	100.00	0.12	3.89	5.33	20.89	100.00	100.00	100.00	100.00	(Grade 58%(Pb + Zn) Recoveries 145%(")
(Rough froth)	31.67	0.30	11.49	16.10	20.40	82.08	92.79	95.64	30.93	
(Mixed rough conc.)	17.93	0.44	17.46	26.72	13.74	68.86	80.59	89.87	11.80	
First middling	13.74	0.11	3.45	2.24	29.08	13.22	12.20	5.77	19.13	
Mixed conc.	11.75	0.46	20.91	37.01	7.57	47.25	63.24	81.57	4.26	
Second middling	6.18	0.40	10.91	7.16	25.50	21.61	17.35	8.30	7.54	
Tail	68.33	0.03	0.41	0.34	21.12	17.92	7.21	4.36	69.07	
Mixed conc. (estimated)	13.8	0.5	20.5	36.0	8.0	60.3	72.8	93.2	5.3	Grade 57%(Pb+Zn) Recoveries 166%(")

(Test condition)



§5. REMARKS

It is the remarkable difference of the new feed ore from the last one that the former contains much baryte, however baryte is supposed to have a little or no influence to the flotation of Pb and Zn, as it can easily be concentrated to flotation tailing. The floatability of sphalerite is satisfactory, but the separation of galena is difficult because of the existence of pyrite. The improvement of Pb recovery is inclined to decrease the effect of Fe elimination. Therefore at the beginning of flotation, using the least possible quantity of pyrite depressive reagent (especially slaked lime), permitting some pyrite to float trying to recover well Pb and Zn ore, and strengthening the collective of Pb and Zn grain especially galena, the concentrate flotation is performed with enough attention to pulp density and PH value, so that Pb recovery may be little influenced and the improvement of concentrate grade may also be expected. Furthermore the feed size being considered as an important factor, the separating effect of Sp-Pb-Zn is improved and stabilized by fine grinding of approx. -150 mesh. The efficiency of two stages grinding could hardly be observed by the test result, though it leaves room for examination.

Each representative result is shown on Table 7. for the convenience of comparison of treatment processes. Bulk flotation process is most satisfactory, simplifying the process of treatment.

Table 7. COMPARISON OF FLOTATION PROCESS

	Process	Qty of conc. (%)	Grade (%)				Recoveries (%)				Flotation agent (g/t)
			Pb	Zn	Pb+Zn	Fe	Pb	Zn	Pb+Zn	Fe	
Test result	Differential	12.2	23.6	31.2	54.8	9.2	74.5	68.1	142.6	5.3	8,370
	Semi-bulk	17.4	19.2	25.5	44.7	12.4	80.5	80.8	161.3	10.4	5,150
	Bulk	12.6	20.5	36.9	57.4	8.0	68.7	84.1	152.8	4.7	3,840
Estimated result	Differential	14.0	23.1	30.6	53.7	9.4	83.7	76.5	160.2	6.2	
	Semi-bulk	18.1	19.1	25.2	44.3	12.5	83.4	83.0	166.4	10.8	
	Bulk	14.3	20.4	35.6	56.0	8.4	78.2	92.3	170.5	5.6	

The comparison among the result of bulk flotation, the result of the last feed ore and the result obtained by Noranda Co., is shown on Table 8. The concentrate grades are more improved than Noranda's result, but the recoveries are somewhat lower. It is especially remarkable that the recoveries are in opposite relation with regard to Pb and Zn.

Table 8. COMPARISON WITH RESULT OF LAST FEED ORE

Feed ore	Q'ty of conc. (%)	Grade (%)					Recoveries (%)					Remarks
		Cu	Pb	Zn	Pb+Zn	Fe	Cu	Pb	Zn	Pb+Zn	Fe	
New feed (arrived in Dec., 1964)	14.3	0.6	20.4	35.6	56.0	8.4	63.0	78.2	92.3	170.5	5.6	Bulk process 3,840 g/t
Last feed (arrived in Feb., 1964)	12.3	0.9	20.4	28.8	49.2	12.5	65.7	82.8	79.7	162.5	7.1	Semi-bulk process 9,360 g/t
Noranda result (Received in Feb., 1965)		1.8	21.5	32.4	53.9	10.2		90.2	78.0 87	177.2		Bulk process two stages grindings Feed grade unknown.