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SIMPLIFIED HYDRAULIC MINERAL SIZING UNIT

by

Robert Moore Lewis

Senior Mineral Engineer

ABSTRACT

A unit for separating minerals into two prescribed size fractions, designated as a Lewis Hydrosizer, was developed at the North Carolina State University Minerals Research Laboratory. Several ore samples with different mineral compositions were separated effectively with the laboratory continuous unit. Three units scaled up to commercial size are now being used in a plant. Additional units are being built or are in the planning stage at several companies.

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RML Project No. 81 - June 1980

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Lab Nos. 4473, 4712, 4478, 4475 Book 403

INTRODUCTION

A common problem encountered by mining and mineral processing industries involves sizing material at specific mesh sizes. The coarse fractions (plus 14 mesh) can be handled fairly satisfactorily by wet screening. However, most mineral processing plants require sizing finer than 14 mesh ahead of processing. Screening presents many problems such as inefficient separation due to blinding (screen hole plug-up), considerable maintenance due to wear, high cost of replacement, and initial investment. Several types of hydraulic classifiers are produced which overcome some of the disadvantages of screens. These sizers are in many instances very large and sophisticated, require considerable capital investment, and present control problems.

A laboratory-scale mineral pulp sizer was developed which alleviates many of the aforementioned objections. The unit operates on the basis of a controlled velocity rising current of mineral pulp to produce a size separation. The sizer is very simple in construction and can be made from any structurally sound material. A straight-line scale up to commercial size can be made as was verified by three units now in plant operation.

DESCRIPTION OF SIZER

The unit (See Figure 1) consists of an elongated box set on end, with the height being approximately 3 to 4 times that of the base width. A baffle plate is secured inside the box at the bottom and sides and at an angle so as to leave a small opening at the top. The baffle rises to a height of approximately one third the height of the box. A pipe to remove the coarse-size material is located at the bottom of the box behind the baffle. An overflow launder is located near the top of the box to remove fine-size material. A bypass valve is located in the feed-pump discharge line to assist in fine tuning the mesh size split; however, in most cases this is not necessary after the flow rate has been established. A fresh water pipe line is inserted behind the baffle plate to reduce the amount of slurry fines which go with the coarse product.

PROCEDURE

A pulp consisting of water and assorted sizes of mineral grains is pumped into the bottom side of the sizer. The material discharges against a deflection plate which changes the direction of flow to an upward thrust. The rising current carries the fine-size material to the top of the sizer where it overflows by way of a launder. The coarse material cannot rise at the set velocity, and keeps settling out until forced by mass action over the top edge of the deflection plate into a hopper. The flow is in a downward direction behind the deflection plate, and the coarse material is removed at the bottom side of the hopper through a pipe. Fresh water is added to the hopper to reduce the amount of fines going with the coarse product. A bypass pipe with a valve, located in the pump discharge line, is adjusted for close regulation of flow velocity by circulating part of the pulp back to the feed. This is not necessary once the desired flow has been established.

SAMPLES

Samples of feed to sand plants, olivine plant tailings, and others were tested in the laboratory separator. Most separations were made at 35, 48, 65, and 150 Tyler mesh. Products from a plant installation were also evaluated.

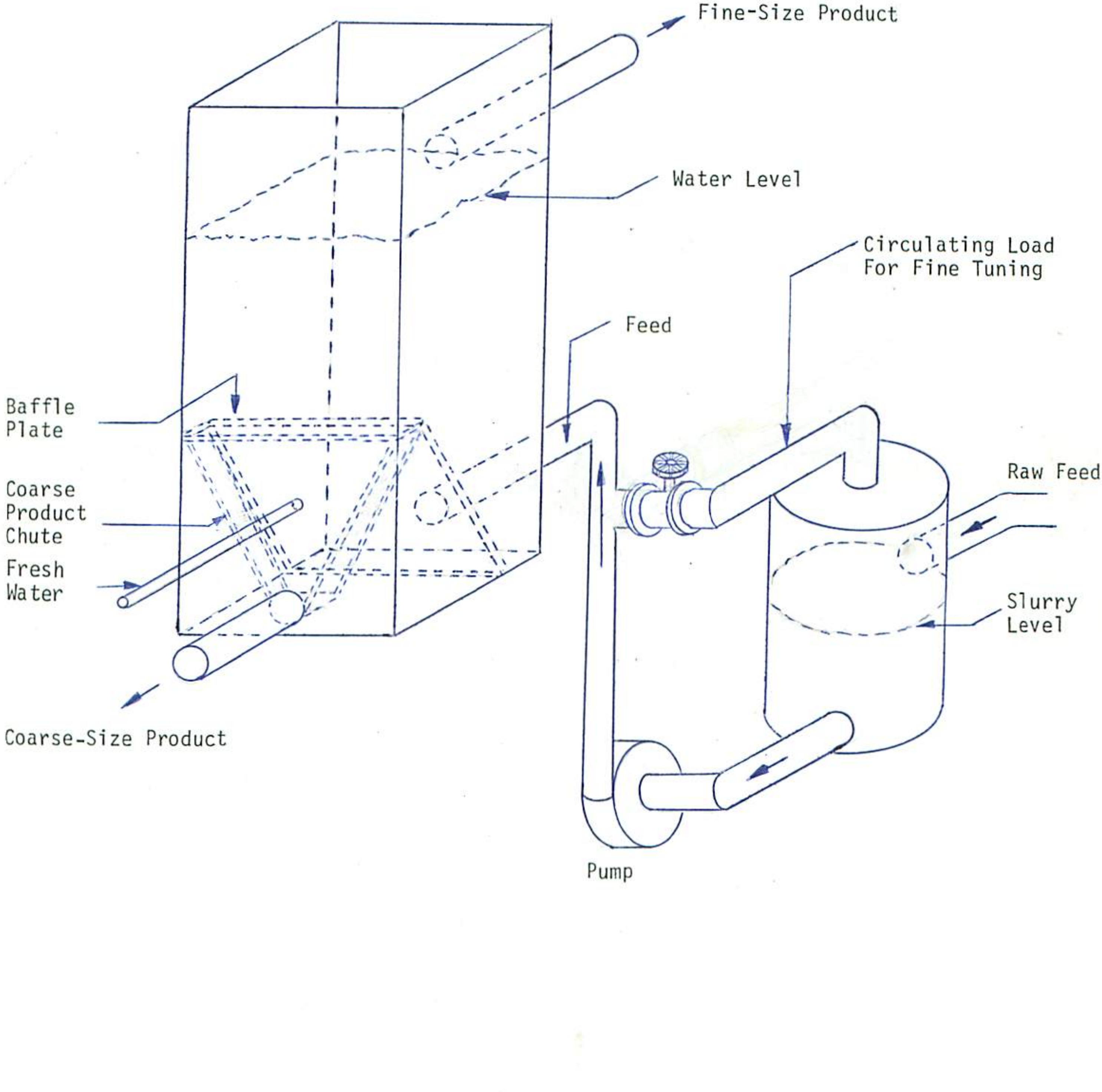


Figure 1 - Isometric view of simplified hydraulic mineral sizing unit.

RESULTS

With the bench-scale unit processing a sand plant feed, 87.6% of the +35 mesh material was recovered in the coarse fraction, and 93.0% of the -35 mesh material was recovered in the fine fraction. A graph (See Figure 2) shows a 90% total efficiency (where curves cross) at 35 Tyler mesh.

Data obtained from classifier evaluation formulas are as follows:

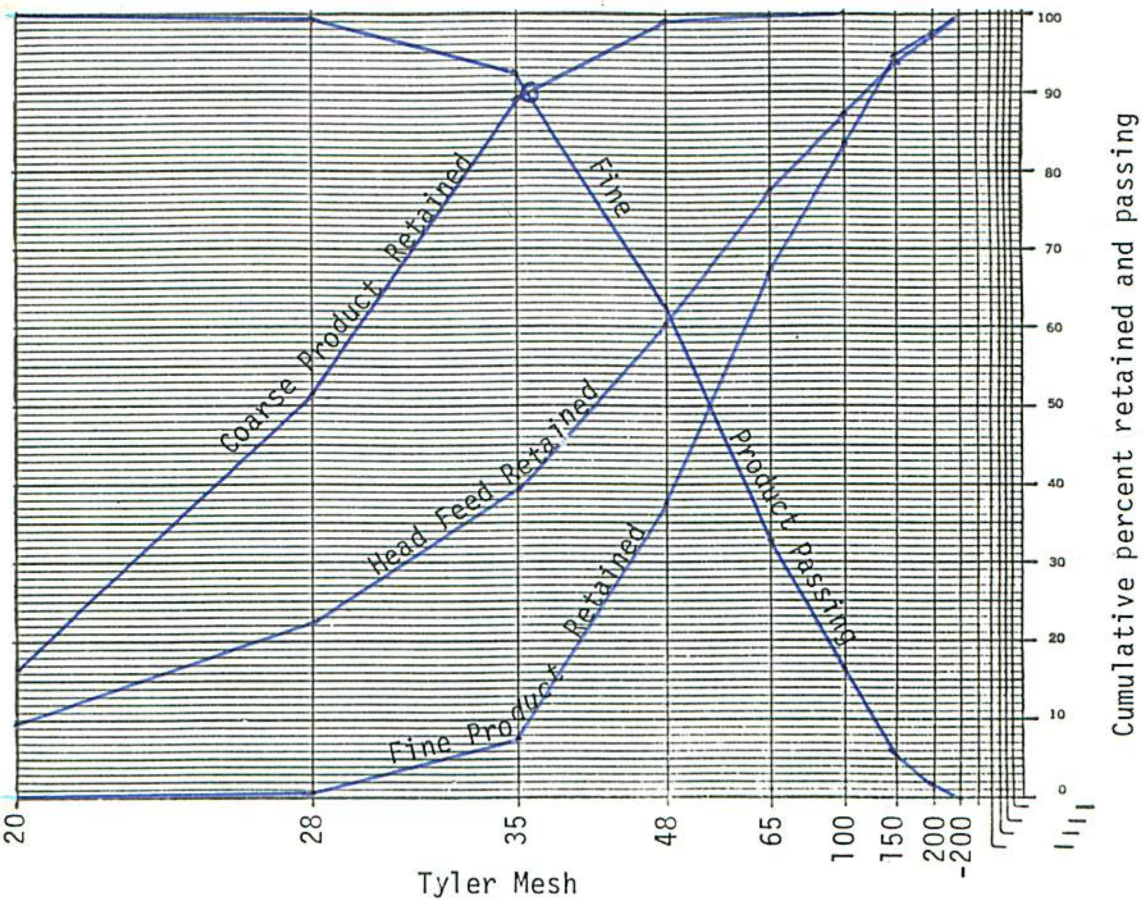
Recovery,	undersize	=	59.8%
Recovery,	oversize	=	40.2%
Efficiency,	undersize	=	90.2%
Efficiency,	oversize	=	92.9%
Efficiency,	overall	=	91.8%

Tons handled per ton of undersize = 1.67

Sharpness index = 1.41

The partition coefficient curve is shown in Figure 3.

A commercial-size unit was built, based on a direct scale up, and the results of its operation were very satisfactory. The screening section has been replaced with two additional units.



	Head Feed		Coarse Product		Fine Product		Fine Product Cum. % Passing	
Mesh Tyler	Per Cent	Per Cent Cumulative Weights	Per Cent	Per Cent Cumulative Weights	Per Cent	Per Cent Cumulative Weights	Per Cent	Per Cent Cumulative Weights
20	9.5	9.5	16.2	16.2	0.0	0.0		100.0
28	13.0	22.5	35.3	51.5	0.4	0.4		99.6
35	17.3	39.8	37.8	89.3	7.1	7.5		92.5
48	20.5	60.3	9.8	99.1	29.8	37.3		62.7
65	17.5	77.8	0.8	99.9	30.1	67.4		32.6
100	9.5	87.3	0.1	100.0	16.3	83.7		16.3
150	6.7	94.0	0.0	-	11.2	94.9		5.1
200	3.2	97.2	0.0	-	3.5	98.4		1.6
-200	2.8	100.0	0.0	-	1.6	100.0		0.0
Total	100.0		100.0		100.0			

Figure 2 - Hydrosizer separation of sand company plant feed.
Lab No. 4478 Test No. 8-A

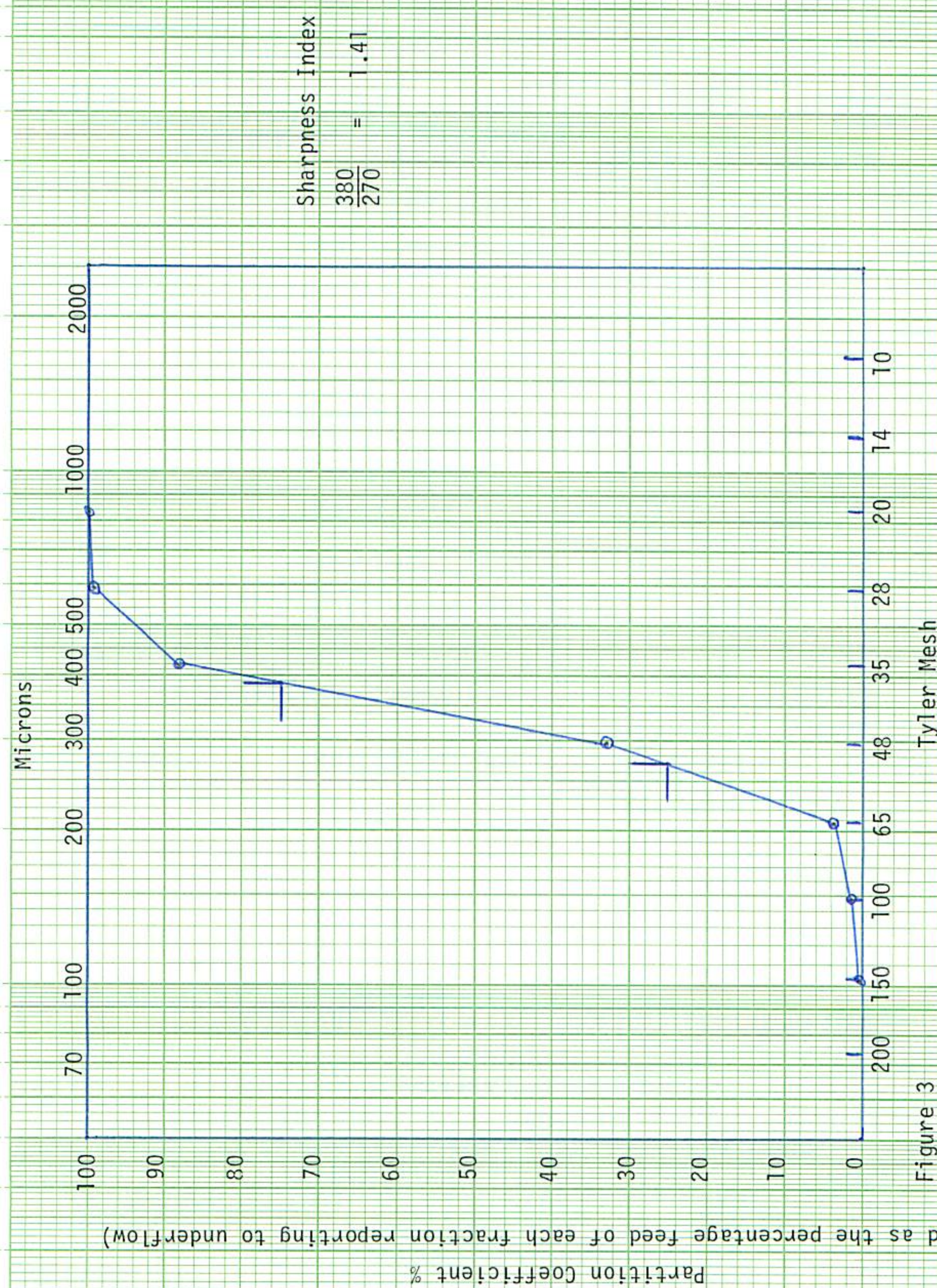


Figure 3

Partition curve for Lewis Hydrosizer at a cut size of 35 Tyler mesh.

Partition coefficient vs geometric mean sizes of particles in size fractions.

Lab No. 4478 Test No. 8-A

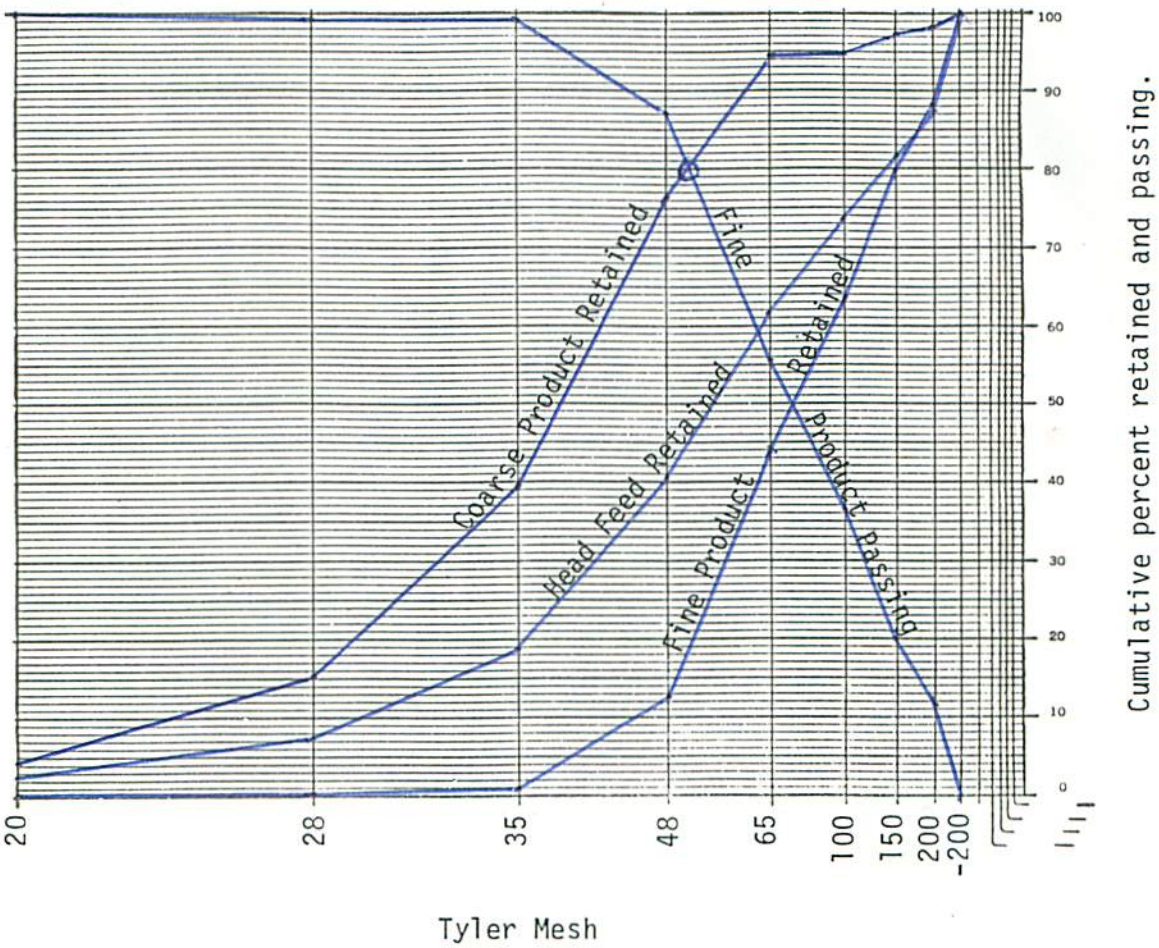
With the bench-scale unit processing a plant rod-mill discharge minerals sands, 88.2% of the +48 mesh material was recovered in the coarse fraction and 74.7% of the -48 mesh material was recovered in the fine fraction. A graph (See Figure 4) shows an 80.5% overall efficiency at slightly finer than 48 Tyler mesh. To present the data in another way, a feed sample was screened on 48 Tyler mesh. Screen analyses were run on the coarse and fine screen fractions, and the data were plotted on a graph and compared with data derived from the sizer products (See Figure 5). Data obtained from classifier evaluation formulas are as follows:

Recovery,	undersize	=	56.3%
Recovery,	oversize	=	43.7%
Efficiency,	undersize	=	82.6%
Efficiency,	oversize	=	82.1%
Efficiency,	overall	=	82.5%

Tons handled per ton of undersize = 1.78

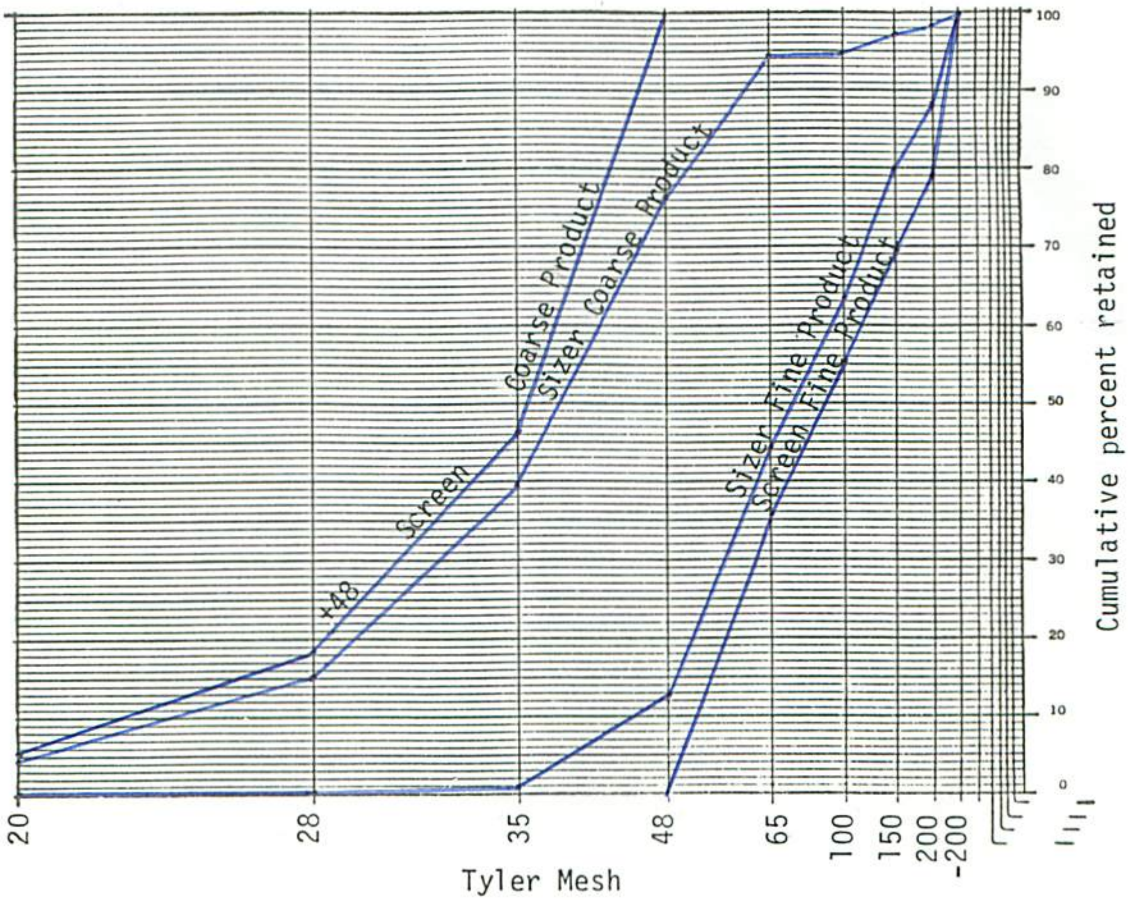
Sharpness index = 1.58

The partition coefficient curve is shown in Figure 6.



	Head Feed		Coarse Product		Fine Product			Fines Cum. % Passing
Mesh	Per Cent	Per Cent Cumulative Weights	Per Cent	Per Cent Cumulative Weights	Per Cent	Per Cent Cumulative Weights	Per Cent	Per Cent Cumulative Weights
20	2.1	2.1	4.3	4.3	0.1	0.1		99.9
28	5.3	7.4	10.8	15.1	0.2	0.3		99.7
35	11.4	18.8	24.5	39.6	0.5	0.8		99.2
48	21.9	40.7	36.9	76.5	12.1	12.9		87.1
65	21.2	61.9	17.7	94.2	31.3	44.2		55.8
100	11.5	73.4	0.4	94.6	19.4	63.6		36.4
150	8.5	81.9	2.5	97.1	16.4	80.0		20.0
200	5.7	87.6	1.2	98.3	8.4	88.4		11.6
-200	12.4	100.0	1.7	100.0	11.6	100.0		0.0
Total	100.0		100.0		100.0			

Figure 4 - Hydrosizer separation of mineral company rod mill discharge. Lab No. 4712 Test No. 7.



	Screened (48 Mesh)				Sizer			
	Coarse Product		Fine Product		Coarse Product		Fine Product	
Mesh Tyler	Per Cent	Per Cent Cumulative Weights	Per Cent	Per Cent Cumulative Weights	Per Cent	Per Cent Cumulative Weights	Per Cent	Per Cent Cumulative Weights
20	5.2	5.2	-	-	4.3	4.3	0.1	0.1
28	13.0	18.2	-	-	10.8	15.1	0.2	0.3
35	28.1	46.3	-	-	24.5	39.6	0.5	0.8
48	53.7	100.0	-	-	36.9	76.5	12.1	12.9
65	-	-	35.8	35.8	17.7	94.2	31.3	44.2
100	-	-	19.4	55.2	0.4	94.6	19.4	63.6
150			14.3	69.5	2.5	97.1	16.4	80.0
200	-	-	9.6	79.1	1.2	98.3	8.4	88.4
-200	-	-	20.9	100.0	1.7	100.0	11.6	100.0
Total	100.0		100.0		100.0		100.0	

Figure 5 - Screen separation vs sizer separation, company plant rod mill discharge. Lab No. 4712 Test No. 7

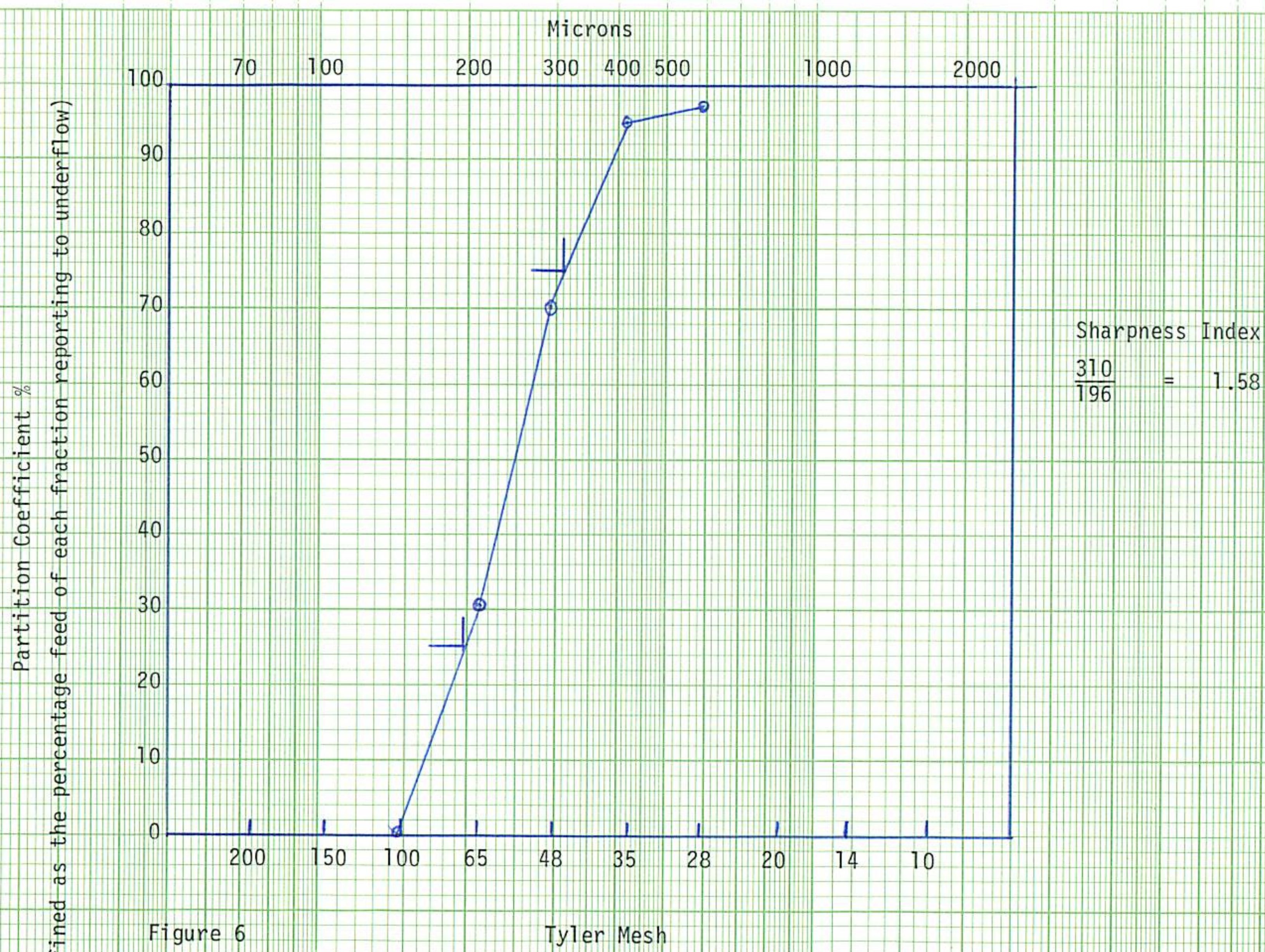


Figure 6

Partition curve for Lewis Hydrosizer at a cut size of 48 Tyler mesh.

Partition coefficients vs geometric mean sizes of particles in size fractions.

Lab No. 4712 Test No. 7

With the bench-scale unit processing olivine, an 80% overall sizing efficiency was obtained at a 48-65 Tyler mesh cut point.

With the bench-scale unit processing a plant product, an 82% sizing efficiency was obtained at a 100 Tyler mesh cut point.

DISCUSSION

The commercial-size hydrosizer unit performs satisfactorily and has replaced the screening section of a sand plant. A minimum amount of maintenance has been required, and after several months of operation, the shop paint had not shown any wear. The pulp surface is calm, with a steady flow of fine-sized sands in the overflow and coarse-sized material in the underflow. A unit 5' X 5' X 12' high can size approximately 40 tph at 35 Tyler mesh.

The bench-scale model performs satisfactorily; however, a small amount of fines goes along with the coarse product. In order to minimize this loss of fines, a small diameter hose is used for the coarse product discharge line to help keep the pulp density reasonably high. Also by injecting fresh water into the coarse material hopper, less fines overflow into the coarse product, and the separating efficiency is increased.