## 6.1. MINERAL PROCESSING--CAPITAL COSTS

## 6.1.4. SOLID-LIQUID SEPARATION

### 6.1.4.1.1. SEDIMENTATION CONCENTRATE THICKENING

The capital cost for concentrate thickening covers all earthwork, construction of tank, purchase and installation of pumps, drive mechanism, and rake. The curve does not apply to high capacity, tray, middling, or deep cone thickeners, or to clarifiers or counter-current decantation arrangements. The cost is based on a three-shift-per-day operation utilizing a settling area of 0.77 $m^2$/mt of dry thickener feed per day (7.5 $ft^2$/st). Costs are based on a slurry feed of 25% solids being thickened to 50% solids.

The thickeners used in this section have tanks of mild steel or concrete. No hydrocyclones are used in conjunction with the thickeners costed in this section.

If more than one concentrate is being produced and thickened, the curves should be entered as often as necessary using the appropriate daily tonnage rates and unit area settling rates.

#### BASE CURVE

The total capital cost is based on a single cost curve having an adjusted feed rate (X), in dry metric tons of thickener feed per day. The curve is valid for operations between 5 and 100,000 mtpd, operating three shifts per day.

The capital cost derived from the curve is a combination of the following costs:

| | |
|---|---|
| Construction labor cost...... | 35% |
| Construction supply cost..... | 18% |
| Purchased equipment cost..... | 46% |
| Transportation cost.......... | 1% |

A typical breakdown of the major cost components is

| | Small (5 to 1,120 mtpd) | Large (1,120 to 100,000 mtpd) |
|---|---|---|
| Pumps, mechanisms, rakes.......... | 8% | 1% |
| 316-L stainless steel tank, earth work and concrete work........... | 92% | 99% |

The total capital cost is $(Y_C) = 5{,}465.673(X)^{0.625}$ and is distributed as follows:

(L) Construction Labor Cost $(Y_L) = 1{,}912.986(X)^{0.625}$

(S) Construction Supply Cost $(Y_S) = 983.821(X)^{0.625}$

(E) Purchased Equipment Cost $(Y_E) = 2{,}568.866(X)^{0.625}$

## ADJUSTMENT FACTORS

<u>Thickener Tank Construction Material Factor</u> A diversity of construction methods and resulting materials of fabrication or concrete are used for thickener tanks. If mild steel or concrete is not used, multiply the supplies portion of the cost obtained from the curve by one of the following factors:

Mild steel with rubber-lining:
Thickener tank construction material factor $(F_R) = 1.026(X)^{0.166}$

316-L stainless steel tanks:
Thickener tank construction material factor $(F_S) = 2.045(X)^{0.131}$

Wood-staved tanks:
Thickener tank construction material factor $(F_W) = 0.933(X)^{0.086}$

where X = dry thickener feed, in metric tons per day.

Wood-staved tanks are not ordinarily constructed in diameters larger than 100 feet; therefore, the adjustment factor for wood-staved tanks is valid only for capacities less than or equal to 800 mtpd. (Conversion from gallons per day to metric tons per day is: gallons per day/896.18 = metric tons per day.)

<u>Mechanism Construction Material Factor</u> To determine the capital cost of the thickener mechanism if the characteristics of the feed slurry require the rakes to be protected, multiply the mechanism cost by the following factor:

Mechanism construction material factor $(F_{C\ RUBBER\text{-}COATED}) = 1.25$
$(F_{C\ STAINLESS\ STEEL}) = 1.50$

<u>Flocculant Factor</u> Flocculants may be added to the thickener to increase the settling rate of particles in the slurry, with the result that thickener diameter, and corresponding effective settling area required per ton of tailings slurry, may also be reduced. This can, in turn, increase capacity of an existing thickener. If flocculant is added to an existing thickener, add the following costs to the total capital cost:

Flocculant factor $(Y_{F\ SMALL}) = 10{,}737.544(X)^{0.382}$
$(Y_{F\ LARGE}) = 1{,}016.462(X)^{0.712}$
where X = dry thickener feed, in metric tons per day.

This added cost is for preparing the equipment and for adding 3 milligrams per liter of polymer as an emulsion to the thickener, required piping, buildings to house the equipment and store the reagents, and preparation, feed, and storage equipment.

<u>High-Rate Thickener Factor</u> If a High-rate design is chosen over a standard bridge-support design for an operation having the same pulp-handling capacity, multiply the cost obtained from the equipment purchase cost portion of the curve by the following factor:

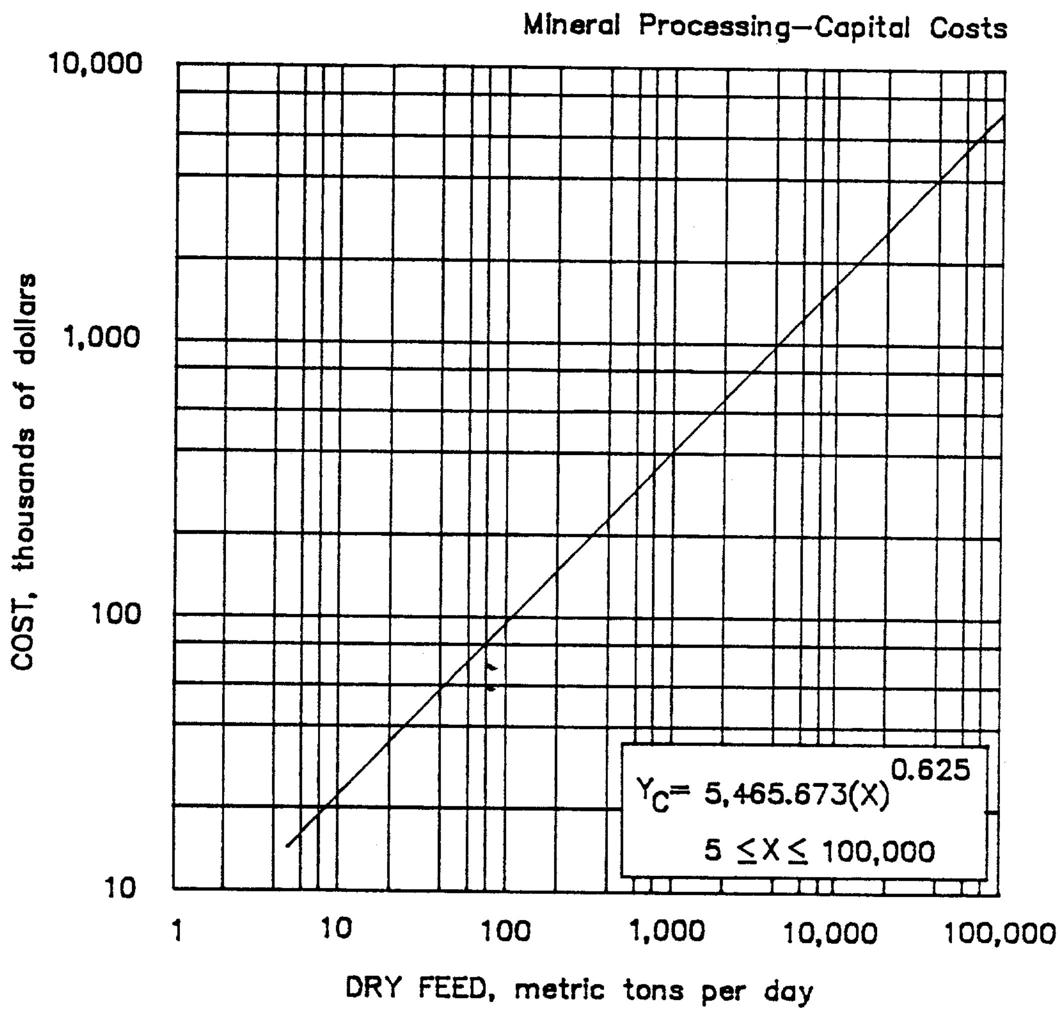
High-rate thickener factor $(F_H) = 0.38$

Additionally, installation cost of the conventional units will be substantially higher than that of the smaller high-capacity units.

Settling Area Adjustment To adjust the capital cost for settling areas differing from the base value of 0.77 $m^2$/mtpd, multiply (X), metric tons of dry thickener feed per day, by the following factor:

Settling area adjustment $(F_A) = (U/0.77)$
where U = unit area or actual solids loading, in square meters per metric ton per day (see table A-1 in the appendix).

This new value must be used in place of (X) in the base equation when calculating new costs.




6.1.4.1.1. Sedimentation
CONCENTRATE THICKENING

## 6.1. MINERAL PROCESSING--CAPITAL COSTS

### 6.1.4. SOLID-LIQUID SEPARATION

#### 6.1.4.1.2. SEDIMENTATION TAILINGS THICKENING

Included in this section are costs of preliminary tailings dewatering via conventional thickening to reduce the slurry volume prior to transportation to the tailings pond. The cost curves are applicable to dewatering directly from the pond and only with extreme discretion to alternative systems necessary for thickening problem slurries, such as red-mud slurries resulting from bauxite processing or slimes slurries from phosphate processing. Also, the curves are not applicable to shaker screens, high-speed vibrators, centrifuges, filters, cyclones, etc. The cost is based on a three-shift-per-day operation utilizing a settling area of 0.77 $m^2$/mt of dry thickener feed per day (7.5 $ft^2$/st). Costs are based on a slurry feed of 25% solids being thickened to 50% solids.

The thickeners used in this section have tanks of mild steel and/or concrete. No hydrocyclones are used in conjunction with the thickeners costed in this section.

BASE CURVE

The total capital cost is based on a single cost curve having an adjusted feed rate (X), in dry metric tons of thickener feed per day. The curve is valid for operations between 5 and 100,000 mtpd, operating three shifts per day.

The capital cost derived from the curve is a combination of the following costs:

| | |
|---|---|
| Construction labor cost...... | 35% |
| Construction supply cost..... | 18% |
| Purchased equipment cost..... | 46% |
| Transportation cost.......... | 1% |

A typical breakdown of the major cost components is

| | Small (5 to 1,120 mtpd) | Large (1,120 to 100,000 mtpd) |
|---|---|---|
| Pumps............................ | 8% | 1% |
| 316-L stainless steel tank, earth work and concrete work........... | 92% | 99% |

The total capital cost is $(Y_C) = 5,465.673(X)^{0.625}$ and is distributed as follows:

(L) Construction Labor Cost $(Y_L) = 1,912.986(X)^{0.625}$

(S) Construction Supply Cost $(Y_S) = 983.821(X)^{0.625}$

(E) Purchased Equipment Cost $(Y_E) = 2,568.866(X)^{0.625}$

## ADJUSTMENT FACTORS

Shift Factor The capital cost equation is based upon a maximum operational effectiveness only possible with a three-shift-per-day operation. Tailings thickeners are not designed to operate on fewer shifts per day on a regularly scheduled basis; therefore, no shift adjustment is made.

Thickener Tank Construction Material Factor A diversity of construction methods and resulting materials of fabrication or concrete are used for thickener tanks. If mild steel is not used, multiply the supplies portion of the total capital cost by one of the following factors:

Mild steel with rubber-lining:
Thickener tank construction material factor $(F_R) = 1.026(X)^{0.166}$

316-L stainless steel tanks:
Thickener tank construction material factor $(F_S) = 2.045(X)^{0.131}$

Wood-staved tanks:
Thickener tank construction material factor $(F_W) = 0.933(X)^{0.086}$

where X = dry thickener feed, in metric tons per day.

Wood-staved tanks are not ordinarily constructed in diameters larger than 100 ft; therefore, the adjustment factor for wood-staved tanks is valid only for capacities less than or equal to 800 mtpd. (Conversion from gallons per day to metric tons per day is: gallons per day/896.18 = metric tons per day.)

Mechanism Construction Material Factor To determine the capital cost of the thickener mechanism if the characteristics of the feed slurry require the rakes to be protected, increase the mechanism cost by 25% for rubber-coated steel rakes and by 50% for stainless steel.

Flocculant Factor Flocculants may be added to the thickener to increase the settling rate of particles in the slurry, with the result that thickener diameter, and corresponding effective settling area required per ton of tailings slurry, may also be reduced. This can, in turn, increase capacity of an existing thickener. If flocculant is added to an existing thickener, add the following costs to the total capital cost:

Flocculant factor $(Y_{F\ SMALL}) = 10,737.544(X)^{0.382}$
$(Y_{F\ LARGE}) = 1,016.462(X)^{0.712}$
where X = dry thickener feed, in metric tons per day.

This added cost is for preparing the equipment and for adding 3 mg/L of polymer as an emulsion to the thickener, required piping, buildings to house the equipment and store the reagents, and preparation, feed, and storage equipment.

High Rate Thickener Factor If a High rate design is chosen over a standard bridge-support design for an operation having the same pulp-handling capacity, multiply the cost obtained from the equipment purchase cost portion of the curve by the following factor:

High-rate thickener factor $(F_H) = 0.38$

Additionally, installation cost of the conventional units will be substantially higher than that of the smaller high-capacity units.

Settling Area Factor To adjust the capital cost for settling areas differing from the base value of 0.77 $m^2$/mtpd, multiply (X), metric tons of dry thickener feed per day, by the following factor:

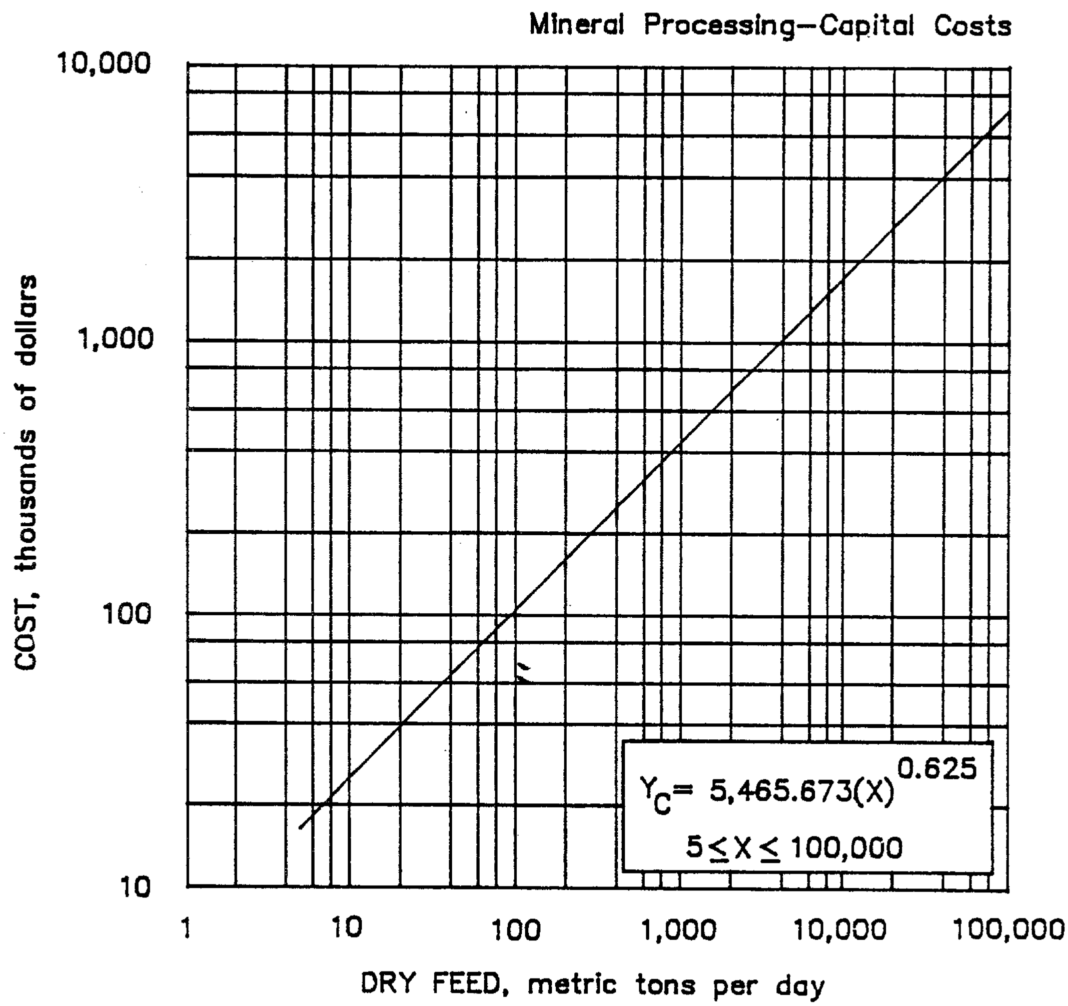
Settling area factor $(F_A) = (U/0.77)$
where U = unit area or actual solids loading, in square meters per metric ton per day

This new value must be used in place of (X) in the base equation when calculating new costs.

See table A-1 for thickener application unit areas.

Amorphous or Colloidal Tailings Factor To adjust the capital cost for amorphous or colloidal tailings that may have an underflow concentration of dry solids of less than 30%, multiply (X), metric tons of dry thickener inflow by the following factor, only if the above settling area factor is not used:

Amorphous or colloidal tailings factor $(F_C) = 2.1$




6.1.4.1.2. Sedimentation
TAILINGS THICKENING

6.1. MINERAL PROCESSING--CAPITAL COSTS

6.1.4. SOLID-LIQUID SEPARATION

6.1.4.1.3. SEDIMENTATION
COUNTERCURRENT DECANTATION

The capital cost for the countercurrent decantation circuit is based on the utilization of high-capacity thickeners for the acquisition and installation of equipment. The countercurrent decantation circuit includes thickener mechanisms and pumps for four-stage circuit at a settling area of 0.06 $m^2$/mt of feed per day.

BASE CURVE

The total cost is based on a single cost curve having a daily adjusted feed rate (X) in metric tons concentrate per day. The curve is valid for operations between 175 and 5,500 mtpd, operating three shifts per day. The curve includes all costs associated with the acquisition and installation of the necessary pumps and thickeners.

The capital cost derived from the curve is a combination of the following costs:

| | |
|---|---|
| Construction labor cost.... | 13.9% |
| Construction supply cost... | 19.0% |
| Purchased equipment cost... | 66.3% |
| Transportation cost........ | 0.8% |

The total capital cost is $(Y_C) = 18{,}344.853(X)^{0.579}$ and is distributed as follows:

(L) Construction Labor Cost $(Y_L) = 2{,}568.208(X)^{0.579}$

(S) Construction Supply Cost $(Y_S) = 3{,}485.426(X)^{0.579}$

(E) Purchased Equipment Cost $(Y_E) = 12{,}290.711(X)^{0.579}$

ADJUSTMENT FACTORS

Shift Factor The curve is based on a three shift per day operation. Typically, countercurrent decantation circuits are operated on a continuous basis to maintain steady flow rates between the individual thickener units. No adjustment factor for a one or two shift operation is recommended for this unit process.

Number of Thickener Units Factor The base curve consists of four-unit counter current decantation circuit. To adjust the base curve for other than four thickener units, multiply the cost obtained from the curve by the following factor:

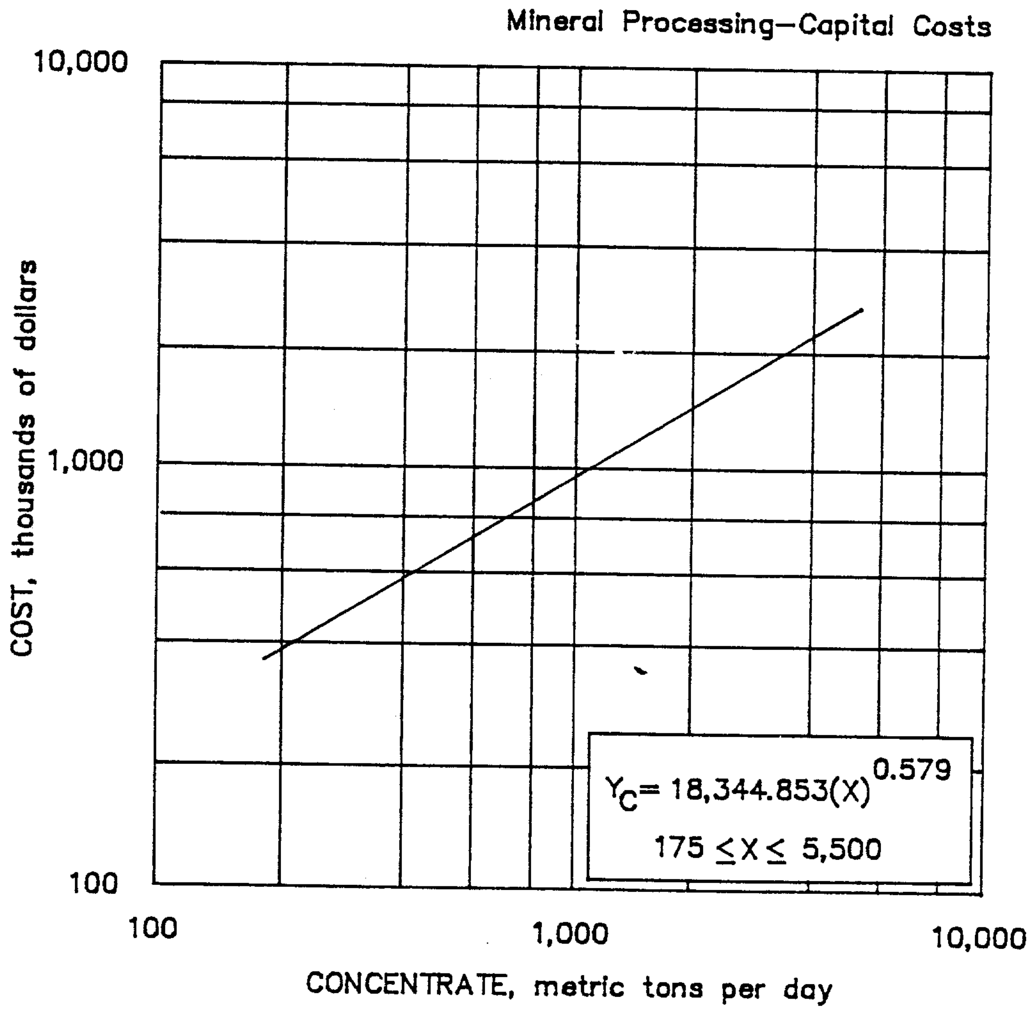
Number of thickener units factor $(F_U) = 0.232(U)+0.072$
where U = total number of thickener units.

Settling Area Factor The base curve is based on a settling area of 0.06 $m^2$/mt of feed per day. To adjust the base curve for different settling areas, add the following factor to the total capital cost:

Settling area factor $(F_A)$ = 98,000,000(A)-5,880,000
where A = actual settling, in square meters per metric ton of feed per day.

Conventional Thickener Factor The curve is based on the utilization of high capacity thickeners. To adjust the base curve for conventional thickeners, multiply the cost obtained from the curve by the following factor:

Conventional thickener factor $(F_C)$ = 1.59




6.1.4.1.3. Sedimentation
COUNTER—CURRENT DECANTATION

## 6.1. MINERAL PROCESSING--CAPITAL COSTS

## 6.1.4. SOLID-LIQUID SEPARATION

### 6.1.4.2.1. CONCENTRATE FILTRATION
### VACUUM, DISK, AND DRUM FILTRATION

The capital cost for concentrate filtration only covers the acquisition and installation of continuous-vacuum filtration equipment. In particular, the cost applies to rotary-disk filter equipment; however, for drum-type or horizontal filter equipment, the cost still represents an approximation.

In addition to the disk-filtration machines themselves, the equipment accounted for in this section consists of wet-type vacuum pumps, filtrate pumps, slurry pumps, air blowers, belt conveyors, and all associated piping and filtrate-receiving facilities. If wet-type vacuum pumps are not employed by the user, then the additional cost of any necessary moisture traps, barometric legs, and associated piping should be added to the filtration base curve cost. Furthermore, if auxiliary steam drying is to be utilized, the extra cost of the required steam hoods and associated equipment should also be added to the curve's base cost.

BASE CURVE

The total cost is based on a single cost curve having a output rate (X), in metric tons concentrate per day. The curve is valid for operations between 5 and 60,000 mtpd, operating three shifts per day.

The capital cost derived from the curve is a combination of the following costs:

| | |
|---|---|
| Construction labor cost.... | 12% |
| Construction supply cost... | 18% |
| Purchased equipment cost... | 67% |
| Transportation cost........ | 3% |

The capital cost consists of the following typical range of major equipment costs:

| | Small (5 to 30,000 mtpd) | Large (30,000 to 60,000 mtpd) |
|---|---|---|
| Disk-filtration machines.... | 60% | 56% |
| Vacuum pumps................ | 12% | 33% |
| Filtrate pumps.............. | 2% | 2% |
| Slurry pumps................ | 3% | 3% |
| Air blowers................. | 2% | 2% |
| Belt conveyors.............. | 21% | 4% |

The total capital cost is $(Y_C) = 5,716.967(X)^{0.650}$ and is distributed as follows:

(L) Construction Labor Cost $(Y_L) = 743.206(X)^{0.650}$

(S) Construction Supply Cost $(Y_S) = 1,086.224(X)^{0.650}$

(E) Purchased Equipment Cost $(Y_E) = 3,887.538(X)^{0.650}$

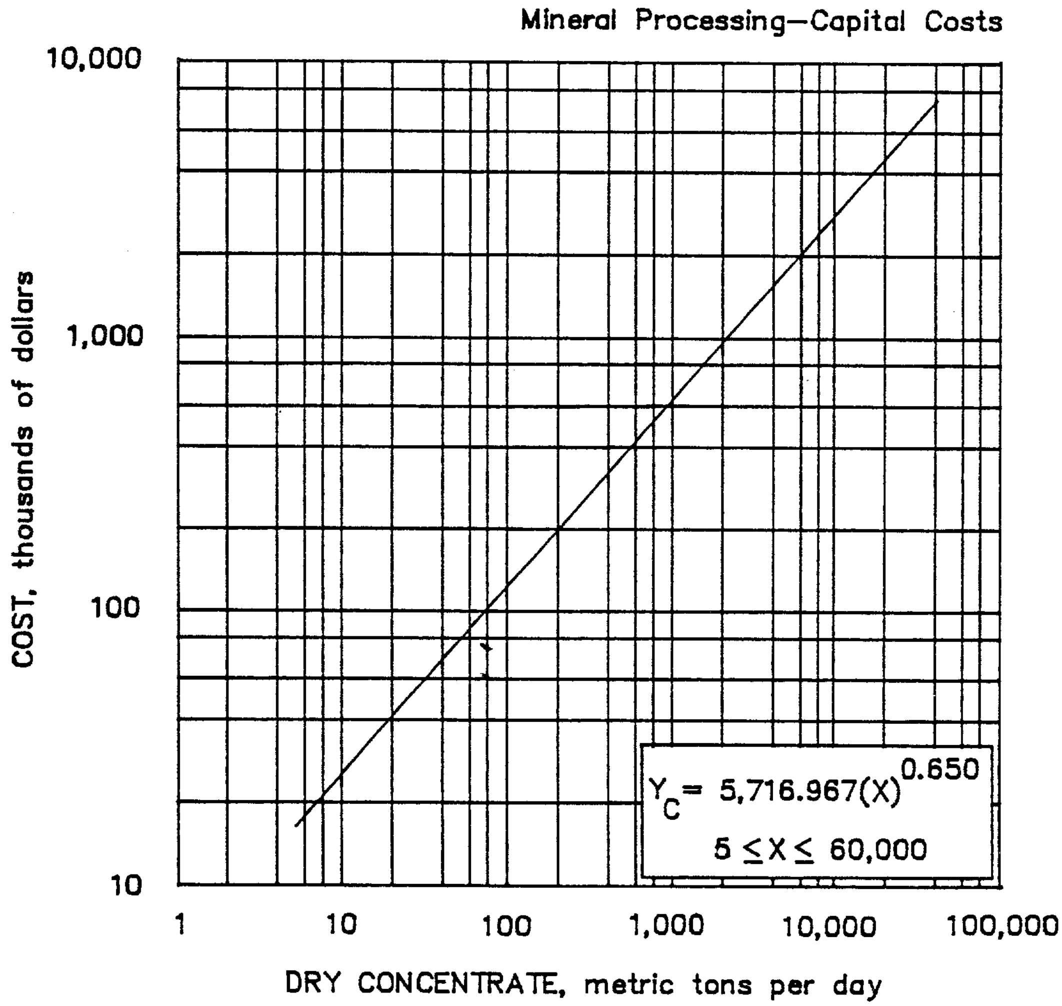
## ADJUSTMENT FACTORS

Filtration Rate Factor The capital cost curve is predicated on a filtration rate of 490 $kg/m^2/h$ (approximately 100 $lb/ft^2/h$). To allow for a different filtration rate, multiply the cost obtained from the curve by the following factor:

Filtration rate factor $(F_R) = (R)^{0.650}/56.057$
where R = actual filtration rate.

Pressure Filter Factor To adjust the capital cost for the substituted use of auto matic pressure filters (e.g., Larox or Lasta-type filter presses), multiply the cost obtained from the curve by the following factor:

Pressure filter factor $(F_P) = 1.71$




6.1.4.2.1. Concentrate filtration
VACUUM, DISK, AND DRUM FILTRATION

## 6.1. MINERAL PROCESSING--CAPITAL COSTS

## 6.1.4. SOLID-LIQUID SEPARATION

### 6.1.4.2.2. CONCENTRATE FILTRATION PRESSURE FILTRATION--SAND

The capital cost for pressure filtration is for the acquisition and installation of the equipment needed to produce a clarified solution. The total cost is based on a single cost curve having an adjusted feed rate (X), in metric tons of solution per day. The curves are valid for operations between 1,900 and 31,900 mtpd, operating three shifts per day. The pressure filtration circuit includes feed pumps, pressure filters, backwash pumps (when needed) and precoat packages.

#### BASE CURVE

The base curve for sand filtration is predicated on processing an unclarified solution containing up to 200 ppm of suspended solids. The specific flow rate for the sand filters was 12 gpm/ft$^2$ of filter area. The filters are constructed of mild steel and are suitable for noncorrosive service.

The cost curves include all the costs associated with the acquisition and installation of the necessary feed pumps, sand filters, and backwash pumps. Not included are unclarified solution and clarified solution storage.

The capital cost derived from the curve is a combination of the following costs:

| | |
|---|---|
| Construction labor cost.... | 3.7% |
| Construction supply cost... | 2.8% |
| Purchased equipment cost... | 92.6% |
| Transportation cost........ | 0.9% |

The total capital cost is $(Y_C) = 38.651(X)^{0.980}$ and is distributed as follows:

(L) Construction Labor Cost $(Y_L) = 1.546(X)^{0.980}$

(S) Construction Supply Cost $(Y_S) = 1.198(X)^{0.980}$

(E) Purchased Equipment Cost $(Y_E) = 35.907(X)^{0.980}$

In examining the above cost distribution, it is important to note that the sand filters represent 70% to 80% of the total cost and that the filters are supplied as a skid mounted unit, which requires minimal labor to install.

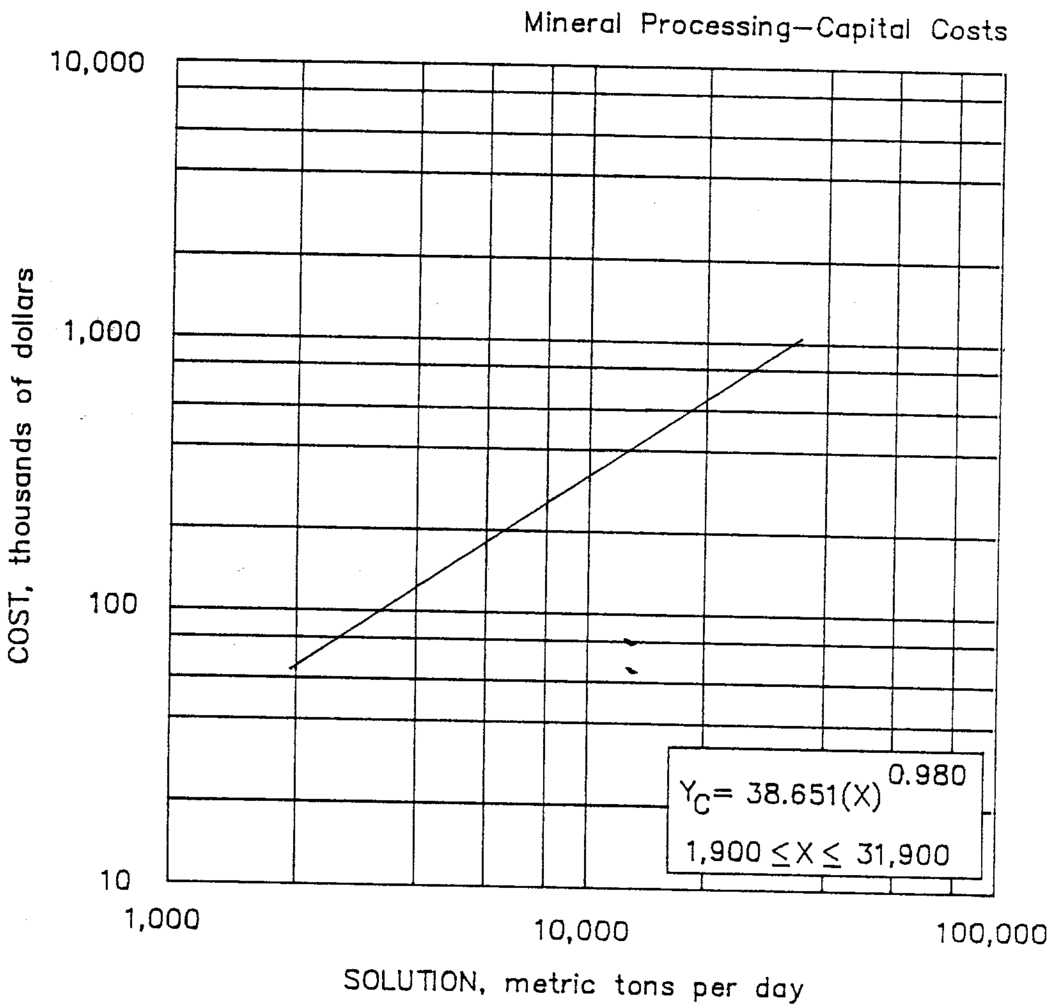
#### ADJUSTMENT FACTORS

Sand Filter Factor There are two adjustment factors for the sand filter: (1) specific flowrate and (2) construction material for corrosive resistance. The capital cost for the base curve is based on a flowrate of 12 gpm per square foot of filter area. To adjust the base curve for other flowrates, multiply the cost obtained from the curve by the following factor:

Sand filter factor $(F_F) = (12/S)$
where S = new specific flow rate, in gallons per minute per square foot of filter media.

Acid Circuit Factor The use of sand filters in an acid circuit (sulfuric or hydro chloric) will raise the capital cost. To adjust for an acid circuit, multiply the cost obtained from the curve by the following factor:

Acid circuit factor $(F_A) = 1.12$




6.1.4.2.2. Concentrate filtration
PRESSURE FILTRATION—SAND

6.1. MINERAL PROCESSING--CAPITAL COSTS

6.1.4. SOLID-LIQUID SEPARATION

6.1.4.2.3. CONCENTRATE FILTRATION
PRESSURE FILTRATION--PRECOAT

The capital cost for pressure filtration is for the acquisition and installation of the equipment needed to produce a clarified solution. The total cost is based on a single cost curve having an adjusted feed rate (X), in metric tons of solution per day. The curves are valid for operations between 2,100 and 16,100 mtpd, operating three shifts per day. The pressure filtration circuit includes feed pumps, pressure filters, backwash pumps (when needed), and precoat packages.

BASE CURVE

The base curve for precoat filtration is predicated on utilizing vertical leaf pressure precoat filters. The solution to be processed can contain up to 200 ppm of suspended solids. The specific flow rate for the precoat filter was 0.6 $gpm/ft^2$ of filter area. The filters are constructed of mild steel.

The cost curves include all the costs associated with the acquisition and installation of the necessary feed pumps, precoat tanks and agitation, body feed tanks and agitation, sludge disposal tanks, and pump and precoat filters.

The capital cost derived from the curve is a combination of the following costs:

| | |
|---|---|
| Construction labor cost.... | 4.4% |
| Construction supply cost... | 2.3% |
| Purchased equipment cost... | 92.6% |
| Transportation cost........ | 0.7% |

The total capital cost is $(Y_C) = 1{,}171.876(X)^{0.658}$ and is distributed as follows:

(L) Construction Labor Cost $(Y_L) = 51.563(X)^{0.658}$

(S) Construction Supply Cost $(Y_S) = 35.156(X)^{0.658}$

(E) Purchased Equipment Cost $(Y_E) = 1{,}085.157(X)^{0.658}$

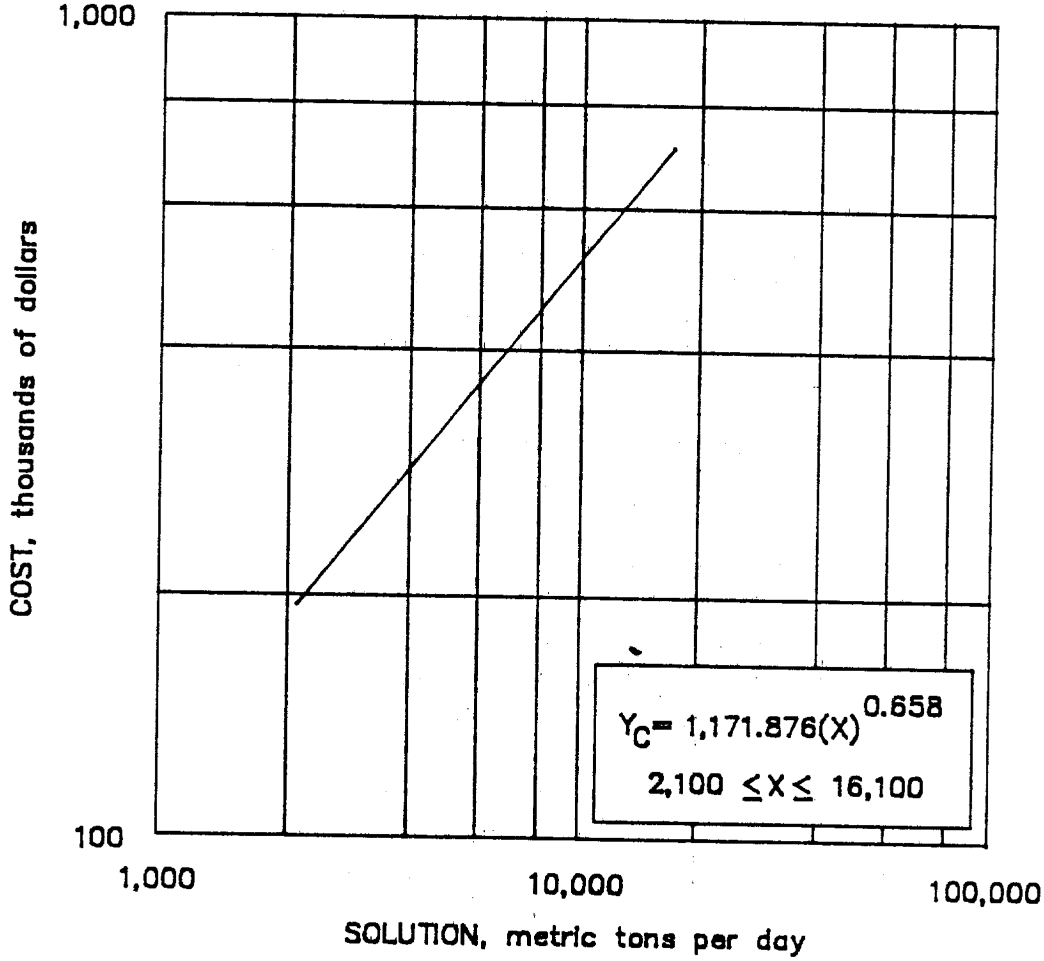
In examining the above cost distribution, it is important to note that the precoat filters represent 75% of the total cost and are supplied as a skid-mounted unit which requires minimal installation cost.

ADJUSTMENT FACTOR

Precoat Filter Factor The capital cost for the base curve is based on a flow rate of 0.6 gpm per square foot of filter media. To adjust for flow rates other than 0.6 gpm, multiply the cost obtained from the curve by the following factor:

Precoat filter factor $(F_P) = (0.6/S)$
where S = new specific flowrate, in gallons per minute per square foot of filter media.

Mineral Processing—Capital Costs




6.1.4.2.3. Concentrate filtration
PRESSURE FILTRATION—PRECOAT

## 6.1. MINERAL PROCESSING--CAPITAL COSTS

## 6.1.4. SOLID-LIQUID SEPARATION

### 6.1.4.2.4. CONCENTRATE FILTRATION CENTRIFUGAL FILTRATION

The capital cost of centrifugal filtration is calculated from estimated daily solid feed, and based on screen-bowl-type centrifuges. Screen bowl centrifuges are normally used for feeds without an excess of minus 325 mesh fines. They are considered high-output units noted for their ability to produce a drier product than an equivalent capacity vacuum filter, and have the added advantage of being able to wash the filter cake. The costs for this curve are based on stainless steel screen bowl units with ceramic facing on high wear areas such as scrolls, inlets, and screens. If liquid clarification, desliming, or slurry dewatering are required, solid bowl centrifuges are usually specified. See the adjustment factor section for such uses.

The total cost is based on a single cost curve having a production rate (X), in metric tons of solids handled per day. The curve is valid for operations between 5 and 30,000 mtpd, operating three shifts per day.

BASE CURVE

Total capital cost accounts for purchase and installation of necessary centrifuges and motors to handle the expected feed. Charges for shipping, handling, setting, aligning, foundation preparation, frame construction, instrumentation, wiring, piping, site clean up, and sales tax are all included.

The capital cost derived from the curve is a combination of the following costs:

| | |
|---|---|
| Construction labor cost...... | 15% |
| Construction supply cost...... | 22% |
| Purchased equipment cost...... | 63% |

The total capital cost is $(Y_C) = 2,339.982(X)^{0.835}$ and is distributed as follows:

(L) Construction Labor Cost $(Y_L) = 350.997(X)^{0.835}$

(S) Construction Supply Cost $(Y_S) = 514.796(X)^{0.835}$

(E) Purchased Equipment Cost $(Y_E) = 1,474.189(X)^{0.835}$

ADJUSTMENT FACTORS

Solid Bowl Centrifuge Factor In situations where water clarification is required, or excessive fines must be dewatered, a solid bowl centrifuge is often called for. If solid bowl centrifuges are used, multiply the equipment portion of the capital cost by the following factor to account for the difference in equipment prices:

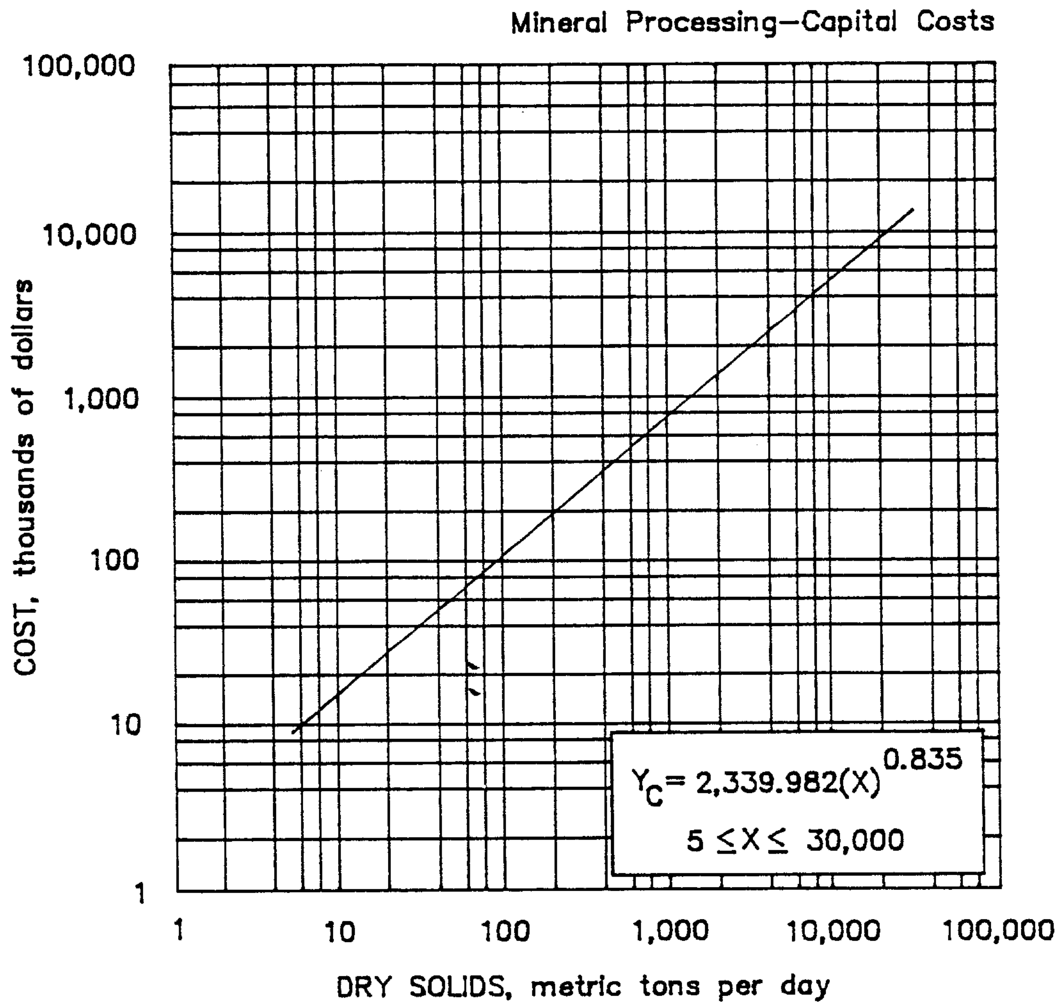
Purchased equipment factor $(F_E) = 0.873$

Installation and construction labor and supply costs will generally remain constant.

<u>Abrasive or Corrosive Feeds Factor</u> If abrasive or corrosive feeds are anticipated, centrifuges are often constructed from materials other than stainless steel. These materials and their costs vary greatly. However, based on a machine constructed of nickel alloy (Monel), multiply the purchased equipment portion of the capital cost by the following factor to account for increased material cost:

Purchased equipment factor $(F_E) = 0.549(X)^{0.133}$
where X = solids handled, in metric tons per day.

Installation and construction labor and supply costs will generally remain constant.




6.1.4.2.4. Concentrate filtration
CENTRIFUGAL FILTRATION

## 6.1. MINERAL PROCESSING--CAPITAL COSTS

### 6.1.4. SOLID-LIQUID SEPARATION

#### 6.1.4.3. CONCENTRATE DRYING

Drying capital costs are for the acquisition and installation of equipment for drying concentrate on a 24-h/d basis. Major items of equipment are rotary-drum dryers, cyclone dust collectors, wet scrubbers, vapor fans, and conveyors.

BASE CURVE

The total cost is based on a single cost curve having a feed rate (X), in metric tons of dry concentrate per day. The curve is valid for operations between 4 and 8,000 mtpd, operating three shifts per day.

The capital cost derived from the curve is a combination of the following costs:

| | Small (4 to 400 mtpd) | Large (400 to 8,000 mtpd) |
|---|---|---|
| Construction labor cost...... | 19% | 15% |
| Construction supply cost..... | 10% | 8% |
| Purchased equipment cost..... | 71% | 77% |

The capital cost consists of the following typical range of equipment costs:

| | Small (4 to 400 mtpd) | Large (400 to 8,000 mtpd) |
|---|---|---|
| Dryers (and related equipment).. | 88% | 95% |
| Conveyors...................... | 12% | 5% |

The total capital cost is $(Y_{C\ SMALL}) = 64,759.148(X)^{0.333}$ and is distributed as follows:

(L) <u>Construction Labor Cost</u> $(Y_{L\ SMALL}) = 11,009.055(X)^{0.333}$

(S) <u>Construction Supply Cost</u> $(Y_{S\ SMALL}) = 5,180.732(X)^{0.333}$

(E) <u>Purchased Equipment Cost</u> $(Y_{E\ SMALL}) = 48,569.361(X)^{0.333}$

The total capital cost is $(Y_{C\ LARGE}) = 47,412.206(X)^{0.370}$ and is distributed as follows:

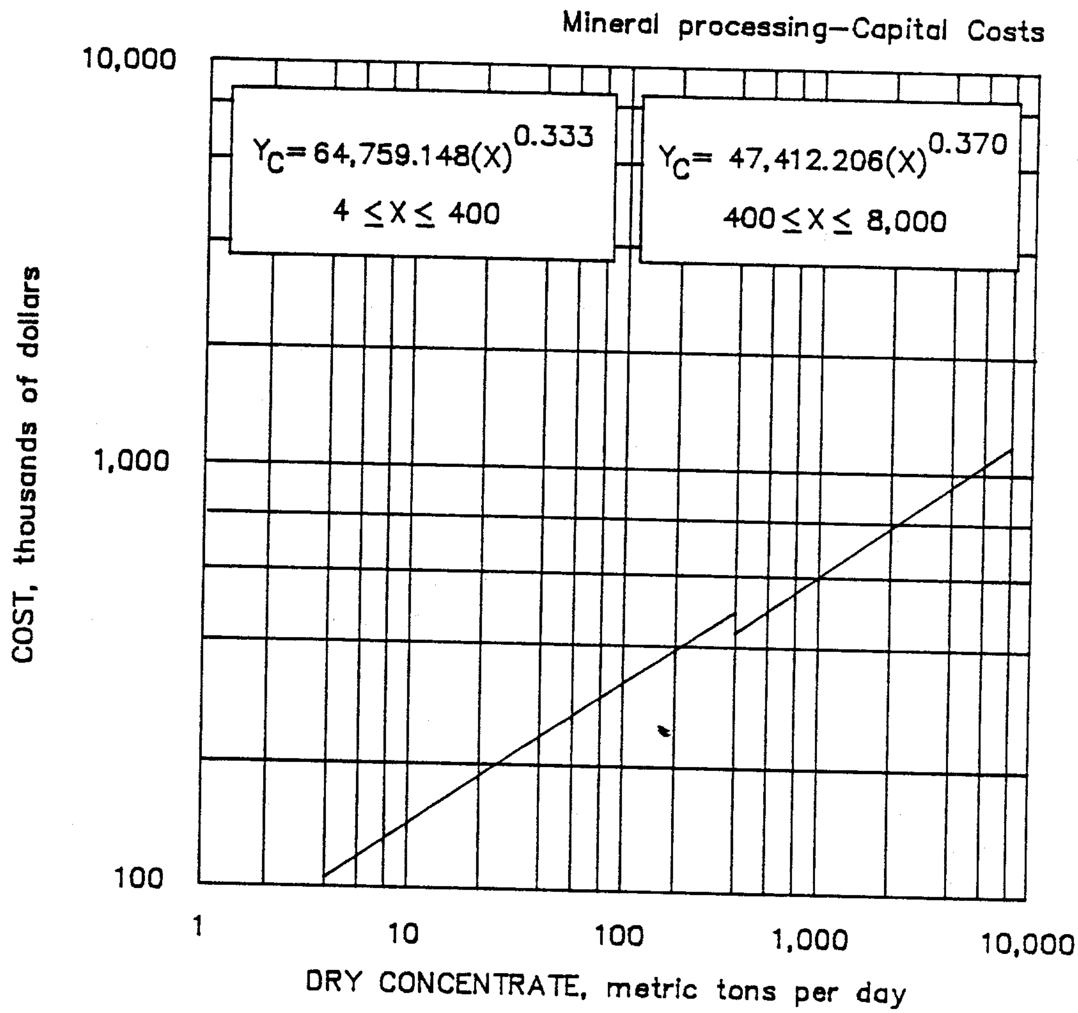
(L) <u>Construction Labor Cost</u> $(Y_{L\ LARGE}) = 8,060.075(X)^{0.370}$

(S) <u>Construction Supply Cost</u> $(Y_{S\ LARGE}) = 3,792.977(X)^{0.370}$

(E) <u>Purchased Equipment Cost</u> $(Y_{E\ LARGE}) = 35,559.154(X)^{0.370}$

ADJUSTMENT FACTOR

Shift Factor The curve is based on a three-shift-per-day operation. Because it would be impractical to operate a dryer less than 24 hpd (because of the large heat losses connected with starting up and shutting down), no shift adjustment factors should be used.




6.1.4.3. Concentrate drying

## 6.1. MINERAL PROCESSING--CAPITAL COSTS

### 6.1.4. SOLID-LIQUID SEPARATION

#### 6.1.4.4. TRANSPORT AND PLACE TAILINGS

The cost curve is for acquisition and installation of the equipment and materials required to transport tailings in a slurry composed of 50% solids to a disposal pond. Major items included in the curve are pumps, cyclones, and steel pipe. The pipe has been sized so that the average total head is 30 m, including a static head of 15 m. The pipeline length for the base curve is 1 km.

BASE CURVE

The total cost is based on a single cost curve having a disposal rate (X), in metric tons tailings per day (dry weight equivalent). The curve is valid for operations between 100 and 100,000 mtpd, operating three shifts per day. The curve includes all costs associated with acquisition and installation of pumps, motors, pipeline, and cyclones.

The capital cost derived from the curve is a combination of the following costs:

| | Small (100 to 10,000 mtpd) | Large (10,000 to 100,000 mtpd) |
|---|---|---|
| Installation labor cost........ | 21% | 18% |
| Installation materials cost.... | 51% | 28% |
| Purchased equipment cost....... | 28% | 54% |

The installation labor cost consists of 91% labor and 9% equipment operation. The equipment operation component of the installation labor cost consists of 50% fuel and lubrication, 48% repair parts, and 2% tires.

The capital cost consists of the following typical range of equipment costs:

| | Small (100 to 10,000 mtpd) | Large (10,000 to 100,000 mtpd) |
|---|---|---|
| Pumps.................. | 70% | 40% |
| Cyclones............... | 30% | 60% |

The total capital cost is $(Y_C) = 599.252(X)^{0.630}$ and is distributed as follows:

(L) Installation Labor Cost $(Y_{L\ SMALL}) = 125.842(X)^{0.630}$
(S) Installation Materials Cost $(Y_{S\ SMALL}) = 305.619(X)^{0.630}$
(E) Purchased Equipment Cost $(Y_{E\ SMALL}) = 167.791(X)^{0.630}$

(L) Installation Labor Cost $(Y_{L\ LARGE}) = 107.865(X)^{0.630}$
(S) Installation Materials Cost $(Y_{S\ LARGE}) = 167.791(X)^{0.630}$
(E) Purchased Equipment Cost $(Y_{E\ LARGE}) = 323.596(X)^{0.630}$

## ADJUSTMENT FACTORS

Gravity Flow Factor If tailings flow by gravity to a ponding area, multiply the cost obtained from the curve by the following factor:

Gravity flow factor $(F_{G\ SMALL}) = 0.3$
$(F_{G\ LARGE}) = 0.5$

Pipeline Length Factor The pipeline is an extra-strength steel pipe 1 km long. For other lengths, multiply the cost obtained from the curve by the following factor:

Pipeline length factor $(F_{L\ SMALL}) = L$
$(F_{L\ LARGE}) = 0.6(L)$
where L = length, in kilometers.

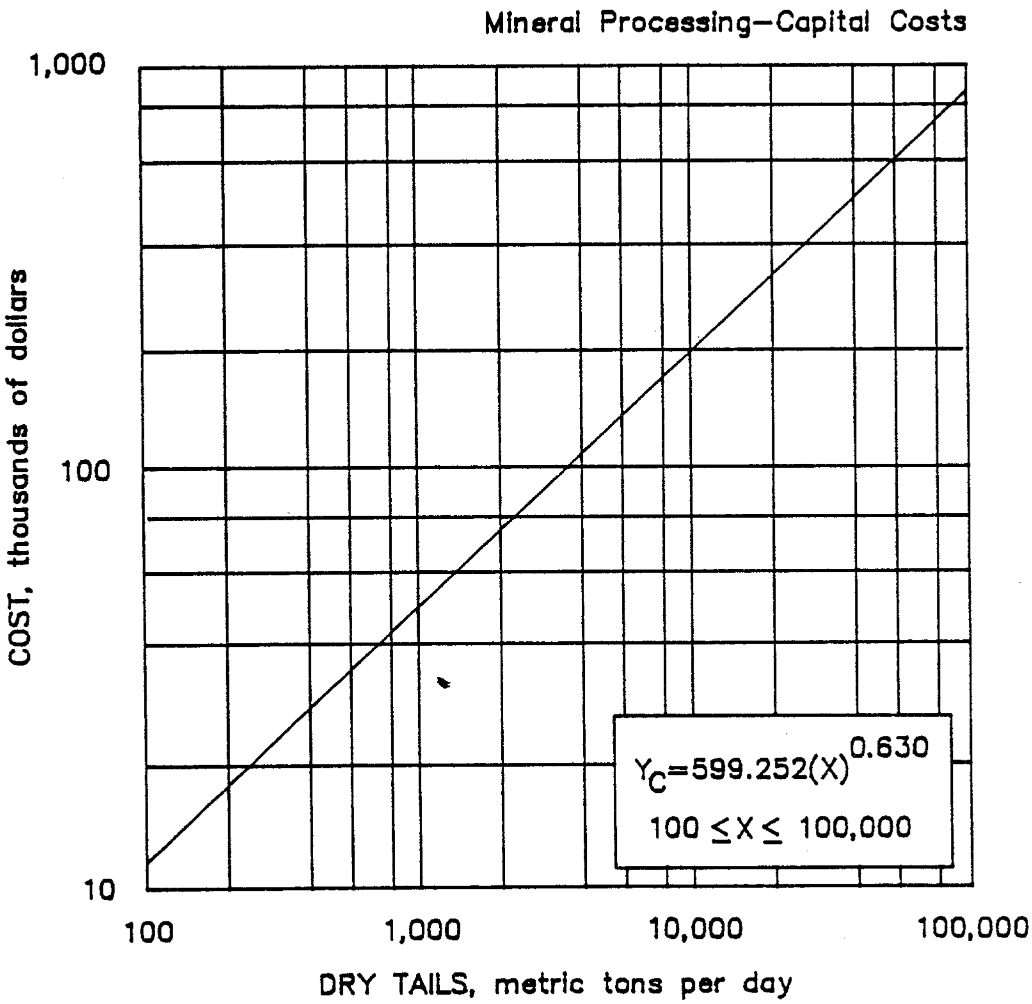
Pipeline Type Factor Where concrete pipe is used instead of steel pipe, multiply the construction supplies cost by the following factor:

Construction supplies factor $(F_S) = 0.6$

Use of cyclones The curve is based on cyclone use that allows distribution of tailings at a rate of 40 mt (dry weight equivalent) per cyclone per hour, 24 h/d, with a 50% utilization of cyclones. The cyclones are placed on the berm of the tailings dam at 9-m intervals. The number of cyclones installed is dependent principally on the length of the dam and spacing between the cyclones. If the number of cyclones are known, the costs should be multiplied by the following factor:

Cyclone factor $(F_C) = 288(N)/(X)$
where N = desired number of cyclones
and X = tailings, in metric tons per day.

If dry tailings are being transported, use a front-end loader and trucks for loading and transporting the tailings (see section 2.2.2.6.).




6.1.4.4. Transport and place tailings

# 6.1. MINERAL PROCESSING--CAPITAL COSTS

## 6.1.4. SOLID-LIQUID SEPARATION

### 6.1.4.5. WATER RECLAMATION

The cost curve covers acquisition and installation of equipment and materials required to return decanted tailings pond water to the mill.

BASE CURVE

The total cost is based on a single curve having a pumping volume (X), in cubic meters per day. The curve is valid between the range of 100 and 325,000 $m^3/d$, operating three shifts per day. The curve is based on an adjustable head of 16.5 m, and for an adjustable pumping distance of 1 km.

The capital cost derived from the curve is a combination of the following costs:

| | |
|---|---|
| Construction labor cost...... | 13% |
| Construction supply cost..... | 64% |
| Purchased equipment cost..... | 22% |
| Transportation cost.......... | 1% |

The capital costs consist of the following typical range of equipment costs for small and large operations:

| | Small (100 to 10,000 $m^3/d$) | Large (10,000 to 325,000 $m^3/d$) |
|---|---|---|
| Pumps.................. | 78% | 62% |
| Motors................. | 22% | 38% |

The total capital cost is $(Y_C) = 2,418.304(X)^{0.444}$ and is distributed as follows:

(L) Construction Labor Cost $(Y_L) = 314.380(X)^{0.444}$

(S) Construction Supply Cost $(Y_S) = 1,547.714(X)^{0.444}$

(E) Purchased Equipment Cost $(Y_E) = 556.210(X)^{0.444}$

ADJUSTMENT FACTORS

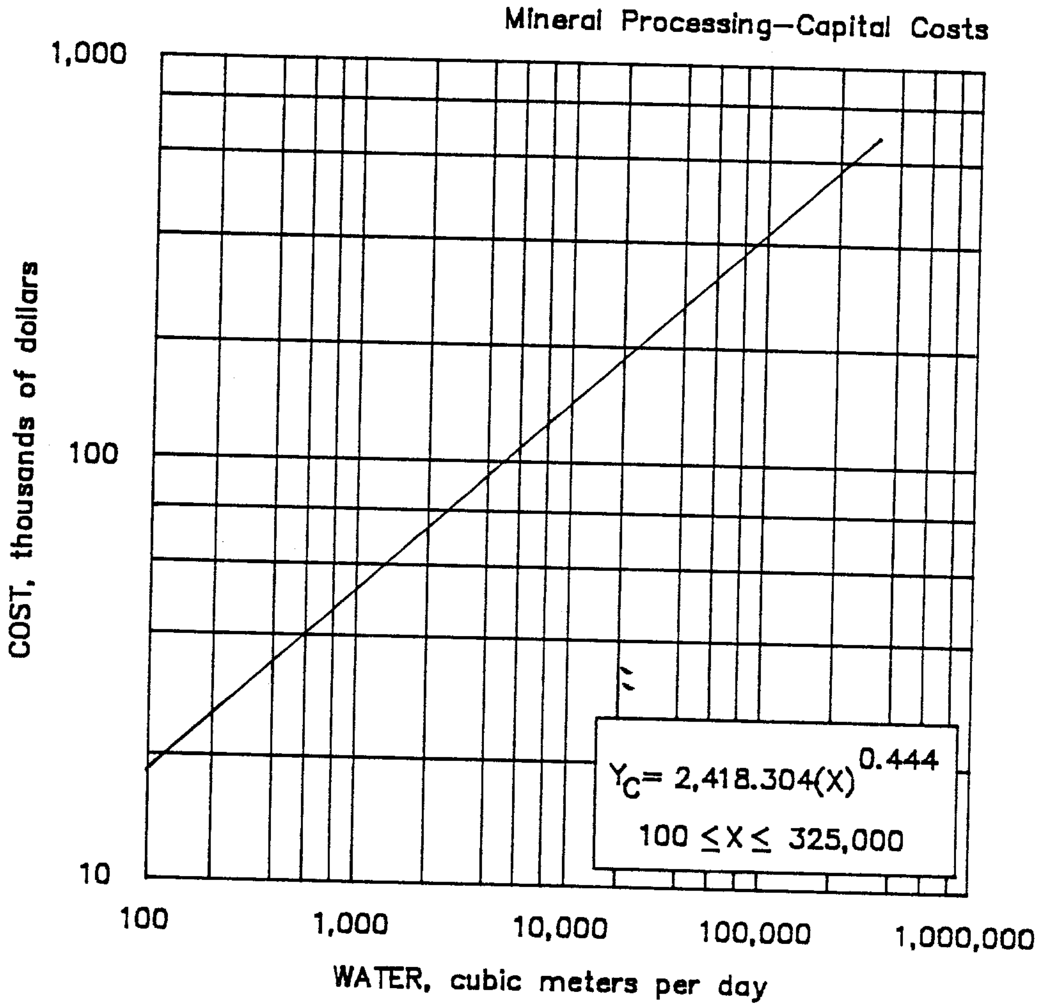
Pumping Distance Factor The capital cost curve is based on a 1 km pumping distance. For actual distances, multiply the cost obtained from the curve by the following factor:

Pumping distance factor $(F_D) = 0.320+0.680(D)$
where D = actual pumping distance, in kilometers.

Pumping Head Factor The capital cost curve is based on a 15-meter static head (lift) and 1.5-meter friction head. This friction head applies to a 1 km standard steel pipeline. For actual heads, multiply the cost obtained from the curve by the following factor:

Pumping head factor $(F_H) = 0.740 + 0.0158(H)$
where H = actual head (static, friction, velocity, and fitting), in meters.

For preliminary estimates of (H), add to the actual static head (lift) 1 to 2 m for each kilometer of pipeline through which water is pumped. For accurate determinations of (H), add to the actual static head the sum of friction, velocity, and fitting heads obtained from hydraulics handbooks for actual pipe quality, pipe diameter, and pipeline pumping distance.




6.1.4.5. Water reclamation