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SCREEN CAPACITY CALCULATION

by Larry Olsen and Bob Carnes

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FOREWORD

Screening of aggregates has been accomplished successfully for some time now and the way the equipment is selected and utilized is familiar, as well. The technology, however, has evolved and refined to the point of needing the definition of additional parameters and their inclusion in a new set of operating formulas. This paper starts with a survey of traditional screen considerations and how they have been incorporated into the aggregate industry, then reviews recent developments. Some heretofore unused (at least in the literature) parameters are discussed and, finally, suggestions are made as to how they can be used to optimize screen usage and maximize usable output.

INTRODUCTION

Current screen capacity calculations do not take into consideration enough of the factors affecting screen efficiency. The old formulas were designed to keep calculations short and manageable for manual calculation. The common use of computers in today's world makes it possible to do more complex screen capacity calculations in much shorter time. This allows for the inclusion of more and more subtle factors, which greatly increase the accuracy of the conclusions.

Increased accuracy will reduce the under or over sizing of screens. Undersized screens cause carryover or reduced plant output. Oversized screens represent a greater capital investment and cost more per unit of production to operate. A screen using half its area to perform the required sizing still carries the oversized product its full length, incurring unnecessary operating expenses in terms of screen cloth wear and unnecessary energy cost.

The following paper is an effort to help improve the accuracy of screen capacity calculations and to identify and quantify additional factors which influence screening efficiency. There are many types and makes of screens on the market and it is our intention that these new factors make it easier to compare one screen to another.

VIBRATING SCREEN – CAPACITY CALCULATIONS

Throughput per square foot of screen area is the name of the screen game, and no design engineer wants to be considered short in the area of capacity and efficiency. It behooves the buyer/operator to examine and evaluate the data available before committing to any screen type or system. The figures in handbooks make many assumptions and can be overly optimistic. The biggest assumptions are the screen will have the correct rpm and stroke length for the given application. Also, there are some obvious errors in the published tables. Most manufacturers use a modified version of the VSMA (Vibrating Screen Manufactures Association) formula to determine screen capacity. The twelve factors used in the formula below are based in large part on the VSMA charts and formula.

Formula: A = B * S * D * V * H * T * K * Y * P * O * W * F

"A", the calculated capacity per square foot of screen area in tons per hour.

B = Basic capacity per square foot in tons per hour
(One ton = 2000 pounds)
S = Incline factor
D = Deck factor
V = Oversize factor
H = Halfsize factor
T = Slot factor
K = Material condition factor
Y = Spray factor
P = Shape factor
O = Open area factor
W = Weight factor
F = Efficiency factor

There are other influences, arising mostly from observations made at actual screening locations, which have yet to be defined, researched, and formally described, but which definately affect screen operation. We have assembled this data and weighted it in accordance with our experience. The additional factors recommended are:

TYP = Type of stroke factor
STR = Stroke length factor
TIM = Timing angle factor
RPM = Revolutions per minute factor
NEA = Near size factor
BED = Bed depth factor

EXPLANATION OF TRADITIONAL PARAMETERS

"A", the **"Actual Capacity"** per square foot of deck, is the amount of input material in tons per hour which can be correctly sorted. The total capacity of a deck is **"A"** multiplied by the area of the deck in square feet. This is the final result of the multiplication of all the screen factors.

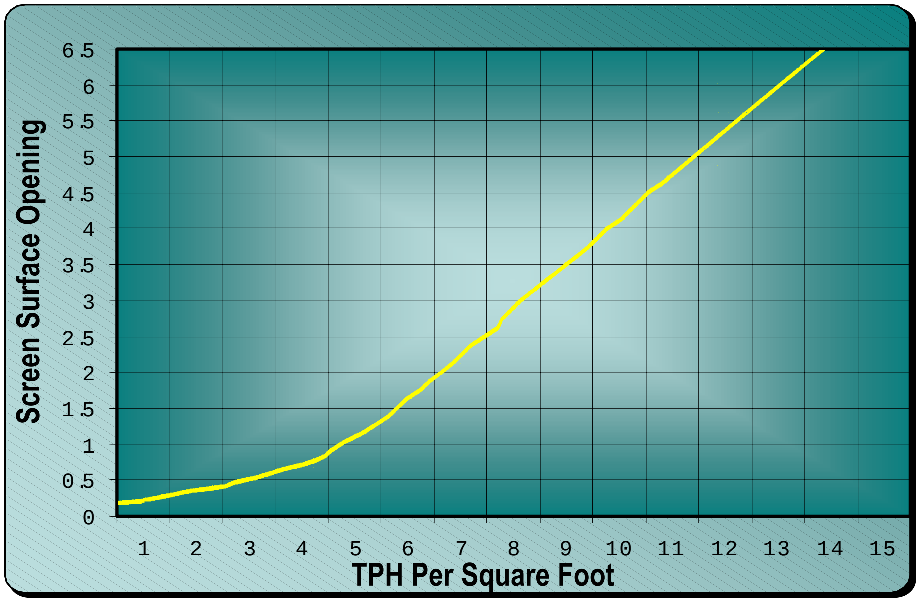


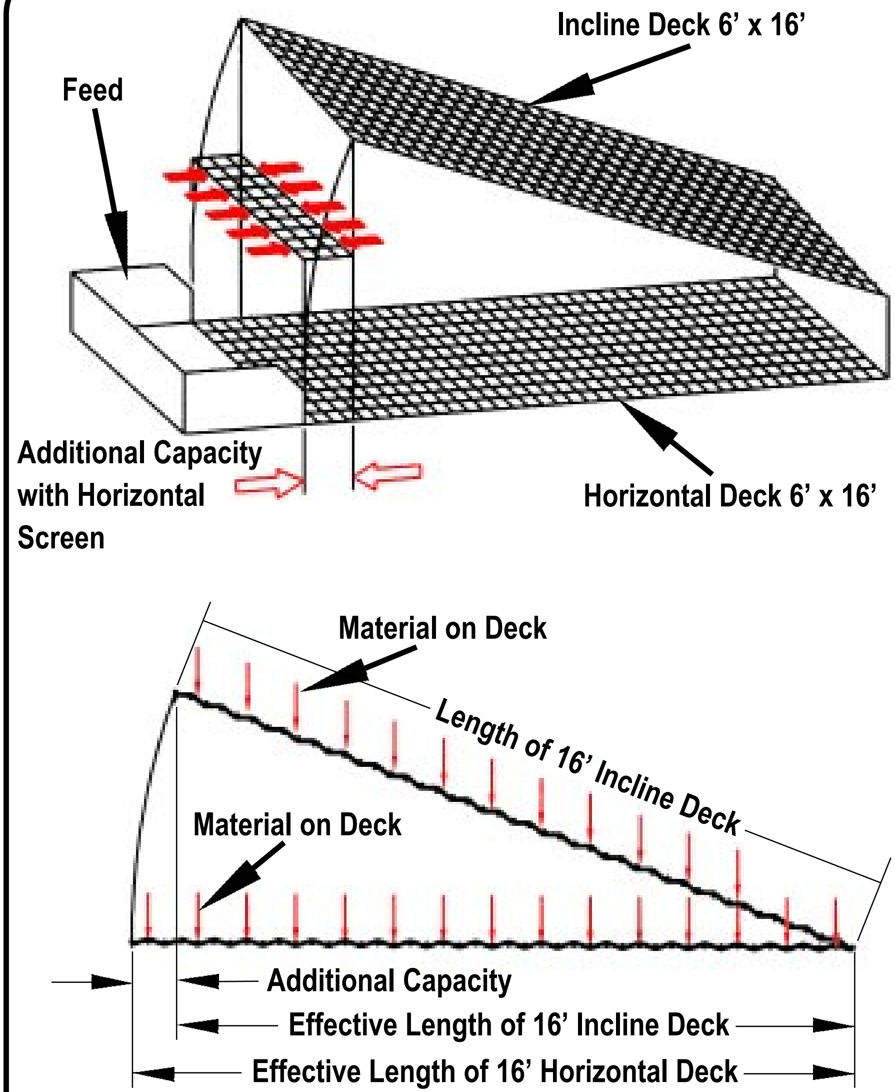
Figure 1 - Basic Capacity

The term wirecloth is used in this paper in reference to screening media. Wirecloth maybe woven wire or other media such as urethane, rubber, or plating used for particle sizing.

"B", the **"Basic Capacity"**, is the inherent ability of each square foot of wirecloth to sort rock. It depends on the wirecloth opening size and design of the screen. For example, 2" wirecloth has a much higher basic capacity than 1/4" wirecloth. Each manufacturer has its own table of basic capacities and in certain applications these can be optimistic. Basic capacities depend greatly on the design of the screen, and most capacity formulas assume the screen design is correct for the application. This assumption is not always justified. A scalping screen used as a finishing or dewatering screen would have a greatly reduced capacity. A finishing screen used as a heavy scalper would also have a greatly reduced capacity. The type of stroke, length of stroke, screen rpm, timing angle, and incline of the screen greatly affect the basic capacity. All of these factors will be explored in subsequent paragraphs. Figure 1 shows the basic capacity per square foot of wirecloth in a screen application with the conditions of 90% efficiency, 25% oversize feed material, 40% half size material with 50% open area.

"S", the **"Incline"** factor, depends on the actual slope of each deck and the opening size of the wirecloth. Steeper slopes have lower factors since the rock has a tendency to bounce off the end before being sorted. The rounder the rock, and the greater the ratio of rock size to opening, the faster the rock moves from the feed end of the screen to the discharge end. The faster the rock is moving the less likely it is to pass through an opening. The flatter the incline angle the easier it is for the rock to pass through an opening. Flat screens have a constant conveying velocity from feed to discharge. Rocks accelerate down an incline screen under the force of gravity.

When viewing a screen opening from above, the more horizontal the screen deck lays, the larger the opening appears. This difference in effective screen opening between flat and incline gives flat screens greater capacity for the same wire opening size. Figure 2 is a demonstration of the effect.



	10°	15°	20°	25°
Effective Length of 16' Incline Deck	15.75'	15.45'	15.04'	14.50'
Effective Length of 20' Horizontal Deck	19.70'	19.32'	18.79'	18.12'

Figure 2 - Deck Comparison, Incline to Flat

Figure 3 shows the incline factor based on wirecloth opening size and slope of the screen. When using slotted wirecloth use the narrow width for the opening size.

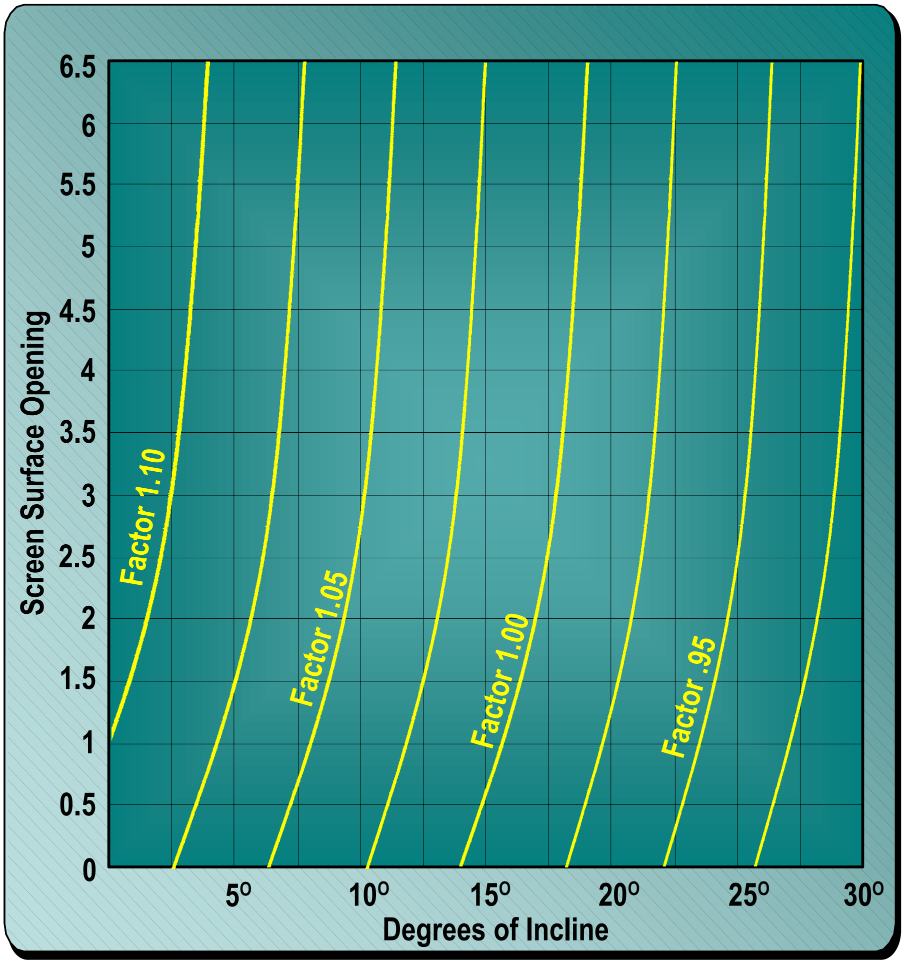


Figure 3 - Incline Angle Factor “S”

"D", the **"Deck"** factor, takes into account that on lower decks not all the length of the screen is being used. By the time material has passed through an upper deck it has traveled part way down the length of the screen. Manufacturers do not change the deck factor based on how easily material passes through the deck above. However, the easier it is for material to properly be sized through the upper decks the greater the usable lengths of the lower decks and the higher the **"D"** factors. Factor **"D"** is usually 1.0 for the top deck, 0.9 for the second deck, and 0.8 for the third (if any). This is a gross oversimplification of course, but at least provides an estimate. Figure 4 shows it in graphical form.

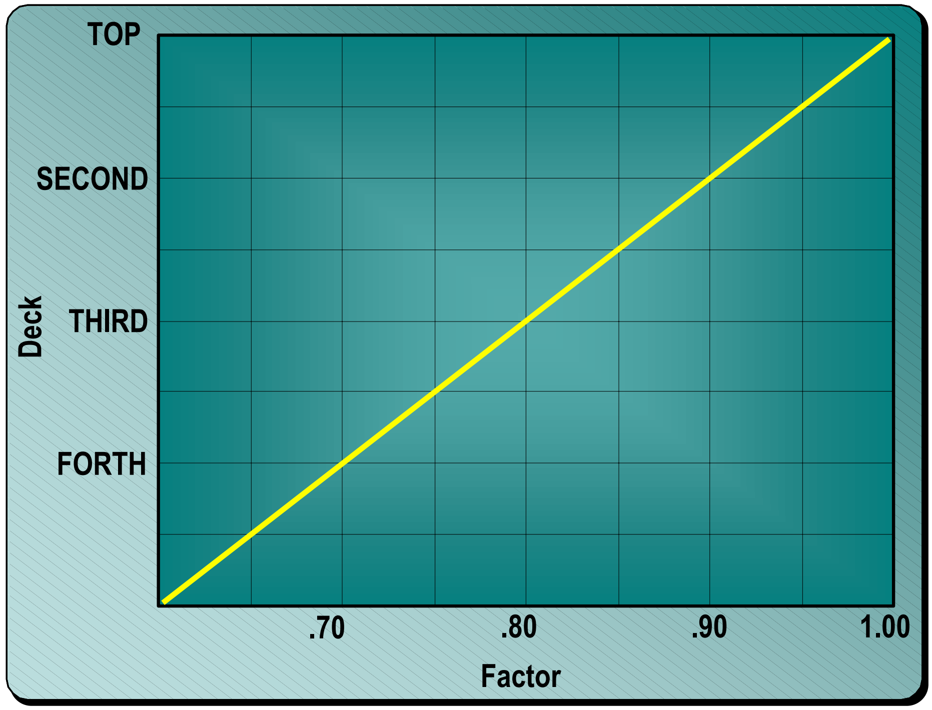


Figure 4 - Deck Factor "D"

“V”, the **“Oversize”** factor, depends on the percentage of input rock that is larger than the size of wirecloth opening. If most of the input is larger than the mesh size, a significant portion of near size material will be suspended above the big rocks on the wirecloth and have no chance of passing through an opening. The **“V”** factor is an attempt at determining the likelihood of near size materials reaching the wirecloth to be screened. Figure 5 shows the percent retained as a measure of oversize material. The related oversize factor is picked off the intersection of percent retained and the curve. For example, 25% oversize generates a **“V”** factor of 1.0 .

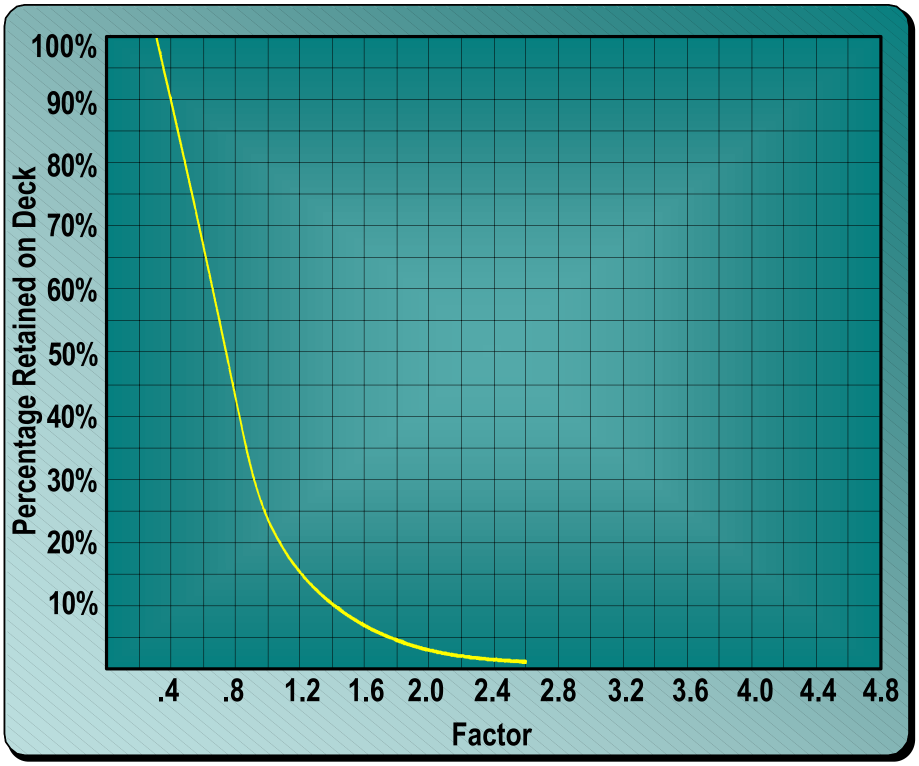


Figure 5 - Oversize Material Factor “V”

"H", the **"Half size"** factor, depends on the percent of material input that is less than half the size of the wirecloth opening. The higher the percentage of small feed material the greater the screen capacity. The faster the material passes through a screen the more open area there is left to screen the remaining material. A feed material with 40% of the feed being half the opening size or smaller equates to a factor of 1.0 . Figure 6 uses the percent of feed material half the wirecloth opening size or smaller to find the half size factor. Once again, the narrow opening width is used for slotted wirecloth.

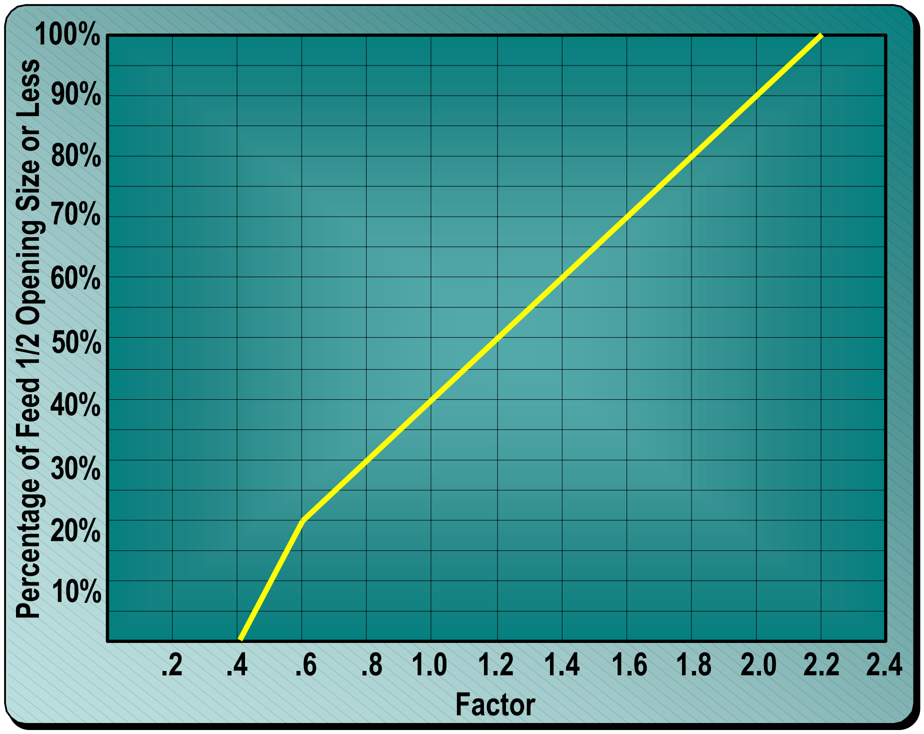


Figure 6 - Half Size Factor "H"

“T”, the **“Slot”** factor, is based on the shape of the openings in the wirecolth and the ease with which material may pass through. Slotted wire has an increased capacity over square opening wire. Of equal importance is the fact that slotted wirecloth is less likely to blind over. The slot factor for square opening wirecloth is 1.0. The slot factor for rectangular or slotted wirecloth is based on the length/width ratio. Round openings have a 0.8 slot factor. Any difference in capacity based on the direction of the slots being either with, or across, the flow of material is not taken into account. When calculating screen capacity blinding is not directly considered. Spring loaded wirecloth (Z wire) does not increase the slot factor over that of standard slotted wire. Spring-loaded wirecloth does help prevent blinding, however, and maintains open area. Determine slot factor based on Figure 7.

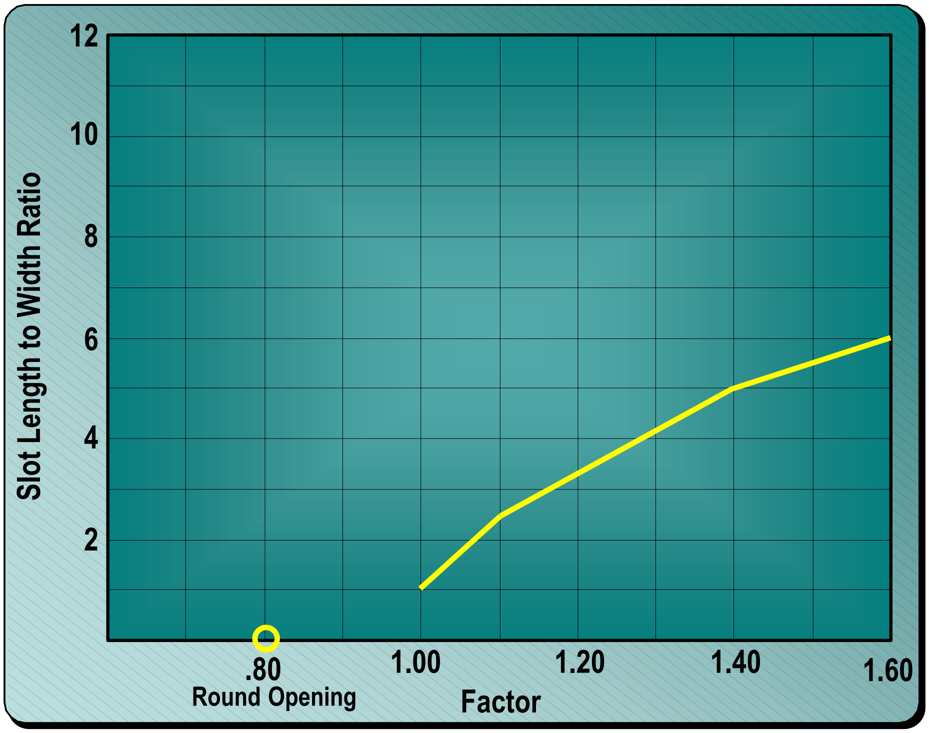


Figure 7 - Slot Factor “T”

“K”, the **“Material Condition”** factor is an indication of how the type of feed material and moisture content affect screen capacity. Most manufacturers have their own values, but generally, crushed dry gravel gets a **“K”** factor of 1.0 and moist dirty materials less than 1. The **“K”** factor is not intended to compensate for blinding, but considers different types of material and how they flow through and over wirecloth. Clay and mud tend to bond to materials reducing the speed at which under size material will pass a given opening or move down a screen deck. Refer to Figure 8 for the material condition factor.

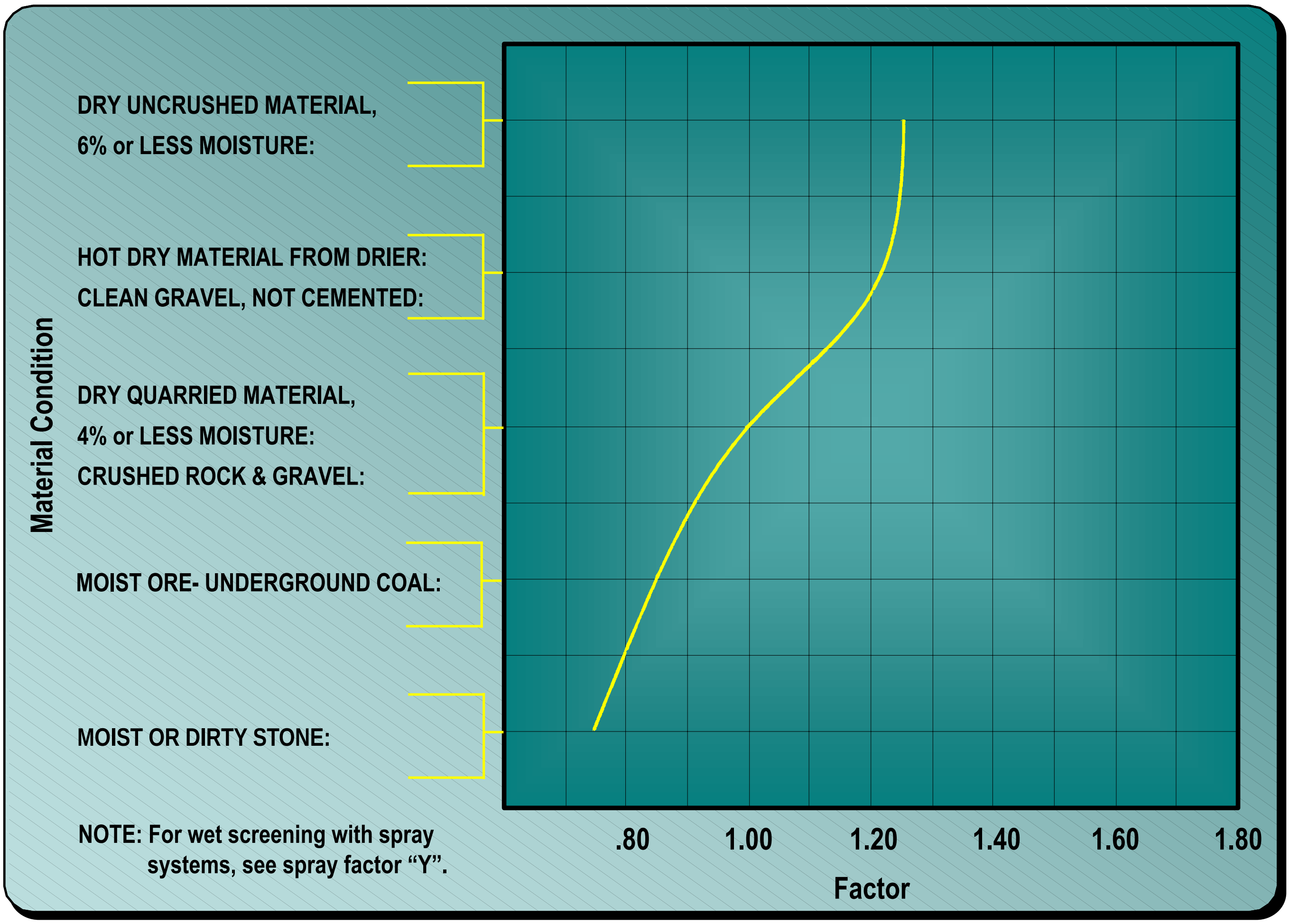


Figure 8 - Material Condition “K”

"Y", the **"Spray Factor"**, is meant to account for the effect that a spray system has on screen capacity. **"Y"** is always 1.0 for decks without sprays. A spray system will almost always increase the capacity of a screen. How much depends on how well the system is designed and on the opening size of the wirecloth. **"Y"** also depends on the relationship of the wire opening to the material sizes. Spray systems are most effective on wirecloth opening sizes from 1/8" to 1". Type of spray pattern and volume of water also play a roll in the spray factor. Spray systems which introduce all the water at the feedbox are generally less effective than sprays which distribute the water over a greater area of the deck. Spray systems, which do not adequately cover a deck, call for a reduced spray factor. Another prerequisite for an efficient spray system is an adequate supply of water. A commonly used rule of thumb in determining the amount of water required calls for 5 to 10 gallons/minute per yard/hour. For 100 lb per cubic foot material 5 to 10 gallons/minute per yard/hour equates to 3.7 to 7.4 gallons/minute per ton/hour. Insufficient water volume may turn fines to sticky mud causing blinding. Blinding reduces the percent of open area, which reduces capacity. Figure 9 provides a measure of how the **"Y"** factor varies with wirecloth opening size.

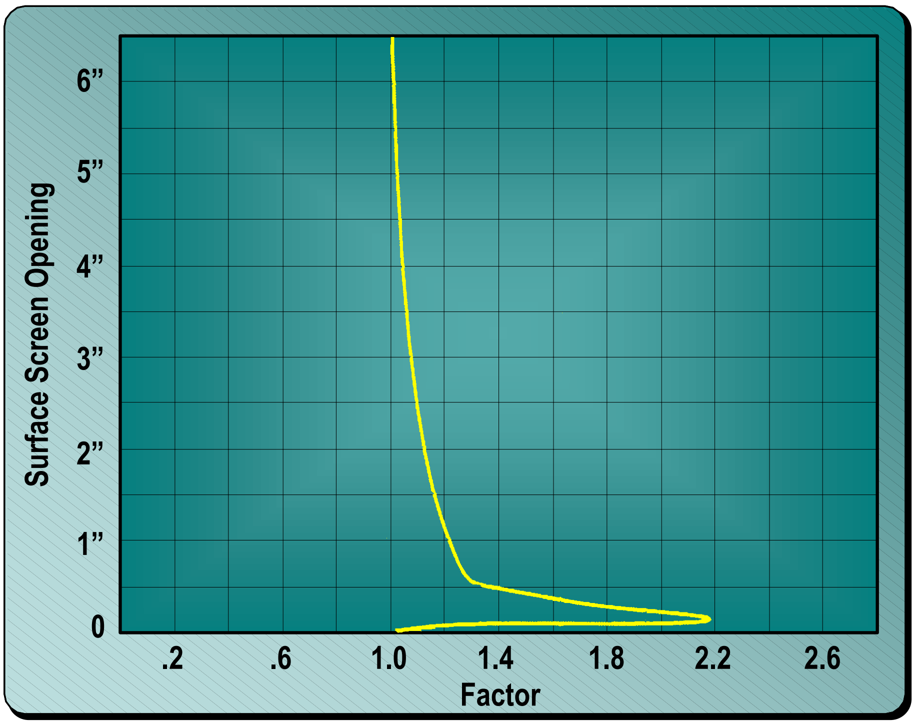


Figure 9 - Wet Screening Factor "Y"

"P", the **"Shape"** factor, is meant to account for the effects on screen capacity of deviations in product shape from cubical or spherical to elongated. Elongated material, "slivers" in aggregate jargon, is that which has a length three or more times its major thickness. The more elongated material there is in the feed the greater the tendency for material to hang in the openings, or simply bounce around on top of the screen without falling through. Refer to Figure 10 for the shape factor **"P"**.

Feed to deck between 1/2 and 1 1/2 times the size of screen opening which have a length more than three times major width.

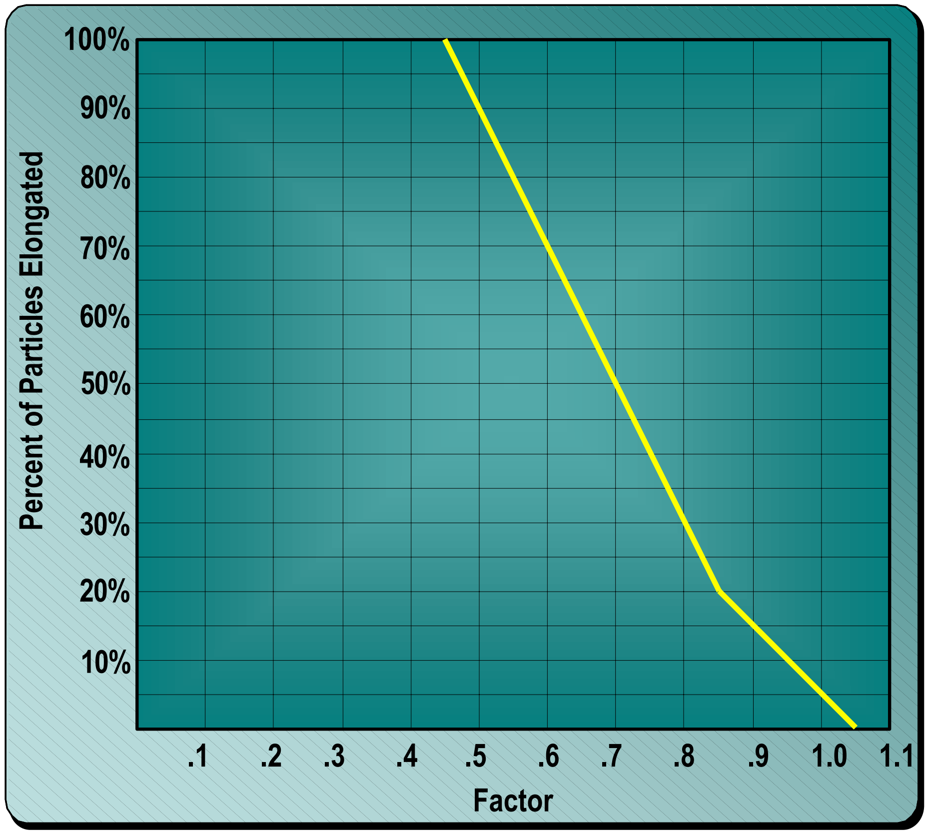


Figure 10 - Shape Factor "P"

"O", the **"Open Area"** factor, is a measure of how much of the screen area is actually "holes" versus how much is wire. Obviously, wirecloth manufactured with thicker gauge wire has less open area. The open area factor is based on the percent of area available for material to pass or the area of the screen deck minus the cross sectional area of the wire. The greater the percent of open area and the larger the openings the greater the capacity. Urethane decks and very small mesh wirecloth may have open area percentages below 50% and thus have factors below 1.0. Refer to Figure 11 for open area factor.

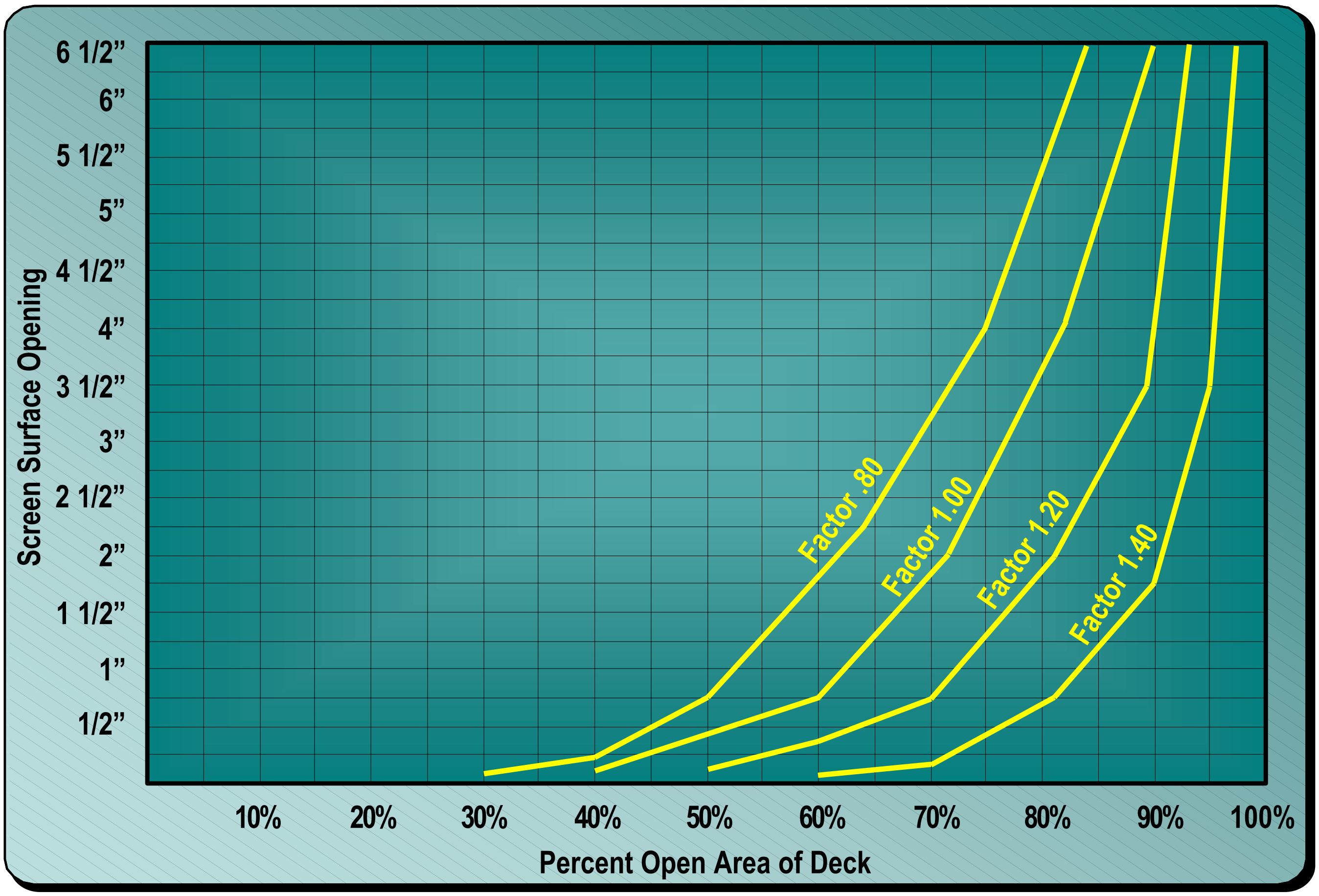


Figure 11 - Open Area Factor "O"

"W", the **"Weight"** factor, depends on the density (pounds per cubic foot) of feed material. Most rock with a density of 100 pounds per cubic foot has a factor of 1.00. A heavy undersize material is likely to pass through an opening while a light undersize material tends to bounce around on top of the oversize material and the wirecloth. Refer to Figure 12 for Weight factor.

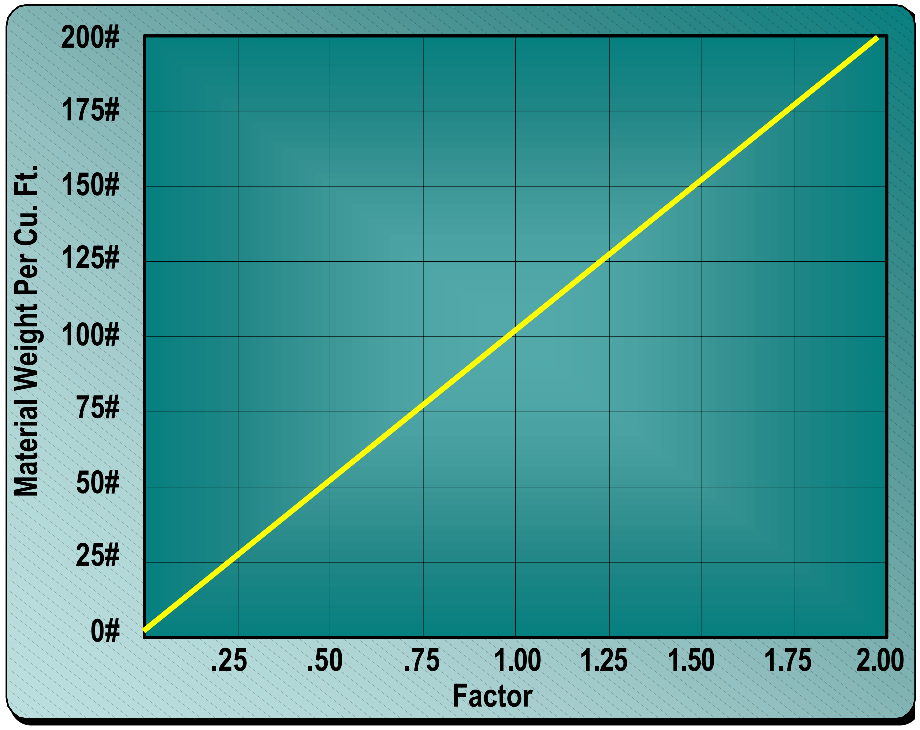


Figure 12 - Material Weight Factor "W"

"F", the **"Efficiency"** factor, is defined as the ratio, expressed as a percentage, of the amount of undersize that actually passes through a given screen deck to that which should theoretically pass. Most screening applications do not require 100% size separation and the lower the requirements in that regard the higher the capacity of a given system. For calculated capacities many manufacturers use an efficiency of 90% or 95%, when not otherwise specified. In Figure 1, at the beginning of the article the system was assumed to be 90% efficient. By using Figure 13, the efficiency factor for any other screening efficiency can be obtained. For example, for a screen with 90% efficiency the factor is 1.0, and for a screen with 70% efficiency the factor is 1.2 .

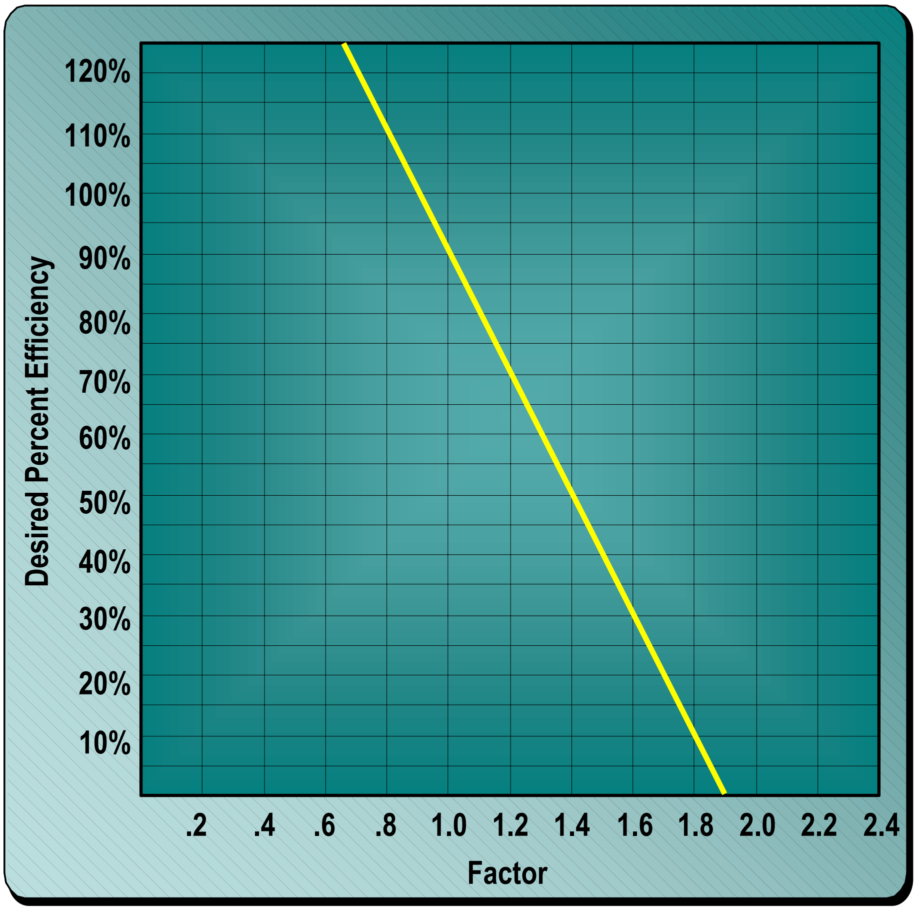


Figure 13 - Efficiency Factor "F"

The efficiency factor can also be used as a fudge factor for making calculated results agree with measured results. In some cases calculated capacities do not match actual results due to some condition not allowed for in the basic formula.

Additional factors:

In the past the number and complexity of screen capacity calculations were few and simple. Even so, sizing equipment took long hours with a slide rule, pencil and paper. When hand held calculators came along they helped, but the job still required a lot of time and effort.

With the advent of computer programs, complete plant layouts with many different pieces of equipment can be simulated in a matter of minutes. The programs are also used to compare manufacturer's equipment. In many cases, understanding of the programs is limited and assumptions are made which lead to erroneous conclusions. One such assumption is that published data from two different manufacturers is equivalent. One source may use conservative data while the other's data could be considered overly optimistic. Sometimes data from the same company can be inconsistent. Using one formula with one set of basic capacities and using factors based on the screen's motion provides more consistent comparisons and greater screen sizing accuracy.

The proliferation of screening methods and screen manufacturers has increased the options to the end users. It has also increased the difficulty of the choices. The factors we have already covered were adequate in their day, but they don't accurately calculate all the information necessary for choosing among modern machines. Following is a description of the additional factors for increasing the accuracy of screen selection.

The following factors are used for increased accuracy in the proper sizing of screens:

TYP = Type of stroke factor
STR = Stroke length factor
TIM = Timing angle factor
RPM = Revolutions per minute factor
NEA = Near size factor
BED = Bed depth factor

The screen capacity formula with 6 new factors above now becomes:
A = B * S * D * V * H * T * K * Y * P * O * W * F * TYP * STR * TIM * RPM * NEA * BED

"TYP", **"Type of Stroke"** factor. The stroke of a screen is the pattern it makes in space during one revolution. If a person put a dot anywhere on the side of the screen and recorded the path of the dot while the screen was running, the shape of that path would describe the machine's stroke (e.g., circular, straight line, and oval).

Circular strokes require gravity to move material down the screen and are employed on incline screens.

A circular stroke along with the incline of the screen tends to tumble the material as it moves over the wirecloth. Tumbling helps to keep material from hanging in the openings and makes it possible for smaller material to pass through.

Horizontal screens and very low degree incline screens employ straight line and oval strokes. A straight-line stroke uses a back and forth action at some positive angle with respect to vertical. The wirecloth lifts the material then drops away from it. The motion conveys the material down the screen even though the screen is horizontal. Since the wirecloth is horizontal, the openings, when viewed from above, present a full length opening for material to pass through. Undersize material has the best chance of falling through when the full length of the opening is used. Conveying velocity is constant on straight line stroke screens from feed to discharge end.

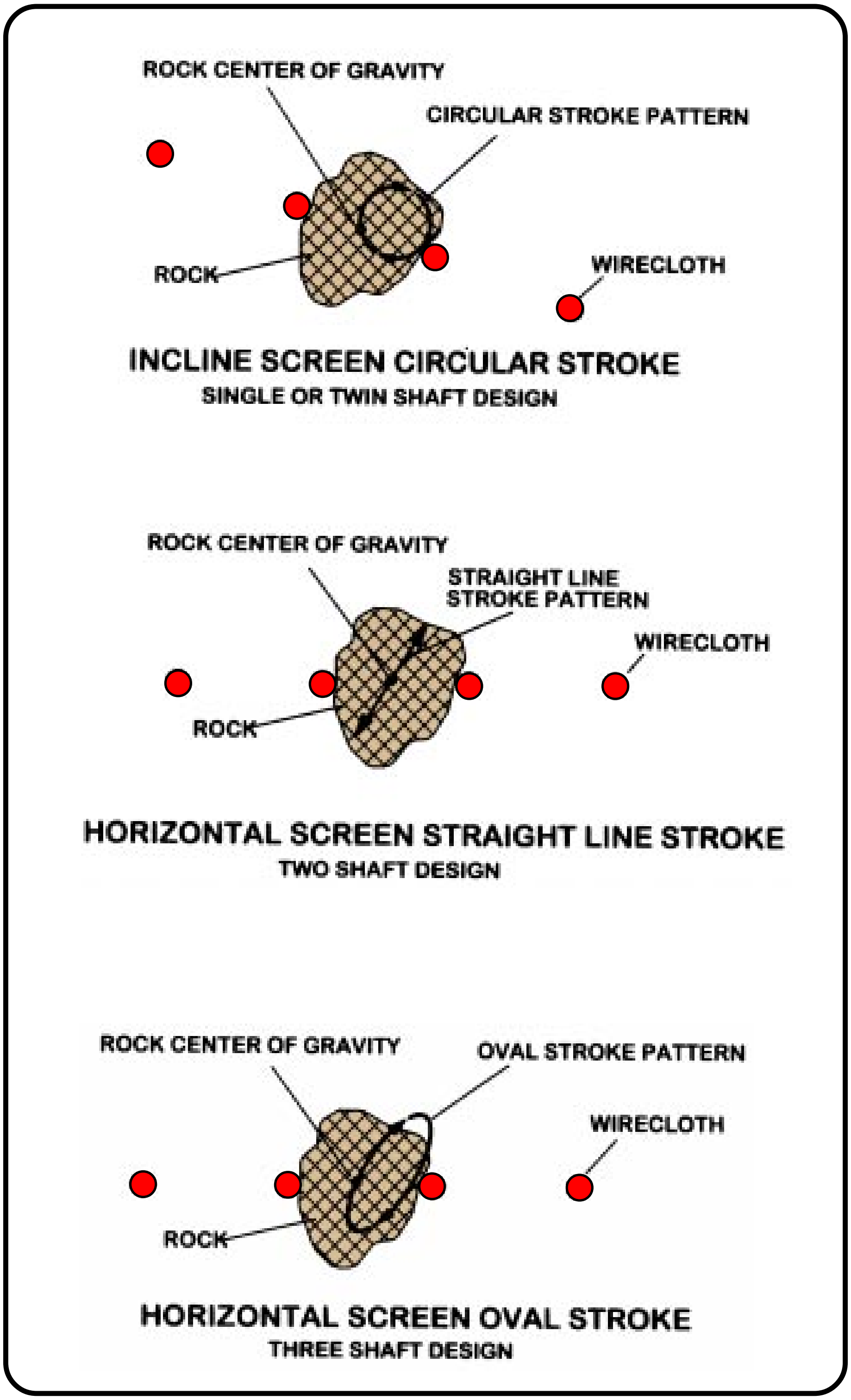


Figure 14 - Types of Strokes

An oval stroke is a combination of both the circular and straight-line stroke patterns, allowing the screen to combine the tumbling action of the incline screen and the full length of horizontal openings on the flat screens. Figure 14 illustrates a visual comparison.

The additional surface area and material action of a horizontal screen usually enables the user to incorporate one-size smaller horizontal screen than he would an incline.

For example, a 6203 oval stroke flat screen set at the correct timing, rpm, and stroke length can handle the same capacity as a 7203 incline screen set at the correct incline, rpm, and stroke length. Refer to Figure 15 for **"TYP"** factor.

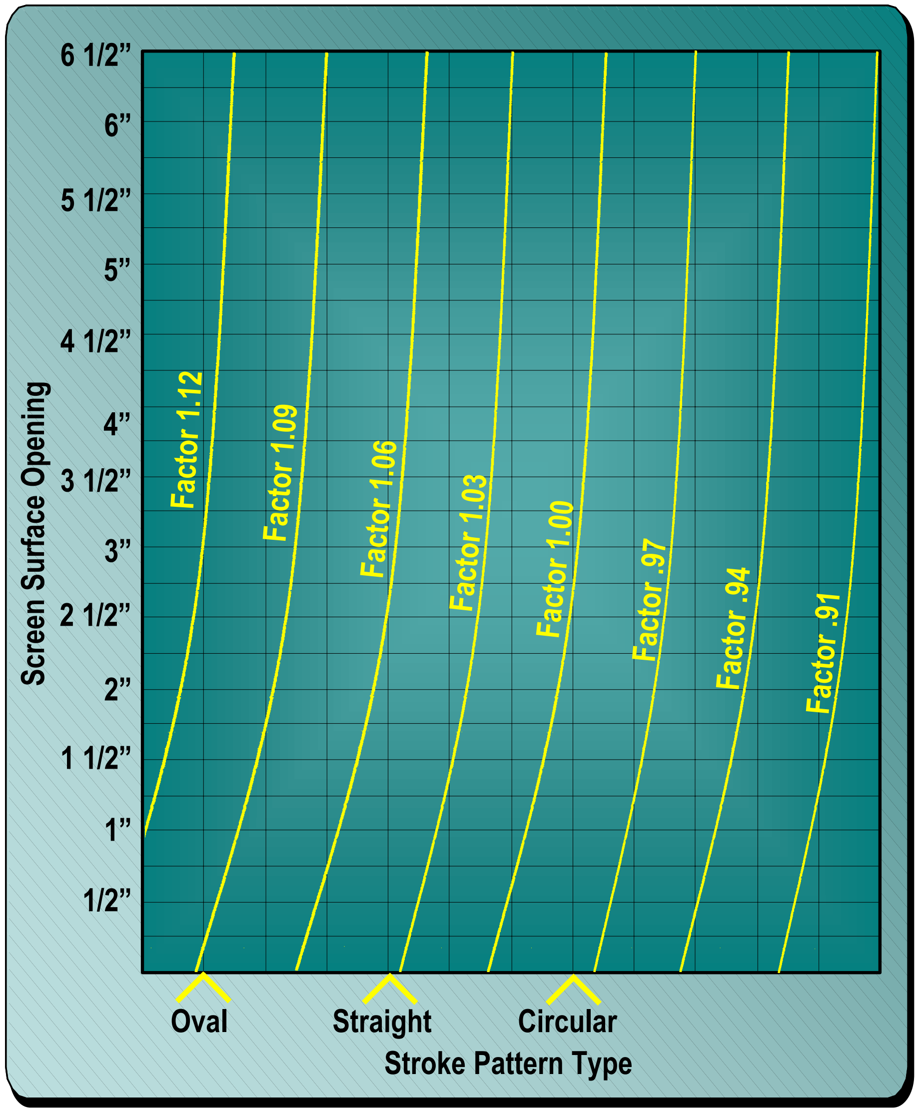


Figure 15 - “TYP” Factor

“STR”, the **“Stroke Length**” factor, is based on the assumption that for each size opening an ideal screen stroke length exists. Too large a stroke or too small a stroke makes the screen less efficient. The stroke length factor also assumes the size of material being screened has a relationship to the size of wirecloth opening used. In general, the smaller the wirecloth opening the smaller the stroke length required. Refer to Figures 16 & 17 for the stroke factor as a function of wirecloth opening and stroke length. Use Figure 16 for flat or horizontal screens and Figure 17 for incline screens.

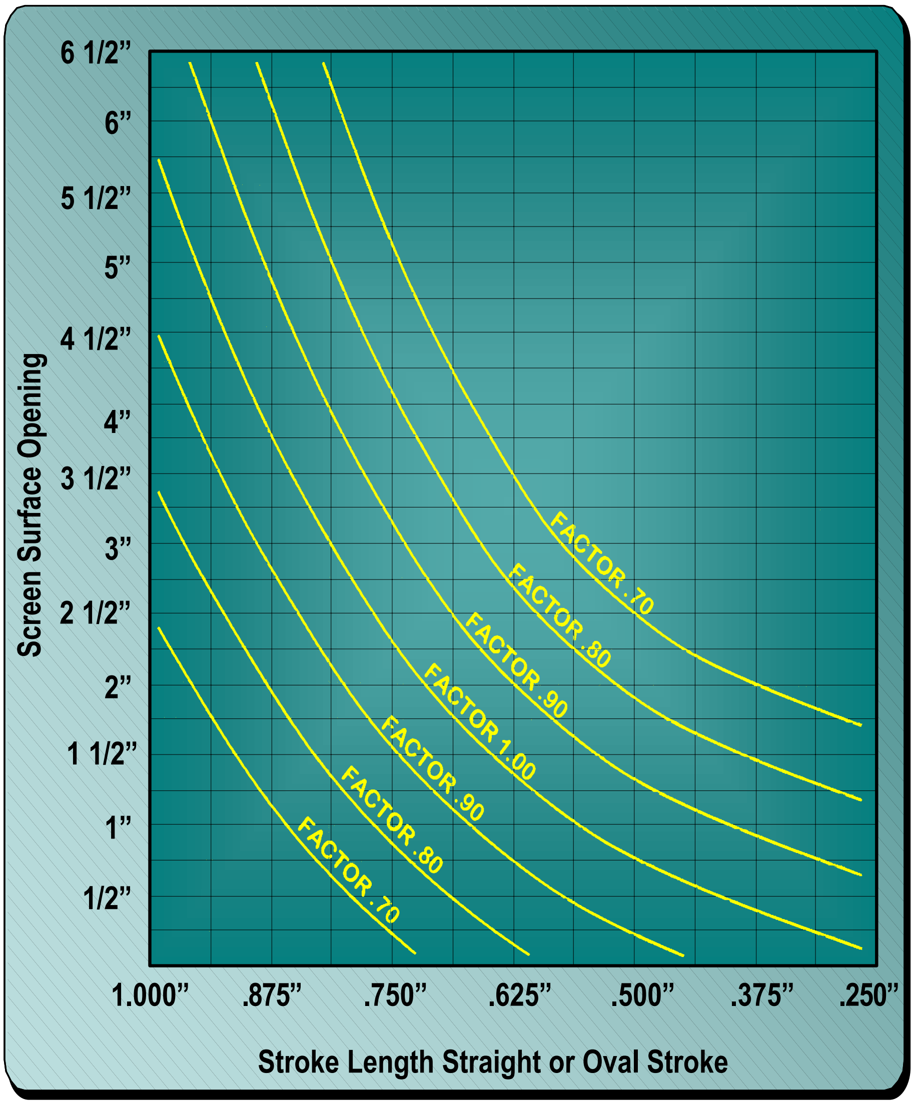


Figure 16 - Stroke Length Factor for Flat or Horizontal Screens

A screen with large openings on the top deck and small openings on the lower decks has to compromise on the length of stroke making the screen less efficient on one or both decks. The old saying “do not scalp and finish on the same screen” applies.

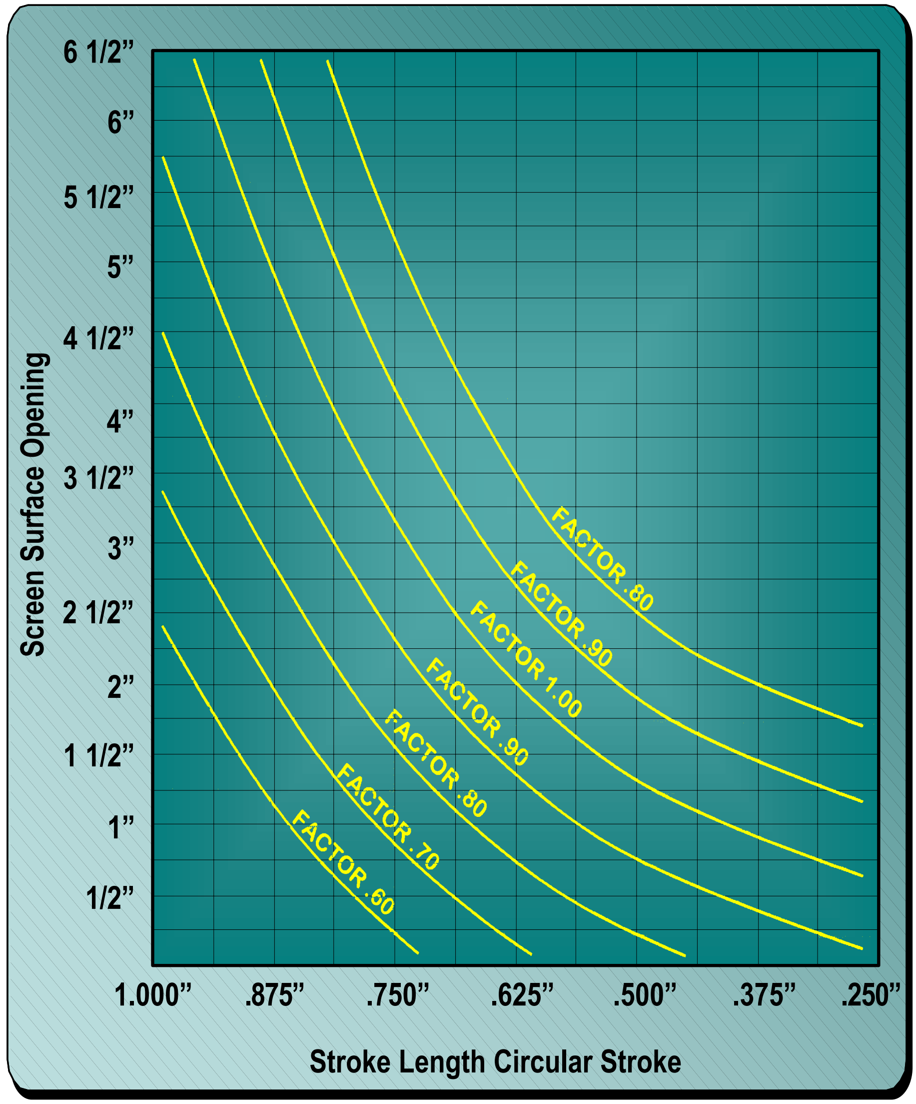


Figure 17 - Stroke Length Factor for Incline Screens

“TIM” is the **“Timing Angle”** factor. Timing angle refers to the angle or slope made by a straight line stroke or the long axis of an oval stroke relative to a vertical line. The larger the wirecloth opening the more vertical lift required to clear material from the screen openings. A more vertical stroke lifts bigger and heavier rocks up and out of the holes, making it possible for smaller material to pass through and helps prevent blinding.

A screen with more than one deck requires a compromise between over or under lifting material. Over lifting has the effect of making material skip holes. Under lifting allows oversize material to hang in the holes preventing undersize material from passing. This has the effect of making one or more decks less efficient. Normally the screen wirecloth openings of top decks are over sized making the lower deck capacity the limiting factor. Consequently, most screens are compromised towards the lower deck requirements.

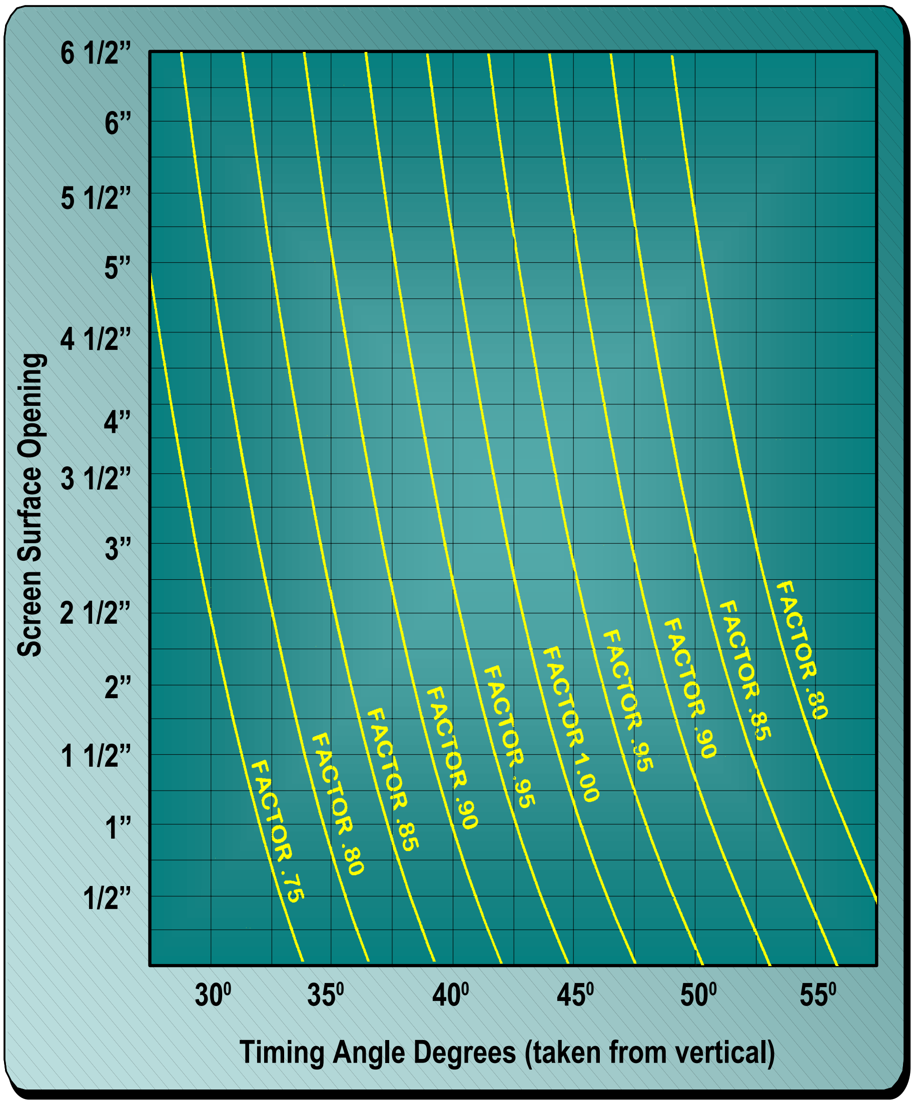


Figure 18 - Timing Angle Flat Screen Factor “TIM”

Timing angles are changed for reasons other than to clear material from the openings. A steeper timing angle retains the material longer on the deck and a flatter angle conveys material faster, however, there are limits both ways. A timing angle flatter than optimum reduces the number of opportunities for material to pass a given size opening. At some point, when flattening the timing angle, material will start to lose conveying speed due to slippage of material on the screening surface. This slippage is similar to a tablecloth being pulled out from under dishes very quickly. The tablecloth moves but the dishes do not. When steepening the timing angle (decreasing the conveying speed) the bed depth can increase and reduce the chances for material to reach the wirecloth and pass through. There is a balance in conveying speed created by the timing angle and the maximum bed depth for the greatest efficiency.

Refer to Figure 18 for the timing angle factor used with flat screens. Note: for incline screens use a factor of 1.0 .

"RPM" is the **"Revolutions Per Minute"** (frequency) factor. Frequency of vibration and material size are inversely proportional and there is an optimum rpm for every size material. Generally, the smaller the size of the material being screened, the faster the **"RPM"** should be. An **"RPM"** too far either side of optimum will reduce the percentage of fines dropping through the wirecloth, thereby decreasing efficiency. At too slow an **"RPM"** the bed of material may act like a single unit or blanket, not allowing the fines to work their way down to the wirecloth.

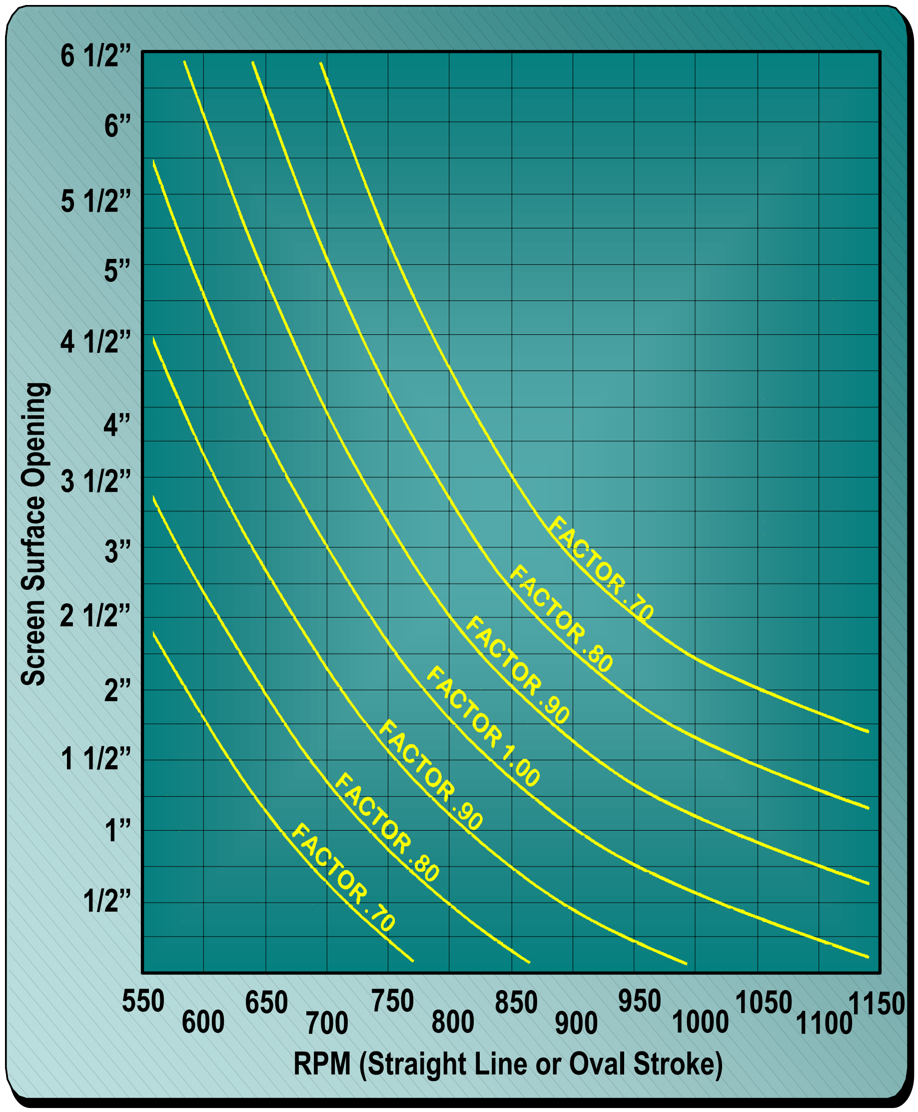


Figure 19 - "RPM" Factor for Flat or Horizontal Screens

At too fast an **"RPM"** the fine material does not have time to pass through an opening without being impacted by the wirecloth and being moved down the screen. Refer to Figure 19 for the **"RPM"** factor used on flat screens and Figure 20 for the incline screen **"RPM"** factor.

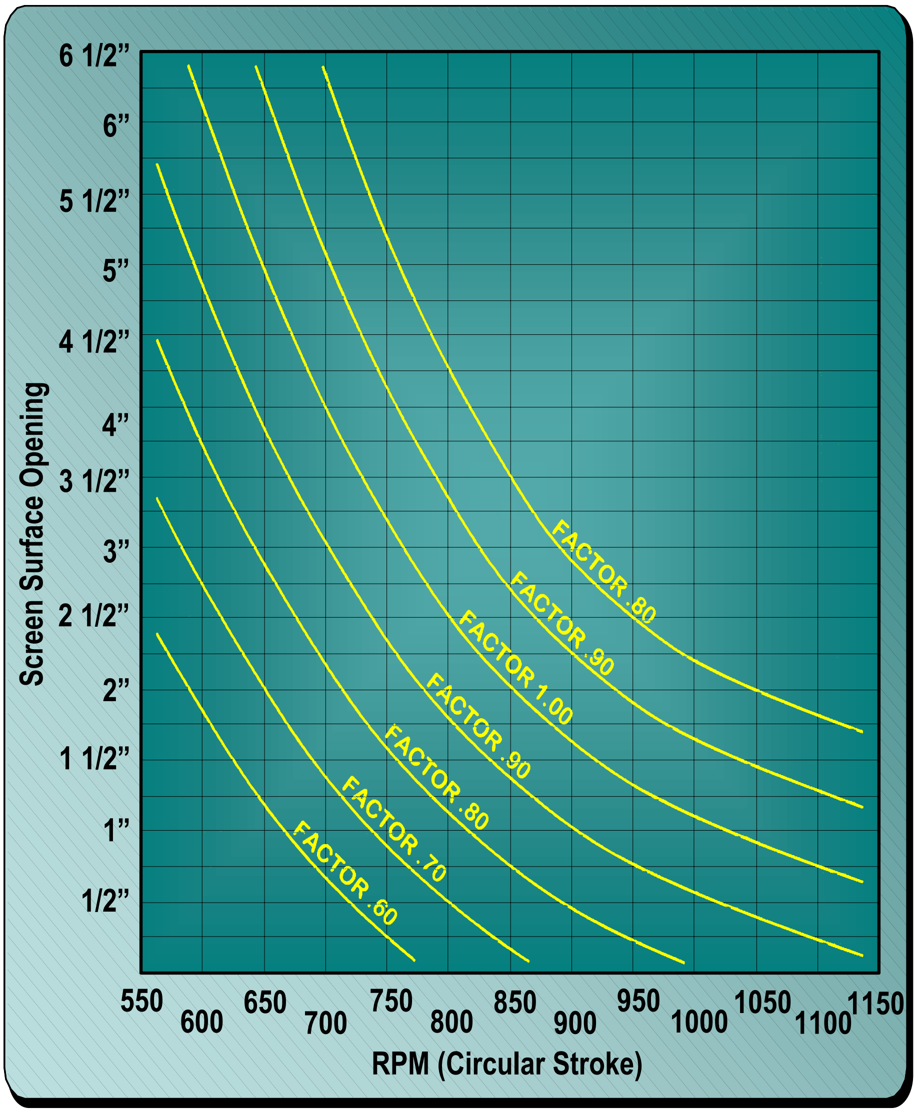


Figure 20 - "RPM" Factor for Incline Screens

"NEA", the **"Near Size"** factor, is a subtle effect and frequently overlooked. The closer a material size is to the wirecloth opening size the harder it is to screen. Near size material is defined as being within plus or minus 25% of the size of the given opening. Such material tends to momentarily lodge in the wirecloth, reducing capacity by blocking off the smaller material. Applications using prescreened material often have increased quantities of near size material in the feed. Screens used in closed circuit applications may also see an increase in near size material.

Figure 21, charts A, B, C, take a single screen with a 2" wirecloth opening size and demonstrate the effects of three different feed size distributions.

Chart A shows an even distribution of material sizes from 0 – 5".

Chart B shows an increased percent of material in the 2" range. The increased material in the 2" opening range would reduce the capacity of the screen.

Chart C shows a decrease in material in the 2" range, which will increase the capacity of a screen.

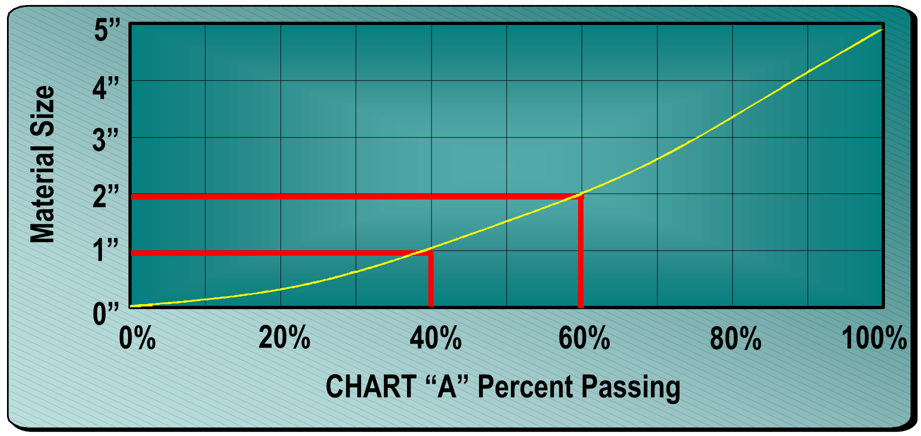


Figure 21, Chart A - Normal Material Distribution Curve

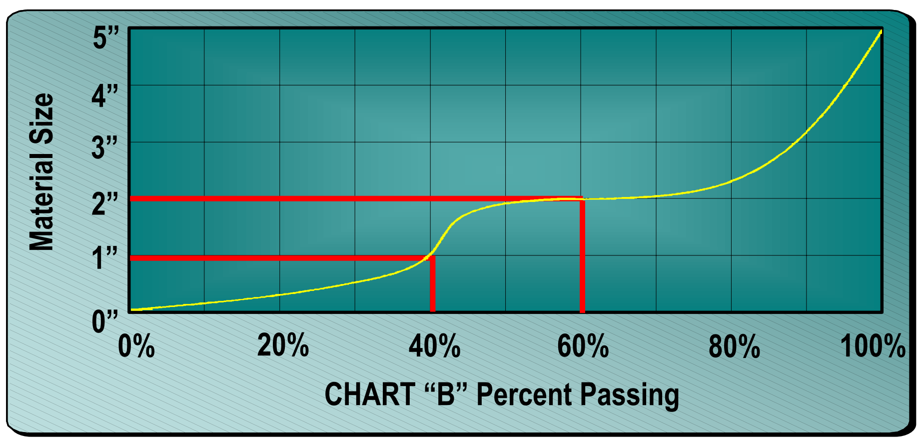


Figure 21, Chart B - Material Distribution Curve with Increased 2" Near Size

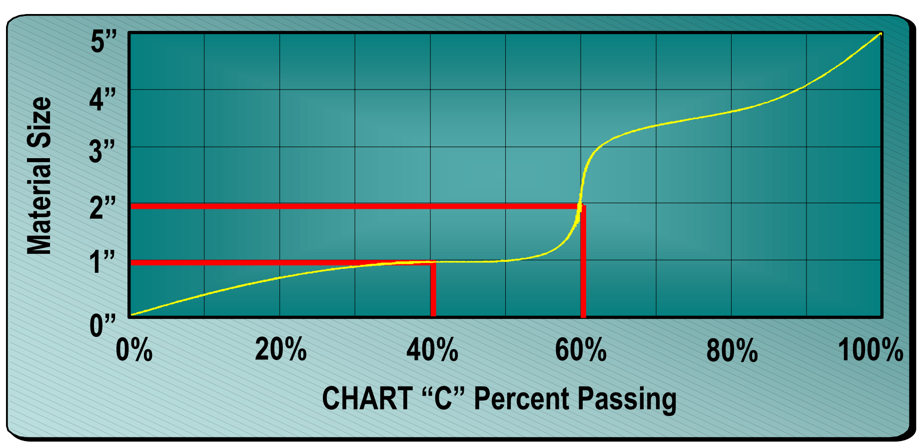


Figure 21, Chart C - Material Distribution Curve with Reduced 2" Near Size

Most formulas use a half size along with an oversize factor to help compensate for variations in size distribution. These factors do not always fully address the effects of near size material. The three curves illustrated on the previous page all show 60% passing a 2” opening, leaving 40% used in determining the oversize factor. They also all show 40% passing a 1” opening used to determine the half size factor. Because all three curves show the same half size and oversize factors, a calculated capacity for all three would be the same. Using a near size factor for all three types of material size distributions would result in different capacity ratings. Refer to Figure 22 for calculating the near size factor.

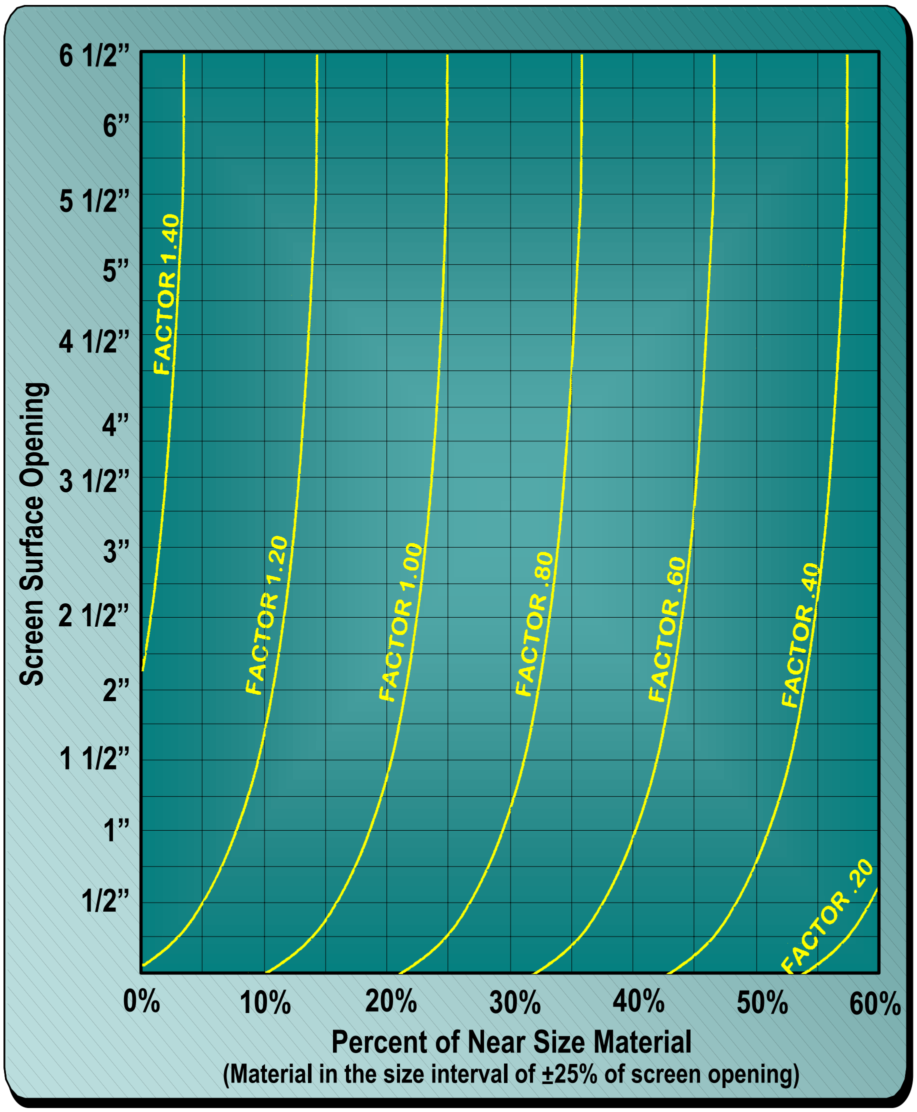


Figure 22 - Near Size Material Factor “NEA”

"BED", the **"Bed Depth"** factor, is based on the observation that the greater the depth of material in relation to the wirecloth opening the less the capacity of the screen. Using the feed rate, density of material, conveying speed, and width of the screen the thoeretical depth of material can be calculated. The ratio calculated depth of material to screen wirecloth opening is used in determining the **"Bed Depth"** factor. Refer to figure 25. Multiply the **"Bed Depth"** factor times the calculated tons per hour the deck is capable of screening and comparing it to the desired production will tell if the deck is sized correctly. Material depth is a calculated number and it is possible to have a calculated depth of 2" and a feed size of 6" minus material.

The formula for calculating material depth is shown below.

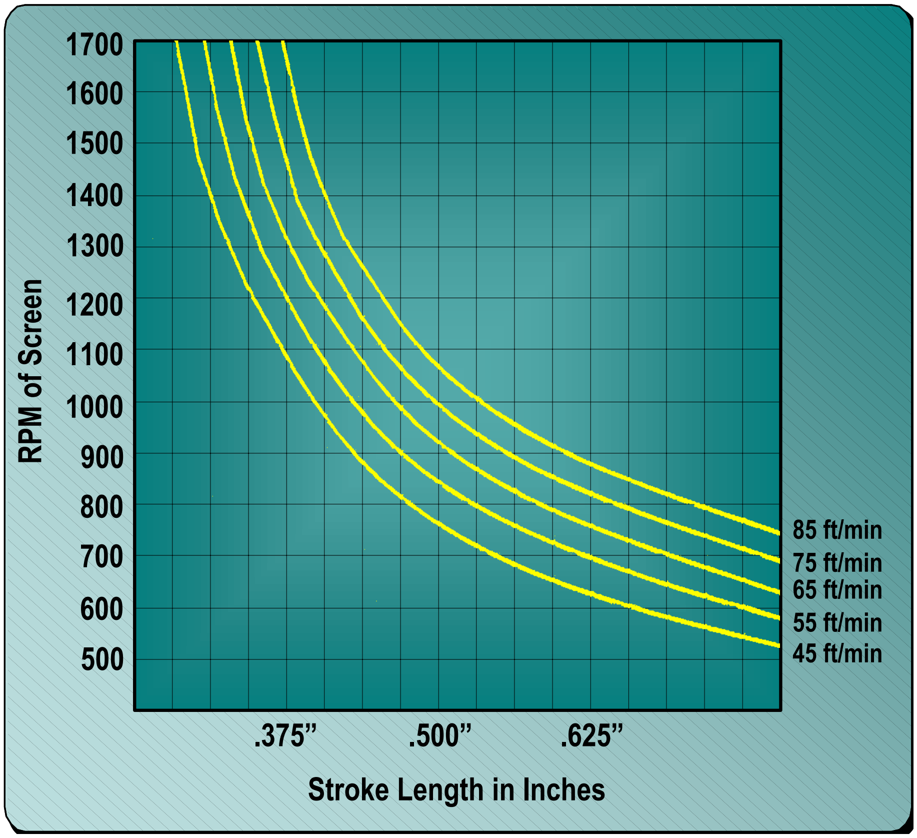
DM = (TP * KD) / (5.0 * SP * WD)

Where **"DM"** is the calculated **"Depth of Material"** in inches.

"TP" is the tons per hour of material going off the end of the deck, not just the oversize but also the carryover. If a screen deck is undersized the carryover includes a measure of fines, which did not pass through the screen openings. If the calculated tons per hour that the deck is capable of handling is less than the actual feed rate to the deck the excess is carryover. For example, if a deck is capable of handling 100 tons per hour but is fed 110 tons per hour, then the carryover is 10 tons per hour, which has to be added to the oversize material being fed to the deck.

"KD" is the density of material in cubic feet per ton. (For most rock KD is 20)

"SP" is the **"Conveying Speed"**, the speed that material moves down the screen. For incline screens it depends on the degree of incline, rpm, stroke diameter, and direction of rotation. For an incline screen set at 20 degree incline, ½" stroke, 1000 rpm, and with flow in the direction of rotation, the conveying speed is 70 ft per minute. For incline screens set with rotation against the flow of material the conveying velocity should be reduced 15% from what is shown in the accompanying graphs below. Figure 23, charts A, B, C, illustrate conveying velocities for incline screens set at 20º, 15º and 10º inclines.



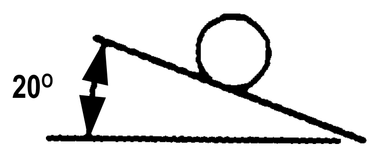


Figure 23, Chart A - Conveying Velocity at 20º Incline
Incline Screen with Circular Stroke

NOTE: Steep inclines with round rock may allow material to convey too fast for effective screening. Screening media and shape of material to be screened greatly effect conveying velocity.

NOTE: Screening media and shape of material to be screened greatly effect conveying velocity.

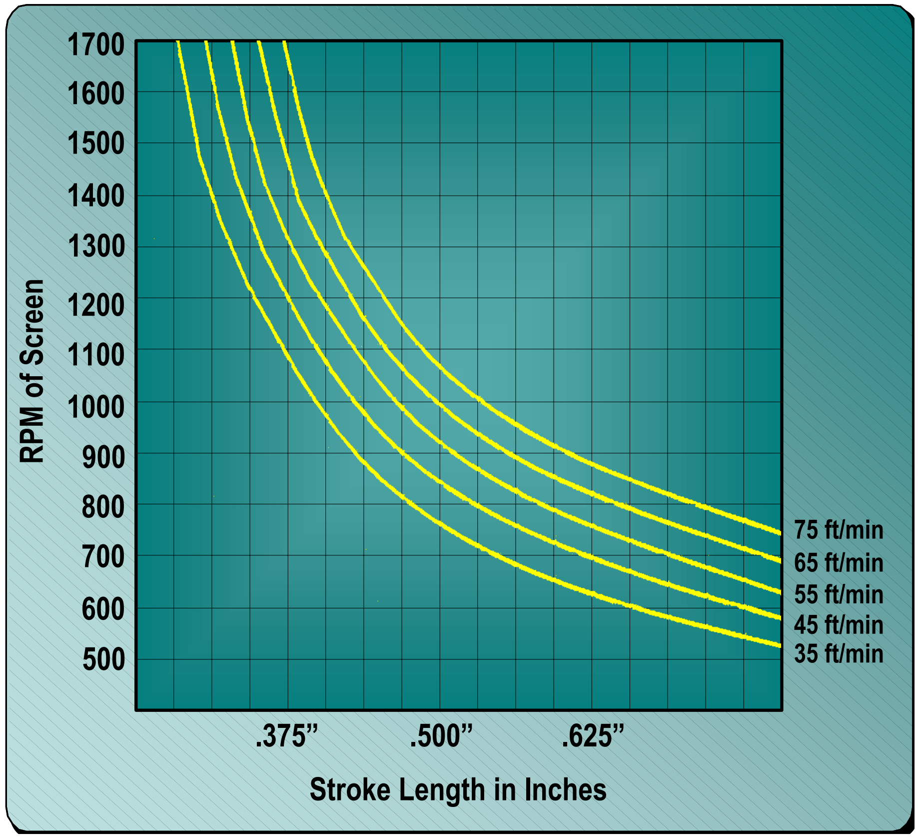


Figure 23, Chart B - Conveying Velocity at 15° Incline Incline Screen with Circular Stroke

NOTE: Screening media and shape of material to be screened greatly effect conveying velocity.

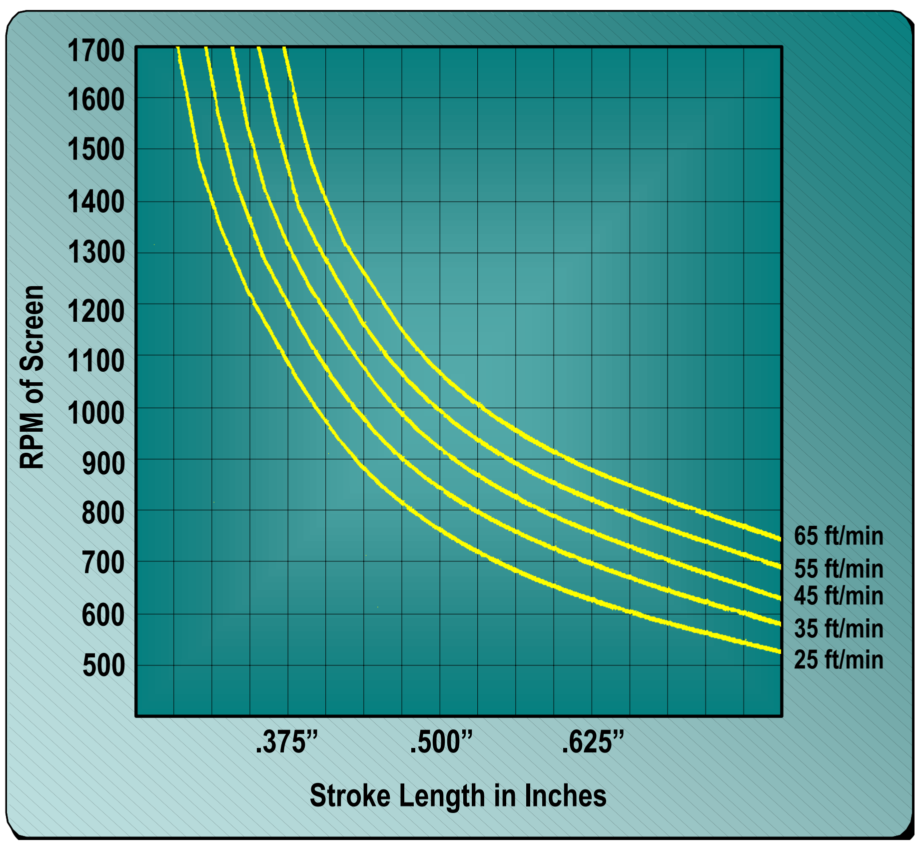


Figure 23, Chart C - Conveying Velocity at 10° Incline Incline Screen with Circular Stroke

For flat or horizontal screens, **"SP"** depends on timing angle, rpm, and stroke length. For a screen with 45 degree timing, 830 rpm, and 11/16 stroke the conveying speed is 60 ft per minute. Refer to Figure 24, charts A, B, C, D, E, F, G, for conveying velocity of flat screens. Other factors affecting conveying speed which are normally not considered are shape of material, weight, volume, type of stroke, and the condition of the surface of the screening medium, including wirecloth tension and support.

NOTE: Screening media and shape of material to be screened greatly effect conveying velocity.

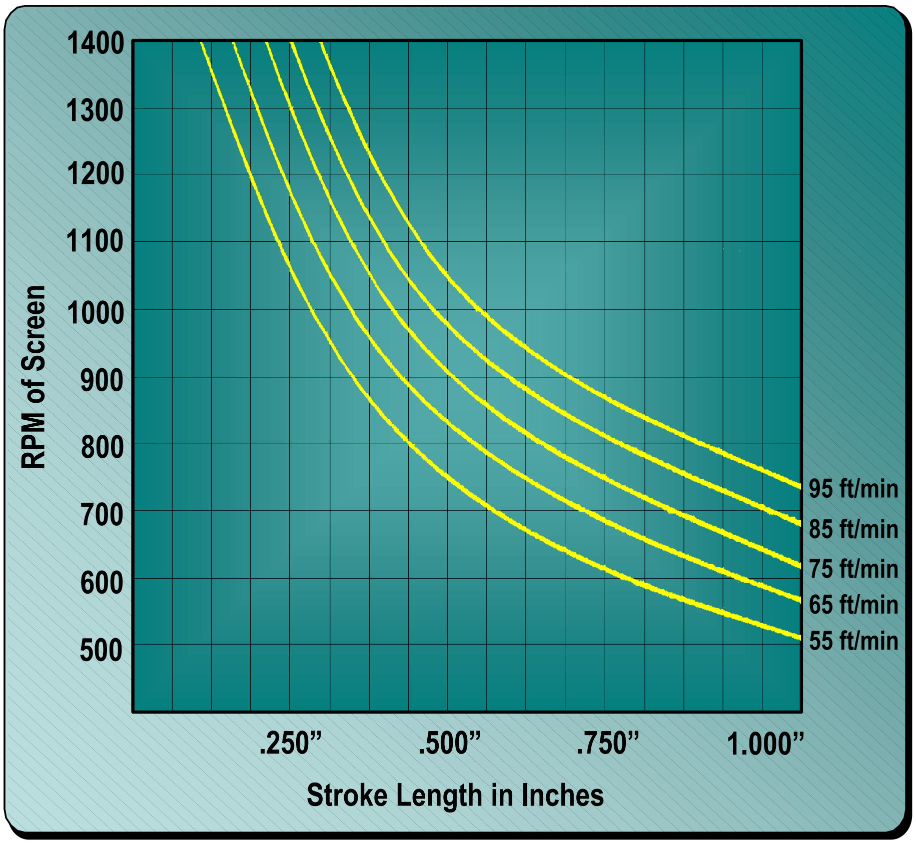


Figure 24, Chart A - Conveying Velocity at 60° Timing Angle Flat Screens

NOTE: Screening media and shape of material to be screened greatly effect conveying velocity.

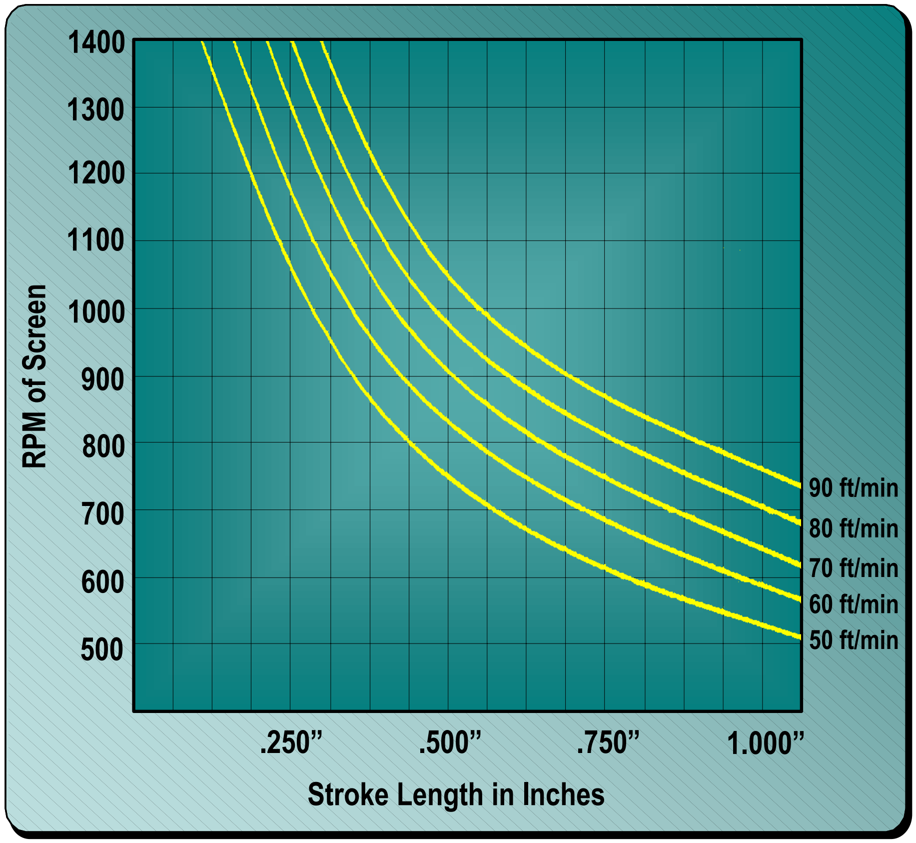


Figure 24, Chart B - Conveying Velocity at 55° Timing Angle Flat Screens

NOTE: Screening media and shape of material to be screened greatly effect conveying velocity.

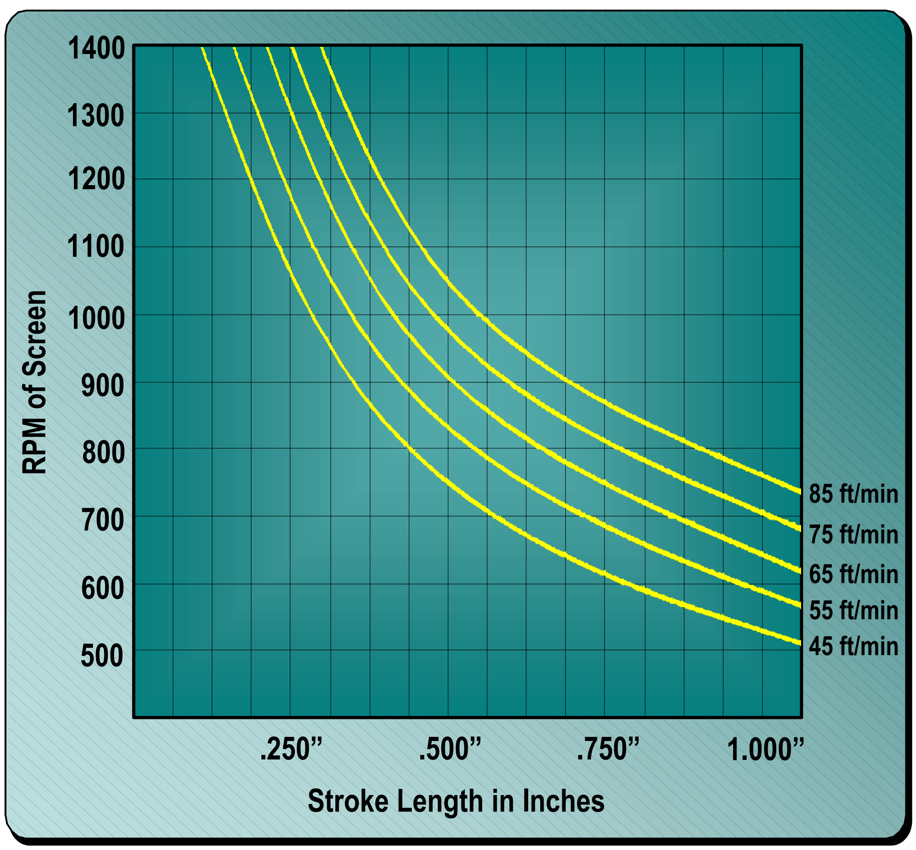


Figure 24, Chart C - Conveying Velocity at 50° Timing Angle Flat Screens

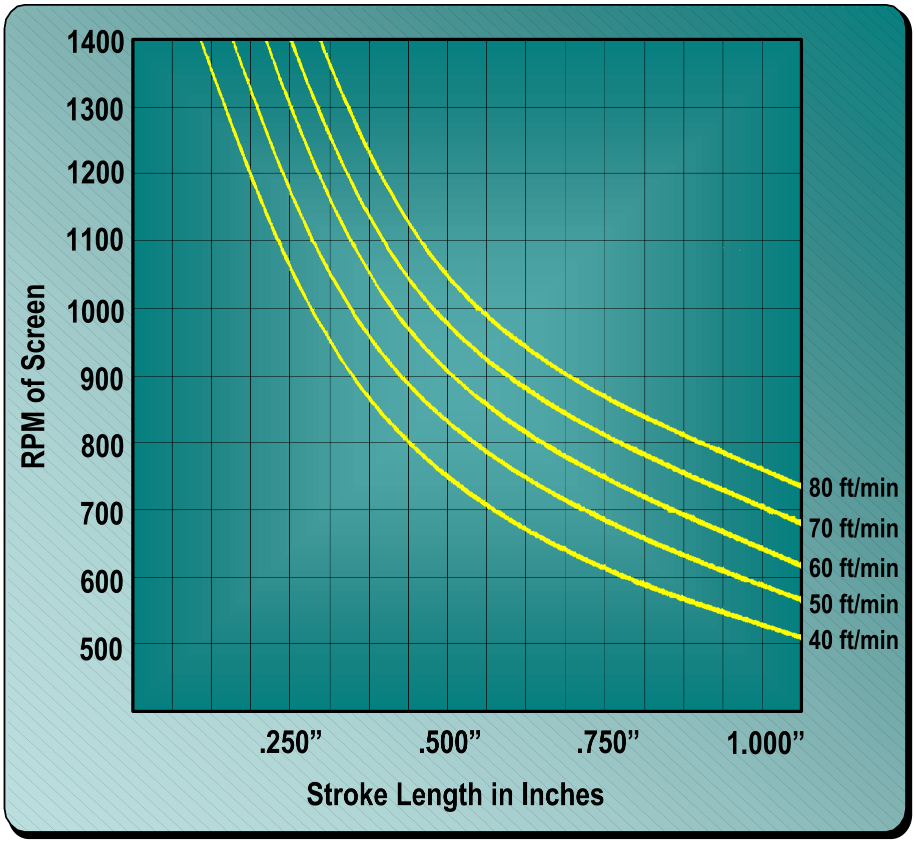


Figure 24, Chart D - Conveying Velocity at 45° Timing Angle Flat Screens

NOTE: Screening media and shape of material to be screened greatly effect conveying velocity.

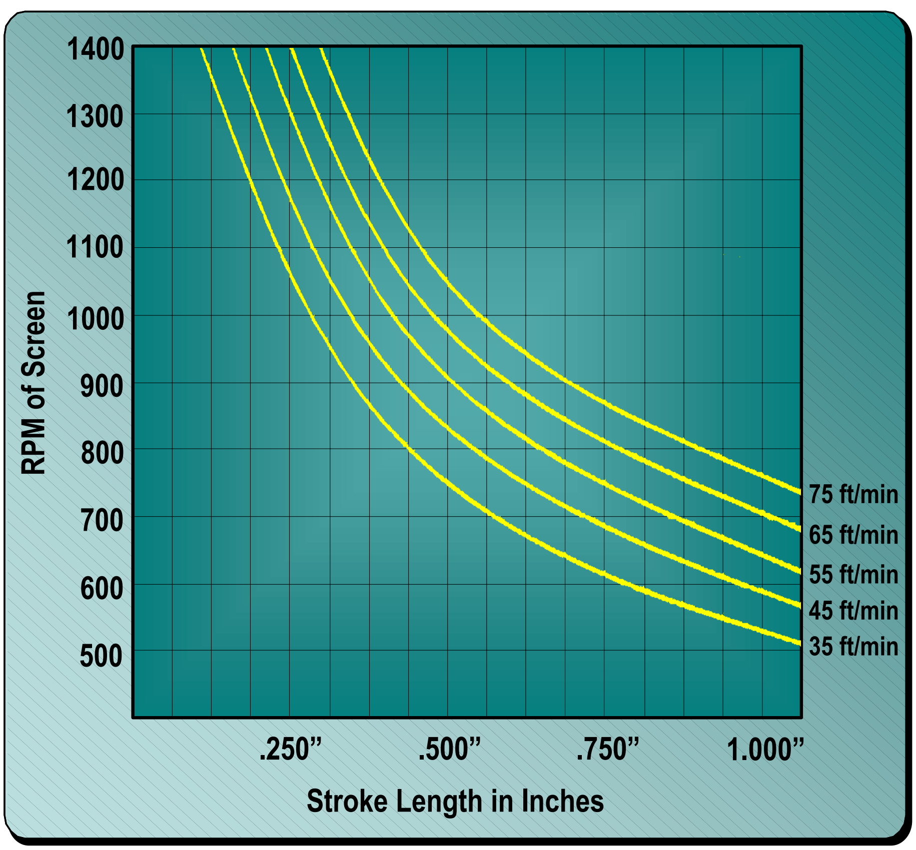


Figure 24, Chart E - Conveying Velocity at 40° Timing Angle Flat Screens

NOTE: Screening media and shape of material to be screened greatly effect conveying velocity.

NOTE: Screening media and shape of material to be screened greatly effect conveying velocity.

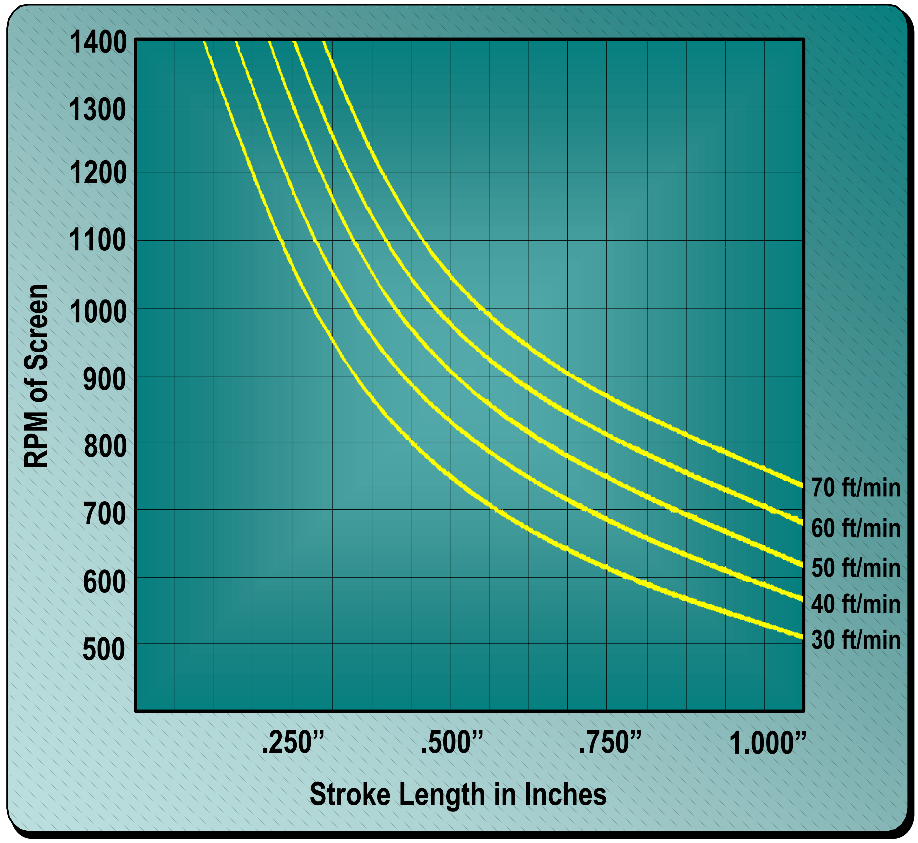


Figure 24, Chart F - Conveying Velocity at 35° Timing Angle Flat Screens

NOTE: Screening media and shape of material to be screened greatly effect conveying velocity.

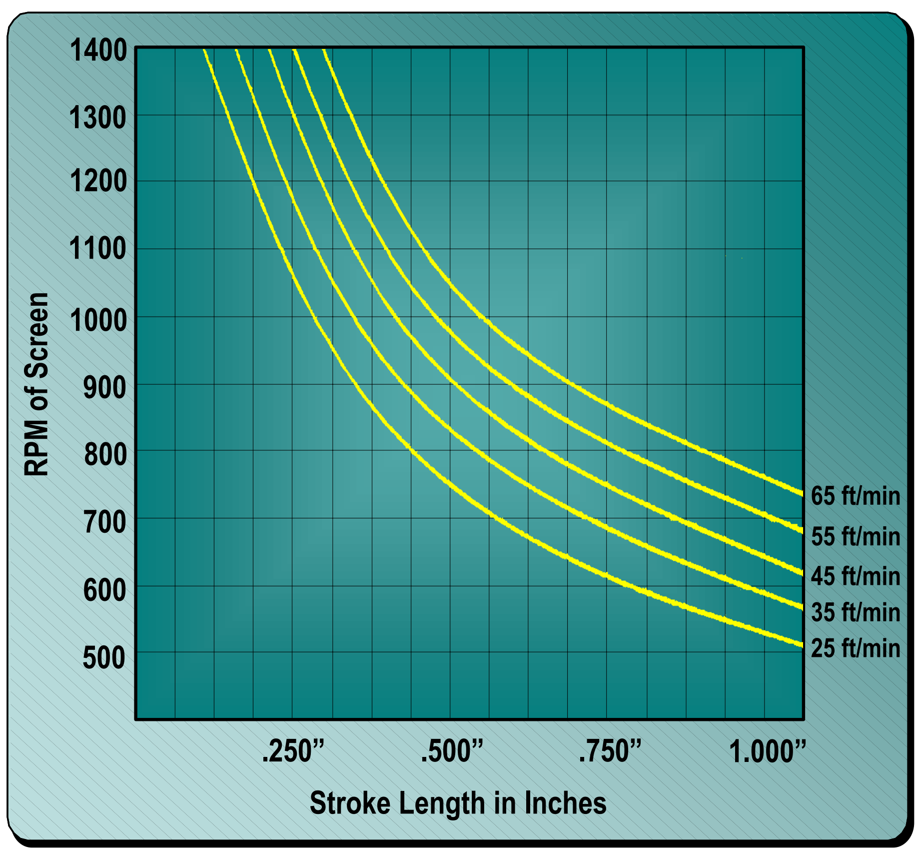


Figure 24, Chart G - Conveying Velocity at 30° Timing Angle Flat Screens

"WD" is the **"Width"** of the screen in feet.

As an example of bed depth, consider a 6 x 16 horizontal screen with 100 TPH Overs,

DM = (TP * KD) / (5 * SP * WD) = (100 * 20) / (5 * 65 * 6) = 1.026 inches

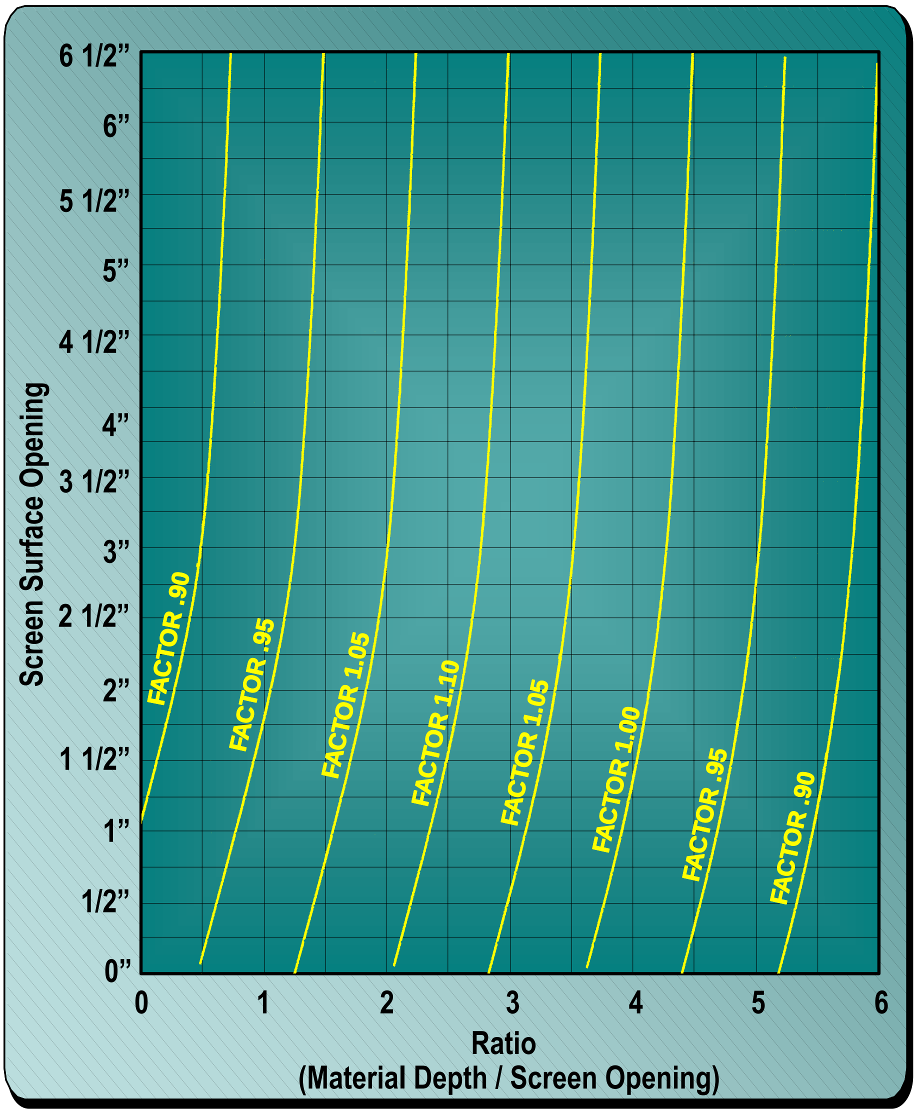


Figure 25 - Bed Depth Factor "BED"

For 2" wirecloth opening the ratio of material depth to opening is (2) / (1.026) = 1.95 ration.

Refer to Figure 25 for the bed depth factor.

It should also be noted that too little bed depth may let material bounce around on the deck like popcorn. With an increase of material on the deck the material settles down and undersize material has a chance to pass through the openings. Calculated bed depths under .75 inches have a reduced capacity for this reason.

These additional factors greatly affect the performance of a screen. We haven't just invented them, they have always affected screen operation. We have only observed them, described them and estimated their values. The situation obviously warrants further and deeper research, but until that happens our estimates can help operators to optimize their process flow and maximize use of operating capital.

As a measure of how they can affect your operation, consider a hypothetical screen with a given set of operating parameters and figure capacities using only the traditional equation, then add the additional factors and see how the capacities differ.

COMPARISON OF SCREEN SIZING USING OLD FACTORS AND ADDITION OF NEW FACTORS:

The operational factors are as follows.

1. Desired screen size 6202
2. Flat screen with oval stroke pattern
3. Feed material 500 TPH from pit with the following gradation

Opening	% Passing
1-3/4”	100.0%
1-1/2”	98.0%
1-1/4”	94.0%
1-1/8”	90.0%
1”	85.0%
7/8”	80.0%
¾”	78.0%
11/16”	73.0%
5/8”	71.0%
9/16”	70.0%
½”	69.0%
7/16”	65.0%
3/8”	40.0%
5/16”	35.0%
¼”	30.0%
4M	27.0%

4. Top deck 1” square opening with 75% open area
5. Bottom deck ½” square opening with 65% open area
6. Material dry crushed rock with less than 3% moisture
7. Stroke length 11/16”
8. Rpm of screen 830
9. Timing angle 45 degrees
10. No spray
11. 5% slivers or elongated material
12. Screen to be at least 95% efficient

The traditional equation yields the following:

Basic Formula: A = B * S * D * V * H * T * K * Y * P * O * W * F

FACTOR	TOP DECK	BOTTOM DECK
B = Basic capacity per square foot in tons/hour	5.50 TPH/SQ FT	3.80 TPH/SQ FT
S = Incline factor (1.0 for flat screens)	1.00	1.00
D = Deck factor	1.00	.90
V = Oversize factor	1.25	1.13
H = Halfsize factor	1.55	.90
T = Slot factor	1.00	1.00
K = Material condition factor	1.00	1.00
Y = Spray factor	1.00	1.00
P = Shape factor	1.00	1.00
O = Open area factor	1.30	1.20
W = Weight factor	1.00	1.00
F = Efficiency factor	.95	.95
	13.16 TPH/SQ FT	3.97 TPH/SQ FT

A 6202 screen has 120 square feet per deck screening area.

Top deck 120 SQ FT x 13.16 TPH/SQ FT = 1579.2 TPH CAPACITY
Deck only needs to handle 500 TPH

Bottom deck 120 SQ FT x 3.97 TPH/SQ FT = 476.4 TPH CAPACITY
Deck only needs to handle 425 TPH

The traditional equation tells us that the upper deck capacity is over 1500 TPH. Therefore the upper deck is comfortably over sized and the bottom deck is over sized by 50 TPH (10%). The system has no problem handling what is asked of it.

If, however, the additional factors described in this paper are taken into account:

FACTOR	TOP DECK	BOTTOM DECK
TYP = Type of stroke factor	1.11	1.10
STR = Stroke length factor	.85	.80
TIM = Timing angle factor	.98	.97
RPM = Revolutions per minute factor	.90	.83
NEA = Near size factor	1.10	.59
BED = Bed depth factor (6 FT SCREEN)	1.10	1.08
	1.007	.451

Using the basic capacity from above for each deck, a greater accuracy can be predicted for the above screen application.

Top Deck

13.16 TPH/SQ FT X 1.007 = 13.25 TPH/SQ FT for the top deck

11.80 TPH/SQ FT X 120 SQ FT = 1590 TPH CAPACITY TOP DECK

Deck only needs to handle 500 TPH

Bottom Deck

3.97 TPH/SQ FT X .451 = 1.79 TPH/SQ FT for the bottom deck

1.74 TPH/SQ FT X 120 SQ FT = 214.80 TPH CAPACITY BOTTOM DECK

Deck needs to handle 425 TPH

While the top deck is still within its limits, the bottom deck is woefully undersized, handling less than half the product required of it. This is an example of how a screening plant designer might be diligent in planning and still under design for a given installation.

The example is not extreme or an exaggeration of what can happen. In fact, only one of the six additional factors greatly effected the results. The inclusion of the NEA factor of .59, a common circumstance, greatly reduced the bottom deck capacity. It is easy to imagine the situation where more than one condition is adverse and the inadequacies build on one another.

Possible remedies for the situation described above:

1. Larger screen to increase the bottom deck area.
2. Reduction in the amount of feed to the screen.
3. Smaller wire opening for the top deck to reduce the load to the bottom deck.
4. Change gradation of feed material by closing or opening the close-side setting on the crusher ahead of the screen.

CONCLUSION

As we pointed out previously, the additional factors we suggest have always been present. Heretofore they have made up a significant portion of the fudge factor that every prudent plant designer has had to incorporate. Our additions will reduce that fudge factor and assure the production of a new system will more closely match what was planned for. Time and experience will tell if they are sufficient for every use or if new factors or new values for the ones existing are appropriate.

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