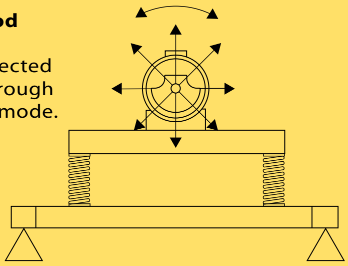
SELECTING THE ELECTRIC VIBRATOR

Vibration systems and methods

The systems that use the vibration technique can be divided into the following categories:
• freely oscillating systems, which will be described in this guide
• oscillating systems bound to resonance, which require specific in-depth research. Please contact the Technical Sales Service of Italvibras if these systems are required.
The free oscillation system includes two different methods:
• rotational: the vibrating force is directed in all directions through 360° in a rotational way, either clockwise or anticlockwise.
• unidirectional: the vibrating force is directed in one single direction in fade-free sinoidal reciprocating mode.
The "rotational" method is obtained by using a single electric vibrator.
The "unidirectional" method is obtained by using two electric vibrators with the same electro-mechanical characteristics, each turning in the opposite direction to the other.

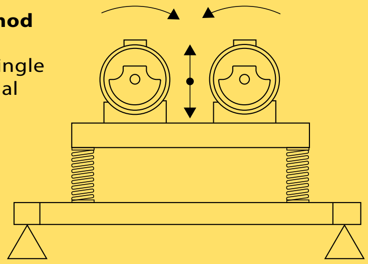
Rotational method

Vibrating force directed in all directions through 306°, in rotational mode.



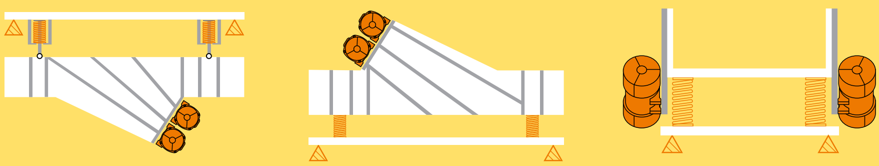
Unidirectional method

Vibrating force in a single direction, in sinusoidal reciprocating mode.

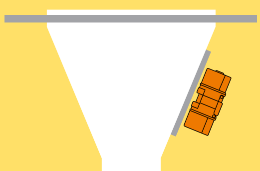


Examples of how electric vibrators are used in different processes

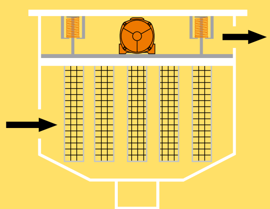
The following examples illustrate a few typical uses:



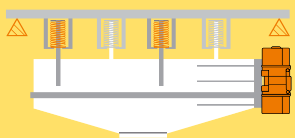
For conveyors, separators, sieves, sizing machines, unloaders, positioners, sorters, feeders and fluidized beds: unidirectional method.



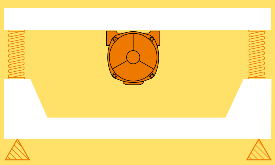
For silos and hoppers: rotational method.



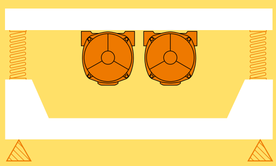
For filters: rotational method.



For vibrating beds: rotational method.



For compacting tables and tests (accelerated ageing, stress, ecc.): rotational method.



For compacting tables and tests (accelerated ageing, stress, ecc.): unidirectional or rotational method.

Choice of the vibration method and rotation speed (and, thus, the vibration frequency) of the electric vibrator applied to the elastically insulated machine, depending on the process

The choice of the vibration method and vibration frequency able to achieve the utmost efficiency for each type of process, depends on the specific weight and granulometry (or piece size) of the material used in the process itself (consult the Table on page XX).

Regardless of the selected vibration method, the electric vibrators can be mounted on the machine, elastically insulated with its axis in a horizontal or vertical position or, if necessary, in an intermediate position between the two directrices.

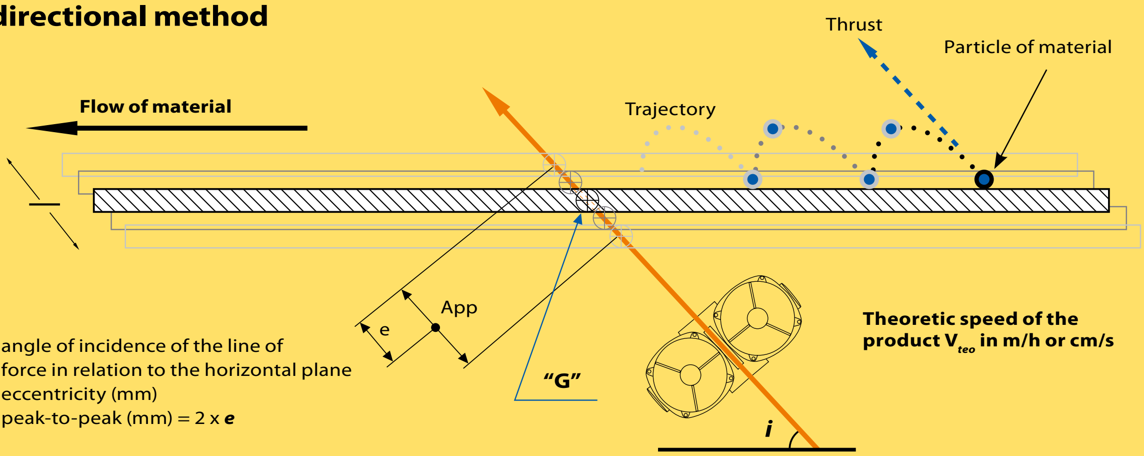
The angle of incidence “i” (measured in degrees) of the line of force in relation to the horizontal plane should be taken into due consideration when electric vibrators are applied with the “unidirectional” method.

Important: the line of force for any angle of incidence must pass through center of gravity “G” of the elastically insulated machine (see figure below).

Determination of the angle of incidence of the line of force depends on the type of process and must be within the indicated range.

“i”	**Processes / Uses**
da 6° a 12°	for special separators (e.g.: the milling industry);
da 25° a 30°	for conveying, unloading, feeding, positioning and sorting;
da 31° a 45°	for sifting, grading and separating;
da 45° a 80°	for fluidized beds.

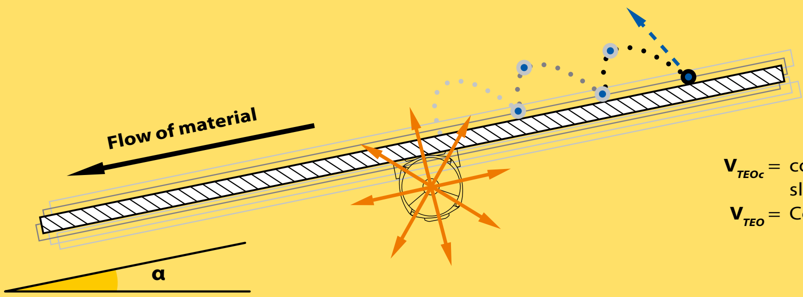
Unidirectional method



Theoretic speed of the product V_{teo} in m/h or cm/s

i = angle of incidence of the line of force in relation to the horizontal plane
e = eccentricity (mm)
App = peak-to-peak (mm) = 2 x ***e***

Rotational method



Corrected theoretic speed of the product V_{TEOc} in m/h or cm/s

$$V_{TEOc} = \frac{V_{teo} + V_i}{F\alpha}$$

V_{TEOc} = corrected theoretic speed to take the slant of the machine into account
V_{TEO} = Corrected theoretic of the product

α = angle of inclination of machine in relation to horizontal plane
i = angle of incidence = 90 -α
Vi = speed of incidence (cm/s or m/h)
Fα = corrective factor to calculate corrected theoretic speed V_{TEOC}
e = eccentricity (mm)

Calculated according to α (see table on right)

Established value	**Values calculated according in α**		
α	***i***	**Fα**	***Vi***
10°	80°	0,81	80
15°	75°	0,71	75
20°	70°	0,60	70
25°	65°	0,48	65
35°	55°	0,25	55

How to choose the right type of electric vibrator for use in typical processes (e.g.: conveying material)

Use the Table on page (78) to select the vibration method and the required number of vibrations per minute depending on the process and the granulometry of the material.
Now move to the diagram (amongst those on pages 79 - 88) corresponding to the obtained number of vibrations per minute. Choose the corresponding curve on the diagram, for a previously calculated angle of incidence «i» of the line of force (consult the descriptions on page 75).
Using that diagram and that curve: eccentricity value «e» or peak-to-peak amplitude «App», measured in mm and required to obtain the previously mentioned theoretic product advancement speed value «V_{TEO}» or «V_{TEOc}» can be identified for a required theoretic product advancement speed «V_{TEO}» (m/h or cm/s) or «V_{TEOc}» (m/h or cm/s) for tilted machines.
«V_{TEO}» is determined by the flow of material, taking a reduction coefficient into account (see conveyor channel example below). Given eccentricity value «e», it is possible to determine the value of the total static moment «Mt» (Kg.mm) of the electric vibrator or vibrators. This value is calculated by means of the following formula:

Mt = e x Pv

where: Pv = Pc + Po

with

Pv = total weight of the vibrating complex (Kg);

Pc = weight of the elastically isolated appliance (Kg);

Po = weight of the installed electric vibrator (or vibrators) (Kg); hypothetic weight to be subsequently compared to that of the determined vibrator.

Important: calculated moment Mt is the total moment of the electric vibrators. For example, if the vibrating machine has two electric vibrators, the calculated moment must be divided by two to obtain the static moment of each vibrator.

Once the static moment of the vibrator has been calculated, consult the catalogue to determine the type of electric vibrator required.

Checking the validity of the chosen electric vibrator

Having chosen the type of electric vibrator, centrifugal force value «Fc» (in Kg) of the vibrator itself can now be found in the catalogue.

Use formula $a = \frac{Fc}{Pv}$ (measured n times g)

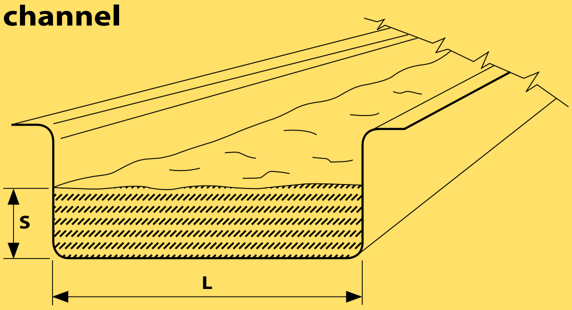
to establish acceleration value «a» along the line of force. This value must be within the range indicated in the Table (on page 78) for the required type of process.
Attention: if the chosen vibration method is "unidirectional", value «Fc» to use in the above mentioned formula will obviously be twice the value indicated in the catalogue as two electric vibrators are installed.

Conveyor channel

Flow rate and speed of product

$$Q = V_p \times L \times S \qquad V_p = V_{teo} \times K_r$$

Q = flow rate **(m^3/h)**
V_p = speed of product **(m/h)**
L = channel width **(m)**
S = layer of material **(m)**



V_{teo} = theoretic speed of the product **(m/h)** (if channel is slanting, indicated **V_{TEOc}**)
K_r = reduction factor depending on the type of product conveyed.
A few values pertaining to this factor are indicated below.

Leaf vegetables	0,70	Wooden shaving or PVC granules	0,75÷0,85
Gravel	0,95	Sand	0,70
Small pieces of coal	0,80	Sugar	0,85
Large pieces of coal	0,85	Salt	0,95

Mechanical insulation of the vibrating equipment from the bearing structure sizing the elastic systems

If free oscillation systems are used, it is advisable to fit anti-vibration mounts (such as helical steel springs, rubber supports or pneumatic actuators) to allow the vibrating machine to freely move in all directions.
Do not use connecting rods, leaf springs or flat springs, etc., for free oscillation systems.
The non-vibrating element must be of adequate capacity, able to bear a weight equal to total weight «Pt» (i.e. the sum of the weights of the elastically insulated machine, or the electric vibrator or vibrators «Pv» and the material bearing on the machine itself «Ps») multiplied by the factor of safety, the value of which is between 2 and 2.5. Capacity «Q» of the elastic element will therefore be:

$$K_{kg} = \frac{Pv + Ps}{N} \times 2{,}5$$

Where
Pv = total weight of the vibrating complex (Kg)
Ps = static weight of material on machine (Kg)
N = number of anti-vibration mounts

Diagram A

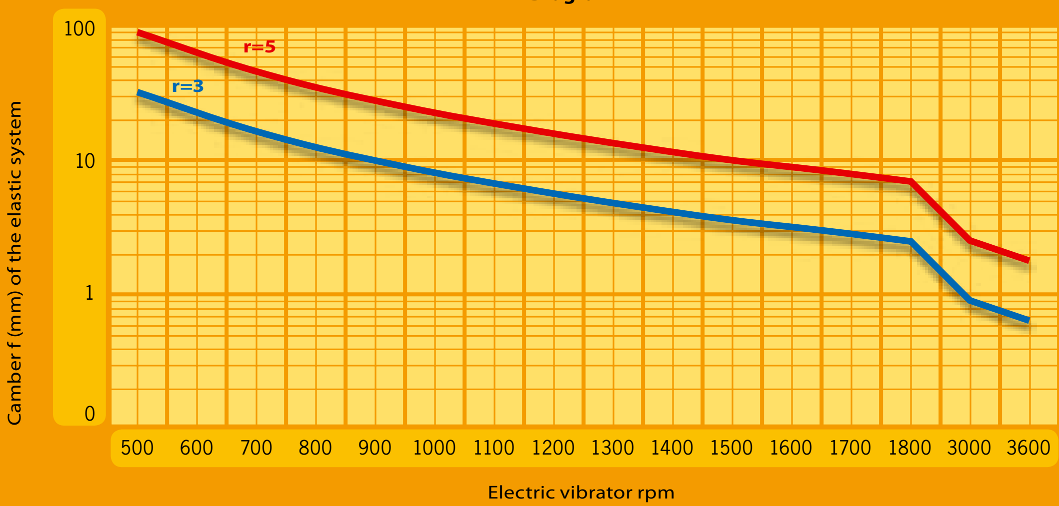
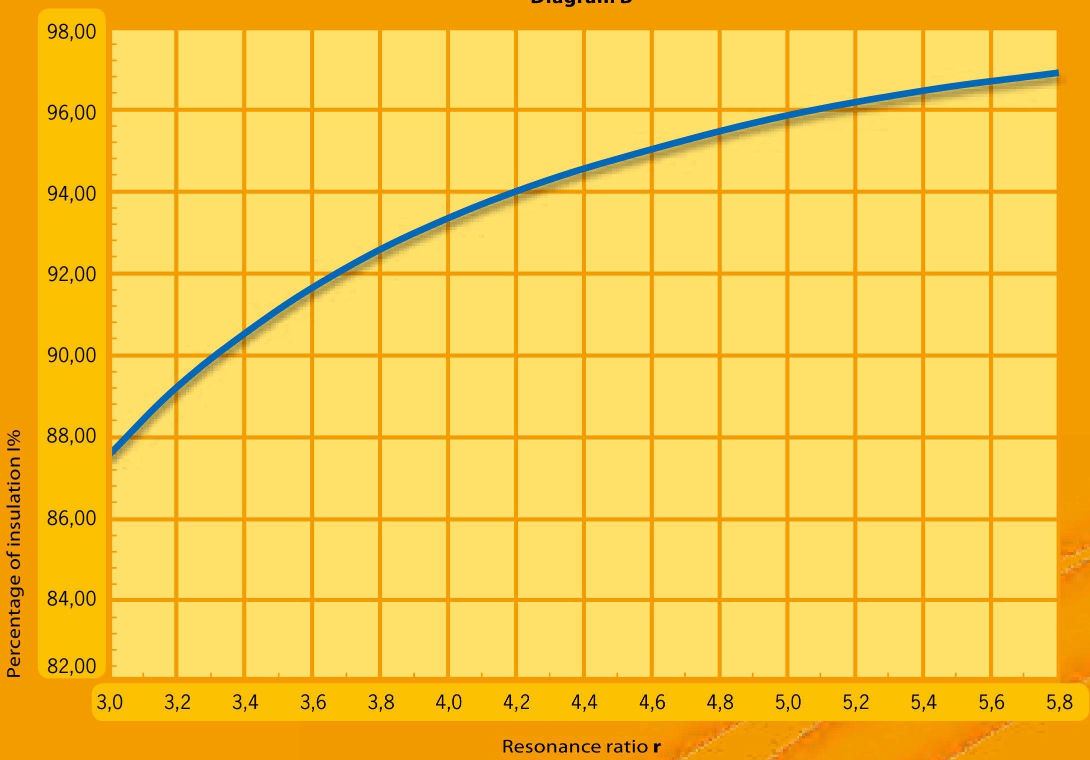


Diagram B



Now determine the camber «f.»of the elastic system by means of diagram A, depending on the vibration frequency (rpm of the electric vibrator) and considering a resonance ratio «r.» (between the vibration frequency of the vibrating complex and the frequency of the elastic system itself) between 3 and 5.
The elastic constant of the anti-vibrating mount thus equals:

$$K_{kg\text{-}mm} = \frac{Pv}{f \times N}$$ where f = camber of the elastic system (mm)

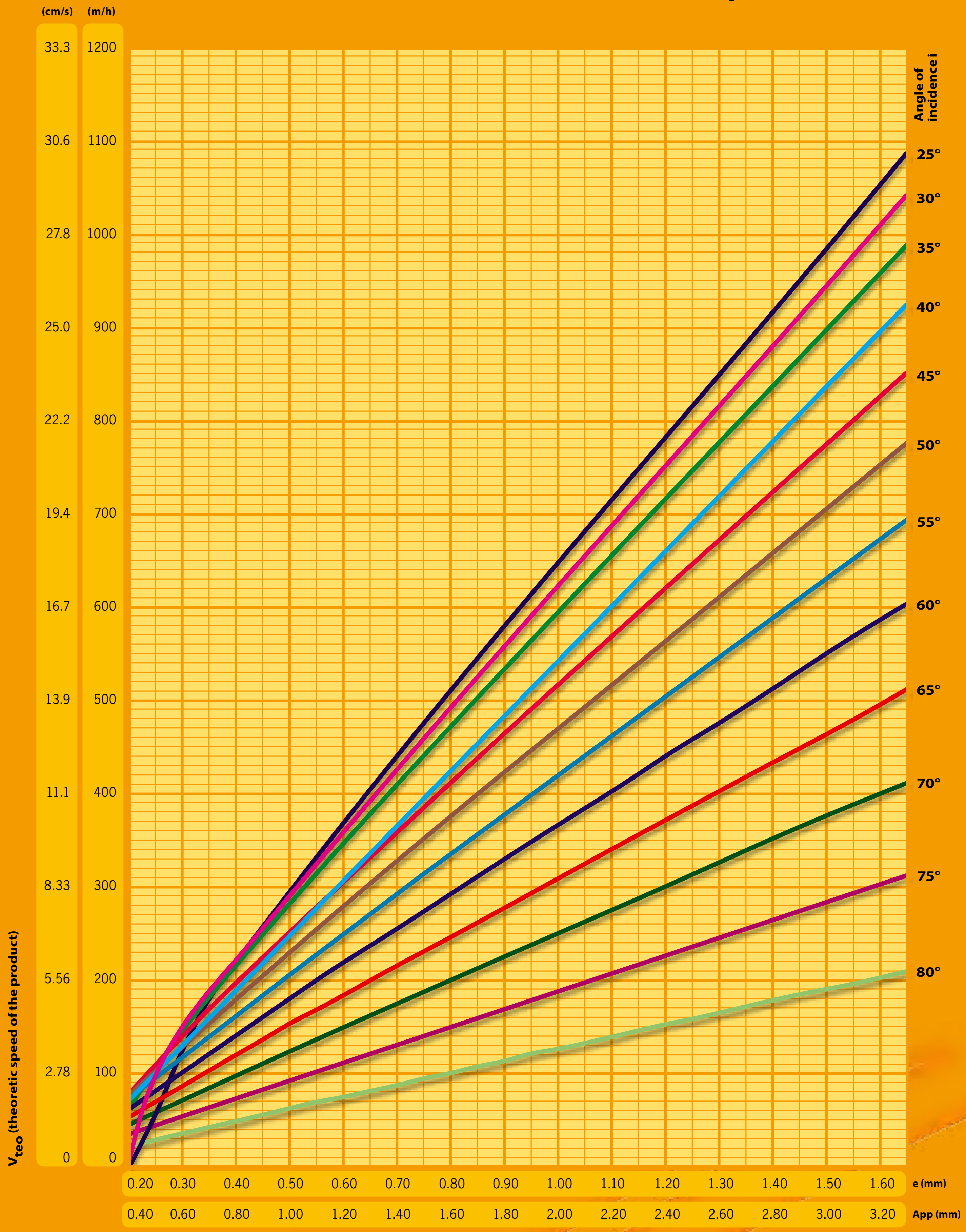
The capacity «$\mathbf{Q_{kg}}$» and the elastic constant «$\mathbf{K_{kg\text{-}mm}}$» are the two entities required to choose the anti-vibration mounts on the market.
It is absolutely essential to distribute the load of the vibrating complex evenly over the elastic system.
Diagram B gives the percentage of elastic insulation (I%) between the vibrating structure and bearing structure, depending on ratio «r».
The anti-vibration mounts must be positioned so that the flexure is the same on all the elements, in order to balance the machine.
Important: the bearing structure to which the anti-vibration mounts of the vibrating complex are fastened must be rigidly anchored to the ground or to some other type of bearing structure and always without any further anti-vibration elements.

Type of process	Specific weight	Sise	Vibrating force Rotat.	Vibrating force Gericht.	Vibrations per minute 600 (50Hz) / 720 (60Hz)	750 (50Hz) / 900 (60Hz)	1000 (50Hz) / 1200 (60Hz)	1500 (50Hz) / 1800 (60Hz)	3000 (50Hz) / 3600 (60Hz)	6000 (50Hz) / -	9000 (50Hz) / -	Accelerat. on the line of force a (nxg)
Conveying, Separating, Sieving, Positioning, Grading, Sizing, Extracting, Feeding	A	F		●				●	●			4÷9
		M		●			●	●				4÷6
		G		●		●	●					3.5÷4.5
	B	F		●				●				5÷7
		M		●			●					4÷5.5
		G		●		●	●					3.5÷5.5
Filter cleaning	A/B	F	●					●	●			2÷3
Slackening and emptying material in silos, hoppers, etc.	A/B	F	●						●			Note (1)
	A/B	M	●						●			
	A/B	G	●					●	●			
Fluidized beds				●		●	●					2÷4
Separators (eg. for mills),				●	●	●						2÷4
Vibrating beds		F	●						●			0.7÷2
		M	●					●	●			
		G	●					●				
		F	●					●				
		M	●					●				
		G	●					●				
Compacting		F	●	●				●	●	●		2÷6
		M	●	●				●	●	●		
		G	●	●				●	●	●		
Compacting concrete	-	-	●	●					●	●	●	1÷2
Test benches (accelerated ageing)	-	-	●	●	●	●	●	●	●	●	●	0.5÷24

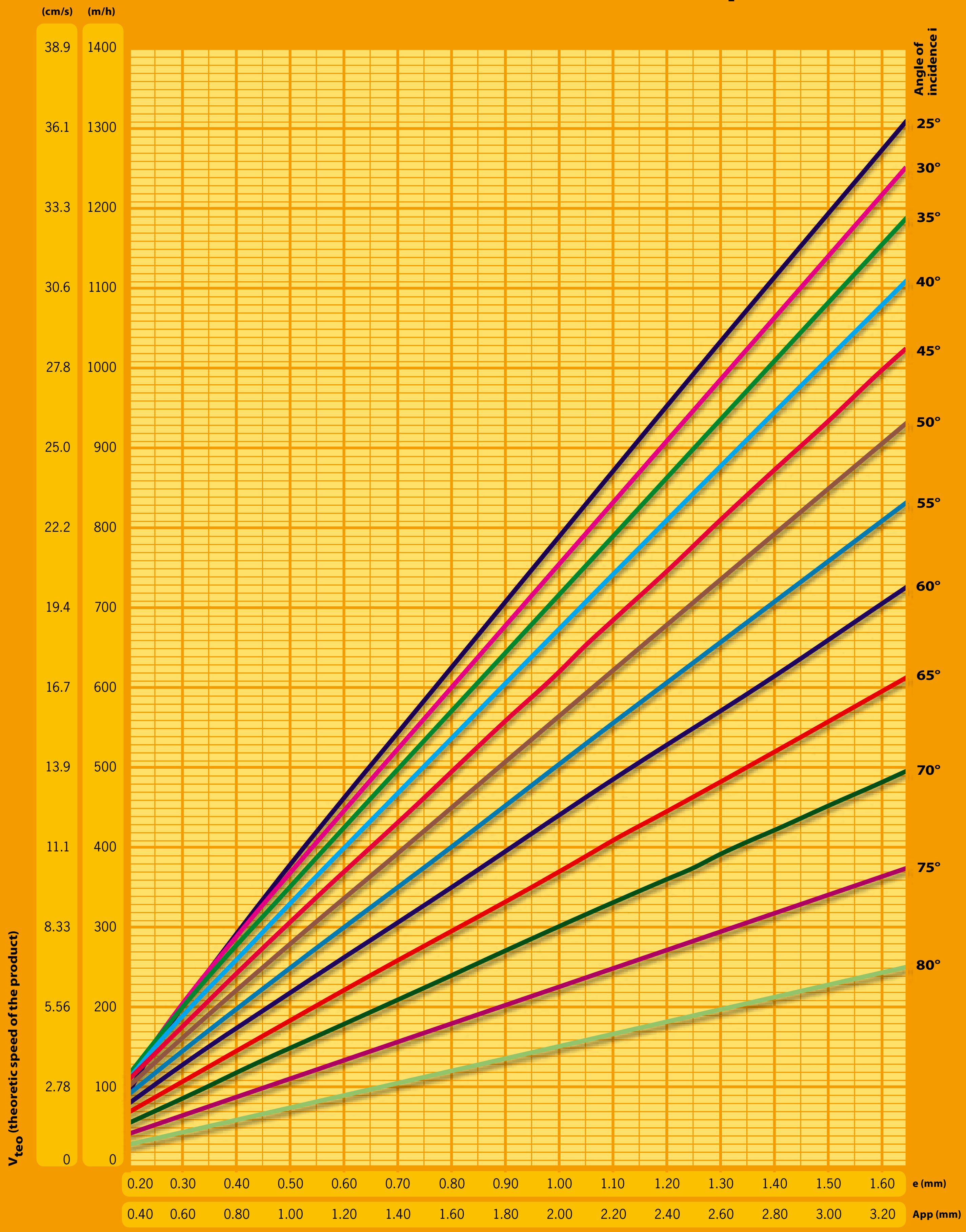
Key: Specific weight A = high B = low
Size F = fine G = coarse M = medium

Note (1): Centrifugal force of the electric vibrator = 0.1 ÷ 0.25 for weight of material cpntained in the vibrating apparatus conic part.

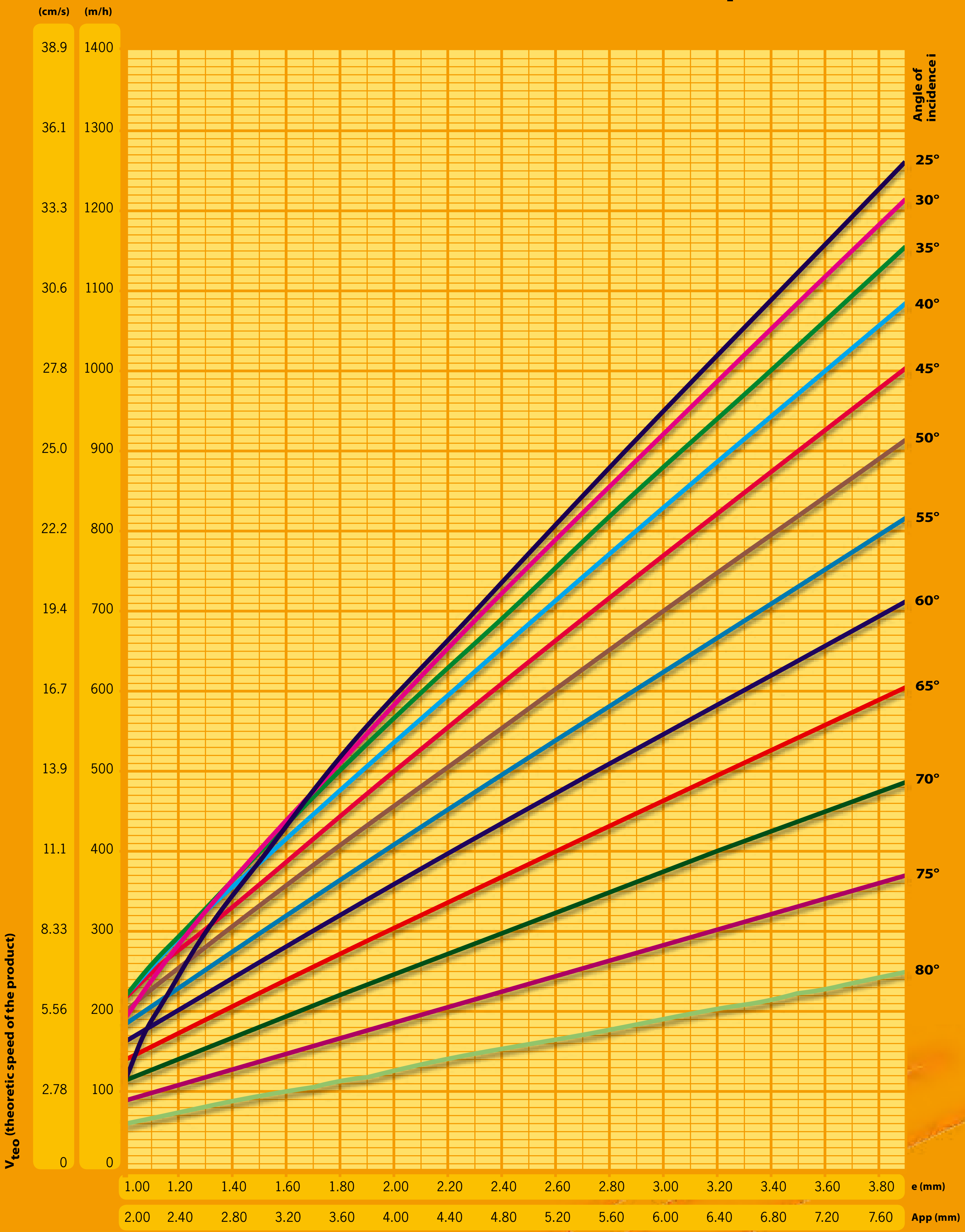
3000 rpm - 50 Hz



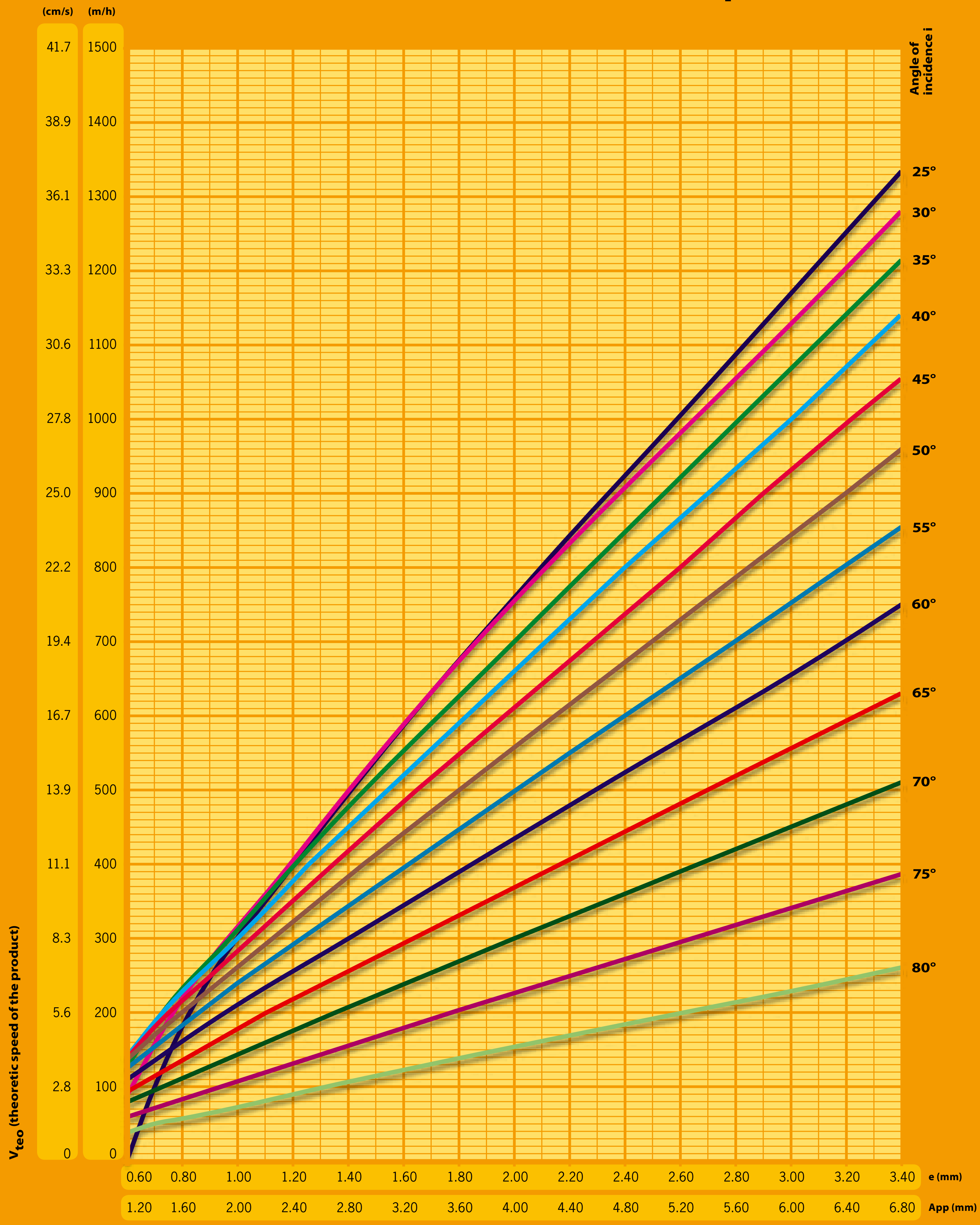
3600 rpm - 60 Hz



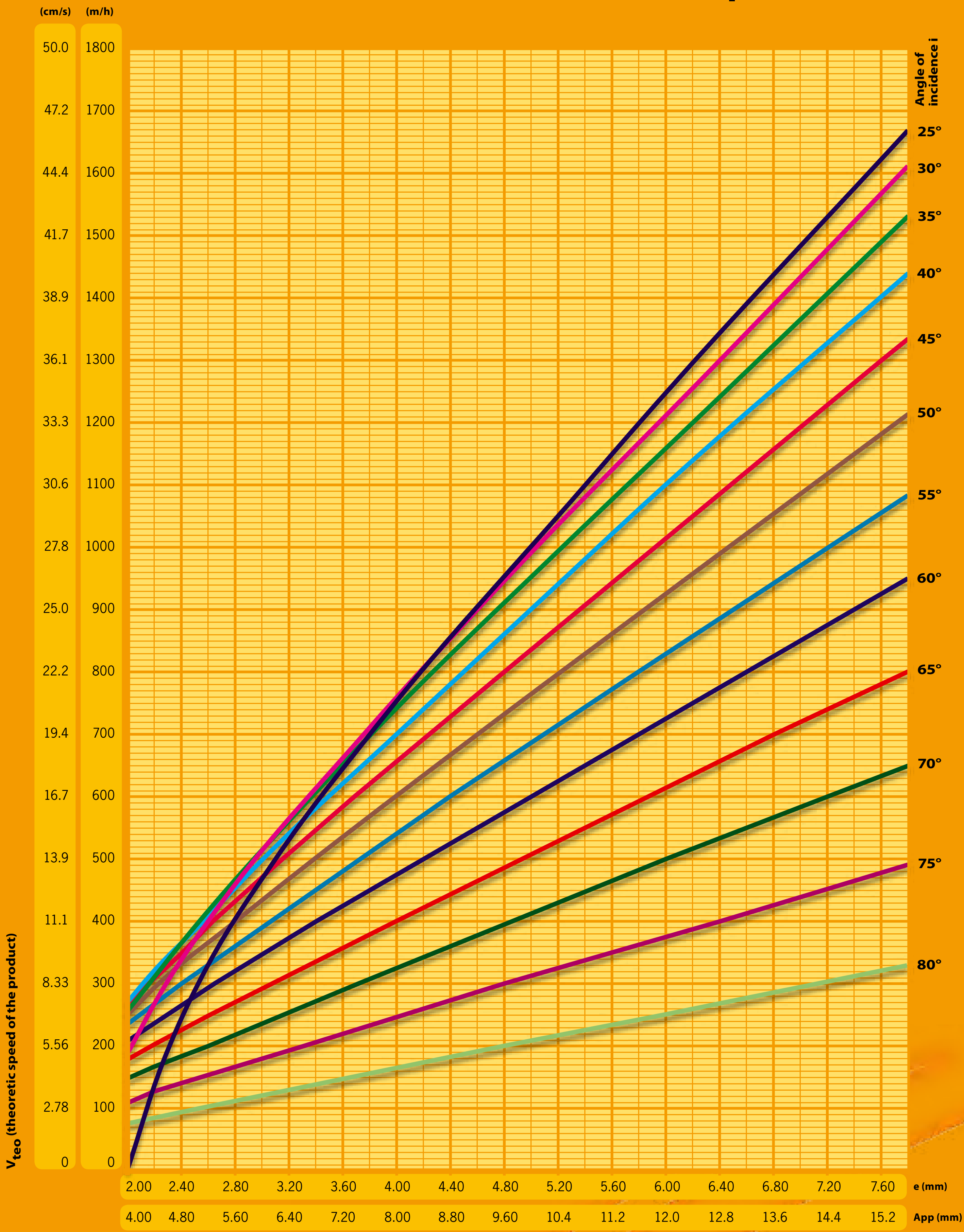
1500 rpm - 50 Hz



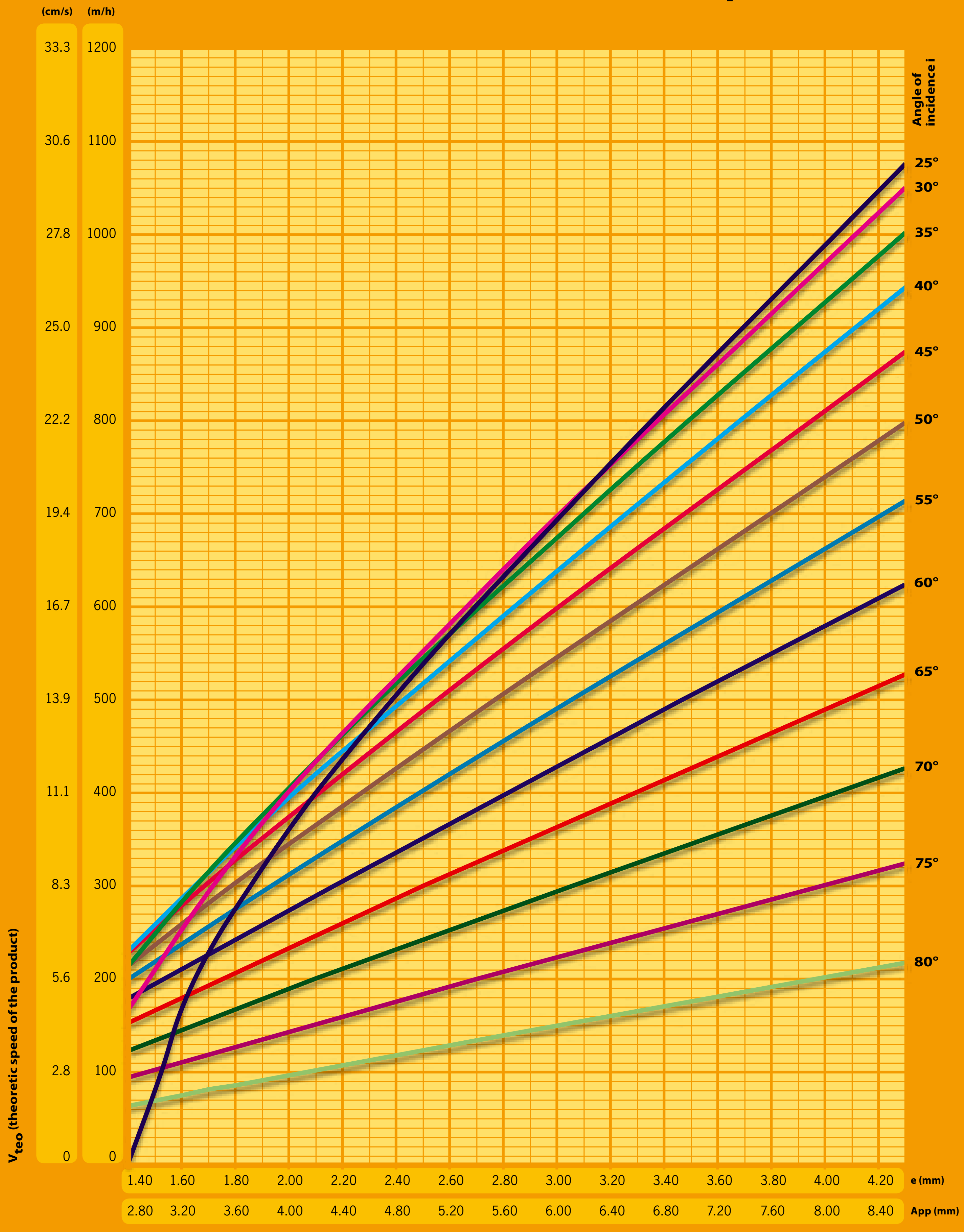
1800 rpm - 60 Hz



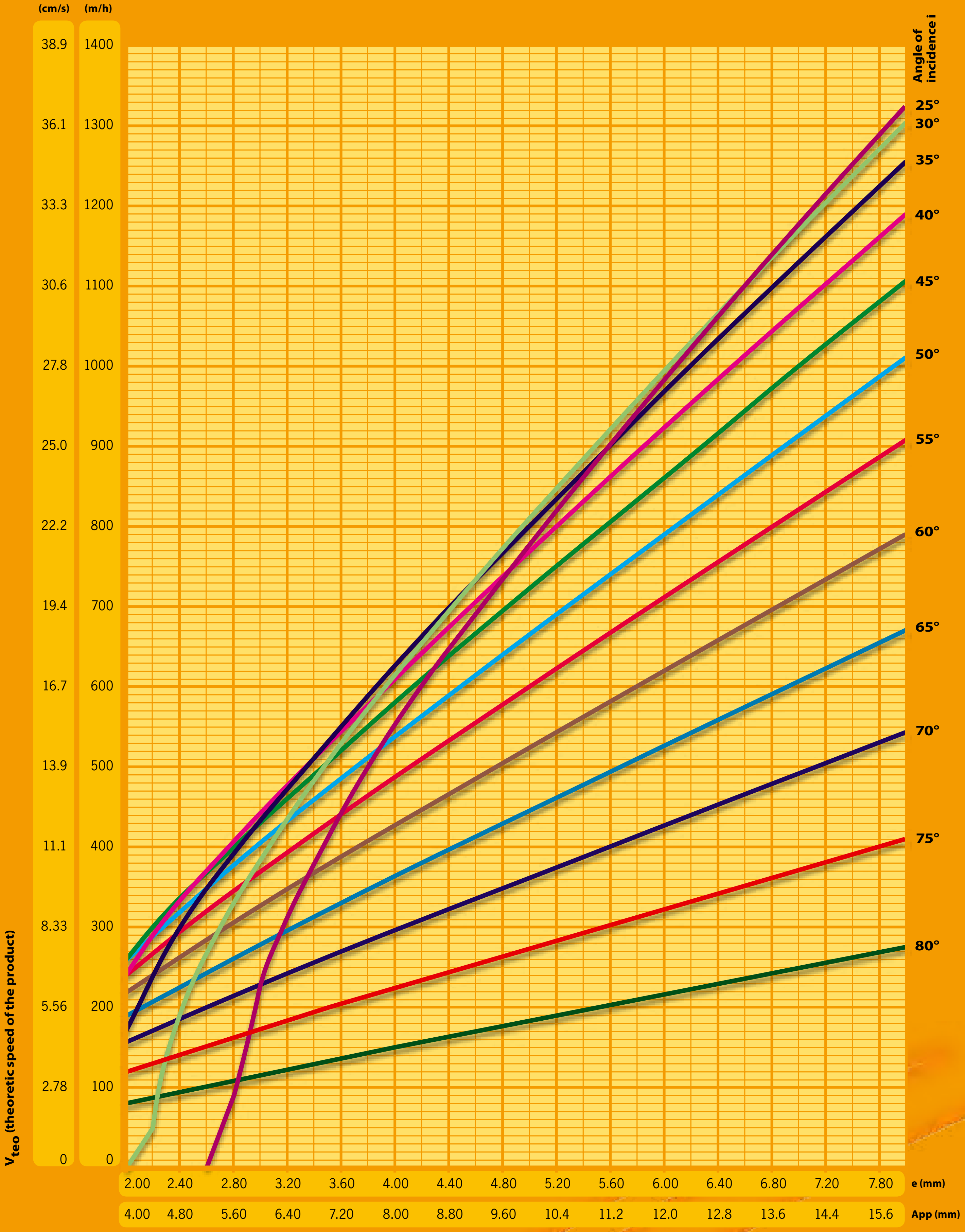
1000 rpm - 50 Hz



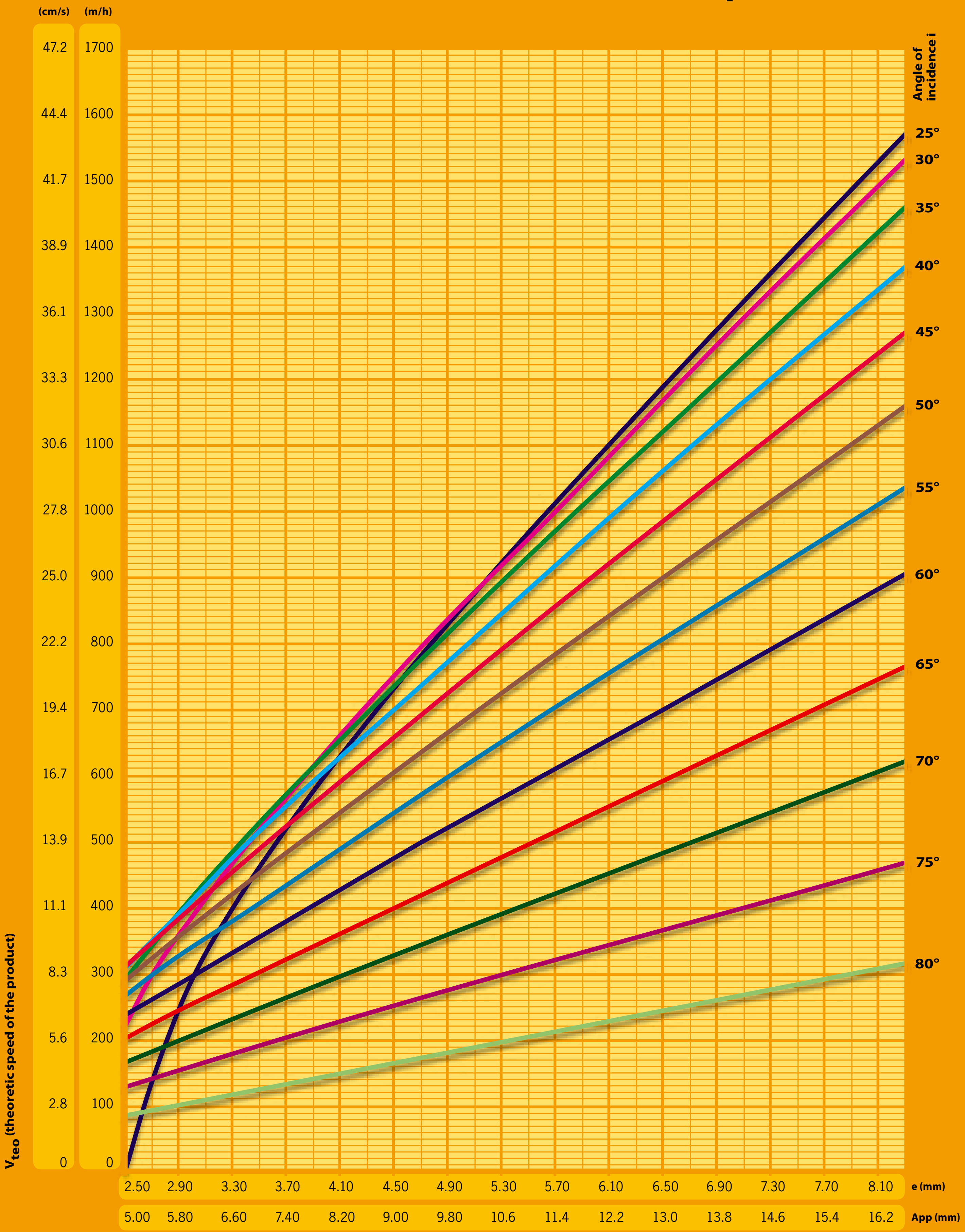
1200 rpm - 60 Hz



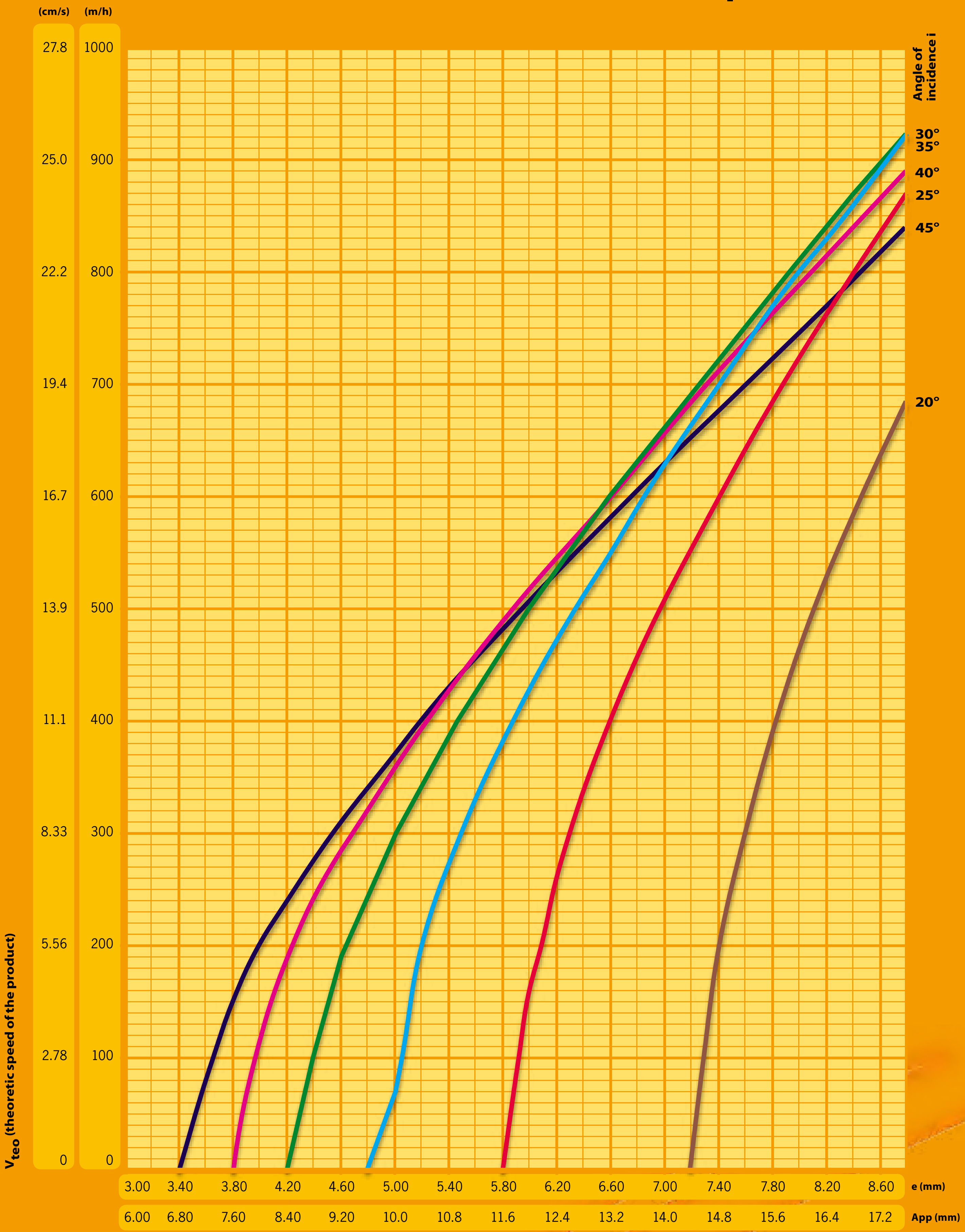
750 rpm - 50 Hz


(cm/s)
(m/h)
38.9
36.1
33.3
30.6
27.8
25.0
22.2
19.4
16.7
13.9
11.1
8.33
5.56
2.78
0
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
V_{teo} (theoretic speed of the product)
Angle of incidence i
25°
30°
35°
40°
45°
50°
55°
60°
65°
70°
75°
80°
2.00 2.40 2.80 3.20 3.60 4.00 4.40 4.80 5.20 5.60 6.00 6.40 6.80 7.20 7.80
e (mm)
4.00 4.80 5.60 6.40 7.20 8.00 8.80 9.60 10.4 11.2 12.0 12.8 13.6 14.4 15.6
App (mm)

900 rpm - 60 Hz

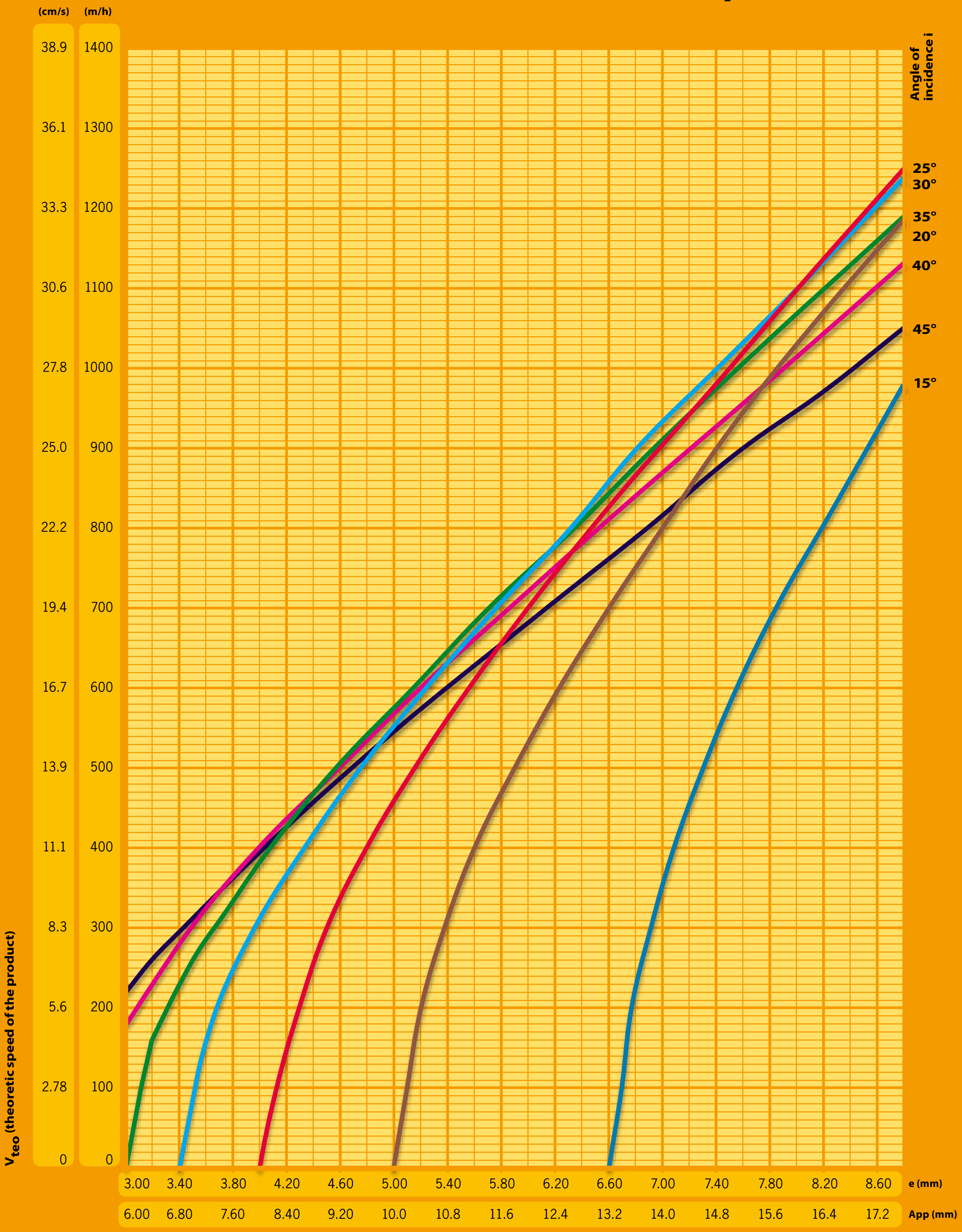

(cm/s)
(m/h)
47.2 1700
44.4 1600
41.7 1500
38.9 1400
36.1 1300
33.3 1200
30.6 1100
27.8 1000
25.0 900
22.2 800
19.4 700
16.7 600
13.9 500
11.1 400
8.3 300
5.6 200
2.8 100
0 0
V_{teo} (theoretic speed of the product)
Angle of incidence i
25°
30°
35°
40°
45°
50°
55°
60°
65°
70°
75°
80°
2.50 2.90 3.30 3.70 4.10 4.50 4.90 5.30 5.70 6.10 6.50 6.90 7.30 7.70 8.10 e (mm)
5.00 5.80 6.60 7.40 8.20 9.00 9.80 10.6 11.4 12.2 13.0 13.8 14.6 15.4 16.2 App (mm)

600 rpm - 50 Hz



(cm/s)
(m/h)
27.8
25.0
22.2
19.4
16.7
13.9
11.1
8.33
5.56
2.78
0
1000
900
800
700
600
500
400
300
200
100
0
V_{teo} (theoretic speed of the product)
Angle of incidence i
30°
35°
40°
25°
45°
20°
3.00 3.40 3.80 4.20 4.60 5.00 5.40 5.80 6.20 6.60 7.00 7.40 7.80 8.20 8.60
e (mm)
6.00 6.80 7.60 8.40 9.20 10.0 10.8 11.6 12.4 13.2 14.0 14.8 15.6 16.4 17.2
App (mm)

720 rpm - 60 Hz



(cm/s)
(m/h)
38.9
36.1
33.3
30.6
27.8
25.0
22.2
19.4
16.7
13.9
11.1
8.3
5.6
2.78
0
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
V teo (theoretic speed of the product)
Angle of incidence i
25°
30°
35°
20°
40°
45°
15°
3.00 3.40 3.80 4.20 4.60 5.00 5.40 5.80 6.20 6.60 7.00 7.40 7.80 8.20 8.60
e (mm)
6.00 6.80 7.60 8.40 9.20 10.0 10.8 11.6 12.4 13.2 14.0 14.8 15.6 16.4 17.2
App (mm)