Scaling Parameters for Pneumatic Conveying

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Scaling parameters

Scaling Requirements
- Conveying Air Velocity
- Solids Loading Ratio

Conveying Distance

Pipeline Bore

Pipeline Bends
- Bend Geometry

Vertical Pipelines
- Vertically up
- Vertically Down

Pipeline Material

Stepped Pipelines
- Conveying Performance

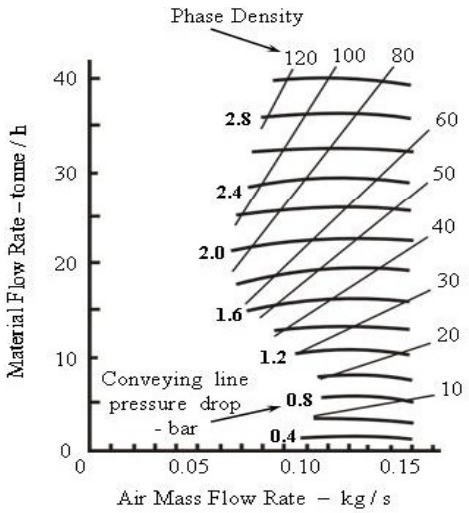


Fig. 105 Conveying Characteristics for Fine Fly Ash Conveyed Over 100m Through An 80mm Bore Pipeline

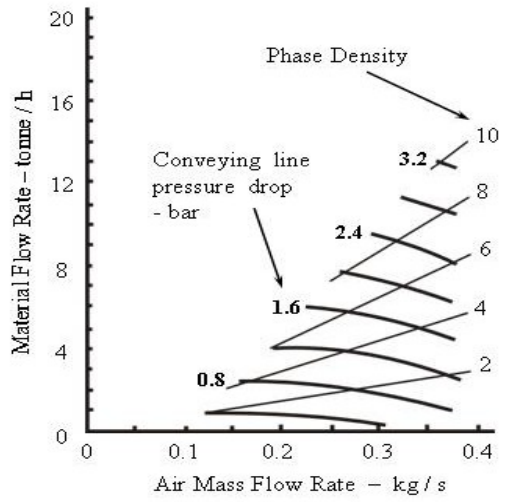


Fig. 106 Conveying Characteristics for Coarse Fly Ash Conveyed Over 100m Through an 80mm Bore Pipeline

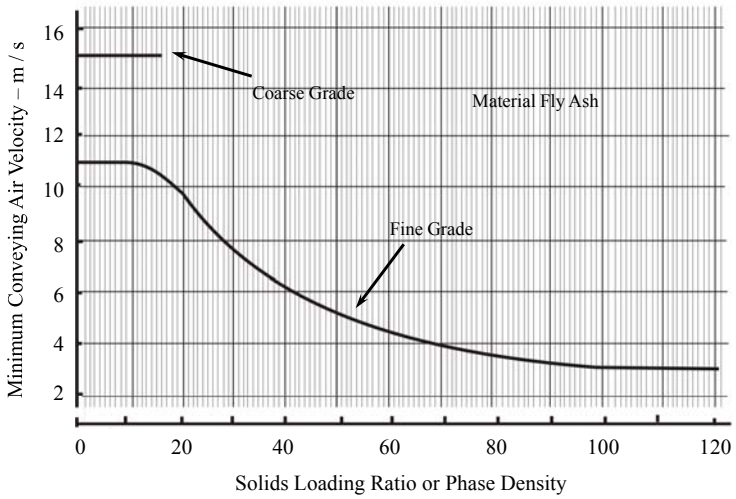


Figure 107 : Influence of Solids Loading Ratio on Minimum Conveying Air Velocity for Fine and Coarse Grade of Fly Ash Being Considered

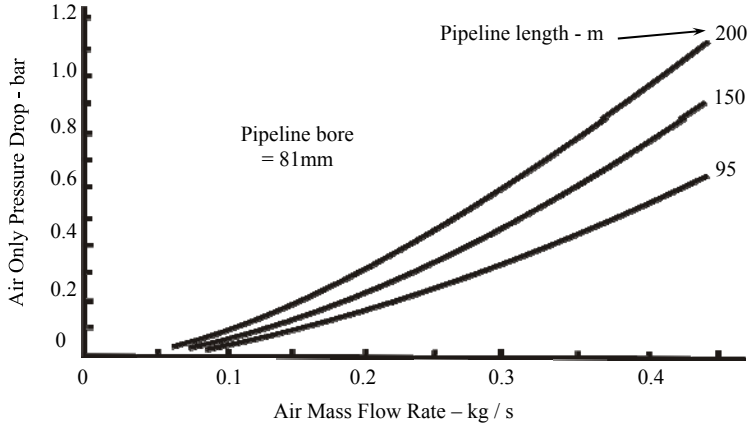


Figure 108 : Influence of Pipeline Length and Air Flow Rate on the Empty Pipeline Pressure Drop Relationships

Scaling model

$$\dot{m}_p \propto \frac{1}{L_e} \qquad \text{----------(61)}$$

Or alternatively :

$$\dot{m}_{p1} L_{e1} = \dot{m}_{p2} L_{e2} = \text{ Const. ----------(62)}$$

For a constant air mass flow rate and pressure drop due to The conveyed material.

Where $\dot{m}_p$ = material flow rate
and L_e = equivalent length of pipeline

Equivalent length

Conveying distance is expressed in terms of an equivalent length of the total pipeline.this comprises the three main elements of the pipeline routing or geometry.

1. Horizontal pipeline
2. Vertical pipeline
3. Bends

Working model

The working from of this scaling model is :

$$\dot{m}_{p2} = \dot{m}_{p1} \times \frac{L_{e1}}{L_{e2}}$$

where subscripts 1 and 2 relate to the appropriate equivalent lengths of the two pipelines

Scaling for Distance and Pipeline Layout

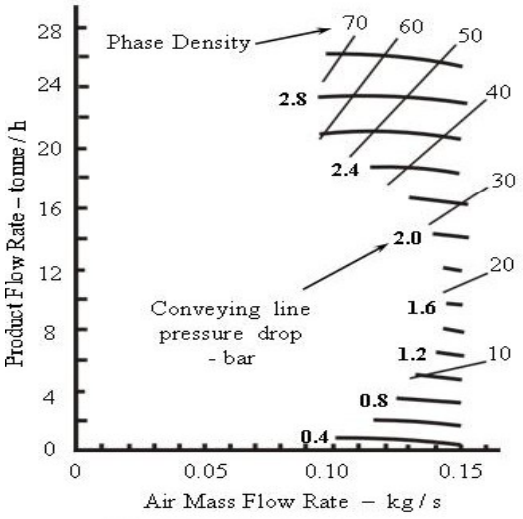
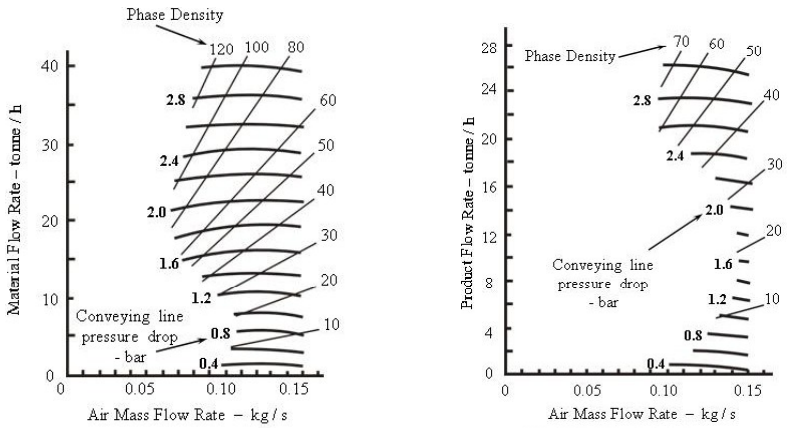


Fig. 109 Conveying Characteristics for Fine Fly Ash Conveyed Over 150m Through an 80mm Bore Pipeline

Comparison between 100m and 150m Pipeline for **Fine** Fly Ash both conveyed through an 80mm bore Pipeline



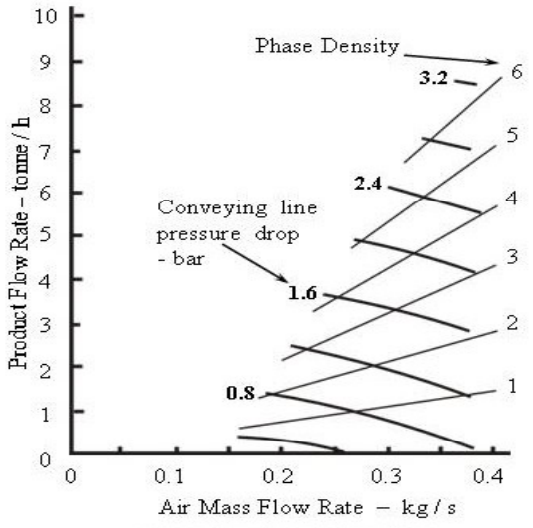
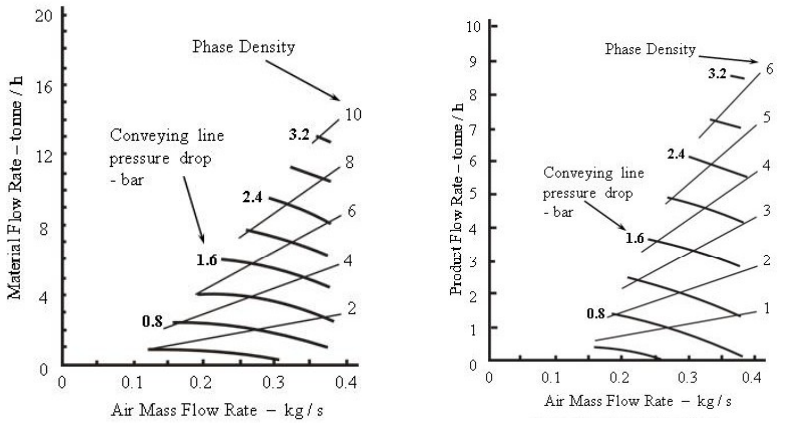


Fig. 110 Conveying Characteristics for Coarse Fly Ash Conveyed Over 150 m Through an 80 mm Bore Pipeline

Comparison between 100m and 150m Pipeline for **Coarse** Fly Ash both conveyed through an 80mm bore Pipeline



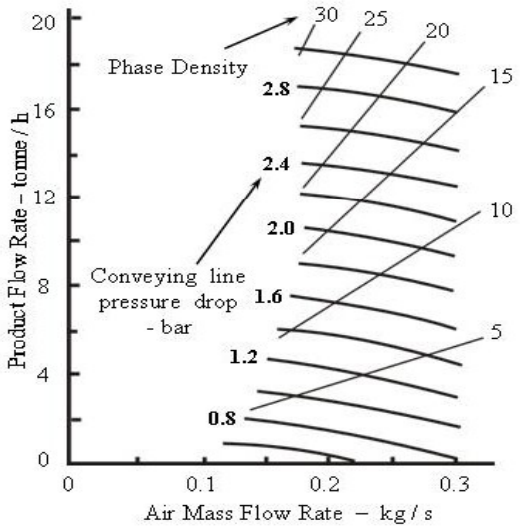


Fig. 111 Conveying Characteristics for Fine Fly Ash Conveyed Over 200m Through an 80mm Bore Pipeline

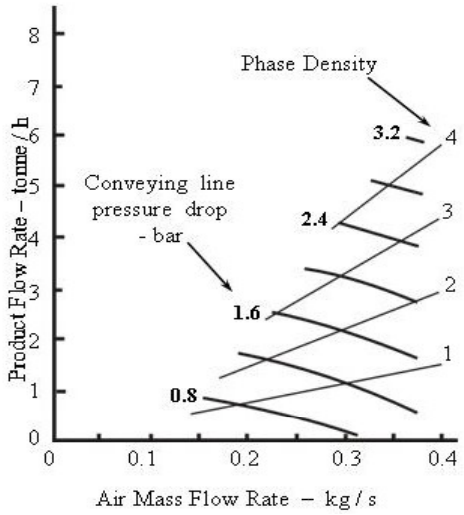


Fig.112 Conveying Characteristics for Coarse Fly Ash Conveyed Over 200m Through an 80mm Bore Pipeline

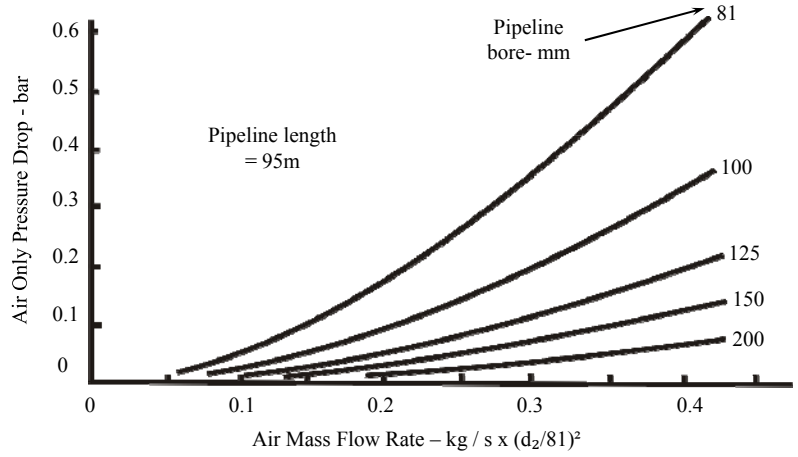


Figure 113 : Influence of Pipeline Bore and Air Flow Rate on the Empty Pipeline Pressure Drop Relationships

Scaling Model

$$\dot{m}_p \propto A \propto d^2 \qquad \text{----------(64)}$$

Or alternatively :

$$\frac{m_{p1}}{d_1^{\,2}} = \frac{m_{p2}}{d_2^{\,2}} = \text{ Const. } \text{----------(65)}$$

Working Model

The working form of this scaling model is :

$$\dot{m}_{p2} = \dot{m}_{p1} \times \left(\frac{d_2}{d_1}\right)^2 \qquad \text{----------(66)}$$

Where subscripts 1 and 2 relate to the appropriate pipe bores of the two pipelines

Scaling for Pipeline Bore

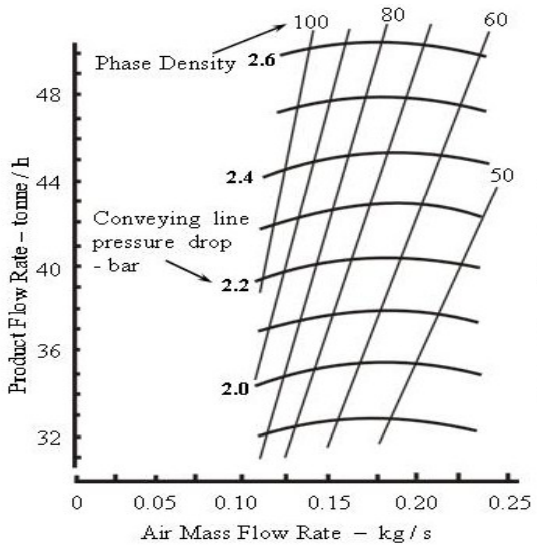
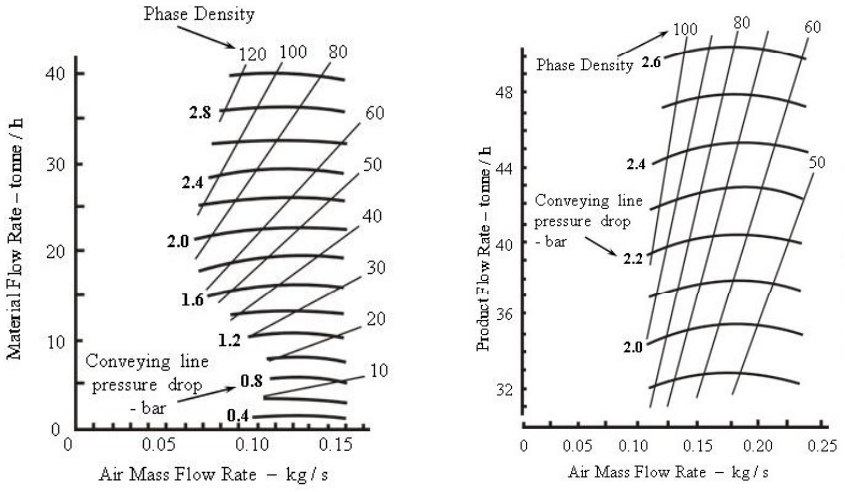


Fig. 114 Conveying Characteristics for Fine Fly Ash Conveyed Over 100m Through a 100mm Bore Pipeline

Comparison between 80mm and 100mm bore Pipelines for **Fine** Fly Ash both conveyed over a Distance of 100m



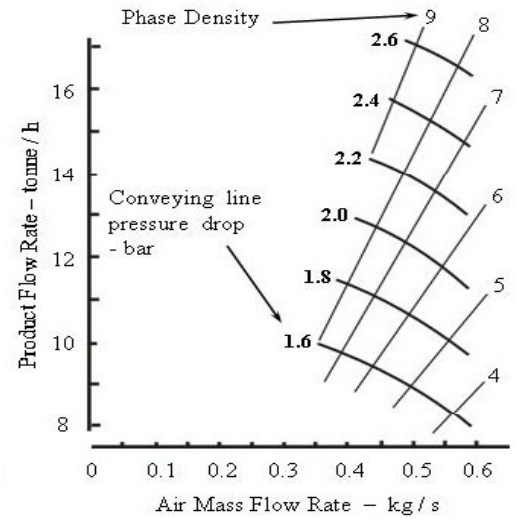


Fig. 115 Conveying Characteristics for Coarse Fly Ash Conveyed Over 100m Through a 100 mm Bore Pipeline

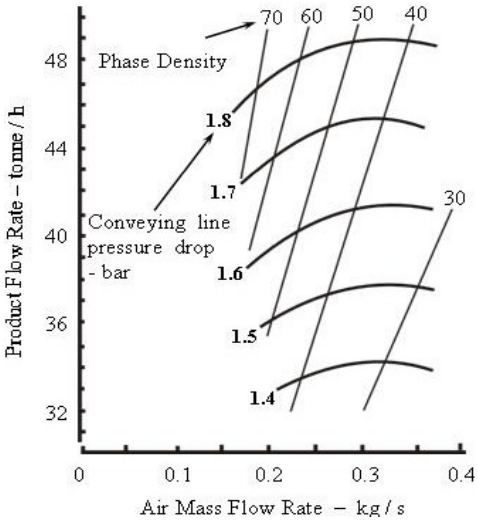


Fig. 116 Conveying Characteristics for Fine Fly Ash Conveyed Over 100m Through A 125 mm Bore Pipeline

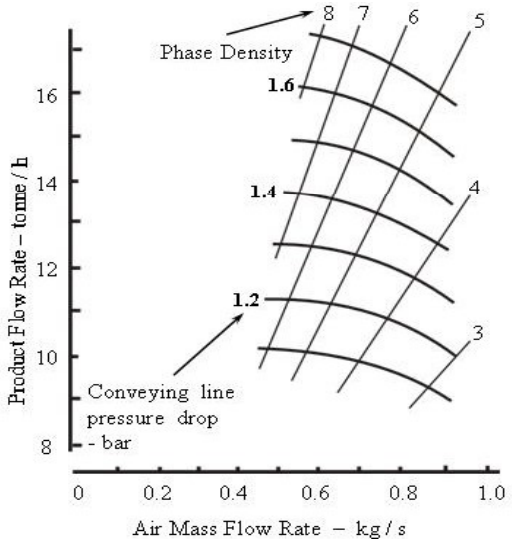


Fig. 117 Conveying Characteristics for Coarse Fly Ash Conveyed Over 100m Through a 125mm Bore Pipeline

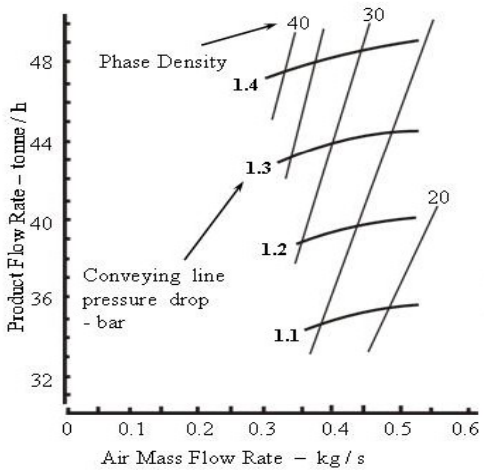


Fig.118 Conveying Characteristics for Fine Fly Ash Conveyed Over 100m Through A 150mm Bore Pipeline

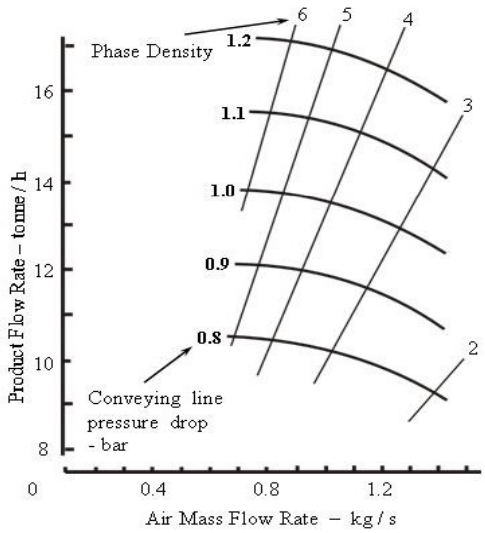


Fig.119 Conveying Characteristics for Coarse Fly Ash Conveyed Over 100m Through a 150mm Bore Pipeline

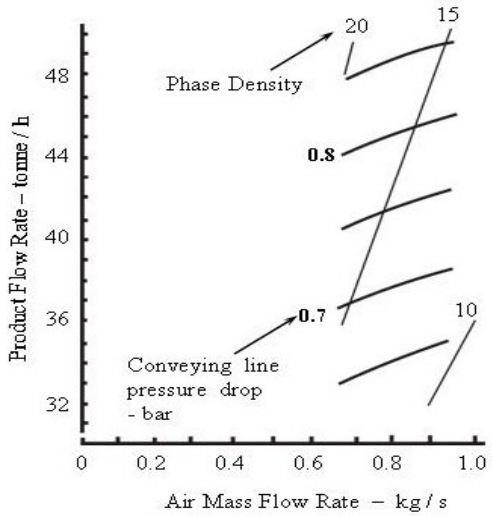


Fig.120 Conveying Characteristics for Fine Fly Ash Conveyed Over 100m Through a 200mm Bore Pipeline

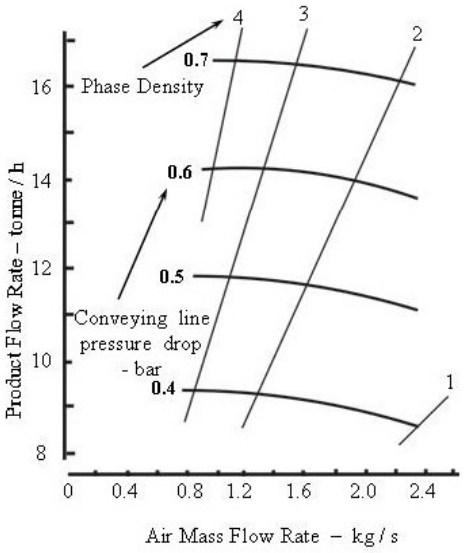


Fig. 121 Conveying Characteristics for Coarse Fly Ash Conveyed Over 100m Through a 200mm Bore Pipeline

Pipe Bore mm	Air Required		Solids Loading Ratio	Conveying Air Velocity m/s		Power Required kW
	Pressure bar gauge	Flow Rate Kg/s		Inlet	Exit	
80	3.00	0.102	109	4.2	16.8	23
100	2.20	0.128	87	4.3	13.5	24
125	1.61	0.207	54	5.4	14.0	32
150	1.22	0.405	27	8.6	19.0	53
200	0.73	0.785	14	12.0	20.7	70

Pipe Bore mm	Air Required		Solids Loading Ratio	Conveying Air Velocity m/s		Power Required kW
	Pressure bar gauge	Flow Rate Kg/s		Inlet	Exit	
80	3.20	0.41	8.2	16.3	67.7	96
100	1.93	0.47	7.1	17.1	49.6	83
125	1.26	0.57	5.8	17.2	38.5	76
150	0.90	0.71	4.7	17.6	33.3	74
200	0.51	1.03	3.2	18.0	27.2	69

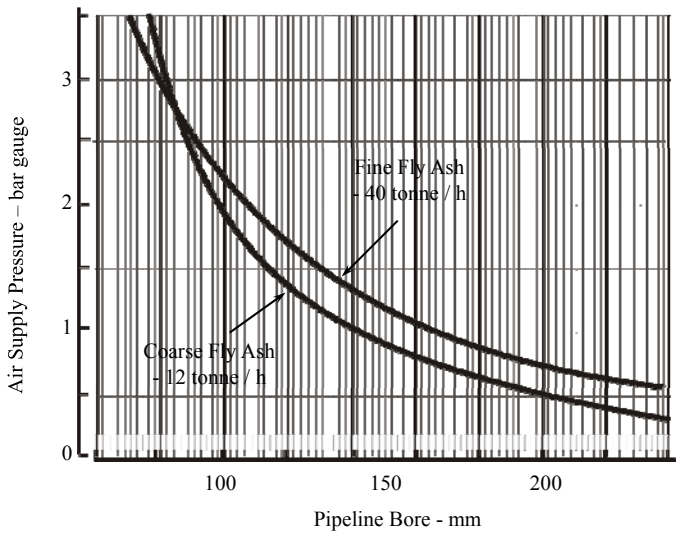


Figure 122 : Influence of pipeline bore on air supply pressure for given parameters

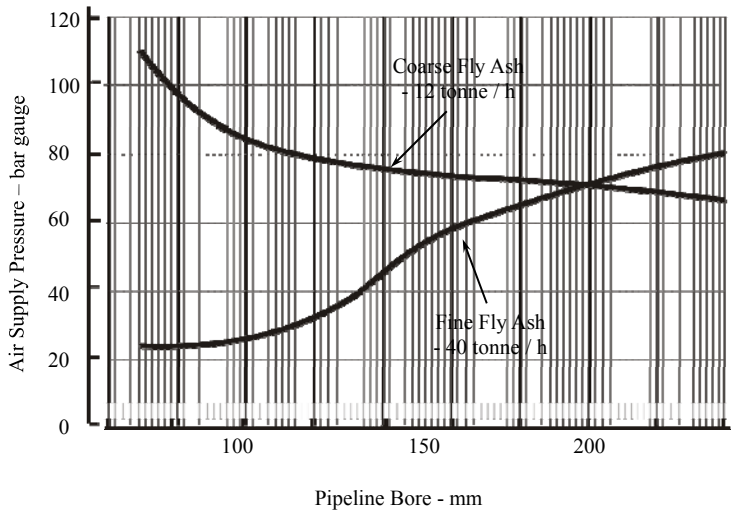


Figure 123 : Influence of Pipeline Bore on Power Requirements for Given Parameters

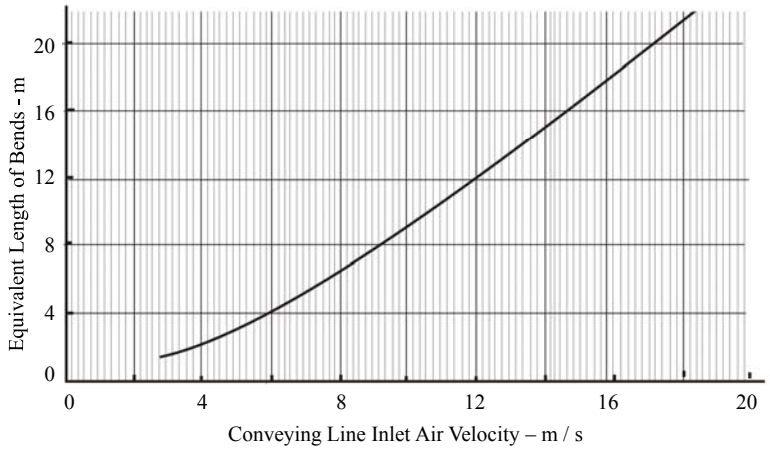


Figure 124 : Equivalent Horizontal Length of Long Radius 90° Bends

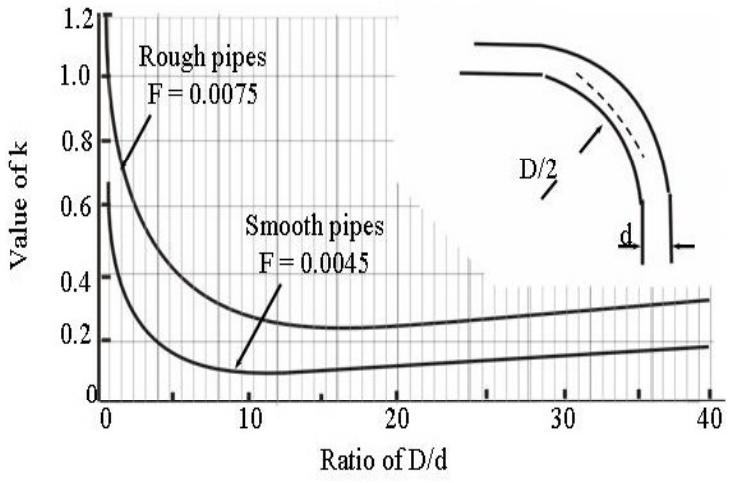


Fig. 73 Head Loss for 90 Degree Bends

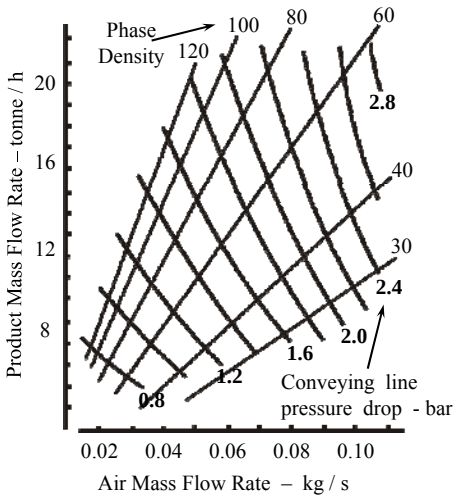


Figure 125 : Conveying Characteristics for Fly Ash in Long Radius Bends

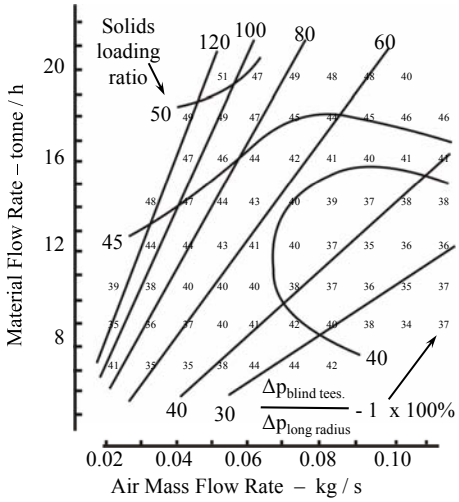


Figure 126 : Blind Tees (D/d=0) Comparison of Conveying Performance of Given Bends With Long Radius (D/d = 24) Bends in Terms of Percentage Increase in Pressure Drop Created

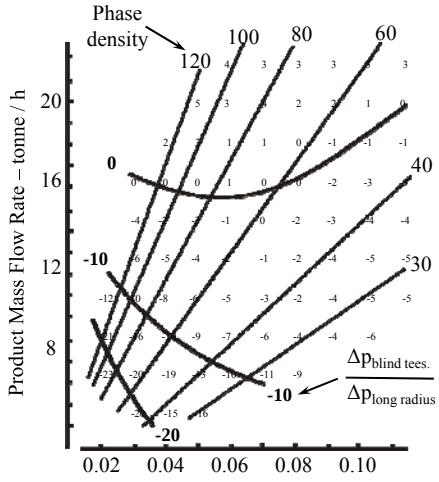


Fig. 127 Comparison of Performance of Short Radius and Long Radius Bends

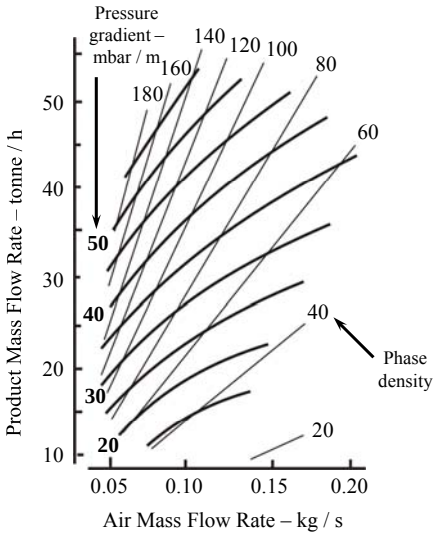


Figure 128 : Pressure Gradient in Vertically Up Flow for Fly Ash in 81 mm Pipeline

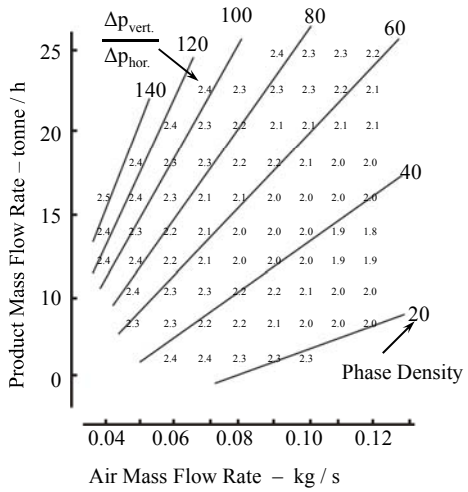


Figure 129 : Ratio of Vertical to Horizontal Pressure Drop for Fly Ash in 53 mm Pipeline

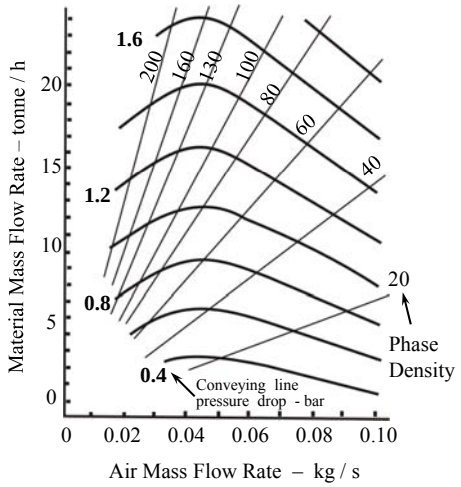


Figure 130 : Conveying Characteristics for Cement in Steel Pipeline

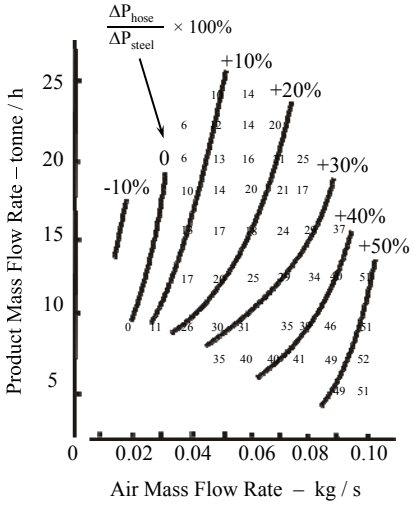


Figure 131 : Comparison of Pressure Drop Data for Steel and Rubber Hose Pipeline

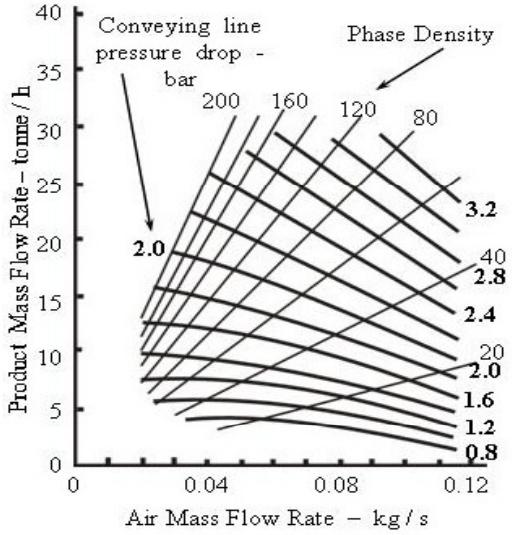


Fig.132 : Product Conveying Characteristics for Single Bore Pipeline

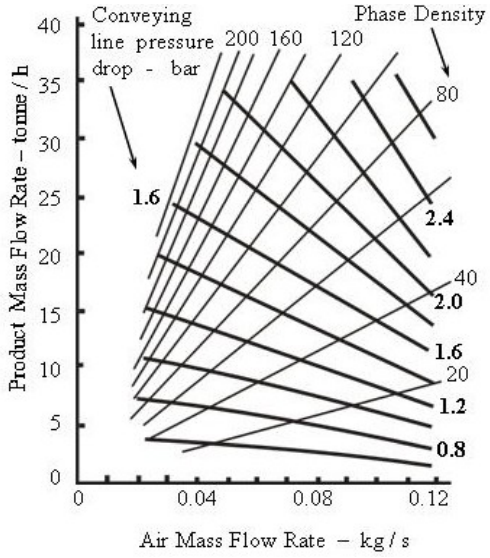


Fig. 133: Product Conveying Characteristics for Pipeline With Single Step

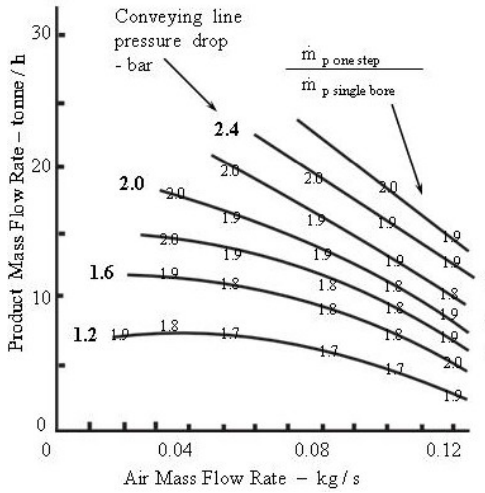


Fig.134 : Comparison of Product Flow Rate Data for Single Step and Single Bore Pipelines

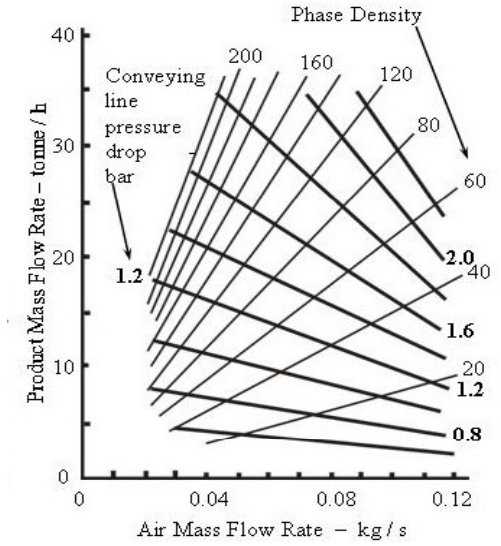


Fig.135 : Product Conveying Characteristics for Pipeline With Two Steps