DATA SHEET

- **Formulae for System Design & Graph Calculation**
- **Nomograms**

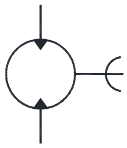
1. Flow-Pressure-Output Power-Volumetric efficiency-Input Power
2. Force-Cylinder Bore-Pressure
3. Cylinder Bore-Flow-Cylinder speed
4. Delivery Flow Rate-Flow Velocity-Pipe Size

- **Mounting Bolt Tightening Torques**
- **Mounting Bolt Tightening Sequence**

Formulae for System Design and Graph Calculation

MKS System

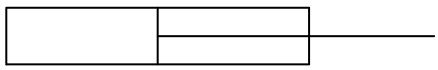
Oil Motor – Power Output



$$L = \frac{2\pi\, T.N}{6120}$$

L	: Output Power	kW
T	: Torque	Kgf.m
N	: Speed	r/min.

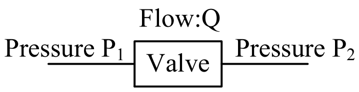
Cylinder – Power Output



$$L = \frac{F.V}{6120}$$

L	: Power Output	kW
F	: Force	Kgf
V	: Velocity	m/min

Pressure Drop from Valve



Pressure Drop : $\Delta P = P_1 - P_2$
Power loss between Input and Output of Valve : L

$$L = \frac{\Delta P.Q}{612}$$

L	: Power Output	kW
ΔP	: Pressure Drop	Kgf/cm^2
Q	: Flow	L/min.

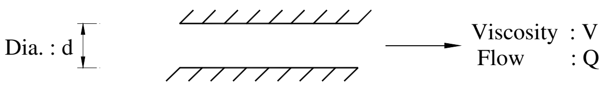
Viscosity (Absolute Viscosity) and Kinematic Viscosity

$$\mu = \rho\ .\ \upsilon_1 = \frac{\gamma}{g} \qquad \upsilon_1 = \frac{\gamma.\upsilon_2}{100g}$$

μ	: Viscosity (Absolute Viscosity)	$Kgf.s/cm^2$
ρ	: Density	Kg/cm^3
υ_1	: Kinematic Viscosity	cm^2/s
υ_2	: Kinematic Viscosity	cSt
γ	: Specific Weight	Kgf/cm^3
g	: Acceleration due to gravity	$980\ cm/s^2$

※ $1cSt = 0.01\ cm^2/s$

Reynolds Number



R : Reynolds Number
υ : Kinematic Viscosity

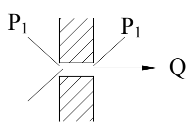
$$R = \frac{V.d}{\upsilon_1} = \frac{4000Q}{60\pi d.\upsilon_1} = \frac{2120Q}{d.\upsilon_2}$$

R : Dimensionless Value
V : cm/s
d : cm
υ_1 : cm^2/s
υ_2 : mm^2/s (cSt)
Q : L/min

※ R < 2300 ……. Laminar Flow
R > 2300 ……. Turbulant Flow

Flow Through Orifice

ΔP = P1 – P2
C : Flow Co-efficient
γ : Specific Weight
ρ : Density



A : Passage Area

$$Q = C.A\sqrt{\frac{2g}{\gamma}.\Delta P} \times \frac{60}{1000} = 2.66C.A\sqrt{\frac{\Delta P}{\gamma}}$$

Q : L/min		g	: $981\ cm/s^2$
C : Flow Co-efficient		γ	: Kgf/cm^3
A : cm^2		ΔP	: Kgf/cm^2

Flow Co-efficient will change according to reynolds number generally -0.6 ~ 0.9

Output Power

$$L_0 = \frac{P.Q}{612}$$

L_0 = Output Power kW
P = Pressure Kgf/cm^2
Q = Flow L/min.

1 kW = 102 Kgf.m/s
=6120 Kgf m/min

Input Power

$$L_1 = \frac{2\pi TN}{6120}$$

L_1 : Input power kW
T : Torque Kgf m
N : Speed r/min.

Volumetric Efficiency

$$\eta_v = \frac{Q_P}{Q_0} \times 100$$

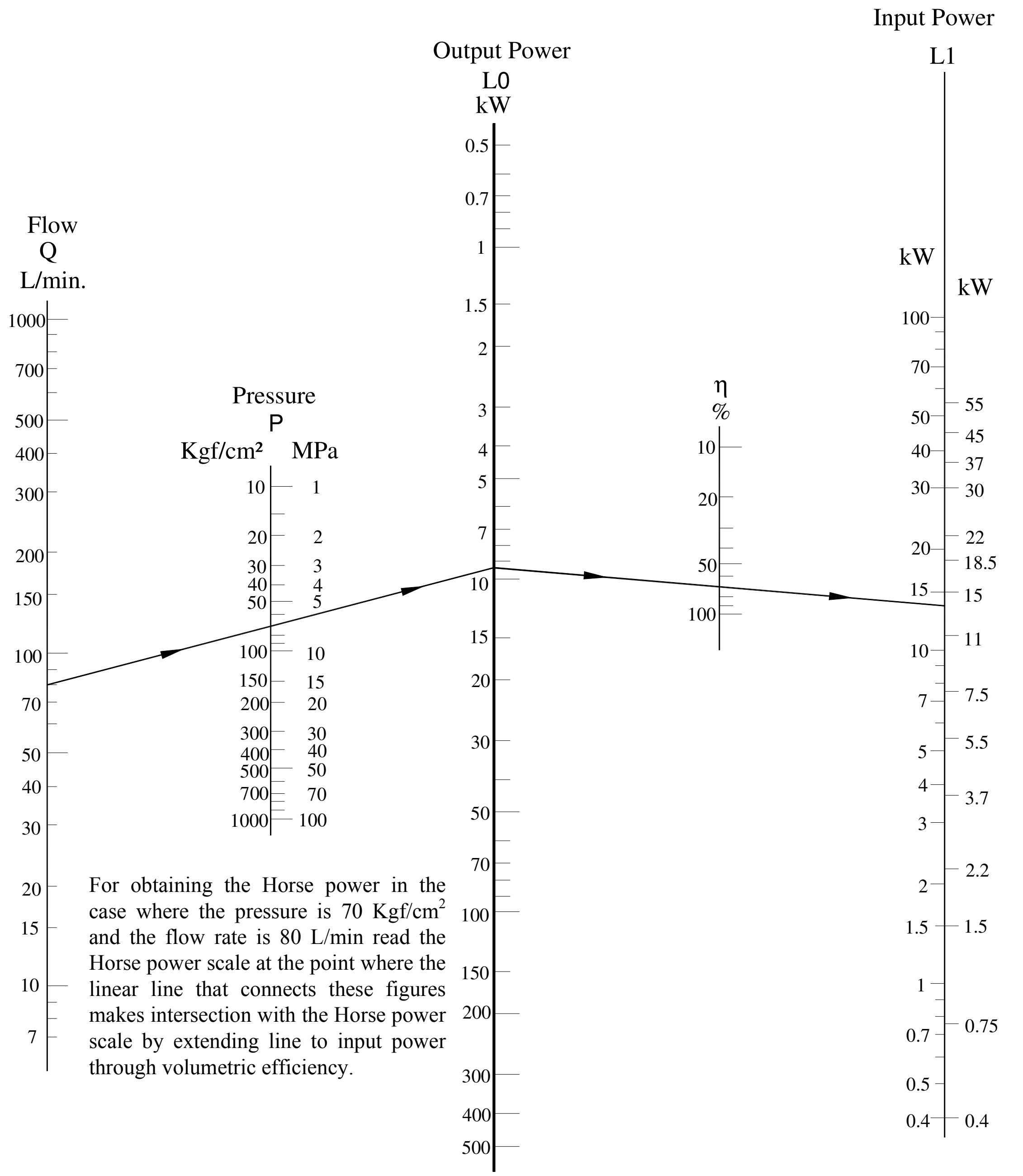
η_v = Volumetric Efficiency %
Q_P = Flow at Pressure P, L/min.
Q_0 = Flow at no load condition, L/min.

Overall Efficiency

$$\eta = \frac{L_0}{L_1} \times 100 = \frac{P.Q}{612L_1} \times 100$$

η : Overall Efficiency %
L_0 : Output Power kW
L_1 : Input Power kW
P : Pressure Kgf/cm^2
Q : Flow at pressure 'P' L/min.

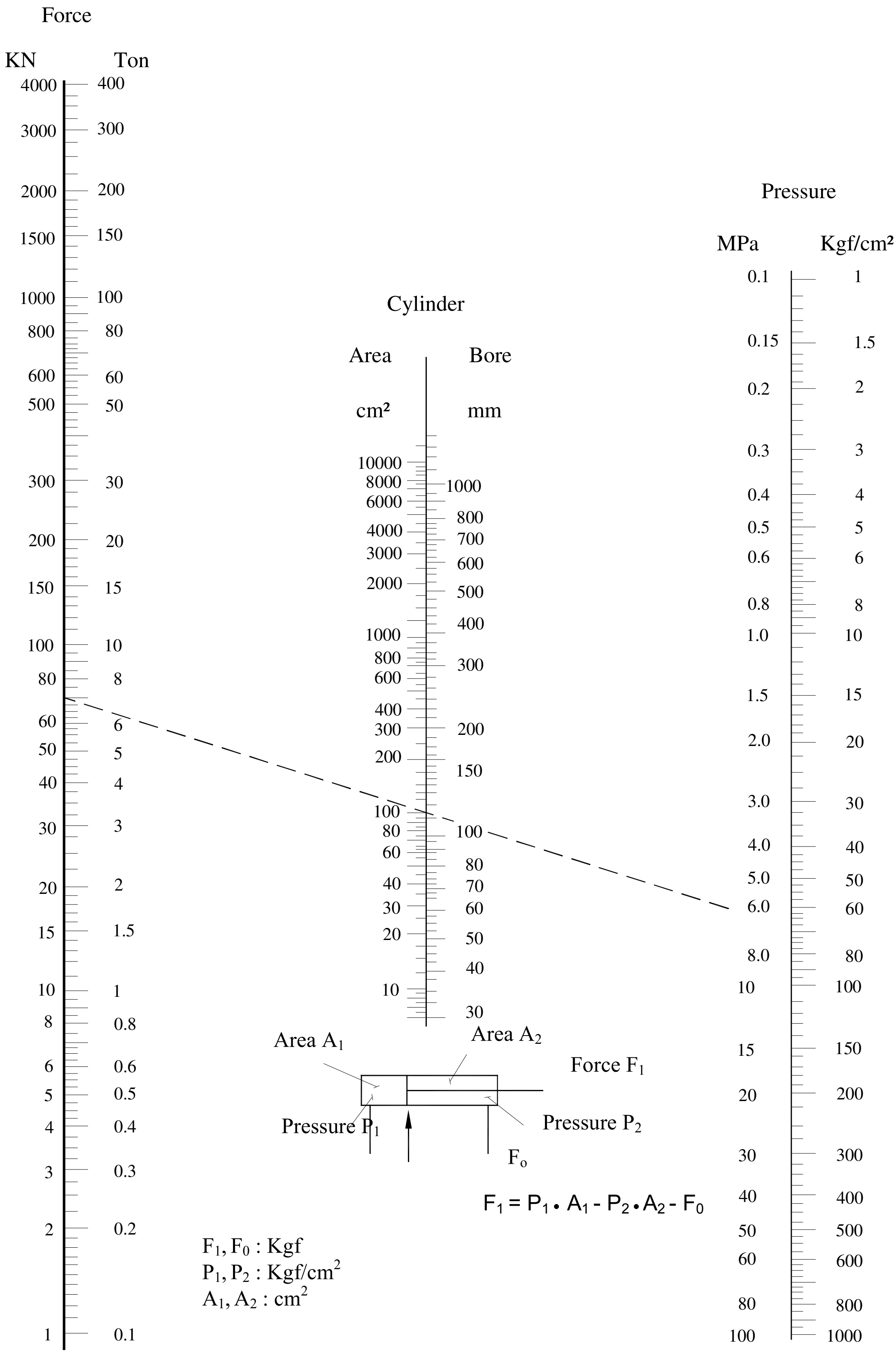
Flow – Pressure – Output Power – Volumetric Efficiency – Input Power



For obtaining the Horse power in the case where the pressure is 70 Kgf/cm^2 and the flow rate is 80 L/min read the Horse power scale at the point where the linear line that connects these figures makes intersection with the Horse power scale by extending line to input power through volumetric efficiency.

Flow – Pressure – Output Power – Volumetric Efficiency – Input Power

Force – Cylinder Bore - Pressure

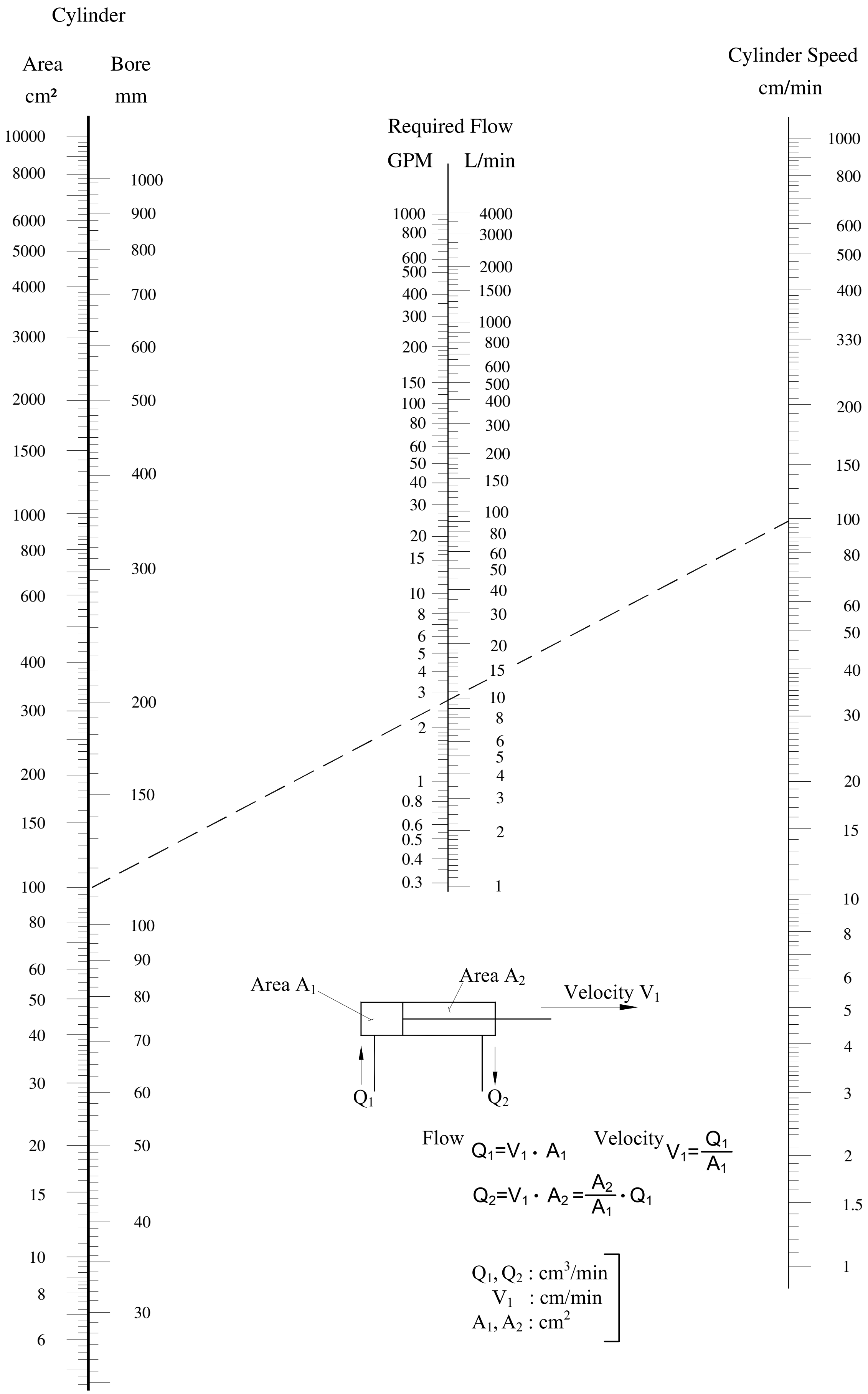


$F_1 = P_1 \cdot A_1 - P_2 \cdot A_2 - F_0$

F_1, F_0 : Kgf
P_1, P_2 : Kgf/cm^2
A_1, A_2 : cm^2

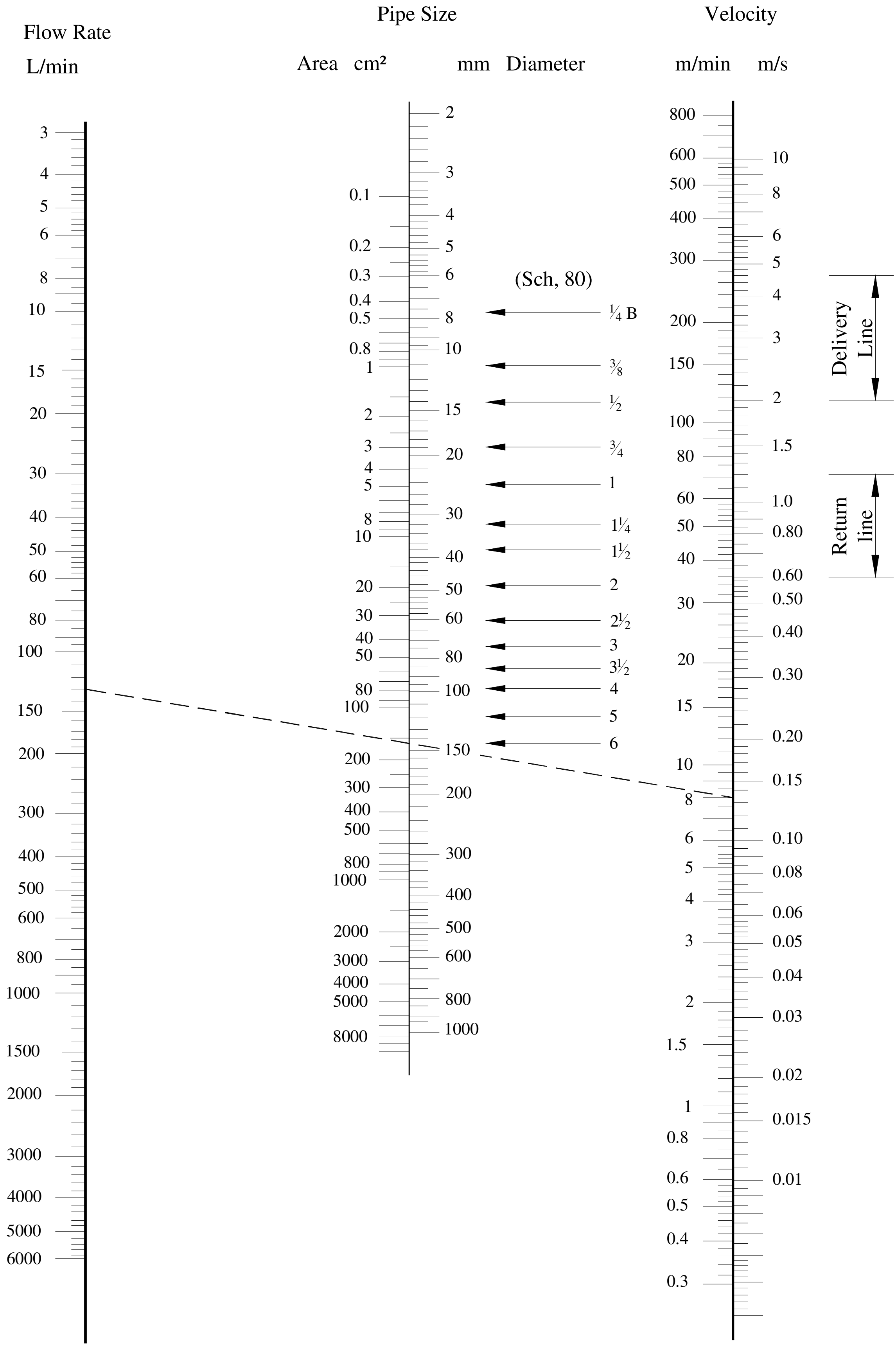
Force – Cylinder Bore - Pressure

Cylinder Bore – Flow – Cylinder Speed



Delivery Flow Rate-Flow Velocity-Pipe Size

Example; what should be the diameter of the delivery pipe for a hydraulic pump of delivery flow rate of 130 L/min? As the pipe is on the return line side, assume the flow velocity as 0.135 m/sec and draw a linear line connecting flow rate L/min. & Velocity, Sch pipe size is obtained as the pipe diameter.

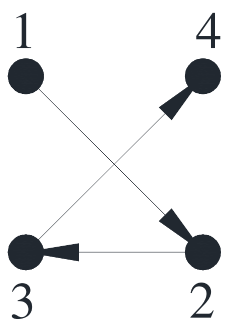


Delivery Flow Rate – Flow Velocity – Pipe Size

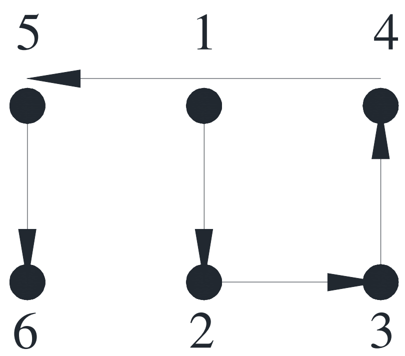
Mounting Bolt Tightening Torques

Sl. No.	Size	Tightening Torque Kgf-cm
1	M4	44.0
2	M5	90.0
3	M6	154.0
4	M8	365.0
5	M10	720.0
6	M12	1235.0
7	M16	3010.0
8	M18	4150.0
9	M20	5860.0
10	M30	16800.0

Mounting Bolt Tightening Sequence



For 4 Bolts



For 6 Bolts