

LDi P32 Predict valve, membrane, & liquid mass motion, responses to flow from recip. pump action, to generate the pressure pulsation. Ex : Initial choice, outline of equations, for compiling a fortran dt iterative **LDI PULSEVIEW** display for motions & resultant pressure pulsation.



Note, in this primitive skeletal outline example of LDi method, position numbers : D, G, L, P, & V, 00, 01, 02, 03, 04, etc. are as pg 29.

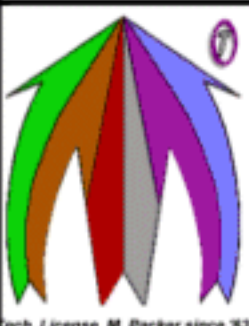
C_{fr} Viscous friction coefficient, N sec /m C_{spr} Spring rating, N/m D Diameter, m E Bulk modulus of liquid, Pa
 F Area meters squared m^2 G Mass flow, Kg/sec $l = L/F$ - Fluid column inertia, 1/m L Length, m m Mass, kg
 N_{fr} Coulomb friction force, N P pressure Pa R Crankshaft radius, m t Time, sec X Piston position, m
 Y & Z Valve position, m ρ Density, kg/m^3 ω Angular velocity, 1/radius In these descriptions: N Newtons, m meters, Pa Pascals,

Assumption in this example are: That there is no vortex or other instability at system inlet, and that the system load, is not applied by a "spill back loop" or a "controller" that "modulates" open and closed.

		Ref.	
1	$P_{00} = \text{Constant}$		Suction Source, Load
11	$P_{17} = \text{Constant}$		Suction Source, Load
2	$G_{01} = \mu_{01} F_{01} \sqrt{\rho^2 (P_{00} - P_{01})}$	A	Suction Manifold Inlet Flow
3	$G_{02} = \mu_{02} F_{02} \sqrt{\rho^2 (P_{02} - P_{03})}$	A	Suction Manifold Outlet Flow
4	$P_{01} = P_{02} + l_{00} \frac{dG_{01}}{dt} + \lambda_{00} \frac{L_{00}}{D_{00}} \rho \frac{U_{00}^2}{2}$	B	Suction Manifold Pressure Balance
5	$G_{02} = \mu_{11} \pi D_{11} Z \sqrt{\rho^2 (P_{03} - P_{11})}$	A	Suction Check Inlet Mass Flow
6	$G_{01} - G_{02} = \rho \frac{V_{03}}{E} \frac{dP_{03}}{dt}$	B	Suction Check Pocket Flow Balance
7	$m \frac{D^2 Z}{dt^2} = (P_{03} - P_{11}) \frac{\pi}{4} D_{11}^2 - P_{spr} - C_{spr} Z - N_{fr} \text{Sign} \frac{dZ}{dt} - C_{fr} \frac{dZ}{dt} - mg$	C	Suction Check Motion
8	$X = \sqrt{L^2 - R^2 \sin^2(\omega t) - L + R [1 - \cos(\omega t)]}$	A	Piston Position
9	$\rho F_p \frac{dX}{dt} + G_{02} - G_{11} = \rho \frac{V_{11}}{E} \frac{dP_{11}}{dt}$	B	V11 Flow Balance
10	$V_{11} = F_p (2R - X) + V_{110}$		V11 Volume Change
12	$G_{11} = \mu_{11} \pi D_{11} Y \sqrt{\rho^2 (P_{11} - P_{12})}$	A	Discharge Check Inlet Mass Flow
13	$m \frac{D^2 Y}{dt^2} = (P_{11} - P_{12}) \frac{\pi}{4} D_{11}^2 - P_{spr} - C_{spr} Y - N_{fr} \text{Sign} \frac{dY}{dt} - mg$	C	Discharge Check Motion
14	$G_{11} - G_{12} = \rho \frac{V_{12}}{E} \frac{dP_{12}}{dt}$	B	Discharge Check Pocket Flow Balance
15	$G_{12} = \mu_{12} F_{12} \sqrt{\rho^2 (P_{12} - P_{13})}$	A	Discharge Check Outlet Mass Flow
16	$P_{13} = P_{14} + l_{13} \frac{dG_{12}}{dt} + \lambda_{13} \frac{L_{13}}{D_{13}} \rho \frac{U_{13}^2}{2}$	B	Discharge Manifold Pressure Balance
17	$G_{13} = \mu_{14} F_{14} \sqrt{\rho^2 (P_{14} - P_{15})}$	A	Discharge Manifold Outlet Mass Flow

REFERENCES: A. Pump Handbook 2nd Ed. Karassik eq 38., p3.8. B. Mechanics of Fluids 6th Ed. Massey eq 13.14 & 13. 16 C. Handbook of Noise & Vibration 6th Ed. Barber, M.I.T 1960 Lib. of Con. Cat Card Nbr 59-6759 E&OE

Whilst LDI PulseView software also displays "acoustics"; it is primarily a mass, motion, & pressure model - not an attempt to determine them from "acoustic" frequencies and amplitudes.



LIQUID DYNAMICS INTERNATIONAL Inc.
Prediction by Software with Analysis & Diagnostics.

Phone USA --910-270-2737 Color Fax --910-270-0320 UK (for EC) --44-161-442-6222 Color Fax --44-161-443-1486
 Box 506 Hampstead NC 28443 www.liquid-dynamics.com Box 47, Stockport, SK3-0LH, UK

