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.**

No.	Equation	Ref.	
1	$P_{00}=$ Constant **11** $P_{17}=$ 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	$m\frac{D^2Z}{dt^2}=(P_{03}-P_{11})\frac{\pi}{4}D_{11}^2-P_{spr}-C_{spr}Z-N_{fr}Sign\frac{dZ}{dt}-C_{fr}\frac{dZ}{dt}-mg$	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	$m\frac{D^2Y}{dt^2}=(P_{11}-P_{12})\frac{\pi}{4}D_{11}^2-P_{spr}-C_{spr}Y-N_{fr}Sign\frac{dY}{dt}-mg$	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,

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