Calculating Barrel Pressure and Projectile Velocity in Gun Systems

© 1993 Developed by Sam Raheb of Close Focus Research (CFR)

The following information is provided by CFR for those who are interested in Calculating Barrel Pressure and Projectile Velocity in Gun Systems.

Enter your values in the red colored font cells. The units are automatically added. The blue colored fonts cells contain formulas, do not overwrite.
http://www.closefocusresearch.com/calculating-barrel-pressure-and-projectile-velocity-gun-systems

Comments

Enter the projectile parameters D, L, and W							
Calibers	**9 mm**	**.357 magnum**	**.44 magnum**	**.45 ACP**	**.223 / 5.56 NATO**	**.308 / 7.62 NATO**	**.50 BMG**
D = Bore Diameter	0.355 in.	0.353 in.	0.429 in.	0.451 in.	0.222 in.	0.305 in.	0.500 in.
L = Barrel Length	4.50 in.	6.00 in.	6.00 in.	5.00 in.	20.00 in.	22.00 in.	45.00 in.
W = Projectile Weight	124 grains	158 grains	240 grains	230 grains	55 grains	150 grains	700 grains
A = Bore Area	0.10 in²	0.10 in²	0.14 in²	0.16 in²	0.04 in²	0.07 in²	0.20 in²
m = Projectile Mass	0.00055 slug	0.00070 slug	0.00107 slug	0.00102 slug	0.00024 slug	0.00067 slug	0.00311 slug

Calculate Projectile Velocity by entering the Barrel Pressure P							
Calculated Velocity	**9 mm**	**.357 magnum**	**.44 magnum**	**.45 ACP**	**.223 / 5.56 NATO**	**.308 / 7.62 NATO**	**.50 BMG**
P = Barrel Pressure	35,000 psi	35,000 psi	36,000 psi	21,000 psi	55,000 psi	60,000 psi	55,000 psi
V_p = Projectile Velocity	1,254 ft/sec	1,276 ft/sec	1,276 ft/sec	955 ft/sec	3,112 ft/sec	2,836 ft/sec	2,947 ft/sec
E = Projectile Energy	433 ft-lbs	571 ft-lbs	867 ft-lbs	466 ft-lbs	1,183 ft-lbs	2,679 ft-lbs	13,499 ft-lbs
M = Projectile Momentum	0.69 lb-sec	0.89 lb-sec	1.36 lb-sec	0.98 lb-sec	0.76 lb-sec	1.89 lb-sec	9.16 lb-sec

Calculate Barrel Pressure by entering the Projectile Velocity V_p							
Calculated Pressure	**9 mm**	**.357 magnum**	**.44 magnum**	**.45 ACP**	**.223 / 5.56 NATO**	**.308 / 7.62 NATO**	**.50 BMG**
V_p = Projectile Velocity	1,100 ft/sec	1,250 ft/sec	1,250 ft/sec	850 ft/sec	3,000 ft/sec	2,700 ft/sec	2,850 ft/sec
P = Barrel Pressure	26,923 psi	33,601 psi	34,558 psi	16,627 psi	51,103 psi	54,372 psi	51,430 psi
E = Projectile Energy	333 ft-lbs	548 ft-lbs	833 ft-lbs	369 ft-lbs	1,099 ft-lbs	2,428 ft-lbs	12,623 ft-lbs
M = Projectile Momentum	0.61 lb-sec	0.88 lb-sec	1.33 lb-sec	0.87 lb-sec	0.73 lb-sec	1.80 lb-sec	8.86 lb-sec

Newton's Second Law of Motion:

$$\sum F = 0 = ma = m\frac{d^2x}{dt^2}$$

Applied to Gun Systems:

$$F = ma = PA \Rightarrow F = m\frac{d^2x}{dt^2} = m\frac{dv}{dt}$$

Since:

$$\frac{d^2x}{dt^2} = \frac{dv}{dt} \text{ then } \frac{dv}{dt} * \frac{dx}{dx} = \frac{dx}{dt} * \frac{dv}{dx} = v\frac{dv}{dx}$$

Newton's Second Law of Motion changes to:

$$F = m\frac{dv_p}{dt} = mv_p\frac{dv_p}{dx_p} = P_pA$$

Now Derive Energy by Integrating the following:

$$mv_p\frac{dv_p}{dx_p} = P_pA \Rightarrow mv_pdv_p = P_pAdx_p$$

$$\int mv_pdv_p = \int_{i=0}^{L} P_pAdx_p$$

Where:

$$\frac{1}{L}\int_{i=0}^{L} P_pdx_p = Average\ Pressure = \overline{P}$$

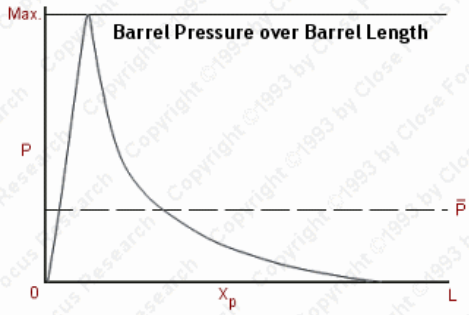
Since A = Constant:

$$\frac{1}{2}mv_p^2 = A\int_{i=0}^{L} P_pdx_p = A\overline{P}_pL$$

$$and\ \ \overline{P}_pL = \int_{i=0}^{L} P_pdx_p$$

Then solve for the Velocity and Pressure:

$$v_p = \left(\frac{2\overline{P}AL}{m}\right)^{1/2} \qquad \overline{P} = \frac{mv_p^2}{2AL}$$



To take into account for the other variables that would affect the results such as Projectile Friction, Rotational Energy, and Heat transfer without having to include them in the equations, a correction factor Cf is applied to the equations to make the results closely represent real world values.

$$v_p = \left(\frac{2P_mAL}{C_fm}\right)^{1/2} \qquad P_m = \frac{C_fmv_p^2}{2AL}$$

Since the average pressure is roughly 25% of the peak pressure, and we would like to use the SAAMI Maximum Cartridge Pressure Pm (or peak pressure) for pressure in the equations, then a correction factor of 0.25 would be applied to the equations. Therefore, the modified equations using maximum peak pressure Pm and a Correction Factor, Cf = 0.25, yields following equations:

$$v_p = 2\left(\frac{2P_mAL}{m}\right)^{1/2} \qquad P_m = \frac{mv_p^2}{8AL}$$

The equations used in the downloadable spreadsheet are:

$$v_p = \frac{\left(\frac{2P_mAL}{C_fm}\right)^{1/2}}{12} \qquad P_m = \frac{C_fm(12v_p)^2}{2AL}$$

where CF is an editable cell value and 12 is the inch-foot conversion (12 inches / foot)