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Design of Engine Valves Formulas

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List of 44 Design of Engine Valves Formulas

Design of Engine Valves

Valve Disk

1) Bending Stress in Valve Disk

Open Calculator

fx $$\sigma b_{disk} = \left(\frac{d_p \cdot k_c}{t}\right)^2 \cdot p_{max}$$

ex $$52.89256\text{N/mm}^2 = \left(\frac{40\text{mm} \cdot 0.5}{5.5\text{mm}}\right)^2 \cdot 4\text{MPa}$$

2) Diameter of Port given Thickness of Valve Disk

Open Calculator

fx $$d_p = \frac{t}{k_c} \cdot \sqrt{\frac{\sigma b_{disk}}{p_{max}}}$$

ex $$39.66106\text{mm} = \frac{5.5\text{mm}}{0.5} \cdot \sqrt{\frac{52\text{N/mm}^2}{4\text{MPa}}}$$

3) Maximum Thickness of Valve Disk at Edges

Open Calculator

fx $$t_e = 0.85 \cdot t$$

ex $$4.675\text{mm} = 0.85 \cdot 5.5\text{mm}$$

4) Minimum Thickness of Valve Disk at Edges

Open Calculator

$$t_e = 0.75 \cdot t$$

$$4.125\text{mm} = 0.75 \cdot 5.5\text{mm}$$

5) Thickness of Valve Disk

Open Calculator

$$t = k_c \cdot d_p \cdot \sqrt{\frac{p_{max}}{\sigma b_{disk}}}$$

$$5.547002\text{mm} = 0.5 \cdot 40\text{mm} \cdot \sqrt{\frac{4\text{MPa}}{52\text{N/mm}^2}}$$

6) Thickness of Valve Disk given Projected Width of Valve Seat

Open Calculator

$$t = k_c \cdot \frac{w}{0.06} \cdot \sqrt{\frac{p_{max}}{\sigma b_{disk}}}$$

$$6.933752\text{mm} = 0.5 \cdot \frac{3\text{mm}}{0.06} \cdot \sqrt{\frac{4\text{MPa}}{52\text{N/mm}^2}}$$

7) Thickness of Valve Disk Made of Cast Iron

Open Calculator

$$t = 0.54 \cdot d_p \cdot \sqrt{\frac{p_{max}}{\sigma b_{disk}}}$$

$$5.990762\text{mm} = 0.54 \cdot 40\text{mm} \cdot \sqrt{\frac{4\text{MPa}}{52\text{N/mm}^2}}$$

8) Thickness of Valve Disk Made of Steel

Open Calculator

fx $$t = 0.42 \cdot d_p \cdot \sqrt{\frac{p_{max}}{\sigma b_{disk}}}$$

ex $$4.659482\text{mm} = 0.42 \cdot 40\text{mm} \cdot \sqrt{\frac{4\text{MPa}}{52\text{N/mm}^2}}$$

Valve Head

9) Diameter of Port given Diameter of Valve Head and Projected Width of Valve Seat

Open Calculator

fx $$d_p = d_v - 2 \cdot w$$

ex $$44\text{mm} = 50\text{mm} - 2 \cdot 3\text{mm}$$

10) Diameter of Port given Projected Width of Valve Seat

Open Calculator

fx $$d_p = \frac{w}{0.06}$$

ex $$50\text{mm} = \frac{3\text{mm}}{0.06}$$

11) Diameter of Valve Head given Diameter of Port and Projected Width of Valve Seat

Open Calculator

fx $$d_v = d_p + 2 \cdot w$$

ex $$46\text{mm} = 40\text{mm} + 2 \cdot 3\text{mm}$$

12) Diameter of Valve Head given Load on Exhaust Valve and Back Pressure

Open Calculator

fx $$d_v = \sqrt{\frac{4 \cdot P_g}{\pi \cdot P_{back}}}$$

ex $$51.70883\text{mm} = \sqrt{\frac{4 \cdot 1680\text{N}}{\pi \cdot 0.8\text{MPa}}}$$

13) Diameter of Valve Head given Port Diameter

Open Calculator

fx $$d_v = 1.12 \cdot d_p$$

ex $$44.8\text{mm} = 1.12 \cdot 40\text{mm}$$

14) Diameter of Valve Head given Projected Width of Valve Seat

Open Calculator

fx $$d_v = 18.666 \cdot w$$

ex $$55.998\text{mm} = 18.666 \cdot 3\text{mm}$$

15) Maximum Projected Width of Valve Seat given Port Diameter

Open Calculator

fx $$w = 0.07 \cdot d_p$$

ex $$2.8\text{mm} = 0.07 \cdot 40\text{mm}$$

16) Minimum Projected Width of Valve Seat given Port Diameter

Open Calculator

fx $$w = 0.05 \cdot d_p$$

ex $$2\text{mm} = 0.05 \cdot 40\text{mm}$$

17) Port Diameter given Diameter of Valve Head

Open Calculator

fx $$d_p = \frac{d_v}{1.12}$$

ex $$44.64286\text{mm} = \frac{50\text{mm}}{1.12}$$

18) Projected Width of Valve Seat given Diameter of Port and Diameter of Valve Head

Open Calculator

fx $$w = \frac{d_v - d_p}{2}$$

ex $$5\text{mm} = \frac{50\text{mm} - 40\text{mm}}{2}$$

19) Projected Width of Valve Seat given Diameter of Valve Head

Open Calculator

fx $$w = \frac{d_v}{18.666}$$

ex $$2.678667\text{mm} = \frac{50\text{mm}}{18.666}$$

20) Projected Width of Valve Seat given Port Diameter

Open Calculator

fx $$w = 0.06 \cdot d_p$$

ex $$2.4\text{mm} = 0.06 \cdot 40\text{mm}$$

Valve Lift

21) Diameter of Port given Maximum Lift of Valve

Open Calculator

fx $d_p = 4 \cdot h_{max} \cdot \cos(\alpha)$

ex $31.1127\text{mm} = 4 \cdot 11\text{mm} \cdot \cos(45^\circ)$

22) Force Required to Lift Engine Valve

Open Calculator

fx $P_2 = k \cdot h_{max}$

ex $102.3\text{N} = 9.3\text{N/mm} \cdot 11\text{mm}$

23) Lift of Engine Valve

Open Calculator

fx $h_{max} = \frac{P_2}{k}$

ex $26.88172\text{mm} = \frac{250\text{N}}{9.3\text{N/mm}}$

24) Maximum Lift of Valve for Flat Headed Valves

Open Calculator

fx $h_{max} = \frac{d_p}{4}$

ex $10\text{mm} = \frac{40\text{mm}}{4}$

25) Maximum Lift of Valve given Diameter of Port and Valve Seat Angle

Open Calculator

fx $$h_{max} = \frac{d_p}{4 \cdot \cos(\alpha)}$$

ex $$14.14214\text{mm} = \frac{40\text{mm}}{4 \cdot \cos(45^\circ)}$$

26) Valve Seat Angle given Maximum Lift of Valve

Open Calculator

fx $$\alpha = \arccos\left(\frac{d_p}{4 \cdot h_{max}}\right)$$

ex $$24.61998^\circ = \arccos\left(\frac{40\text{mm}}{4 \cdot 11\text{mm}}\right)$$

Valve Port

27) Acceleration of Exhaust Valve

Open Calculator

fx $$a_v = \frac{Pa_{valve}}{m}$$

ex $$255.5556\text{m/s}^2 = \frac{115\text{N}}{0.45\text{kg}}$$

28) Area of IC Engine Port given Cross-Section Area of Piston

Open Calculator

fx $$a_p = \frac{a \cdot s_p}{v_p}$$

ex $$1318.5\text{mm}^2 = \frac{5860\text{mm}^2 \cdot 4.5\text{m/s}}{20\text{m/s}}$$

29) Cross-Section Area of IC Engine Piston given Area of Port

Open Calculator

fx $$a = \frac{a_p \cdot v_p}{s_p}$$

ex $$5511.111\text{mm}^2 = \frac{1240\text{mm}^2 \cdot 20\text{m/s}}{4.5\text{m/s}}$$

30) Diameter of IC Engine Port

Open Calculator

fx $$d_p = \sqrt{\frac{4 \cdot a \cdot s_p}{v_p \cdot \pi}}$$

ex $$40.97275\text{mm} = \sqrt{\frac{4 \cdot 5860\text{mm}^2 \cdot 4.5\text{m/s}}{20\text{m/s} \cdot \pi}}$$

31) Diameter of IC Engine Port given Area of Port

Open Calculator

$$d_p = \sqrt{\frac{4 \cdot a_p}{\pi}}$$

$$39.73433\text{mm} = \sqrt{\frac{4 \cdot 1240\text{mm}^2}{\pi}}$$

32) Engine Speed given Mean Velocity of Piston and Stroke Length

Open Calculator

$$N = 60 \cdot \frac{s_p}{2 \cdot l_s}$$

$$490.9091 = 60 \cdot \frac{4.5\text{m/s}}{2 \cdot 275\text{mm}}$$

33) Mean Velocity of Gas through IC Engine Port given Engine Speed, Stroke, Area of Piston and Port

Open Calculator

$$v_p = \frac{a \cdot \frac{2 \cdot N \cdot l_s}{60}}{a_p}$$

$$21.65995\text{m/s} = \frac{5860\text{mm}^2 \cdot \frac{2 \cdot 500 \cdot 275\text{mm}}{60}}{1240\text{mm}^2}$$

34) Mean Velocity of Gas through IC Engine Port given Velocity of Piston

Open Calculator

$$v_p = \frac{a \cdot s_p}{a_p}$$

$$21.26613\text{m/s} = \frac{5860\text{mm}^2 \cdot 4.5\text{m/s}}{1240\text{mm}^2}$$

35) Mean Velocity of IC Engine Piston given Engine Speed and Stroke Length

Open Calculator

$$s_p = \frac{2 \cdot N \cdot l_s}{60}$$

$$4.583333\text{m/s} = \frac{2 \cdot 500 \cdot 275\text{mm}}{60}$$

36) Mean Velocity of IC Engine Piston given Velocity of Gas through Port

Open Calculator

$$s_p = \frac{a_p \cdot v_p}{a}$$

$$4.232082\text{m/s} = \frac{1240\text{mm}^2 \cdot 20\text{m/s}}{5860\text{mm}^2}$$

37) Stroke Length of Piston given Mean Velocity of Piston and Engine Speed

Open Calculator

fx $$l_s = \frac{60 \cdot s_p}{2 \cdot N}$$

ex $$270\text{mm} = \frac{60 \cdot 4.5\text{m/s}}{2 \cdot 500}$$

Valve Stem

38) Diameter of Port given Diameter of Valve Stem

Open Calculator

fx $$d_p = \frac{d_s}{1.5 \cdot \left(1 - \frac{\sigma_t \cdot t^2}{1.4 \cdot P_{sp}}\right)}$$

ex $$40.73903\text{mm} = \frac{15\text{mm}}{1.5 \cdot \left(1 - \frac{2.2\text{N/mm}^2 \cdot (5.5\text{mm})^2}{1.4 \cdot 63\text{N}}\right)}$$

39) Diameter of Valve Stem

Open Calculator

fx $$d_s = 1.5 \cdot d_p \cdot \left(1 - \frac{\sigma_t \cdot t^2}{1.4 \cdot P_{sp}}\right)$$

ex $$14.72789\text{mm} = 1.5 \cdot 40\text{mm} \cdot \left(1 - \frac{2.2\text{N/mm}^2 \cdot (5.5\text{mm})^2}{1.4 \cdot 63\text{N}}\right)$$

40) Maximum Diameter of Valve Stem

Open Calculator

fx $$d_s = \frac{d_p}{8} + 11$$

ex $$16\text{mm} = \frac{40\text{mm}}{8} + 11$$

41) Minimum Diameter of Valve Stem

Open Calculator

fx $$d_s = \frac{d_p}{8} + 6.35$$

ex $$11.35\text{mm} = \frac{40\text{mm}}{8} + 6.35$$

42) Spring Force on Valve when Seated

Open Calculator

fx $$P_{sp} = \frac{\frac{\sigma_t \cdot t^2}{1-\frac{2 \cdot d_s}{3 \cdot d_p}}}{1.4}$$

ex $$63.38095\text{N} = \frac{\frac{2.2\text{N/mm}^2 \cdot (5.5\text{mm})^2}{1-\frac{2 \cdot 15\text{mm}}{3 \cdot 40\text{mm}}}}{1.4}$$

43) Tensile Stress in Valve Stem due to Spring Force on Valve

Open Calculator

fx $$\sigma_t = 1.4 \cdot \frac{P_{sp}}{t^2} \cdot \left(1 - \frac{2 \cdot d_s}{3 \cdot d_p}\right)$$

ex $$2.186777\text{N/mm}^2 = 1.4 \cdot \frac{63\text{N}}{(5.5\text{mm})^2} \cdot \left(1 - \frac{2 \cdot 15\text{mm}}{3 \cdot 40\text{mm}}\right)$$

44) Thickness of Valve Disk given Force of Spring on Valve

Open Calculator

fx $$t = \sqrt{\frac{1.4 \cdot P_{sp} \cdot \left(1 - \frac{2 \cdot d_s}{3 \cdot d_p}\right)}{\sigma_t}}$$

ex $$5.483446\text{mm} = \sqrt{\frac{1.4 \cdot 63\text{N} \cdot \left(1 - \frac{2 \cdot 15\text{mm}}{3 \cdot 40\text{mm}}\right)}{2.2\text{N/mm}^2}}$$

Variables Used

- **a** Cross Section Area of Piston *(Square Millimeter)*
- a_p Area of Port *(Square Millimeter)*
- a_v Acceleration of Valve *(Meter per Square Second)*
- d_p Diameter of Port *(Millimeter)*
- d_s Diameter of Valve Stem *(Millimeter)*
- d_v Diameter of Valve Head *(Millimeter)*
- h_{max} Lift of Valve *(Millimeter)*
- **k** Stiffness of Valve Spring *(Newton per Millimeter)*
- k_c Material Constant
- l_s Stroke Length *(Millimeter)*
- **m** Mass of Valve *(Kilogram)*
- **N** Engine Speed in rpm
- P_2 Force to Lift Engine Valve *(Newton)*
- P_{back} Back Pressure on Engine Valve *(Megapascal)*
- P_g Gas Load on Exhaust Valve *(Newton)*
- p_{max} Maximum Gas Pressure inside Cylinder *(Megapascal)*
- P_{sp} Spring Force on Seated Valve *(Newton)*
- Pa_{valve} Inertia Force on Valve *(Newton)*
- s_p Mean Piston Speed *(Meter per Second)*
- **t** Thickness of Valve Disk *(Millimeter)*
- t_e Thickness of Valve Disk at Edges *(Millimeter)*

- v_p Velocity of Gas through Port *(Meter per Second)*
- w Projected Width of Valve Seat *(Millimeter)*
- α Valve Seat Angle *(Degree)*
- σ_t Tensile Stress in Valve Stem *(Newton per Square Millimeter)*
- σb_{disk} Bending Stress in Valve Disk *(Newton per Square Millimeter)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **arccos**, arccos(Number)
  Inverse trigonometric cosine function
- Function: **cos**, cos(Angle)
  Trigonometric cosine function
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Area** in Square Millimeter (mm²)
  Area Unit Conversion
- Measurement: **Pressure** in Megapascal (MPa)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Acceleration** in Meter per Square Second (m/s²)
  Acceleration Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Stiffness Constant** in Newton per Millimeter (N/mm)
  Stiffness Constant Unit Conversion

- Measurement: **Stress** in Newton per Square Millimeter (N/mm²)
  Stress Unit Conversion

Check other formula lists

- **Design of Engine Valves Formulas**
- **Design of Push Rod Formulas**
- **Design of Rocker Arm Formulas**
- **Design of Valve Spring Formulas**
- **Engine Cylinder Formulas**

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