Design of Valves

In designing a valve, its is required to determine the following dimensions:

a) Size of the Valve port

Let

a_p = Area of port

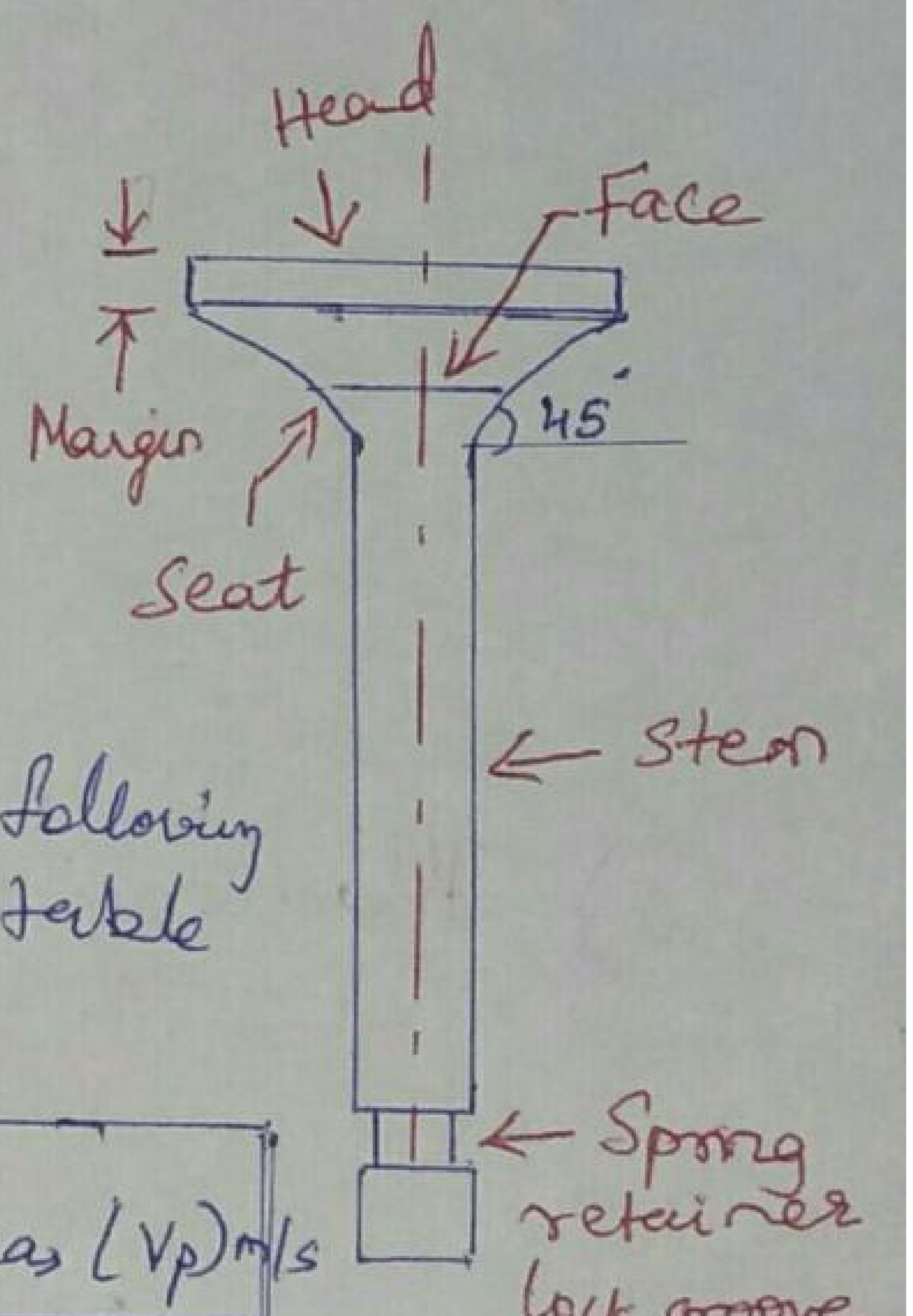
v_p = mean velocity of gas flowing through the port

a = Area of the piston

v = Mean velocity of the piston

We know that $a_p v_p = a \cdot v$

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



The mean velocity of the gas (v_p) may be taken from the following table

Type of engine	Mean Velocity of the gas (v_p) m/s	
	Inlet Valve	Exhaust Valve
Low Speed	33 - 40	40 - 50
High Speed	80 - 90	90 - 100

Some times, inlet port is made 20 to 40 percent larger than exhaust port for better cylinder charging

b) Thickness of the Valve disc

The thickness of the valve disc (t) may be determined empirically from the following relation

$$t = k \cdot d_p \sqrt{\frac{p}{\sigma_b}}$$

Where,

k = constant = 0.42 for steel and 0.54 for cast iron

d_p = diameter of port in mm

p = maximum gas pressure in N/mm^2

σ_b = permissible bending stress in MPa or N/mm^2
= 50 to 60 MPa for carbon steel and 100 to 120 MPa for alloy steel

c) Maximum Lift of the Valve

h = Lift of the valve

The lift of the valve may be obtained by equating the area across the valve seat to the area of port. For a conical valve, we have

$$h = \frac{d_p}{4 \cos \alpha}$$

Where,

α = angle at which valve seat is tapered $= 30^\circ$ to 45°

In case of flat headed valve, the lift of valve is

$$h = \frac{d_p}{4}$$

The valve seat usually have the same angle as the valve seating surface. But it is preferable to make the angle of valve seat $1/2^\circ$ to 1° larger than the valve angle. This results in more effective seat.

d) Valve Steam diameter

The valve steam diameter (d_s) is given by

$$d_s = \frac{d_p}{8} + 6.35 \text{ mm to } \frac{d_p}{8} + 11 \text{ mm}$$

The valve is subjected to spring force which is taken as concentrated load at the center. Due to this spring force (F_s), the stress in the valve (σ_t) is given by

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