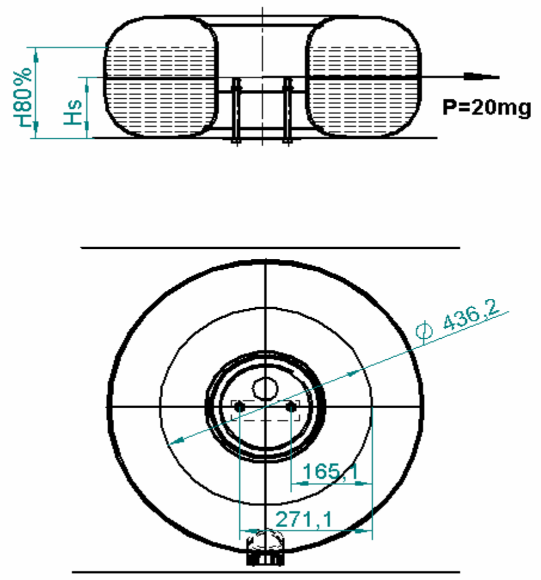
# Strenght calculation of 2-bolt fixing system of toroidal tank, made in accordance with Regulation 67 revision 01

According to point 17.4.6. of the Regulation No 67 revision 01: The fuel container(s) must be mounted and fixed so that the following accelerations can be absorbed (without damage occurring) when the containers are full: Vehicles of categories M1 and N1: (a) 20 g in the direction of travel (b) 8 g horizontally perpendicular to the direction of travel.

According to this documentation the tank is fixed by means of 2 x M12 bolts to the floor of the vehicle. The calculations were made for the biggest capacity tank V=88 litres and maximum mass of the tank 44 kg. The scope of this calculations is all GZWM toroidal tanks made in all versions T01, T11, T02, T12, T03, T13, T04, T14.




m = m1 + m2

m1- mas of tank = 44 [kg]

m2 - masa of cas

$m2 = \rho * V * 0.8$

ρ - density of hydrocarbon gas (liquid $C_3$-$C_4$)

V - capacity of tank

0.8 - 80% filling level

| Data | | |
|---|---|---|
| Mg[kNcm] | $l_1$ [cm] | $l_{max}$ [cm] |
| 219,0475 | 16,51 | 27,11 |

m2 = 0,55 * 88 * 0,8= 38,7 [kg]

m= 44 + 38,7= 82,7 [kg]

Hs= 13,5 [cm]

Mg= m*20*g * Hs

Mg= 82,7 * 20 * g * 13,5

7. 2. 1. Force in one bolt until bending moment

$$Q_{M\max} = \frac{Mg \cdot l_{\max}}{\sum_{i=1}^{\max} l_i^2}$$

$$Qmmax = \frac{219{,}0475 \cdot 27{,}11}{16{,}51^2 + 27{,}11^2}$$

| Results |
|---|
| $Q_{Mmax}$ [kN] |
| 5,89 |

7. 2. Calculation of bolt connection

| | |
|---|---|
| Data | Bolts M12 -8,8-II acc. to PN-74/M.-82101 |

7. 2. 1. Force in one bolt

| Results |
|---|
| Qmmax [kN] |
| 5,89 |

7. 2. 2. Permissible breaking force.

$$Q_{dop} = \frac{\pi \cdot d_r^2 \cdot k_{dop}}{4}$$

| Dane<br>Data | | | |
|---|---|---|---|
| dr [cm] | Rm [Mpa] | $k_{dop}$=Rm [Mpa] | Qdop [kN] |
| 0,97 | 800 | 800 | 59,11849 |

7. 2. 3. Force from initial stress.

$$P \cdot r = 0{,}5 \cdot Q_w \left[ d_p \cdot tg(\gamma + \rho) + dm \cdot \mu \right]$$

$$Qw = \frac{P \cdot r}{0{,}5 \cdot \left[ d_p \cdot tg(\gamma + \rho) + dm + \mu \right]}$$

| Data | | | | | | | |
|---|---|---|---|---|---|---|---|
| P [kN] | r [mm] | dp [mm] | ρ [°] | γ [°] | dm [mm] | μ [–] | P [-] |
| 0,1 | 150 | 1,07 | 5,710593137 | 9,288568 | 12,9 | 0,1 | 1,75 |

| Results |
|---|
| Qw [kN] |
| 19,02722 |

7. 2. 4. Maximum axial force in a bolt.

Qc=Qmmax+Qw+m*g/4 Qc= 5,89 +19,02722+0,202822

| Wyniki | Qc [kN] |
|---|---|
| Result | 25,12004 < $Q_{dop}$ =40,21kN |

7. 2. 5. Maximum stresses in a bolt.

$$\sigma = \frac{4 \cdot Q_c}{\pi \cdot d^2} \leq k_{dop}$$

| Results |
|---|
| σ [Mpa] |
| 339,928 <$k_{dop}$=800 MPa |

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