ME 360 – Project

Your team will design a first stage regulator used for SCUBA. This regulator connects to the valve on the tank and reduces the pressure from the tank pressure to 140 psi gauge. The requirements for the design are listed below.

1. The regulator should be designed for tanks with pressures as high as 4,500 psi gauge and as low as 500 psi gauge. The regulator should have a structural safety factor of 1.5. The yoke assembly should have a safety factor of 2.0 when the tank pressure is 3,500 psi gauge.
2. The regulator should attach to the tank valve with a standard yoke connection.
3. The regulator should have 4 low pressure ports and 2 high pressure ports.
4. The low pressure ports will have a 7/16-20 thread size.
5. The high pressure ports will have a 3/8-24 thread size.
6. The cylindrical shape that connects to the tank valve is .700 inches in diameter.
7. The low pressure setting should be adjustable so that a technician can easily and accurately adjust the pressure.
8. The regulator will compensate for the depth so that the downstream pressure of 140 psi gauge is reasonably accurate for all depths above 200 feet of seawater. One of the measures of the quality of a regulator is how well it maintains this downstream pressure under differing operating conditions. The regulator should maintain a relatively constant downstream pressure when used at different depths and with different flow rates.
9. The regulator must be constructed from materials that are very corrosion resistant in both fresh and seawater. The body of the regulator will be brass. It may be chrome plated to resist corrosion. The internal parts and the yoke assembly may be made of other materials.
10. The regulator must be designed in such a way that seals and other parts subject to wear and aging can easily be replaced by a technician.
11. The regulator maybe either a diaphragm or piston operated regulator.

DELIVERABLES

1. A presentation of your design to members of the class, other faculty, and students.
2. A discussion of your design.
3. Dimensioned drawings of the regulator. The drawings should specify the material used in each part.
4. If springs are used in your design, list the following data for each spring.
    a. The spring constant
    b. The wire diameter
    c. The free length of the spring
    d. The length of the spring in the regulator under both no flow and maximum flow conditions

e. The minimum spacing between the wires under all operating conditions.
f. You must design the spring and use Mechanica to analyze it. You cannot use a standard spring.

5. If a diaphragm is used in your design, list the following data for the diaphragm.
   a. The diaphragm diameter and thickness.
   b. The deflection of the diaphragm under no flow and maximum flow conditions.
   c. You must design the diaphragm and use Mechanica to analyze it.

6. Structural analysis of all regulator parts. The analysis should show a fringe plot and list the maximum von Mises stress for the analysis. This maximum von Mises stress should be compared to the yield stress of the material. The structural analysis should include:
   a. An analysis of the regulator using pressure induced stresses.
   b. 3 other analysis using loading conditions that may occur in the field under expected use and abuse. All loading conditions should be well defined in your report. Less conservative safety factors may be used for some of these loading conditions if reducing the safety factor is reasonable.

7. A graph of the calculated downstream pressure at different flow rates and at different depths. The depth should range from zero to 200 feet of seawater. The following flow rates should be used:
   a. An aggressive breathing rate for recreational diving is 37.5 liters per minute to a depth of 200 feet of sea water.
   b. A rate of 62.5 liters per minute (RMV) at 130 feet of sea water is used by both the European Conformance Standard EN250 and US Navy Class A requirements. This equates to two divers breathing from the same regulator.
   c. These volumetric flow rates are measured at the depth of the diver, not at the pressure produced by the regulator. Tank pressures of 3000 psi and 500 psi should be graphed. Discuss the method you used to make the computations.

7. A graph of the valve opening (piston or diaphragm travel) at different flow rates and at different depths. The depth should range from zero to 200 feet of seawater. The flow rates listed in question 6 should be used. Discuss the method you used to make the computations.

Note:
Fresh water weighs 62.4 lbs / ft^3
Seawater weighs 64 lbs / ft^3