Simulation of two rotary seals with different pressure

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Introduction: We simulate two different types of rotary seals applying different pressure. We simulate a Carcoseal/UN, which is used for standard application, with two different values of pressure, and we compare it with a Carcoseal/APWT. This seal is designed so that the effect of pressure generates a favorable stabilizing torque which prevents the surface contact area between lip & shaft from increasing.

Figure 1. Carcoseal/UN

Figure 2. Carcoseal/APWT

Computational Methods: We have used a hyperelastic model, Neo-Hookean in this case, to simulate the rubber used to produce the seal

$$S = \frac{\partial W_s}{\partial \epsilon}$$

$$Ws = \frac{\mu}{2}(I_1 - 3) - \mu \ln J_{el} + \frac{\lambda}{2}[\ln J_{el}]^2$$

$$\epsilon = \frac{1}{2}[(\nabla \mathrm{u})^T + \nabla \mathrm{u} + (\nabla \mathrm{u})^T \nabla \mathrm{u}]$$

Due to annular geometry of seal we have considered a 2D axial symmetric model during simulation.
In the critical points we have used a more crowed mesh to have the best approximation of solution.

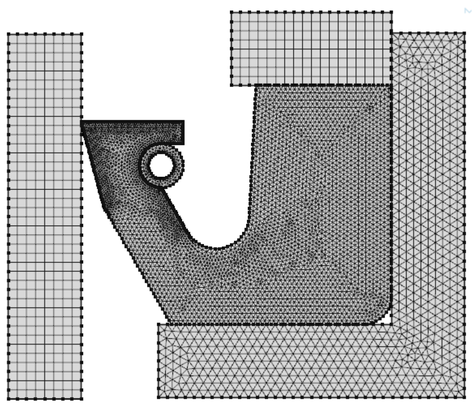

Figure 3. Carcoseal/UN

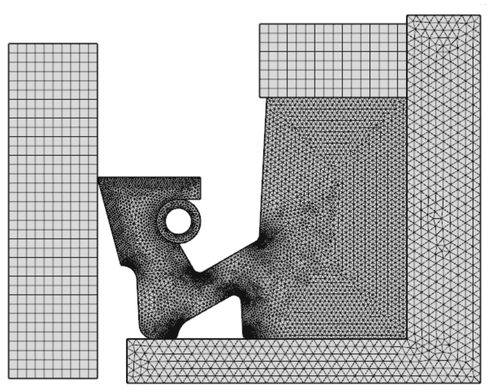

Figure 4. Carcoseal/APWT

Assembly of the seal was simulated compressing the seal with two mobile parts, the first compresses the lip of the seal and the second compresses the back of the seal.

Results: Pressure used during simulation is respectively 0,5 bar and 5 bar.
The simulation with 0,5 bar is the best condition of work for our Carcoseal/UN, because the lip is in contact with the shaft and the strength in the seal is low.

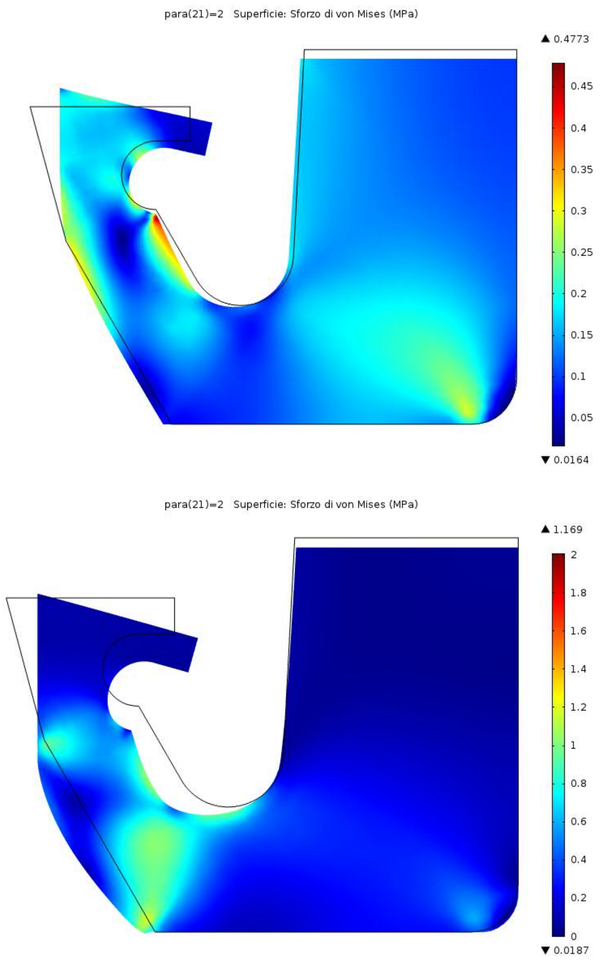

Figure 5. Carcoseal/UN with 0,5 bar

Figure 6. Carcoseal/UN with 5 bar

As you can see the Carcoseal/APWT has the best performance when there is pressure (in this case 5 bar). The particular geometry of Carcoseal/APWT allows the lip to have a support that helps the lip when it is under pressure.

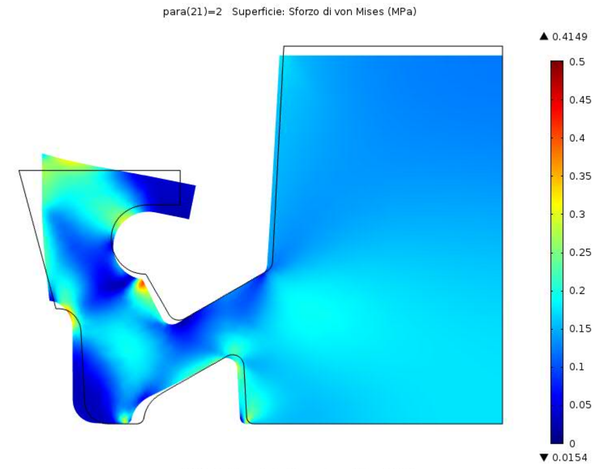

Figure 7. Carcoseal/APWT with 0,5 bar

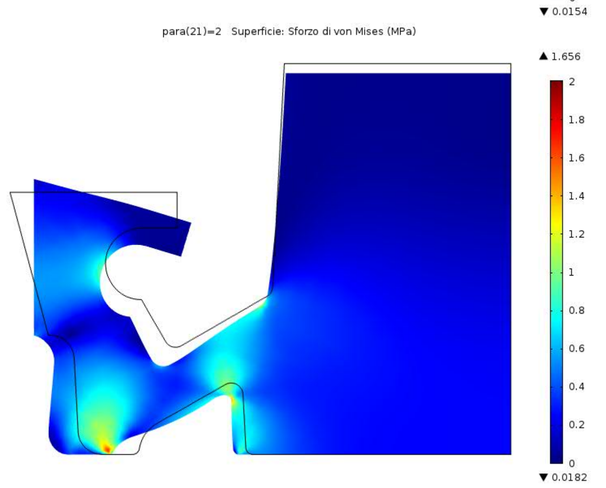

Figure 8. Carcoseal/APWT with 5 bar

Conclusions: For both the seals the Von Mises strength calculated with Comsol is smaller than tensile strength of the rubber (σ_r>13 MPa), with an safety factor of approximately 10.
The choice between the two seals is influenced more than the type of application rather than the geometry of the seal.
With the same pressure (5 bar), the deformation in the lip zone results always to be bigger in Carcoseal/UN rather than in the Carcoseal/APWT.

Excerpt from the Proceedings of the 2012 COMSOL Conference in Milan