



RFD cavity stress assessment and tuning

Cavity of 5 mm thickness

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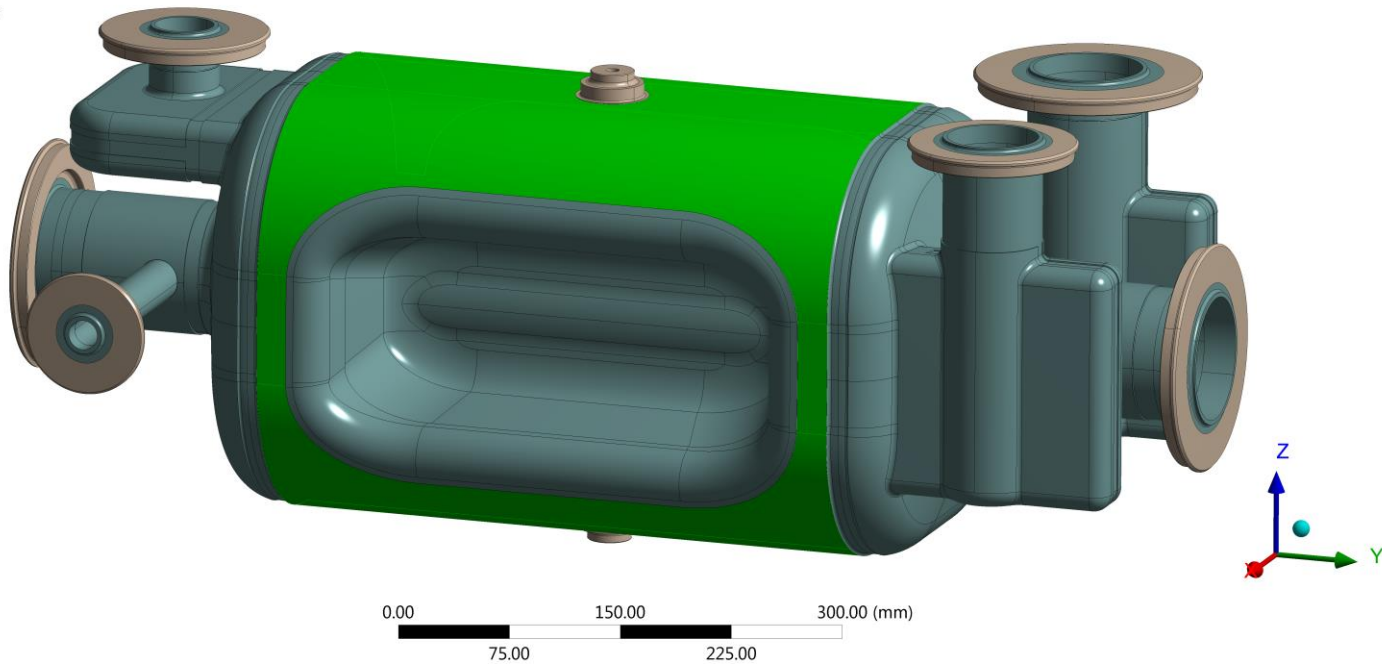


17/11/2017

RFD stress intensity of a cavity of 5 mm thickness

The thickness of the cavity main body (green) has been increased to 5 mm.

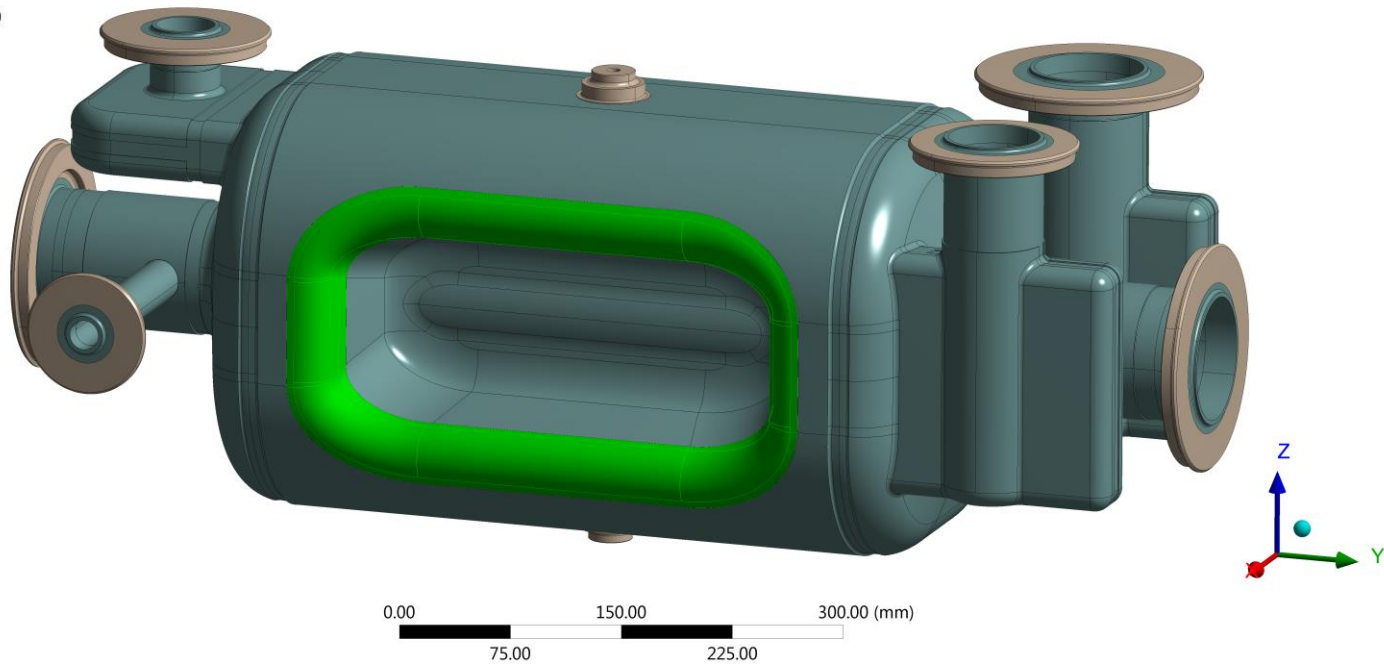
E: Test
Analysis Settings
Time: 7. s
26/10/2017 17:27



RFD stress intensity of a cavity of 5 mm thickness

The thickness of the cavity main body has been increased to 5 mm.
The curved region is 6.35 mm thick.

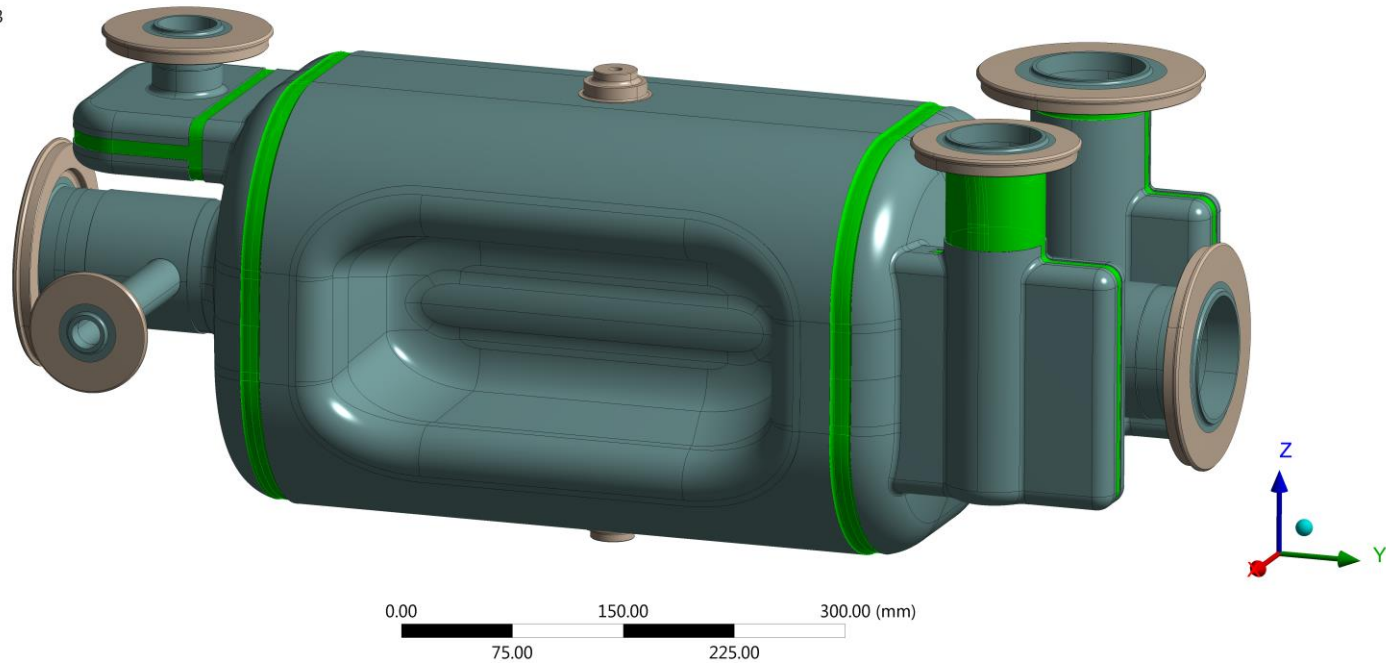
E: Test
Analysis Settings
Time: 7. s
26/10/2017 17:29



RFD stress intensity of a cavity of 5 mm thickness

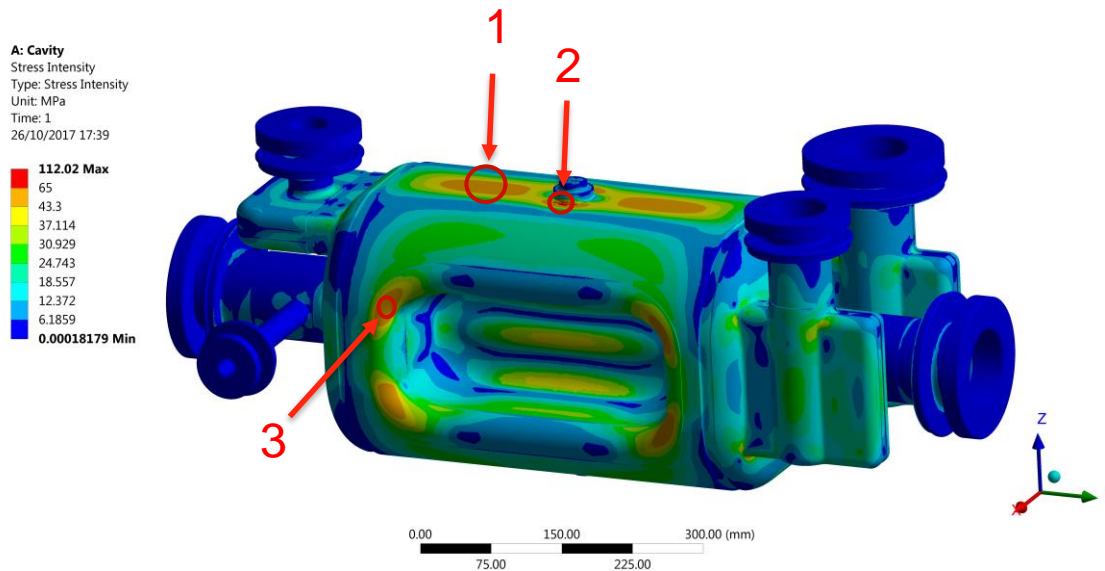
The thickness of the cavity main body has been increased to 5 mm.
The curved region is 6.35 mm thick.
Transitions of 3 mm thickness.

E: Test
Analysis Settings
Time: 7. s
26/10/2017 17:33



5 mm cavity

- Tresca equivalent stress - High stress intensity regions



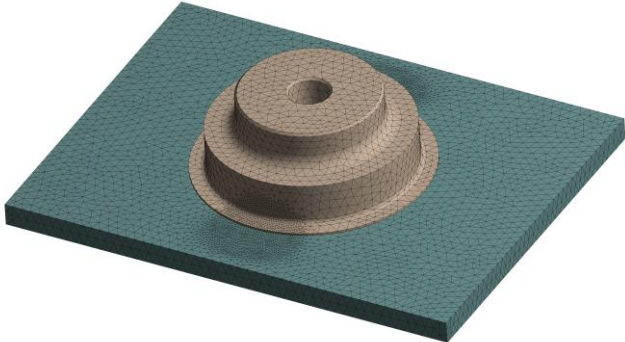
	Linearized stress	
	Pm (MPa)	Pm+Pb (MPa)
1	7.5	50.9
2	15.7	69
3	34.1	60.8
Limit	43.3	65

The tuner regions still present high stresses → Submodel
All the other regions are below the limits

Submodel

Mesh of 2 mm in the tuner region and 0.5 mm in the critical regions

Without weld



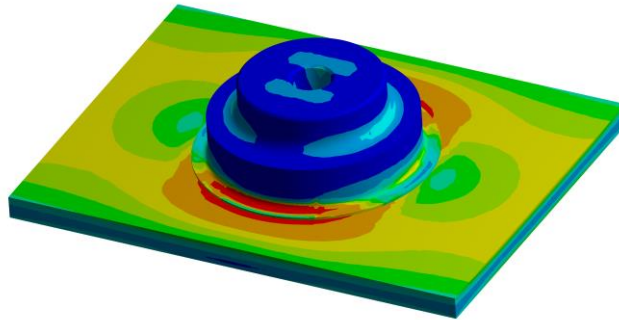
Submodel

Mesh of 2 mm in the tuner region and 0.5 mm in the critical regions

Without weld

B: Submodel tuner
Stress Intensity
Type: Stress Intensity
Unit: MPa
Time: 1
26/10/2017 17:47

169.23 Max
65
43.3
37.126
30.951
24.777
18.602
12.428
6.2537
0.079364 Min



	Linearized stress	
	Pm (MPa)	Pm+Pb (MPa)
	12.3	65.4
Limit	43.3	65

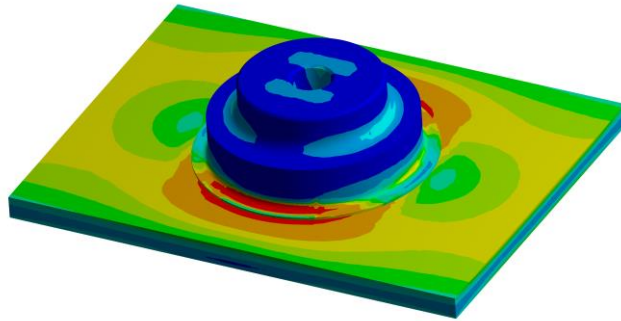
The linearized stress close to the tuner decreases but it is still above the limits

Submodel

Without weld

B: Submodel tuner
Stress Intensity
Type: Stress Intensity
Unit: MPa
Time: 1
26/10/2017 17:47

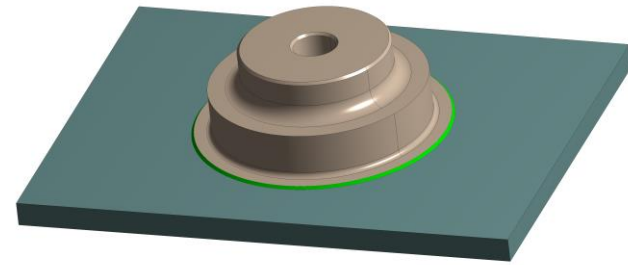
169.23 Max
65
43.3
37.126
30.951
24.777
18.602
12.428
6.2537
0.079364 Min



Welded

Geometry
26/10/2017 17:45

55Ti-45Nb
Niobium



Generation of a volume around the tuner emulating the presence of the weld

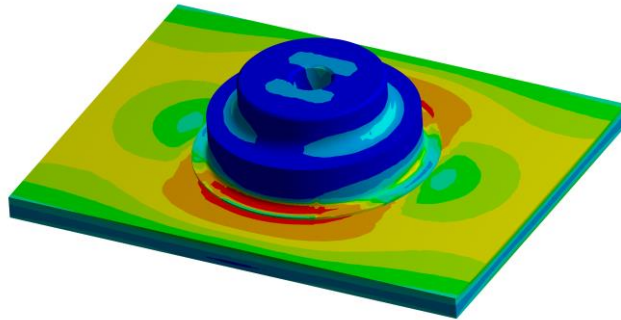
	Linearized stress	
	Pm (MPa)	Pm+Pb (MPa)
	12.3	65.4
Limit	43.3	65

Submodel

Without weld

B: Submodel tuner
Stress Intensity
Type: Stress Intensity
Unit: MPa
Time: 1
26/10/2017 17:47

169.23 Max
65
43.3
37.126
30.951
24.777
18.602
12.428
6.2537
0.079364 Min

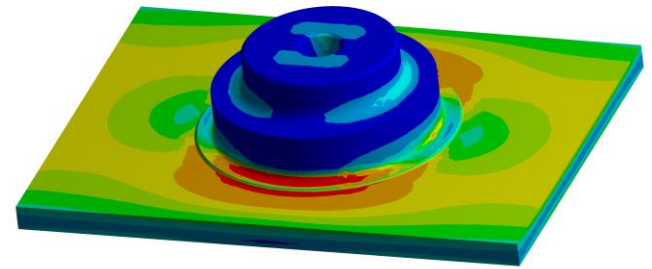


0.00 15.00 30.00 45.00 60.00 (mm)

Welded

C: Submodel tuner with weld
Stress Intensity
Type: Stress Intensity
Unit: MPa
Time: 1
26/10/2017 17:46

157.1 Max
65
43.3
37.119
30.939
24.758
18.578
12.397
6.2163
0.035718 Min



0.00 15.00 30.00 45.00 60.00 (mm)

	Linearized stress	
	Pm (MPa)	Pm+Pb (MPa)
	12.3	65.4
Limit	43.3	65

	Linearized stress	
	Pm (MPa)	Pm+Pb (MPa)
	10.4	60.1
Limit	43.3	65

Using this approach the linearized stress is now below the limits. Special care has to be taken when modeling the tuner region

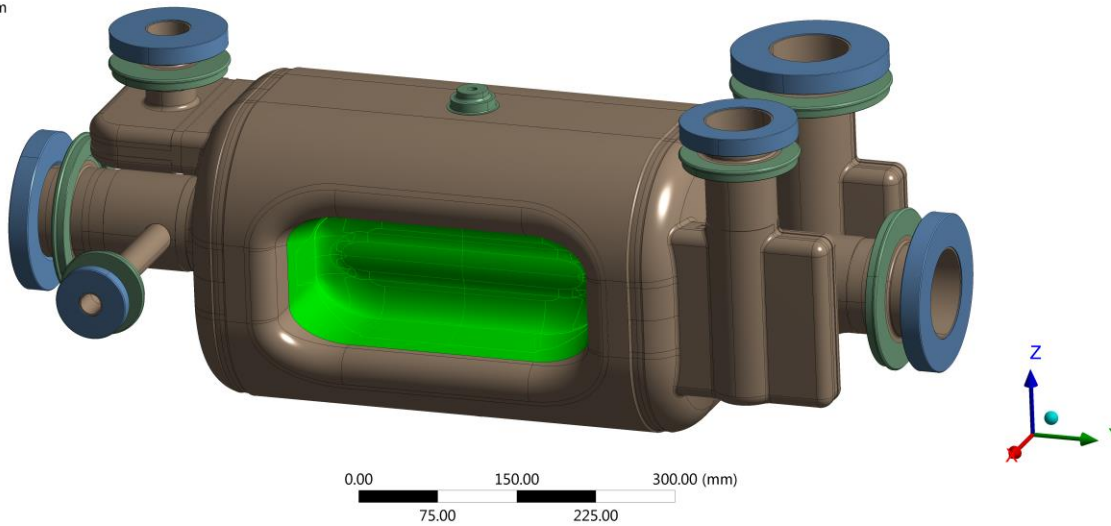
5 mm cavity – realistic thickness distribution in the bowl

- Thickness reduction in specific regions of the bowl during forming

Geometry

16/11/2017 19:10

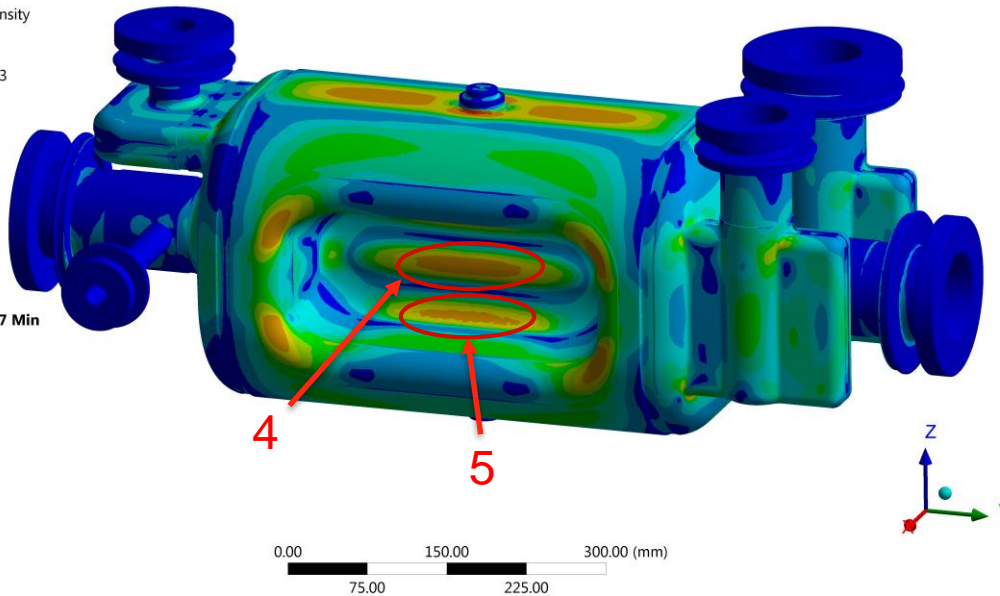
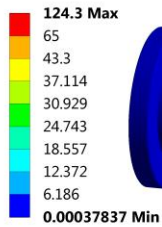
- 316LN
- 55Ti-45Nb
- Niobium



5 mm cavity – realistic thickness distribution in the bowl

- Thickness reduction in specific regions of the bowl during forming

A: Static Structural
Stress Intensity
Type: Stress Intensity
Unit: MPa
Time: 1
15/11/2017 20:23



	Linearized stress	
	Pm (MPa)	Pm+Pb (MPa)
4	5.6	49.1
5	7	45
Limit	43.3	65

Special care to be taken in the bowl central region
Nevertheless, the reduction of the bowl thickness during forming takes place in the corners

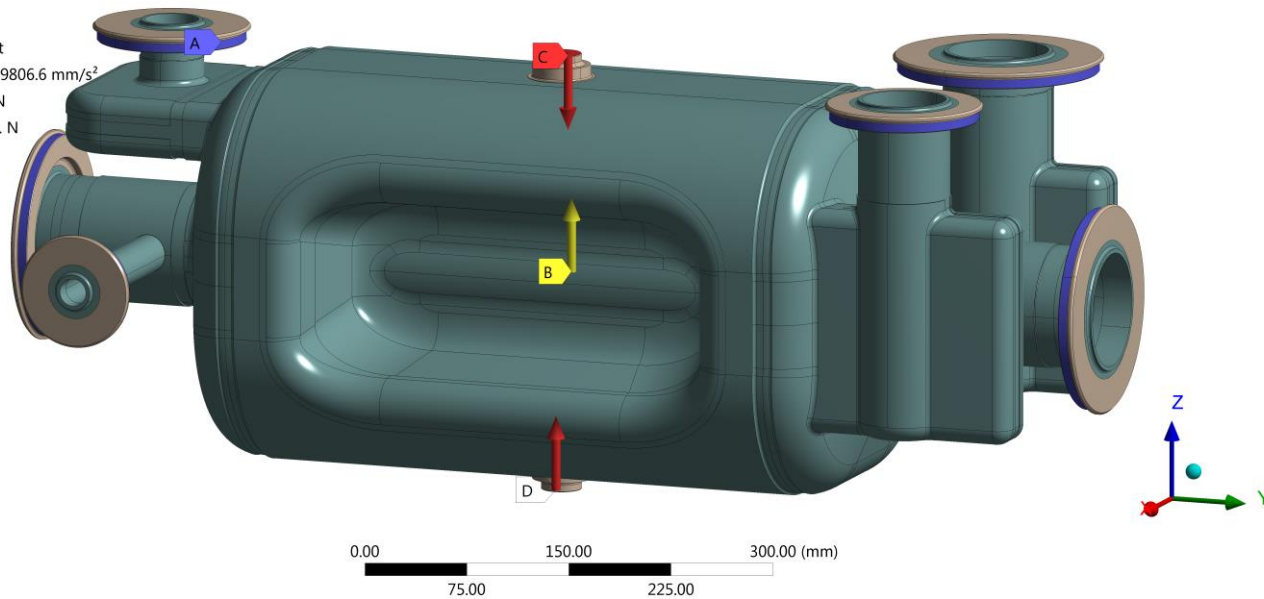
Tuning deformation

- Comparison of the 5 mm cavity and the 4 mm cavity with stiffeners

Vertical force applied to the tuner surfaces

E: Test
Static Structural
Time: 7. s
26/10/2017 18:00

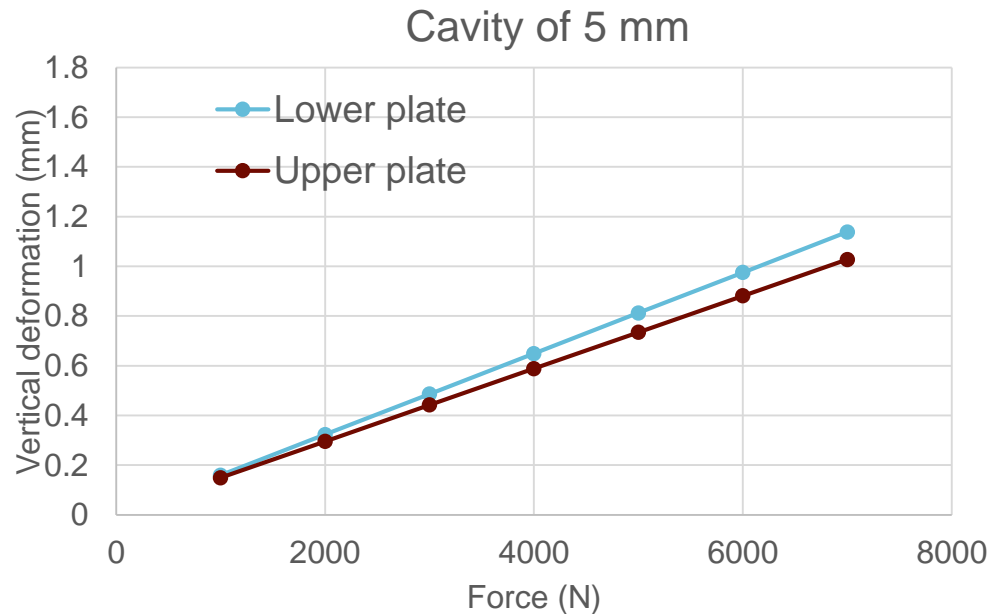
- A** Fixed Support
- B** Acceleration: 9806.6 mm/s²
- C** Force: 7000. N
- D** Force 2: 7000. N



Vertical deformation between plates

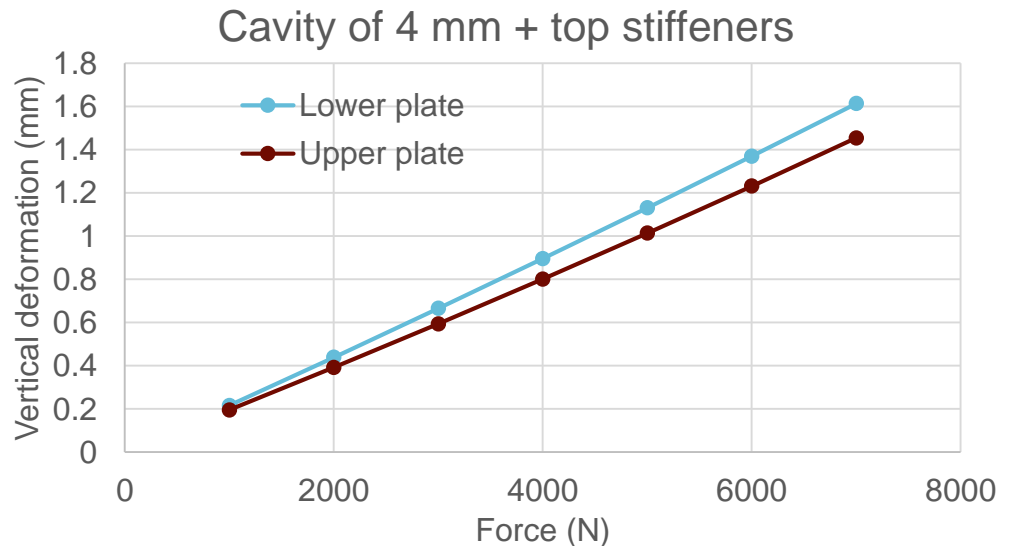
5 mm cavity

3232 N/mm
(between plates)



4 mm cavity + stiffeners

avg. 2358 N/mm
(between plates)

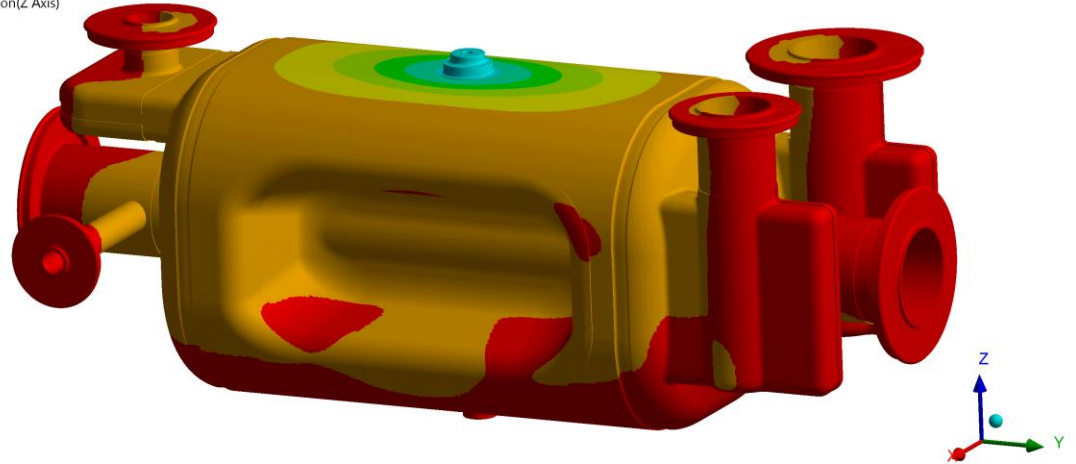
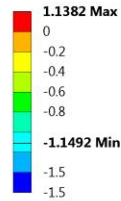


Vertical deformation 7 kN load

5 mm cavity

Large deformation covering a larger area

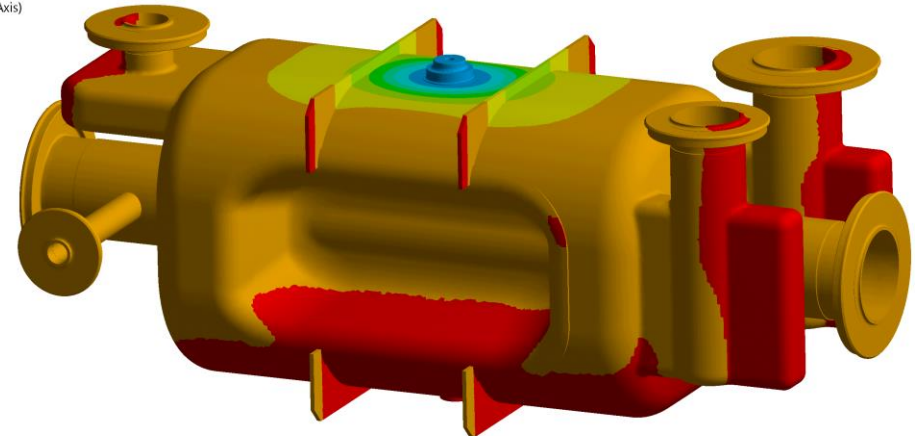
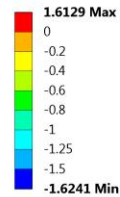
E: Test
Directional Deformation
Type: Directional Deformation(Z Axis)
Unit: mm
Global Coordinate System
Time: 7
26/10/2017 22:03



4 mm cavity + stiffeners

Large deformation concentrated between the stiffeners

B: Tuner deformation
Directional Deformation
Type: Directional Deformation(Z Axis)
Unit: mm
Global Coordinate System
Time: 7
26/10/2017 22:03

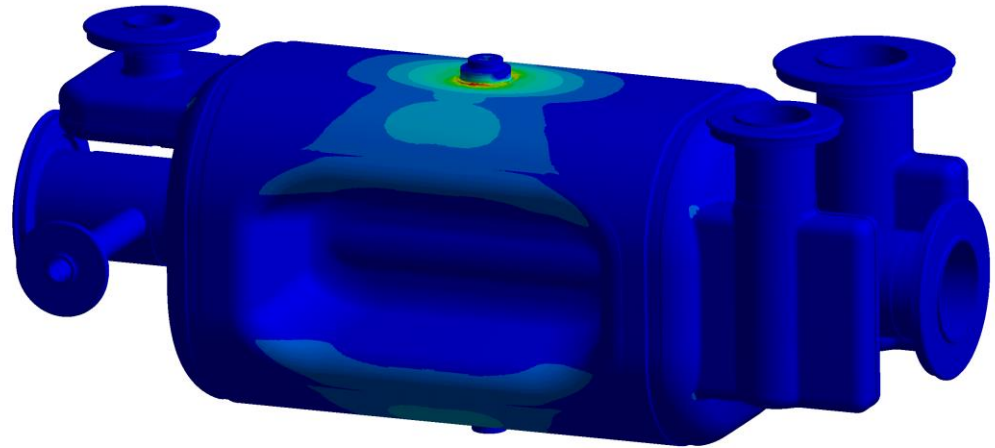
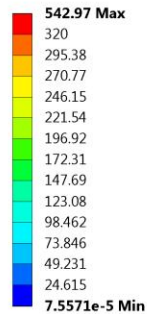


Stress distribution 7 kN load

5 mm cavity

Large stress covering a larger area

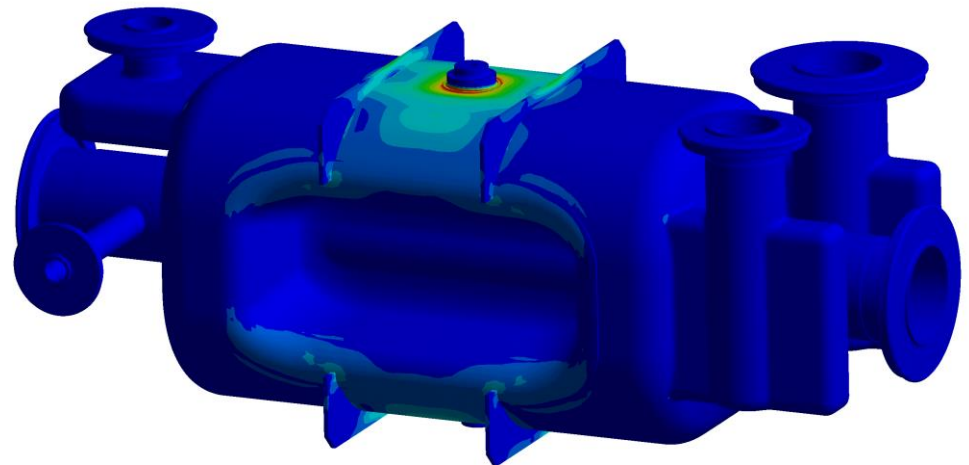
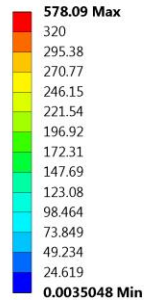
E: Test
Stress Intensity
Type: Stress Intensity
Unit: MPa
Time: 7
26/10/2017 21:49



4 mm cavity + stiffeners

Large stress concentrated between the stiffeners

B: Tuner deformation
Stress Intensity
Type: Stress Intensity
Unit: MPa
Time: 7
26/10/2017 21:49



Design conclusions

- The stress of the 5 mm cavity is below the limits. Nevertheless, special attention has to be still paid to the tuner region.
- The force needed to deform the 5 mm cavity top and bottom plates for tuning is 3232 N/mm, larger than the force needed to deform the cavity of 4 mm + stiffeners.
- When applying the tuning force, the deformation and stress are more evenly distributed along the top and bottom plates of the 5 mm cavity.



RFD cavity stress assessment and tuning

Cavity of 5 mm thickness