
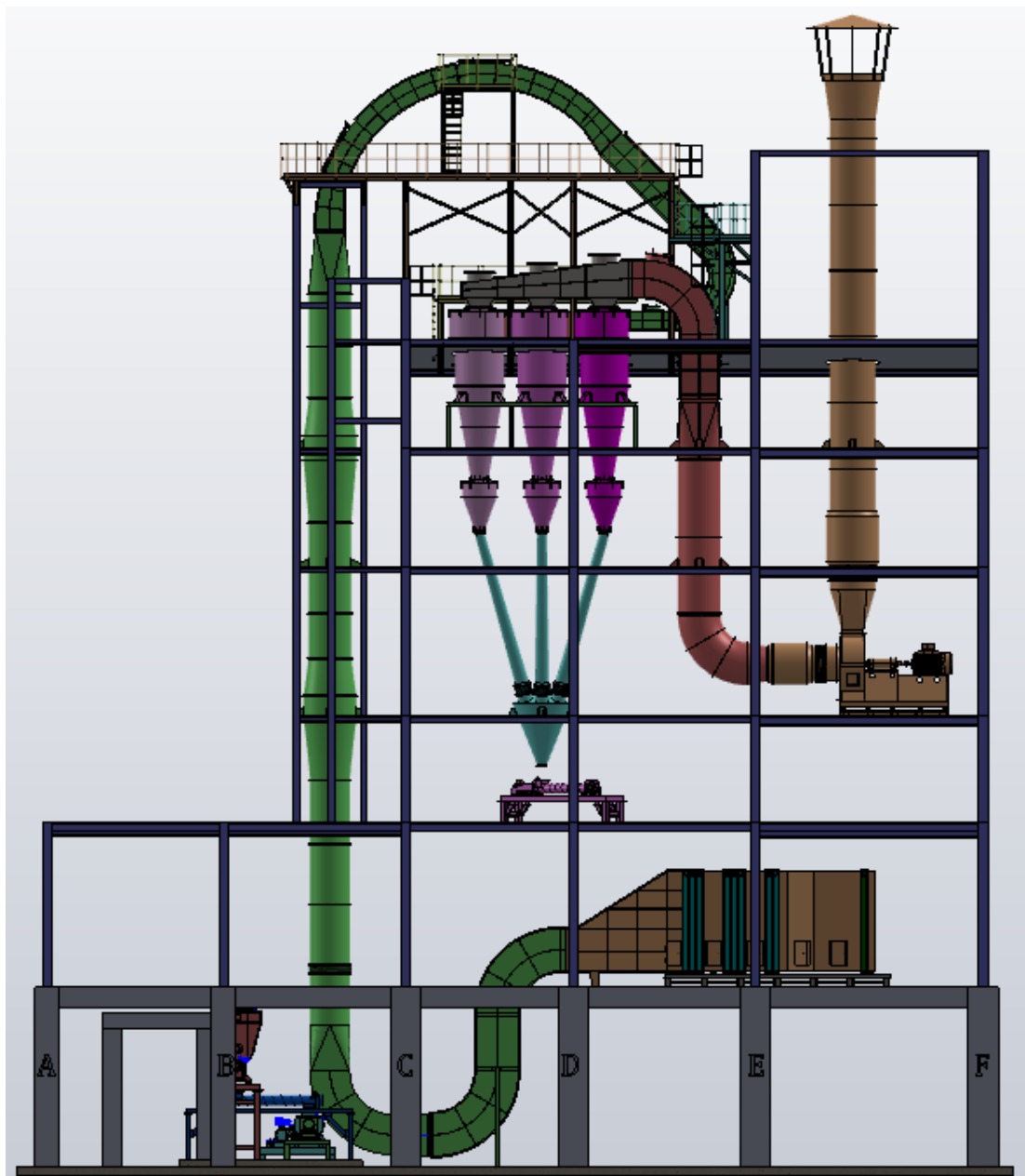
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	FLASH DRYER THICKNESS CALCULATION						
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FLASH DRYER THICKNESS CALCULATION





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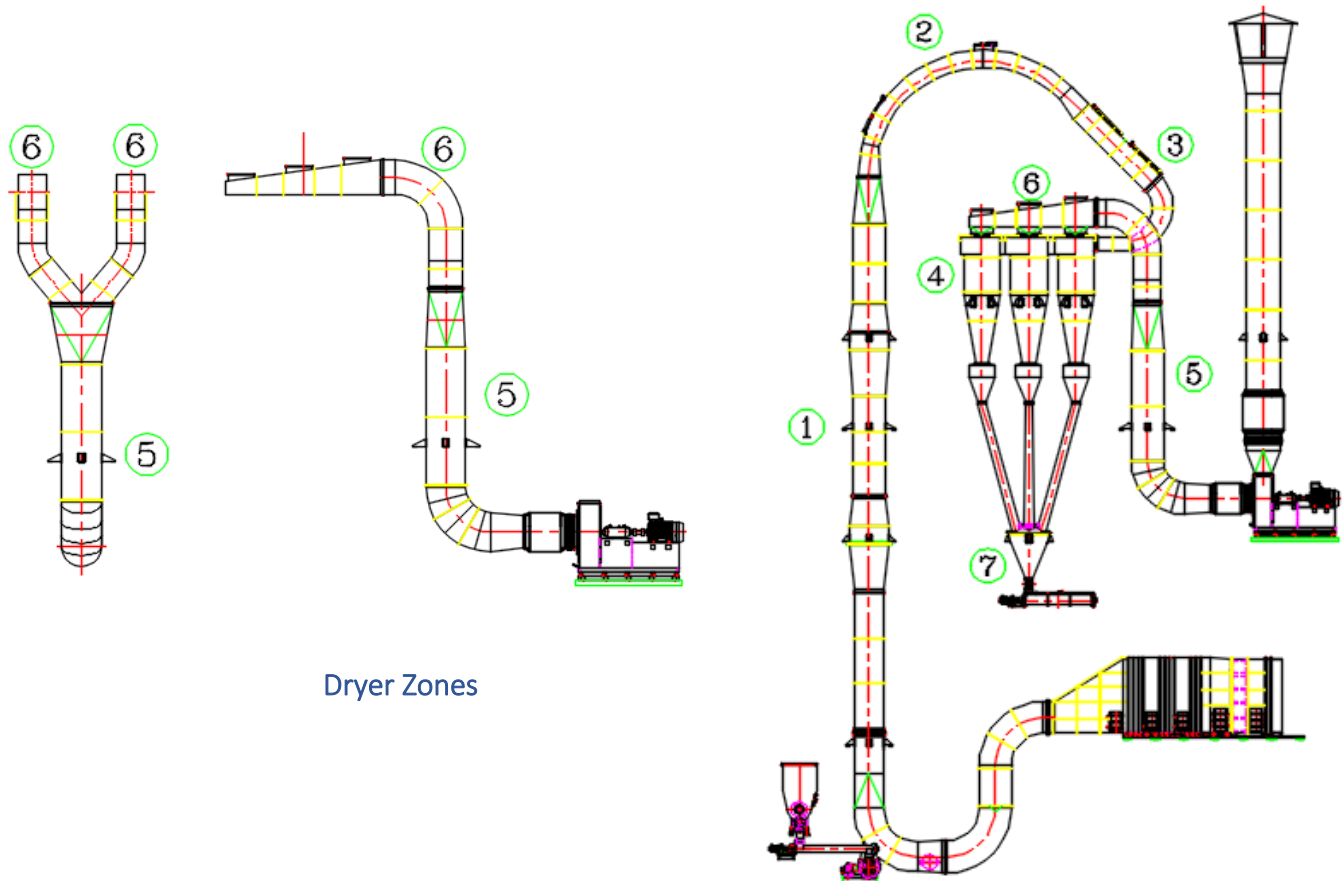
1- INTRODUCTION

Given that the duct of the flash dryer is under the negative pressure induced by the suction fan (0.065 bar), the stress analysis of the duct is performed based on the fan's maximum suction pressure, incorporating an appropriate safety factor. As is known, the maximum inlet air temperature of the fan is approximately 170°C, which decreases along the length of the dryer. To achieve a more accurate analysis and to incorporate a safety margin, the air temperature is assumed to be constant at 170°C throughout the entire length of the dryer. A maximum positive pressure of 0.5 bar (gauge) is considered in accordance with the manufacturer's recommendation.

A critical aspect of the stress analysis and minimum thickness calculation for the dryer is that the calculated minimum required thickness must be compared against the actual thickness specified for each section to ensure it does not exceed the actual value. Furthermore, based on the actual thickness, the maximum allowable working pressure for each section has been calculated. The significance of this maximum allowable working pressure lies in its application for vent sizing calculations; specifically, the Maximum over pressure generated by an explosive atmosphere (P_{req.}) used in vent sizing must not exceed the maximum allowable pressure of any section, or in other words, the weakest section within each controlled volume.



For the purpose of calculating and analyzing stresses induced by pressure, vacuum, and temperature, the dryer duct has been divided into several sections. This division falls into two main categories: sections with circular cross-sections and sections with rectangular cross-sections. Sections with circular cross-sections have been simulated and analyzed using PV Elite software, while sections with rectangular cross-sections have been analyzed using CodeCalc software. It should be noted that, according to the zoning illustrated in the figure below,

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Zone 1 of the dryer duct, which begins approximately above the material inlet and extends to Zone 2. Furthermore, the cyclones (Zone 4) , Fan inlet duct (Zone5) and hopper (Zone 7) have circular cross-sections and have been analyzed using PV Elite software .

Zone 2 , Zone 3 and Zone 6 have rectangular cross-section and have been analyzed using CodeCalc software .

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2- ASSUMPTIONS

The circular section of Zone 5, with a diameter of 1400 mm, is similar to Zone 1; therefore, the analysis results for Zone 1 are also applicable to Zone 5, and a separate analysis is not required.



Zones 2, 3, and the portion of Zone 6 with a rectangular cross-section have been analyzed using CodeCalc software. Zone 3 is the most critical section, as it has both larger dimensions and the highest risk for explosion. Consequently, the analysis results for this section can be generalized to the other rectangular sections, which is a conservative approach that increases the safety factor.

However, stress analysis will be performed for Zones 2, 3, and 6 separately.

The design assumptions, based on the mechanical specifications of the equipment and the data received from the manufacturer, are as presented in the below

- Operating Internal Temperature = 55° C - 165° C
- Design Internal Temperature = 170° C
- Operating External Temperature = -20° C to 35 ° C
- Design External Temperature = 50° C
- Maximum Operating internal pressure (Opening Pressure of Explosion Vents) = 0.1 bar
- Design Internal Pressure = 0.5 bar
- Maximum External Pressure (Maximum Vacuum Pressure of fan)= 0.065 bar
- Design External Pressure (Design Vacuum Pressure) = 0.1 bar
- Circular Duct Thickness(Zone 1 , 4) = 3 mm
- Rectangular Duct Thickness (Zone 2 , 3, 6) = 3 mm
- Duct Material= AISI SS 316

Finally, following the calculations detailed in Appendices 1 through 6, a summary of the calculations and stress analysis is presented in the table below. As can be observed, the actual thicknesses considered are adequate, and the maximum allowable working pressure for each section has been duly incorporated into the calculations for the required vent size.

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3- SUMMARY OF CALCULATIONS



The stresses calculations and analysis summary for the different areas of the dryer duct are as follows :

Table 1- Assumption and Design Data



Zone	Title	Section	Material	Actual Thickness (mm)	Design Internal Pressure (Bar)	Design External Pressure (Bar)	Design Internal Temperature ©	Design External Temperature ©
1	Duct	Circular	AISI 316	3	0.5	0.1	170	50
2	Duct	Rectangular	AISI 316	3	0.5	0.1	170	50
3	Duct	Rectangular	AISI 316	3	0.5	0.1	170	50
4	Cyclone	Circular	AISI 316	3	0.5	0.1	170	50
5	Duct	Circular	AISI 316	3	0.5	0.1	170	50
6	Duct	Rectangular	AISI 316	3	0.5	0.1	170	50
7	Hopper	Circular	AISI 316	3	0.5	0.1	170	50

Table 2- Calculated Data

Zone	Title	Section	Maximum Allowable Internal Working Pressure (Bar)	Maximum Allowable External Working Pressure (Bar)	Minimum Required Thickness (mm)
1	Duct	Circular	3.5	0.137	2.6
2	Duct	Rectangular	0.83	0.1	2.8
3	Duct	Rectangular	0.81	0.1	2.8
4	Cyclone	Circular	1.6	0.27	2
5	Duct	Circular	3.5	0.137	2.6
6	Duct	Rectangular	0.81	0.1	2.8
7	Hopper	Circular	3.9	0.23	2.15

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APPENDIX 1 **CALCULATION** **CIRCULAR SECTION OF DUCT** **ZONE 1**

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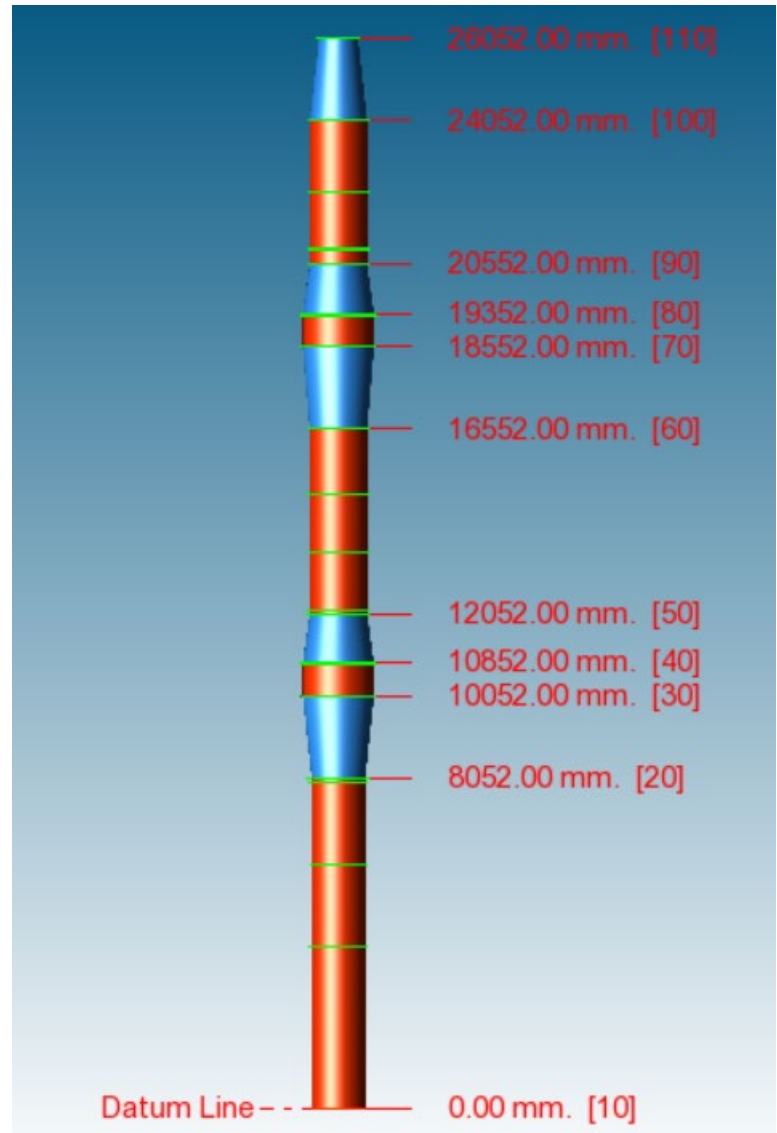






Figure A – Circular Duct - Zone 1

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APPENDIX 2 **CALCULATION** **CYCLONES- ZONE 4**

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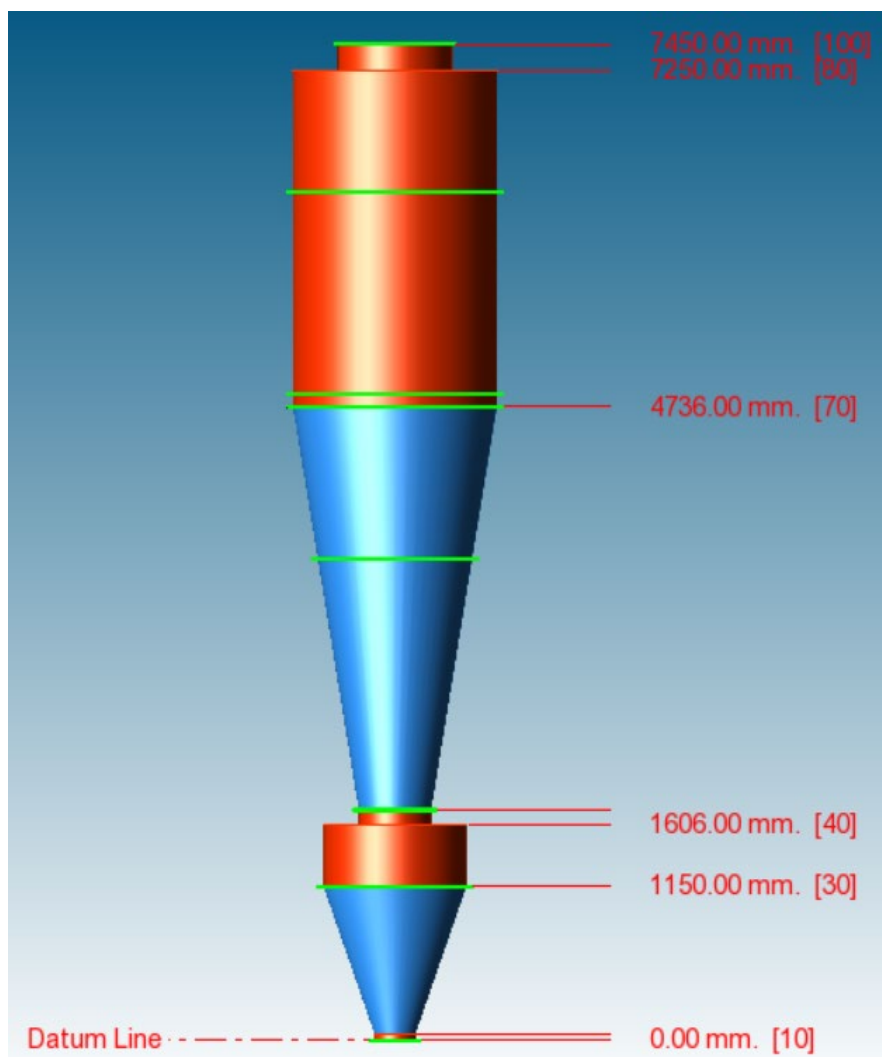
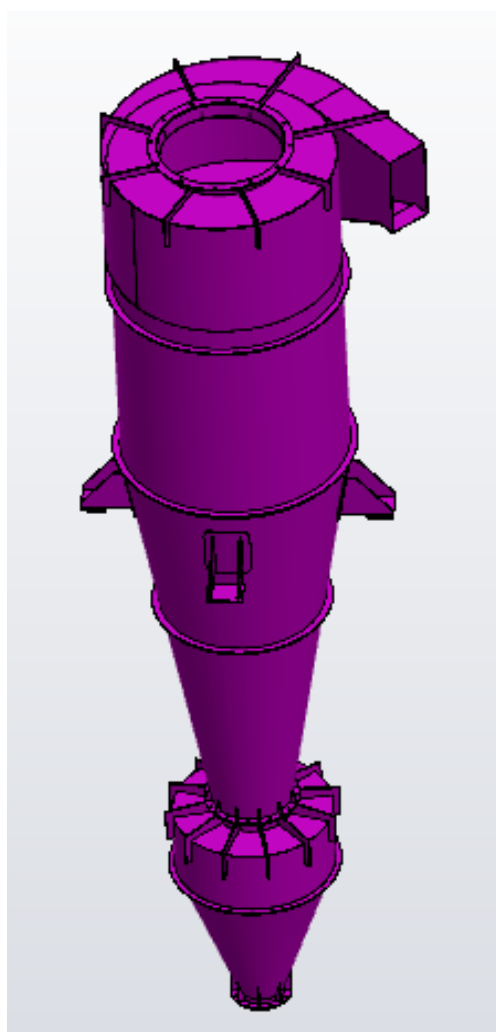






Figure B- Cyclones - Zone 4

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APPENDIX 3 **CALCULATION** **RECTANGULAR SECTION** **ZONE 2**

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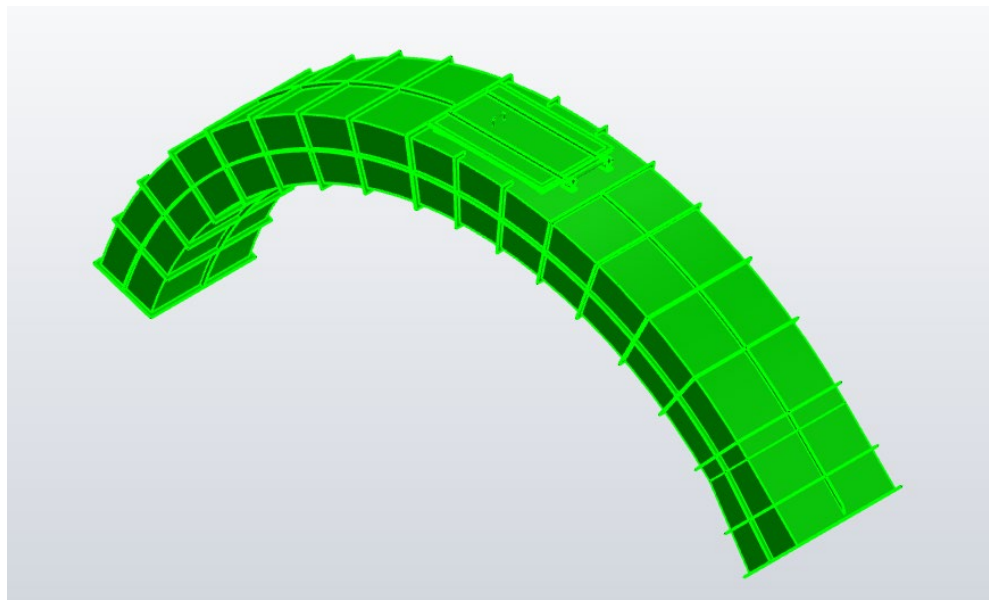
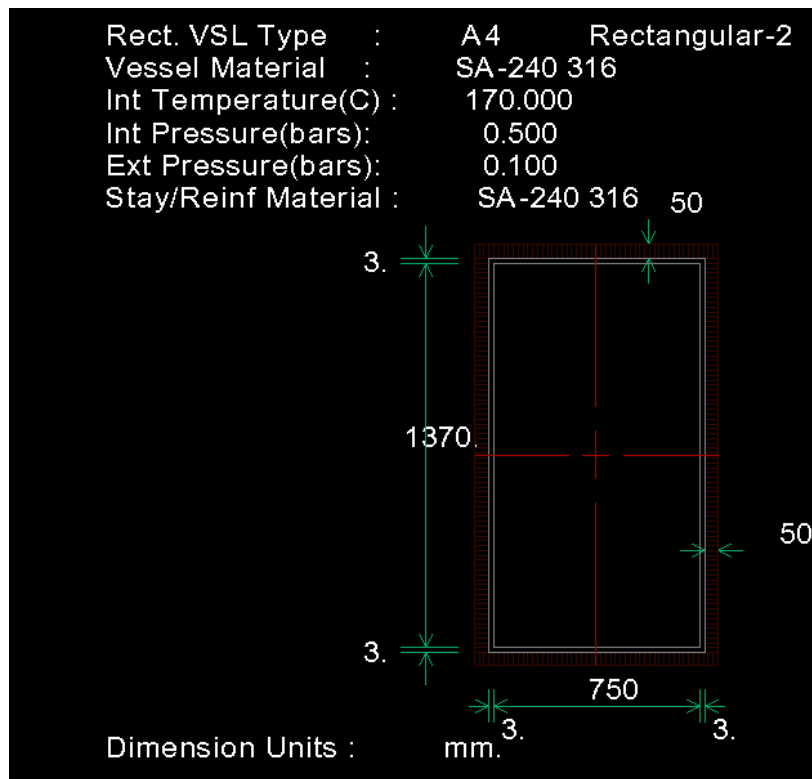






Figure C- Rectangular Duct - Zone 2

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APPENDIX 4 **CALCULATION** **RECTANGULAR SECTION** **ZONE 3**

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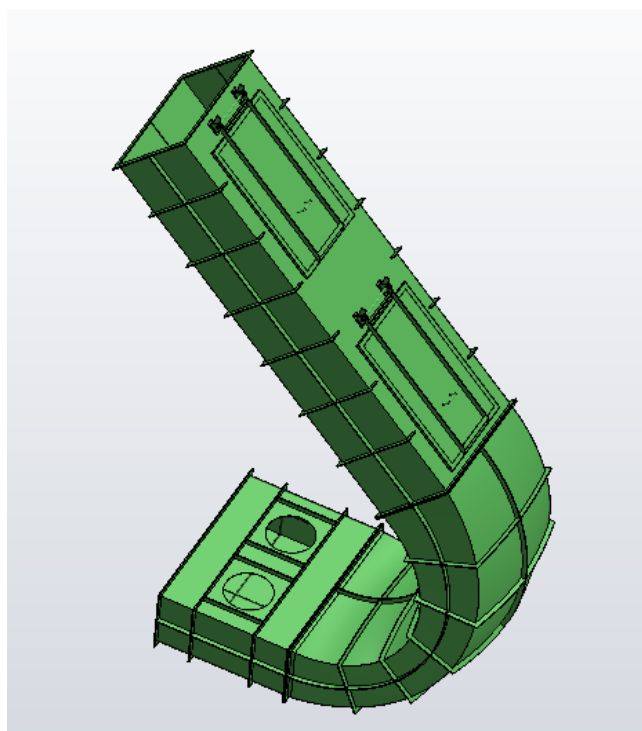
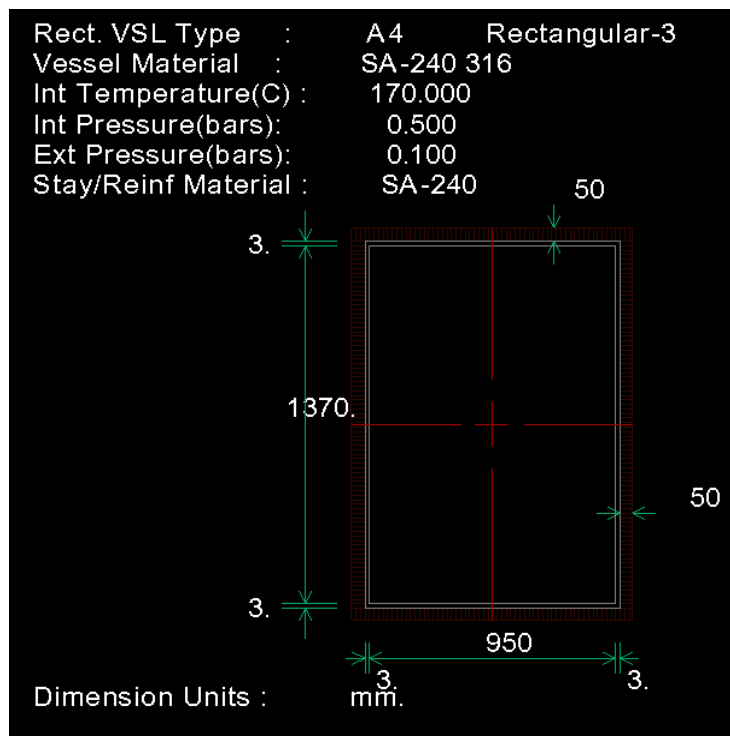






Figure D-Rectangular Duct - Zone 3

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APPENDIX 5 **CALCULATION** **RECTANGULAR SECTION** **ZONE 6**

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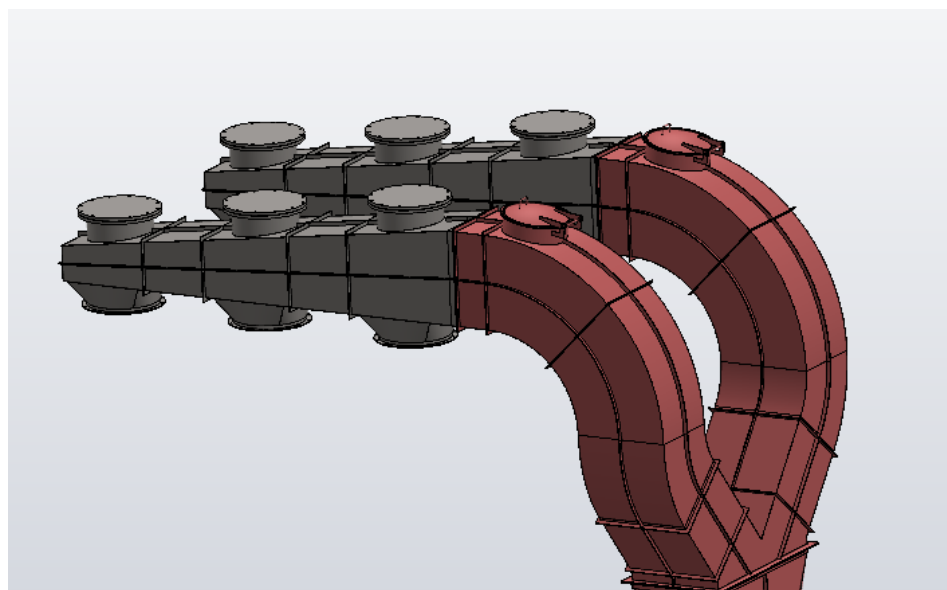
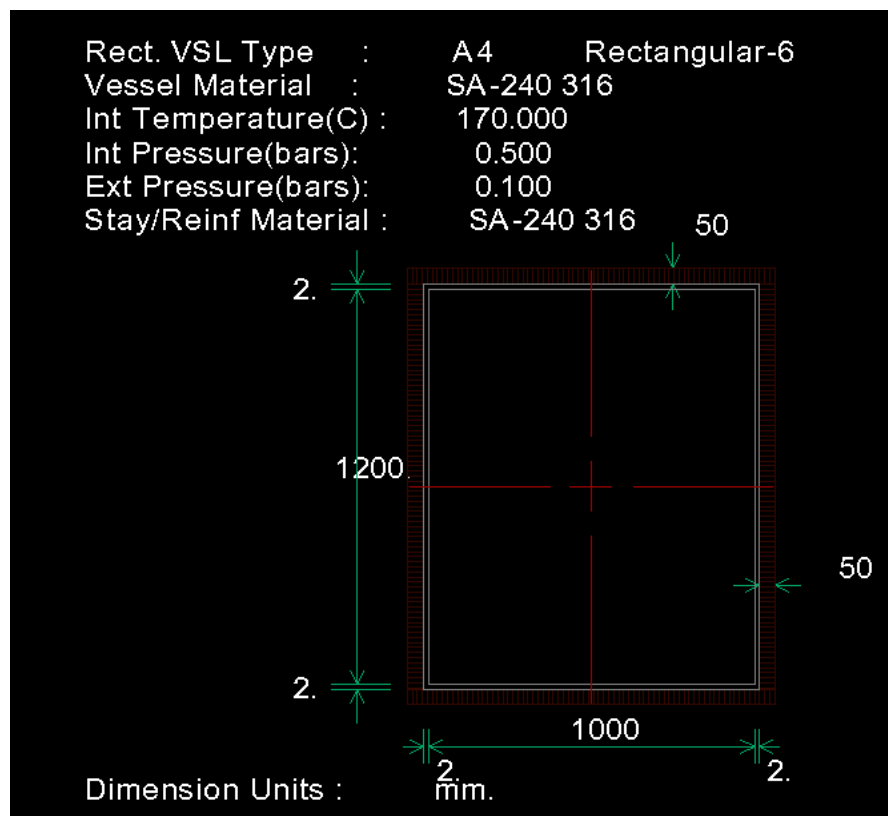






Figure E- Rectangular Duct - Zone 6

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APPENDIX 6 **CALCULATION HOPPER** **ZONE 7**

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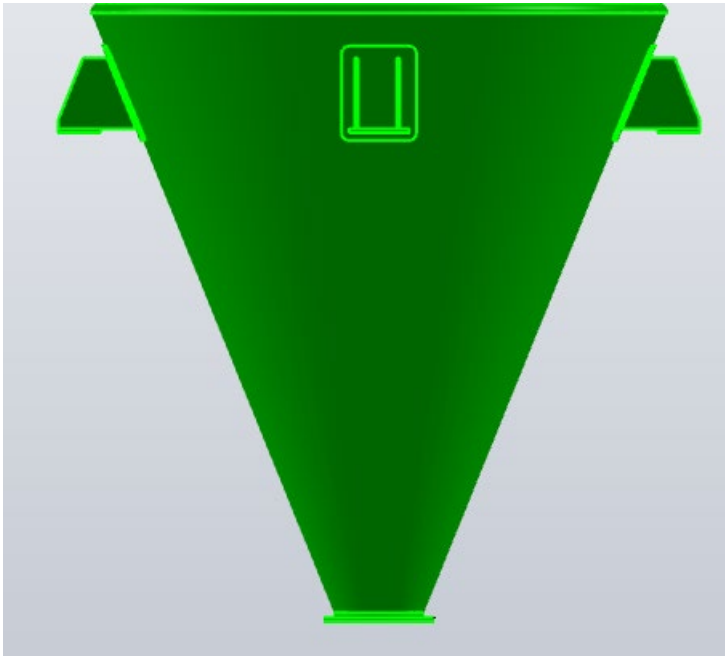
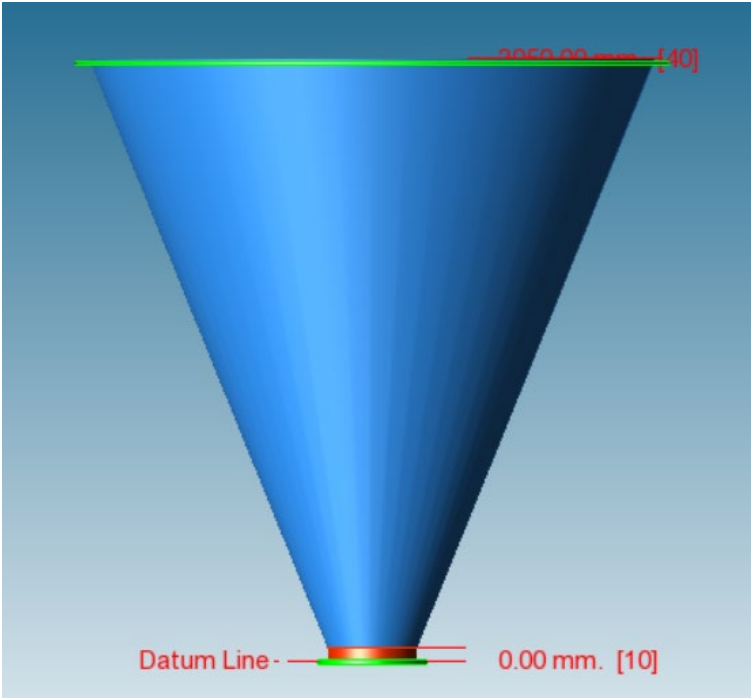


Figure F-Hopper - Zone7