

Vertical Atmospheric Tank

Project **CEREBRO - EXEMPLOS**

Vessel Identification **PTQ-Extrapolado-20000**

1 - Main Characteristics

1.1	Type	Vertical	
1.2	Operation	Atmospheric	
1.3	Useful Volume (V_{PU})	20000	L
1.4	Actual Volume (V_R)	22000	L
1.5	Total Volume (V_{TTV})	24015	L
1.6	Additional of Volume.....	10.00	%
1.7	Top Head	Torispherical ASME 10%	
1.8	Bottom Head.....	Torispherical ASME 10%	
1.9	Product maximum density	1350.00	kg/m ³
1.10	Overthickness (No Overthickness)	0.00	mm
1.11	Shell Weld Efficiency(Not Radiographed)(ϵ_c)	0.70	
1.12	Top Head Weld Efficiency(Not Radiographed)(ϵ_s)	0.70	
1.13	Bottom Head Weld Efficiency(Not Radiographed)(ϵ_i).....	0.70	

2 - Geometry

2.1	Inside Diameter (D).....	2730	mm
2.2	Cylindric Height (H).....	3413	mm
2.3	Liquid Height (H_{LL})	3072	mm
2.4	D/H ratio.....	0.80	
2.5	Shell Height (H_C).....	3393	mm
2.6	Top Head's Height (H_{TS})	542	mm
2.7	Bottom Head's Height (H_{TI}).....	542	mm
2.8	Height from bottom to ground (H_{FP}).....	600	mm
2.9	Vessel total height (H_{TT})	5077	mm

3 - Material

3.1	Top Head	Stainless steel - SA-240 TP 316
3.2	Shell	Stainless steel - SA-240 TP 316
3.3	Bottom Head.....	Stainless steel - SA-240 TP 316
3.4	Legs	Stainless steel - SA-240 TP 316
3.5	Base Plate	Stainless steel - SA-240 TP 316

4 - Plates Thickness

4.1	Top Head(e_{ts})	3.00	mm
4.2	Shell(e_c)	3.00	mm
4.3	Bottom Head(e_{ti})	3.00	mm
4.4	Legs(e_p)	2.77	mm
4.5	Base Plate(e_{sp}).....	5.00	mm
4.6	Overthickness	0.00	mm

5 - Finish

5.1	Tank Inside Surface.....	Polished Grit 220
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5.2	Tank External Surface	Polished Grit 180
5.3	Legs	Polished Grit 180

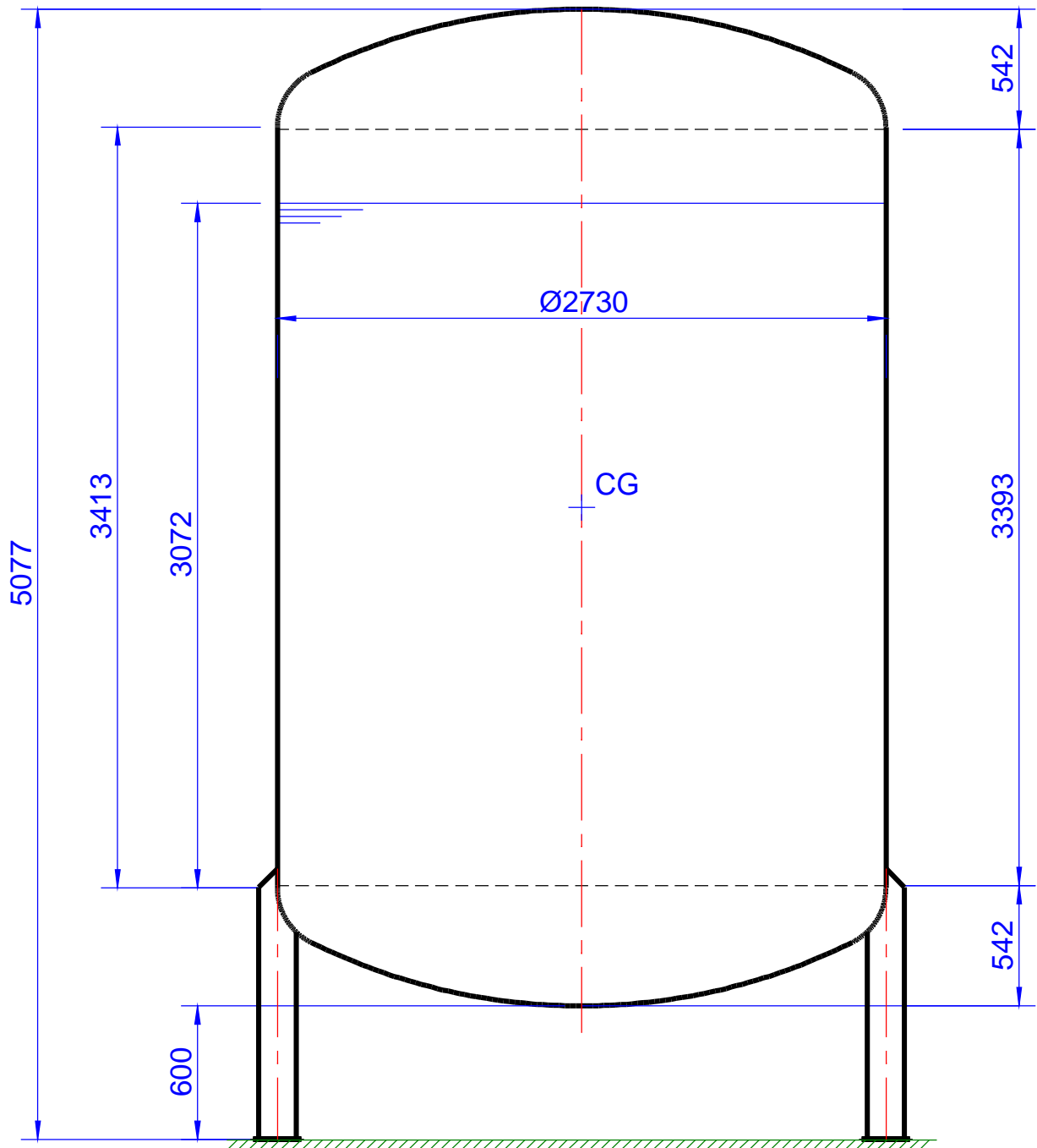
6 - Net Weight (without features)

6.1	Top Head(G_{ts})	177	kgf
6.2	Shell(G_c).....	695	kgf
6.3	Bottom Head(G_c)	177	kgf
6.4	Legs(G_p).....	56	kgf
6.5	Base Plate(G_{sp}).....	6	kgf
6.6	Empty Tank(G_v)	1110	kgf
6.7	Tank with the Product(G_{tot})	30810	kgf

7 - Supporting System - Main Characteristics

7.1	Supporting	Legs	
7.2	Number of Legs	4	
7.3	Leg Type	Schedule	
7.4	Nominal dimensions	Ø6" Schedule 5s	
7.5	Leg Dimension.....	168.30	mm
7.6	Thickness.....	2.77	mm
7.7	Leg total height	1216.7	mm
7.8	Base Plate Type	Leveler	
7.9	Base Plate Dimensions.....	Ø217.00	mm

8 - Vessel (Dimensions)



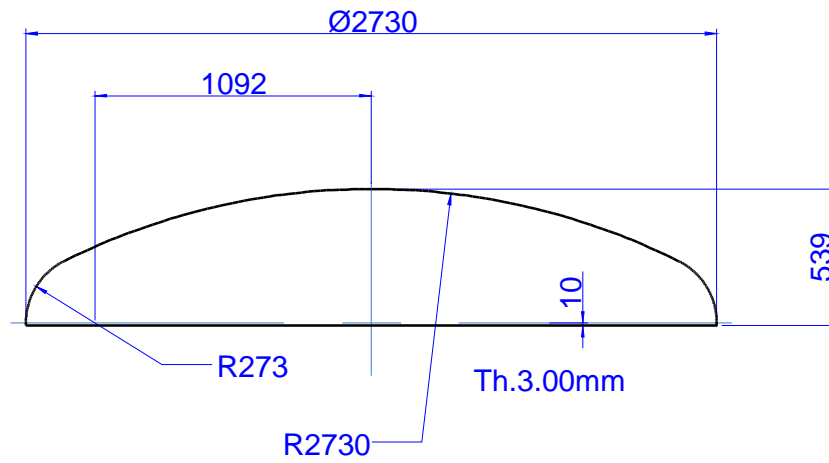
Head Report - Top

9 - Main Data

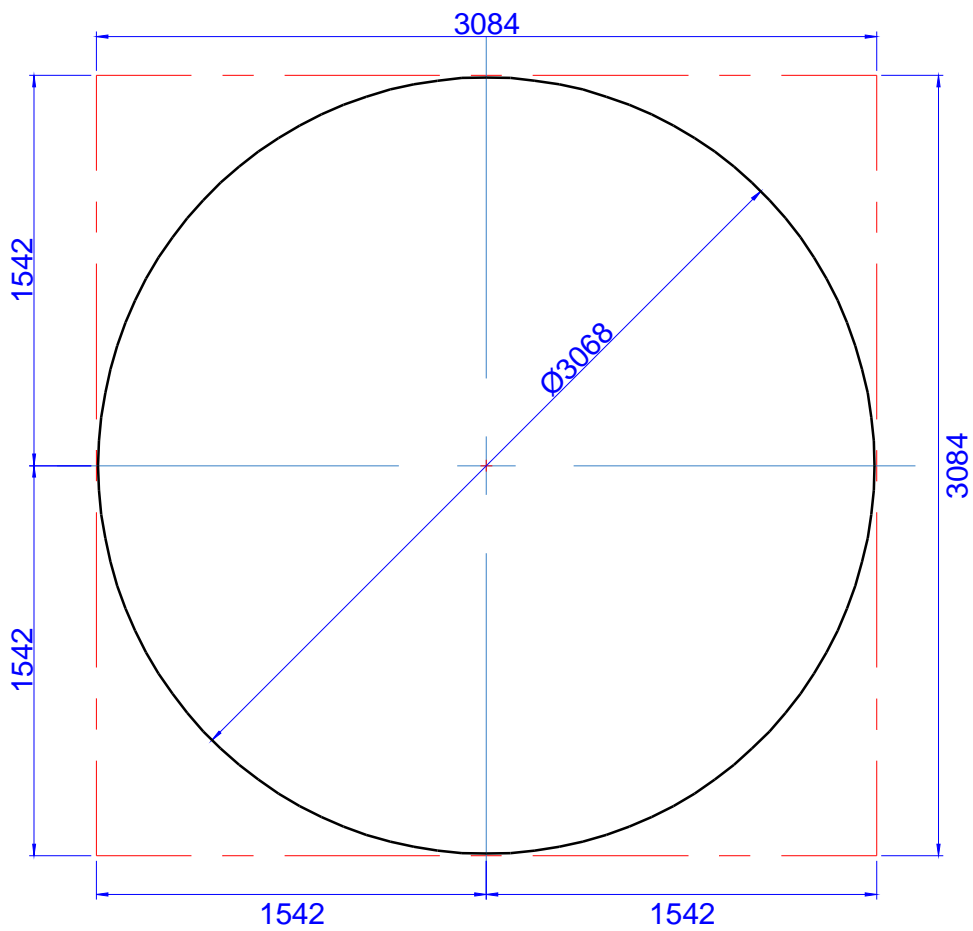
9.1	Head Type	Torispherical ASME 10%	
9.2	Inside Diameter.....	2,730	mm
9.3	Thickness.....	3.00	mm
9.4	Thin Out	0.00	mm
9.5	Material	Stainless steel - SA-240 TP 316	
9.6	Density	7,963	kg/m ³
9.7	R/D ratio.....	1.00	
9.8	r/D ratio	0.10	

10 - Results

10.1	Bending radius (R).....	2,730	mm
10.2	Joining radius (r)	273	mm
10.3	Crown height (h ₂)	284	mm
10.4	Knuckle height (h ₁)	245	mm
10.5	Flange's Height (h _s)	10	mm
10.6	Head's height without cylindrical portion (h _i)	529	mm
10.7	Head inside height (H _i)	539	mm
10.8	Distance from the head center to the inside-corner center (r ₁)	1,092	mm
10.9	Crown external radius (r ₂)	1,214	mm
10.10	Crown semi-angle(α)	26	°
10.11	Head total volume(v _{total})	2.073	m ³
10.12	Developed disc diameter (D _s)	3,068	mm
10.13	Head Net weight (P _L)	176.60	kgf
10.14	Head gross weight (P _B)	227.21	kgf



Head: Torispherical ASME 10% (No scale)



Developed Plate (No scale)

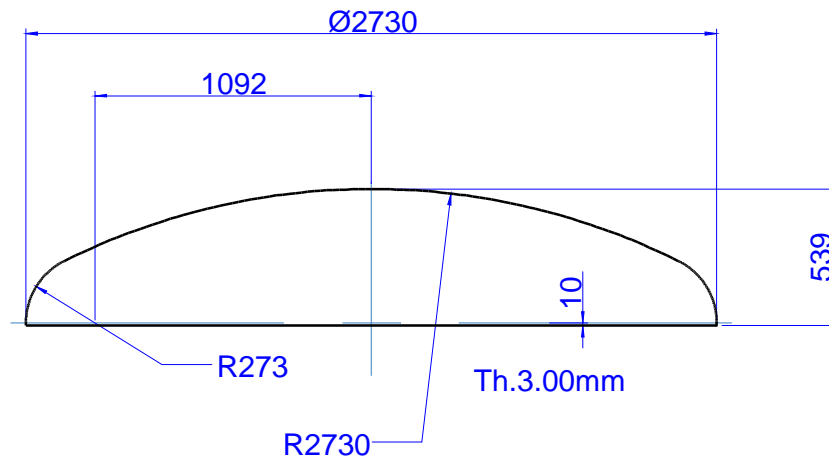
Head Report - Bottom

11 - Main Data

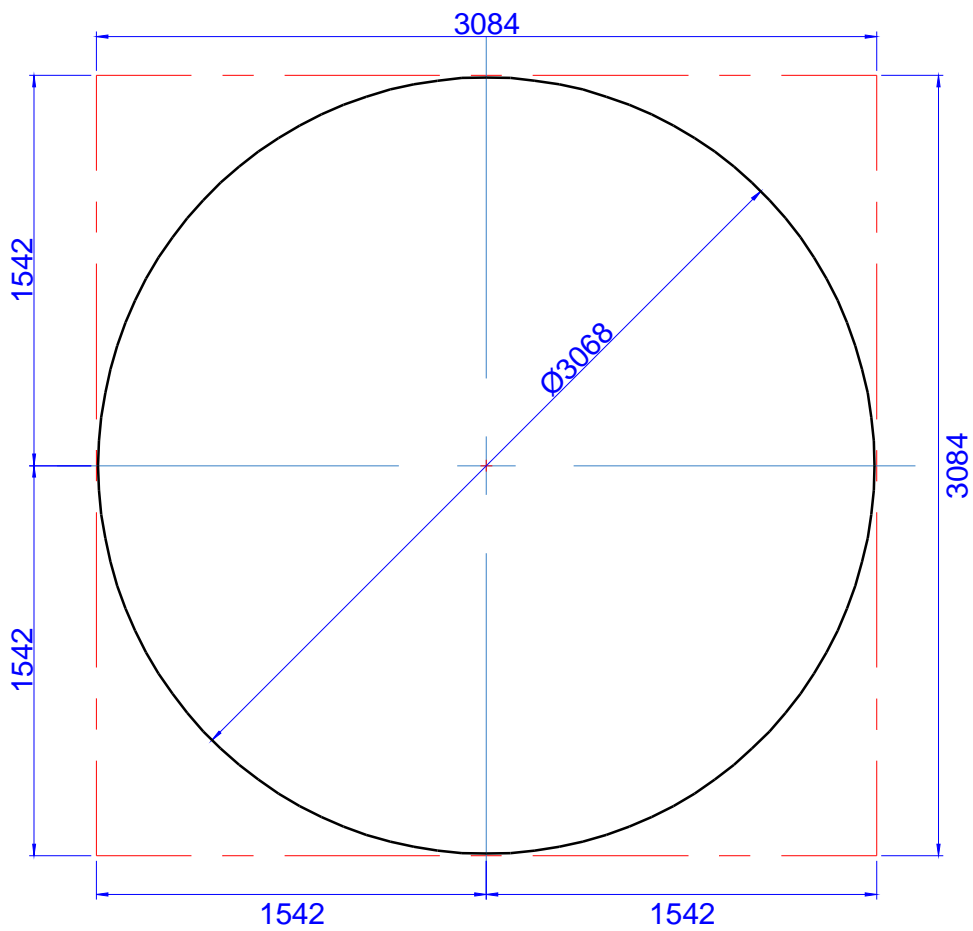
11.1	Head Type	Torispherical ASME 10%	
11.2	Inside Diameter.....	2,730	mm
11.3	Thickness.....	3.00	mm
11.4	Thin Out	0.00	mm
11.5	Material	Stainless steel - SA-240 TP 316	
11.6	Density	7,963	kg/m ³
11.7	R/D ratio.....	1.00	
11.8	r/D ratio	0.10	

12 - Results

12.1	Bending radius (R).....	2,730	mm
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Head: Torispherical ASME 10% (No scale)



Developed Plate (No scale)

Supporting Report

13 - Requirements in Supporting System

13.1	Wind Velocity (V_v)	0	km/h
13.2	Wind Deriving Strength (F_v)	0	kgf
13.3	Seismic Zone	0	
13.4	Seismic Empiric Coefficient (k_{ms})	0.00	
13.5	Horizontal Inertia Strength (F_{JH})	0	kgf
13.6	Horizontal Force (F_H)	0	kgf
13.7	Tumbling Momentum in LTI (M_{LTI})	0	kgf.m
13.8	Tumbling Momentum in Anchorage Point (M_b)	0	kgf.m
13.9	Legs Reaction Opposed to the Wind (F_c)	7687	kgf
13.10	Legs Reaction Towards the Wind (F_T)	-7687	kgf
13.11	Eccentric Strength 1 (F_{ex1})	7687	kgf
13.12	Eccentric Strength 2 (F_{ex2})	-7687	kgf
13.13	Lateral Strength on Legs (F_L)	0	kgf
13.14	Shaft Eccentricity (e_x)	1.50	mm

14 - Base Plate Characteristics

14.1	Base Plate Dimension(l_s)	217.00	mm
14.2	Base Plate Thickness(e_s)	5.00	mm
14.3	Admissible contact pressure between the Base Concret/Pad(δ_b)	73	kgf/cm ²
14.4	Actuating Contact Pressure between Base/Pd(p_c)	29	kgf/cm ²

15 - Welded Joint Dimensioning

15.1	Welding Fillet Unilateral Length (L_1)	306	mm
15.2	Weld Shearing Strength (F_{cs})	81.0	kgf/cm
15.3	Weld Section Linear Module (S_W)	82712	mm ²
15.4	Weld Bending Strength (F_{fs})	1.4	kgf/cm
15.5	Total Combined Strength (F_{tc})	81.0	kgf/cm
15.6	Bending Stress (σ_f)	501	kgf/cm ²
15.7	Weld Fillet width (b_w)	3.00	mm
15.8	Longitudinal Traction Stress on the Shell (σ_{LT})	-44.6	kgf/cm ²
15.9	Longitudinal Compressure Stress on the Shell (σ_{LC})	119.2	kgf/cm ²
15.10	Tension Extension Localized (L_2)	296.4	mm
15.11	Stress Located Above the Leg (σ_L)	864.4	kgf/cm ²

16 - Anchors Characteristics

16.1	Minimum area for anchor screw(A_{CH})	0.0	mm ²
16.2	Anchor screw minimum diameter(d_{CH})	0.0	mm
16.3	Anchor screws fixation diameter(D_{CH})	2739.5	mm

17 - Cylindric Pipe Data

17.1	Pipe External Diameter (d_{ep})	16.68	cm
17.2	Pipe Thickness (e_p)	0.28	cm
17.3	Pipe Material	Stainless steel - SA-240 TP 316	
17.4	Material Drainage Stress (F_y)	2109	kgf/cm ²
17.5	Material Elasticity Module (E)	1989687	kgf/cm ²

18 - Section Characteristics

18.1	Section Area (A)	14.274	cm ²
18.2	Inertia momentum (I _x)	480	cm ⁴
18.3	Resistance elastic Momentum (W _x).....	57.58	cm ³
18.4	Gyration Radius (r _x)	5.800	cm

19 - Data for Axial Compressure

19.1	Maximum length without bracing (L).....	113.209	cm
19.2	Effective Length Factor (K)	2.00	

20 - Actuating Requiring Stresses

20.1	Axial Stress Due To Loading (P _d)	7687.13	kgf
20.2	Bending Momentum Due to Loading (M _d)	1153.07	kgf.cm

21 - Loadings for Dimensioning

21.1	Required Axial Stress : Loading =1.4 D (P _u)	10761.98	kgf
21.2	Bending Momentum Required : Loading =1.4 D (M _u)	1614.30	kgf.cm

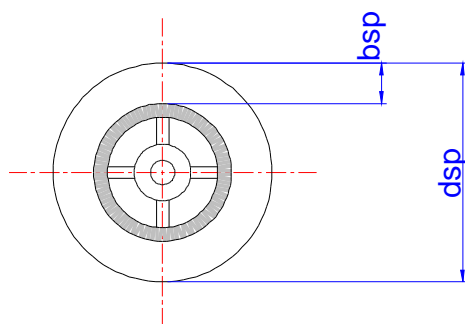
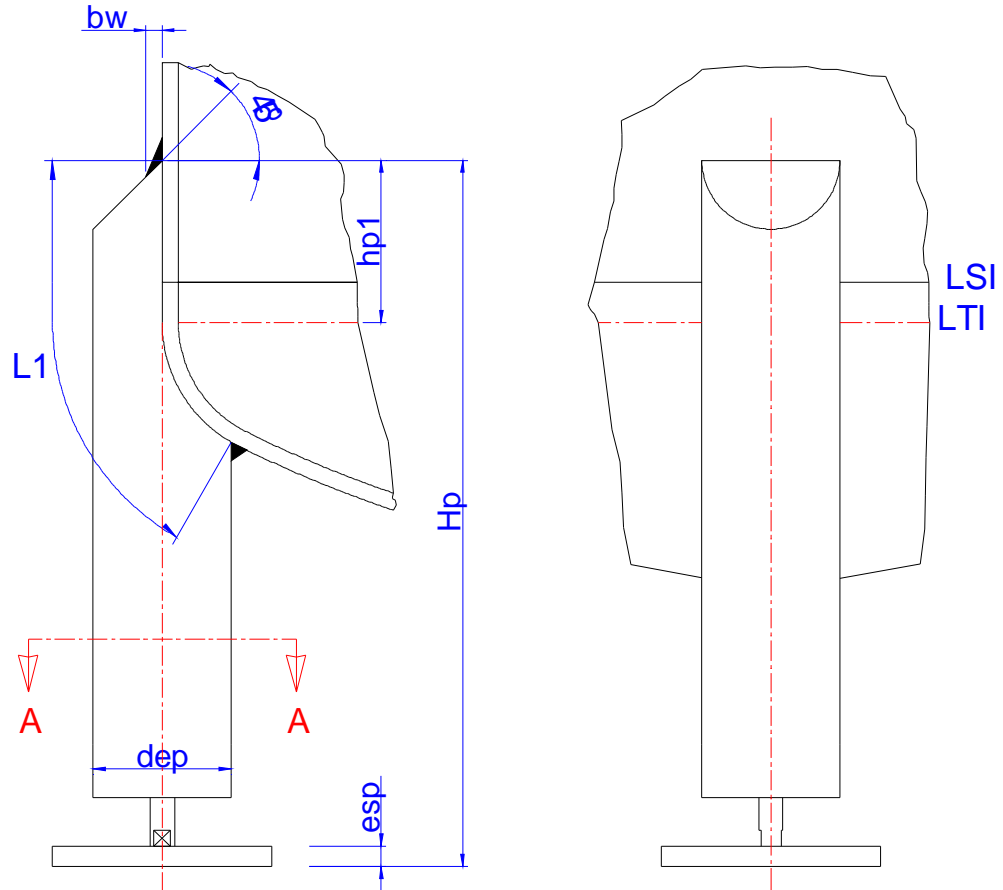
22 - Nominal Stresses For The Profile

22.1	Section C.6: $d_{ep}/e_p \leq 0,441E/F_y$ ($60.22 \leq 416.01$)	OK	
22.2	Section C.6.1	$d_{ep}/e_p \leq 0,070E/F_y$	
22.3	Φ_b	0.95	
22.4	Nominal Bending Momentum (M _n).....	151808.78	kgf.cm
22.5	Checking: $M_u/\Phi_b M_n \leq 1.0$ ($0.01 \leq 1.0$).....	OK	
22.6	Section C.4.1	<i>Sections not subject to buckling by twisting</i>	
22.7	λ	39.04	
22.8	Buckling Elastic Tension (F _e).....	12886.72	kgf/cm ²
22.9	Section C.6.2: <i>Compressure of Cylindric Pipes</i>	$F_e > F_y/2$	
22.10	Φ_c	0.85	
22.11	R Coefficient	0.286	
22.12	A _o	14.274	cm ²
22.13	Effective Section Area (A _e)	14.274	cm ²
22.14	Buckling Stress (F _n)	2022.90	kgf/cm ²
22.15	Nominal Axial Stress: $P_n = F_n \cdot A_e$	28875.41	kgf
22.16	Checking: $P_u/\Phi_c P_n \leq 1.0$ ($0.44 \leq 1.0$)	OK	

23 - Combination of Bending and Compressure:1.4 D

23.1	Section C.5: <i>Combination of Axial and Bending Stress</i>	OK	
23.2	C _{mx}	1.0	
23.3	C _{my}	1.0	
23.4	P _E	183948.05	kgf
23.5	α_{nx}	0.93	
23.6	$P_u/\Phi_c P_n + C_{mx} M_{ux}/\Phi_b M_{nx} \alpha_{nx} + C_{my} M_{uy}/\Phi_b M_{ny} \alpha_{ny} \leq 1.0$ ($0.45 \leq 1.0$)	OK	
23.7	$P_u/\Phi_c P_{n0} + M_{ux}/\Phi_b M_{nx} + M_{uy}/\Phi_b M_{ny} \leq 1.0$ ($0.43 \leq 1.0$)	OK	

24 - Welded Joint Details (no scale)



Cut A-A

Dimension	Value (mm)
bsp	24.35
bw	3.00
dep	168.30
dsp	217.00
esp	5.00
Hp	1216.66
hp1	84.57
L1	306.00

Mixing Report

25 - Vessel Main Characteristics

25.1	Operation	Atmospheric	
25.2	Useful Volume(V_{pu})	20000	L
25.3	Inside Diameter (D).....	2730	mm
25.4	Shell Height(H_c)	3393	mm
25.5	Liquid Height(H_{LL})	3072	mm
25.6	Internal finish	Polished Grit 220	

26 - Product Main Characteristics

26.1	Product Identification	Suco Concentrado	
26.2	Behaviour.....	Newtonian	
26.3	Density (ρ_P).....	1350	kg/m ³
26.4	Maximum Temperature (T).....	-20	°C
26.5	Maximum Viscosity (μ)	45000	cP
26.6	Solids concentration	0	%

27 - Agitator Constructive Way

27.1	Position of Agitator.....	Out-center	
27.2	Shaft Arrangement.....	With footstool	
27.3	Impeller shaft's angle (γ)	0.00	°
27.4	Baffles	No baffles	
27.5	Impeller Type	4 Bladed 45 degrees	
27.6	Quantity of Impellers (N_i)	3	
27.7	Shaft and Blades Material.....	Stainless steel - SA-240 TP 316	
27.8	Tank sample intake material.....	Stainless steel - SA-240 TP 316	
27.9	Frame Material.....	Stainless steel - SA-240 TP 316	
27.10	Agitator finish	Polished Grit 220	
27.11	Frame Finish.....	Polished Grit 180	

28 - Impellers Position regarding LTI

28.1	First Impeller(h_{i1}).....	53.0	mm
28.2	2nd Impeller(h_{i2}).....	1184.0	mm
28.3	3th Impeller(h_{i3}).....	2315.0	mm

29 - Agitation System Characteristics

29.1	Agitation Level (N_a)	1.52	
29.2	Agitation Intensity	Low	
29.3	Product Average Velocity in the Tank (v)	2.74	(m/min)
29.4	Agitator's effective capacity (Q)	16.04	(m ³ /min)
29.5	Reynolds Number (NRey).....	25.28	

$$Re = \frac{d_r^2 N_p}{60000v}$$

where:

- Re : Reynolds number
- d_i : Impeller's diameter, in mm
- N : Rotation, in rpm
- ρ : Density, in kg/m³
- ν : Viscosity, in cp

$$Re = \frac{1060^2 \times 45 \times 1350}{60000 \times 45000}$$

∴ Re = 25.281

29.6 Flow Number (Nq)0.30

30 - Agitator Dimensioning

30.1	Distance to the center (e _{eixo})	454	mm
30.2	Number of impellers (N _i)	3	
30.3	Number of Blades per Impeller (N _p).....	4	
30.4	Impeller Diameter (d _{imp})	1060	mm
30.5	Blades width (b _p).....	210.0	mm
30.6	Blades Thickness (e _p).....	7.10	mm
30.7	Propeller Hub's Height (h _c)	160.0	mm
30.8	Inside Propeller Hub's Diameter (d _{ci}).....	52.10	mm
30.9	Pipe external diameter (d _{ce}).....	160.0	mm
30.10	Hub Thickness (b _c)	53.95	mm
30.11	Estimated Shaft's Length (L _s)	4152	mm
30.12	Shaft Diameter (d _e)	60.00	mm
30.13	Rotation (n)	45	rpm
30.14	Critical frequency (n _c)	601	rpm
30.15	Power (P).....	9.200	kW

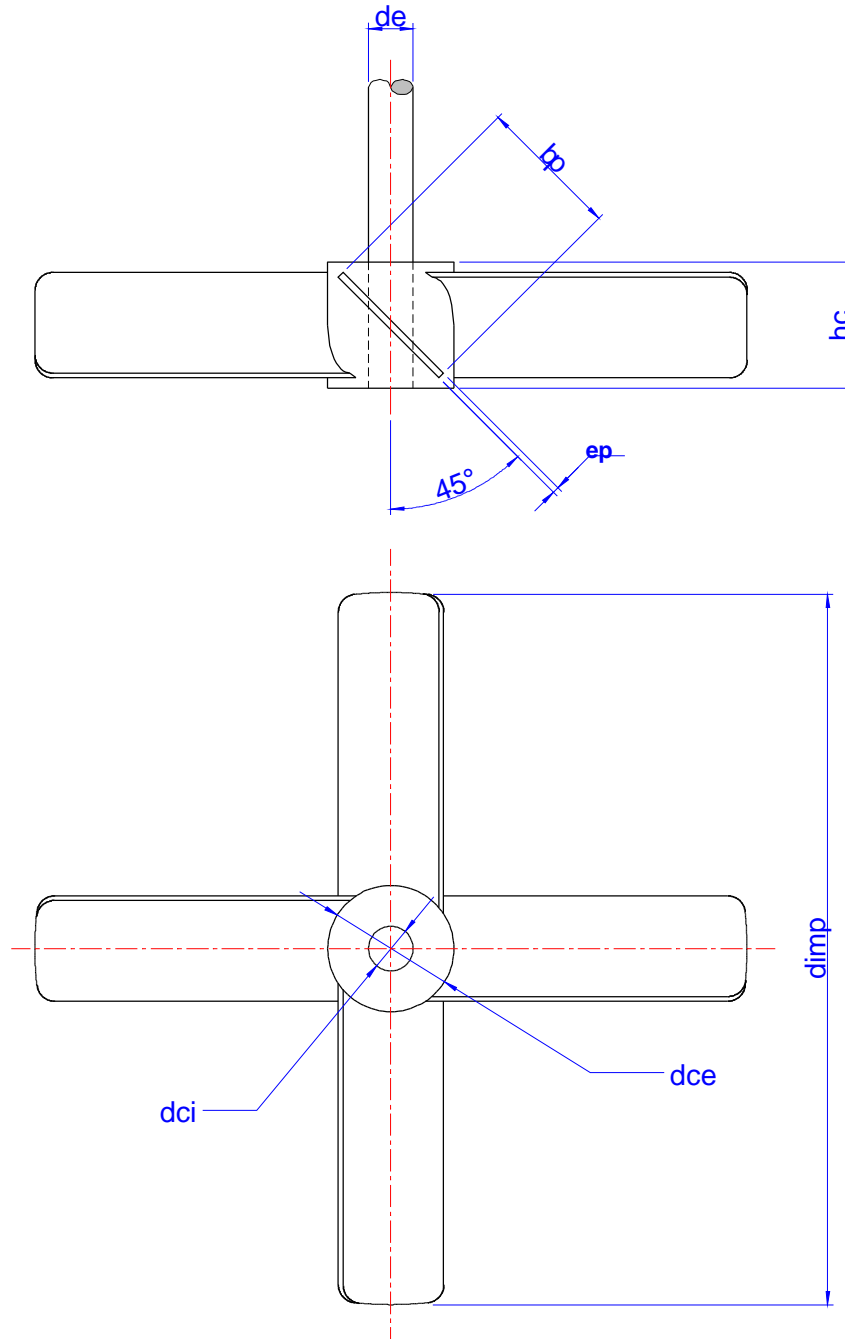
31 - Geared Motor Characteristics

31.1	Manufacturer.....	SEW	
31.2	Model	FAF 87 DX132ML4	
31.3	Power.....	9.200	kW
31.4	Rotation.....	45	rpm
31.5	Reduction (i)	39.30	
31.6	Work Factor (f _s).....	1.35	
31.7	Flange Diameter (a ₁)	350.00	mm
31.8	Shaft Diameter (d _{er})	60.00	mm
31.9	Constructive Way.....	H5	
31.10	Geared Motor's weight (m)	190.00	kgf
31.11	Frequency (f)	60.00	Hz
31.12	Voltage (V).....	440	V
31.13	Motor Shield.....	IP 55	
31.15	Observation	Pintura padrão na cor do fabricante, cinza.	

32 - Weights

32.1	Agitation system weight (G _a)	283	kgf
32.2	Weight of Empty Tank With Agitator (G _{TA})	1332	kgf
32.3	Weight of Full Tank With Agitator (G _{TA}).....	31032	kgf

34 - Straight 4-Blade Impeller Detail



Symbol	bp (mm)	d_{ce} (mm)	d_{ci} (mm)	d_e (mm)	d_{imp} (mm)	bc (mm)	ep (mm)	hc (mm)	Ni	Np
Value	210.00	160.00	60.00	60.00	1060.00	53.95	7.10	160.00	3	4