

ภาคผนวก

ภาคผนวก ก
ตารางค่าคุณสมบัติต่างๆ

ตาราง ก.1 คุณสมบัติของวัสดุ

Materials	Den- sity (Mg/m ³)	Elastic Strength ^a			Ultimate Strength			Endur- ance Limit ^c (MPa)	Modu- lus of Elas- ticity (GPa)	Modu- lus of Rigid- ity (GPa)	Percent Elonga- tion in 50 mm	Coeffi- cient of Thermal Expansi- on (10 ⁻⁶ /°C)
		Ten- sion (MPa)	Comp. (MPa)	Shear (MPa)	Ten- sion (MPa)	Comp. (MPa)	Shear (MPa)					
Ferrous metals												
Wrought iron	7.70	210	^b		330	^b	170	160	190		30 ^d	12.1
Structural steel	7.87	250	^b		450	^b		190	200	76	28 ^d	11.9
Steel, 0.2% C hardened	7.87	430	^b		620	^b			210	80	22	11.9
Steel, 0.4% C hot-rolled	7.87	360	^b		580	^b		260	210	80	29	
Steel, 0.8% C hot-rolled	7.87	520	^b		840	^b			210	80	8	
Cast iron—gray	7.20				170	690		80	100		0.5	12.1
Cast iron—malleable	7.37	220	^b		340	^b			170		20	11.9
Cast iron—nodular	7.37	480			690				170		4	11.9
Stainless steel (18-8) annealed	7.92	250	^b		590	^b		270	190	86	35	17.3
Stainless steel (18-8) cold-rolled	7.92	1140	^b		1310	^b		620	190	86	8	17.3
Steel, SAE 4340, heat-treated	7.84	910	1000		1030	^b	650	520	200	76	19	
Nonferrous metal alloys												
Aluminum, cast, 195-T6	2.77	160	170		250		210	50	71	26	5	
Aluminum, wrought, 2014-T4	2.80	280	280	160	430	^b	260	120	73	28	20	22.5
Aluminum, wrought, 2024-T4	2.77	330	330	190	470	^b	280	120	73	28	19	22.5
Aluminum, wrought, 6061-T6	2.71	270	270	180	310	^b	210	93	70	26	17	22.5
Magnesium, extrusion, AZ80X	1.83	240	180		340	^b	140	130	45	16	12	25.9
Magnesium, sand cast, AZ63-HP	1.83	100	96		270	^b	130	100	45	16	12	25.9
Monel, wrought, hot-rolled	8.84	340	^b		620	^b		270	180	65	3.5	14.0
Red brass, cold-rolled	8.75	410			520				100	39	4	17.6
Red brass, annealed	8.75	100	^b		270	^b			100	39	50	17.6
Bronze, cold-rolled	8.86	520			690				100	45	3	16.9
Bronze, annealed	8.86	140	^b		340	^b			100	45	50	16.9
Titanium alloy, annealed	4.63	930	^b		1070	^b			96	36	13	
Invar, annealed	8.09	290	^b		480	^b			140	56	41	1.1
Nonmetallic materials												
Douglas fir, green ^e	0.61	33	23			27	6.2		11			
Douglas fir, air dry ^f	0.55	56	44			51	7.6		13			
Red oak, green ^e	1.02	30	18			24	8.3		10			3.4
Red oak, air dry ^f	0.69	58	32			48	12.4		12			
Concrete, medium strength	2.41		8			21			21			10.5
Concrete, fairly high strength	2.41		14			34			31			10.5

^aElastic strength may be represented by proportional limit, yield point, or yield strength at a specified offset (usually 0.2 percent for ductile metals).

^bFor ductile metals (those with an appreciable ultimate elongation), it is customary to assume the properties in compression have the same values as those in tension.

^cRotating beam.

^dElongation in 200 mm.

^eAll timber properties are parallel to the grain.

ที่มา : Mechanics of Materials, William, F.Riley, Leroy D.Sturges and Don H.Morris.

ตาราง ก.2 คุณสมบัติของไอน้ำอิ่มตัว

Temp. C T	Press. kPa P	Enthalpy, kJ/kg			Entropy, kJ/kg K		
		Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Evap. s_{fg}	Sat. Vapor s_g
0.01	0.6113	0.00	2501.35	2501.35	0	9.1562	9.1562
5	0.8721	20.98	2489.57	2510.54	0.0761	8.9496	9.0257
10	1.2276	41.99	2477.75	2519.74	0.1510	8.7498	8.9007
15	1.705	62.98	2465.93	2528.91	0.2245	8.5560	8.7813
20	2.339	83.94	2454.12	2538.06	0.2966	8.3706	8.6671
25	3.169	104.87	2442.30	2547.17	0.3673	8.1905	8.5579
30	4.246	125.77	2430.48	2556.25	0.4369	8.0164	8.4533
35	5.628	146.66	2418.62	2565.28	0.5052	7.8478	8.3530
40	7.384	167.54	2406.72	2574.26	0.5724	7.6845	8.2569
45	9.593	188.42	2394.77	2583.19	0.6386	7.5261	8.1647
50	12.350	209.31	2382.75	2592.06	0.7037	7.3723	8.0762
55	15.758	230.20	2370.66	2600.86	0.7679	7.2234	7.9912
60	19.947	251.11	2358.48	2609.59	0.8311	7.0784	7.9095
65	25.03	272.03	2346.21	2618.24	0.8934	6.9375	7.8309
70	31.19	292.96	2333.85	2626.80	0.9548	6.8004	7.7552
75	38.58	313.91	2321.37	2635.28	1.0154	6.6670	7.6824
80	47.39	334.88	2308.77	2643.66	1.0752	6.5369	7.6121
85	57.83	355.88	2296.05	2651.93	1.1342	6.4102	7.5444
90	70.14	376.90	2283.19	2660.09	1.1924	6.2866	7.4790
95	84.55	397.94	2270.19	2668.13	1.2500	6.1659	7.4159
100	101.3	419.02	2257.03	2676.05	1.3068	6.0480	7.3548
105	120.8	440.13	2243.70	2683.83	1.3629	5.9328	7.2958
110	143.3	461.27	2230.20	2691.47	1.4184	5.8202	7.2386
115	169.1	482.46	2216.50	2698.96	1.4733	5.7100	7.1832
120	198.5	503.69	2202.61	2706.30	1.5275	5.6020	7.1295
125	232.1	524.96	2188.50	2713.46	1.5812	5.4962	7.0774
130	270.1	546.29	2174.16	2720.46	1.6343	5.3925	7.0269
135	313.0	567.67	2159.59	2727.26	1.6869	5.2907	6.9777
140	361.3	589.11	2144.75	2733.87	1.7390	5.1908	6.9298
145	415.4	610.61	2129.65	2740.26	1.7906	5.0926	6.8832
150	475.9	632.18	2114.26	2746.44	1.8417	4.9960	6.8378
155	543.1	653.82	2098.56	2752.39	1.8924	4.9010	6.7934
160	617.8	675.53	2082.55	2758.09	1.9426	4.8075	6.7501
165	700.5	697.32	2066.20	2763.53	1.9924	4.7153	6.7078
170	791.7	719.20	2049.50	2768.70	2.0418	4.6244	6.6663
175	892.0	741.16	2032.42	2773.58	2.0909	4.5347	6.6256
180	1002.2	763.21	2014.96	2778.16	2.1395	4.4461	6.5857
185	1122.7	785.36	1997.07	2782.43	2.1878	4.3586	6.5464
190	1254.4	807.61	1978.76	2786.37	2.2358	4.2720	6.5079

ที่มา : Fundamentals of Thermodynamics, Sonntag, Borgnakke and Van Wylen.

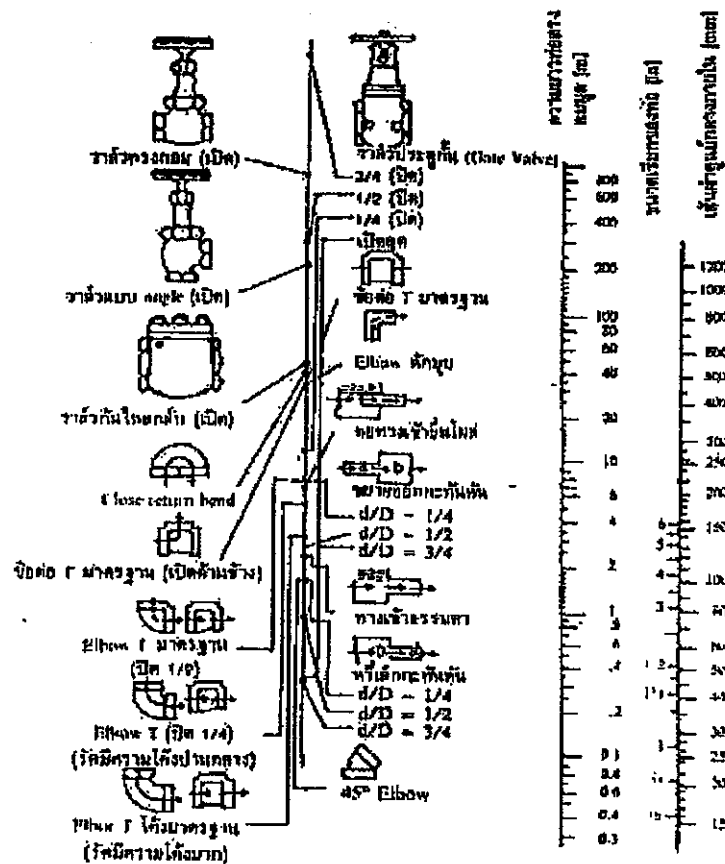
ตาราง ก.3 Minor Loss Coefficients for pipe entrances

Entrance Type	Minor Loss Coefficient, K^a								
Reentrant	0.78								
Square-edged	0.5								
Rounded	<table border="1"> <tr> <td>r/D</td> <td>0.02</td> <td>0.06</td> <td>≥ 0.15</td> </tr> <tr> <td>K</td> <td>0.28</td> <td>0.15</td> <td>0.04</td> </tr> </table>	r/D	0.02	0.06	≥ 0.15	K	0.28	0.15	0.04
r/D	0.02	0.06	≥ 0.15						
K	0.28	0.15	0.04						

^a Based on $h_{l_m} = K(\bar{V}^2/2)$, where \bar{V} is the mean velocity in the pipe.

ที่มา : Introduction to Fluid Mechanics , Robert W. Fox and Alan T. McDonald

ตาราง ก.4 ความยาวท่อสมมูลของข้อต่อและวาล์วต่างๆ



ที่มา : คู่มืออุปกรณ์การผลิตในอุตสาหกรรมเคมี, สำนักพิมพ์ไทย-ญี่ปุ่น

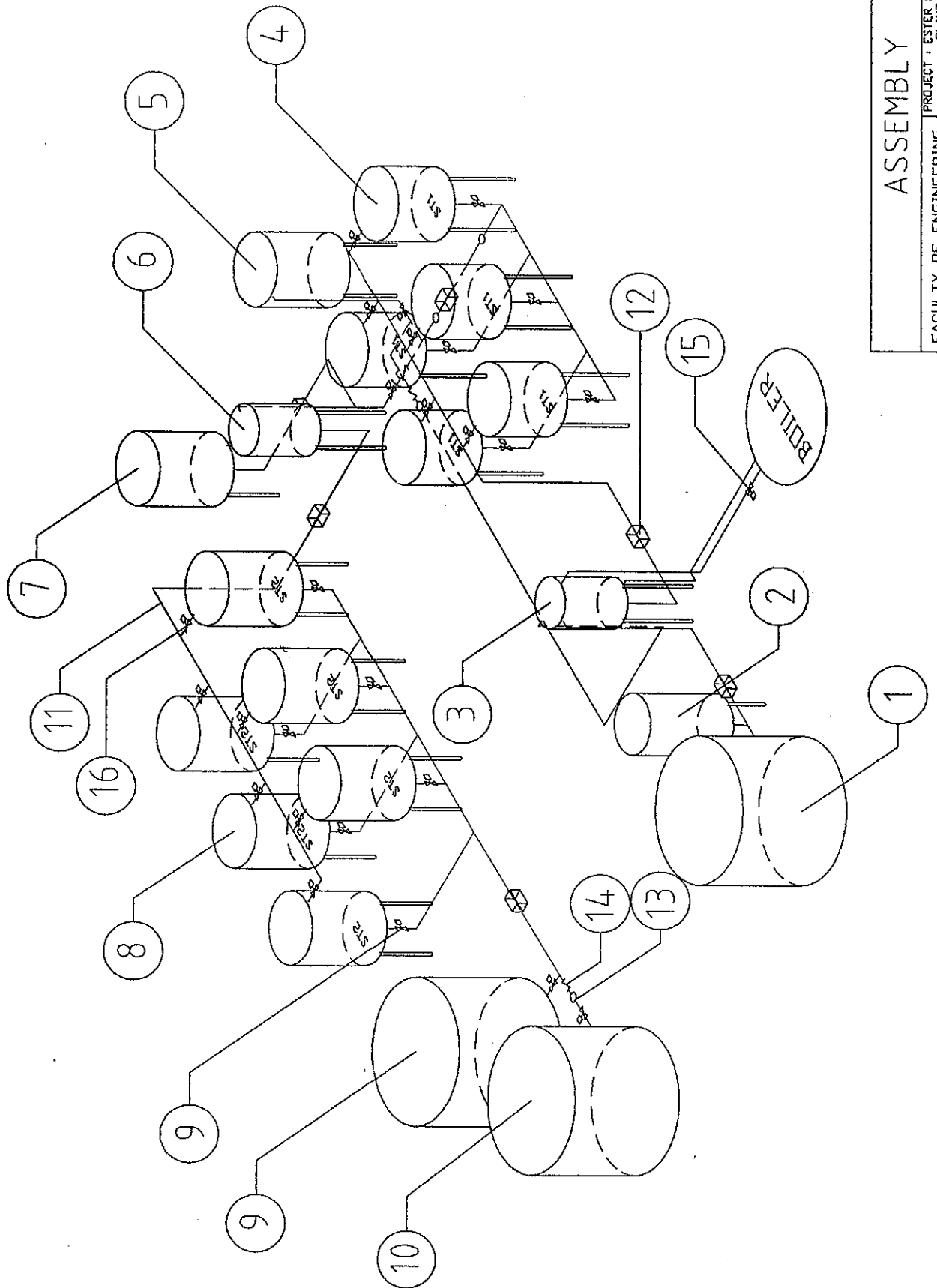
ตารางที่ 5.5 Representative Dimensionless Equivalent Lengths (L_e/D) for Valves and Fittings

Fitting	Equivalent Length, ^a L_e/D
Valves (fully open)	
Gate valve	8
Globe valve	340
Angle valve	150
Ball valve	3
Lift check valve: globe lift	600
: angle valve	55
Foot valve with strainer : poppet disk	420
: hinged disk	75
Standard elbow : 90 °	30
: 45 °	16
Return bend, close pattern	50
Standard tee : flow through run	20
:flow through branch	60

$$^a \text{Based on } = f \frac{Le \bar{V}^2}{D^2}$$

ที่มา : Introduction to Fluid Mechanics , Robert W. Fox and Alan T. McDonald

ภาคผนวก ข
แบบโรงงานต้นแบบและอุปกรณ์ในระบบการผลิต



ASSEMBLY

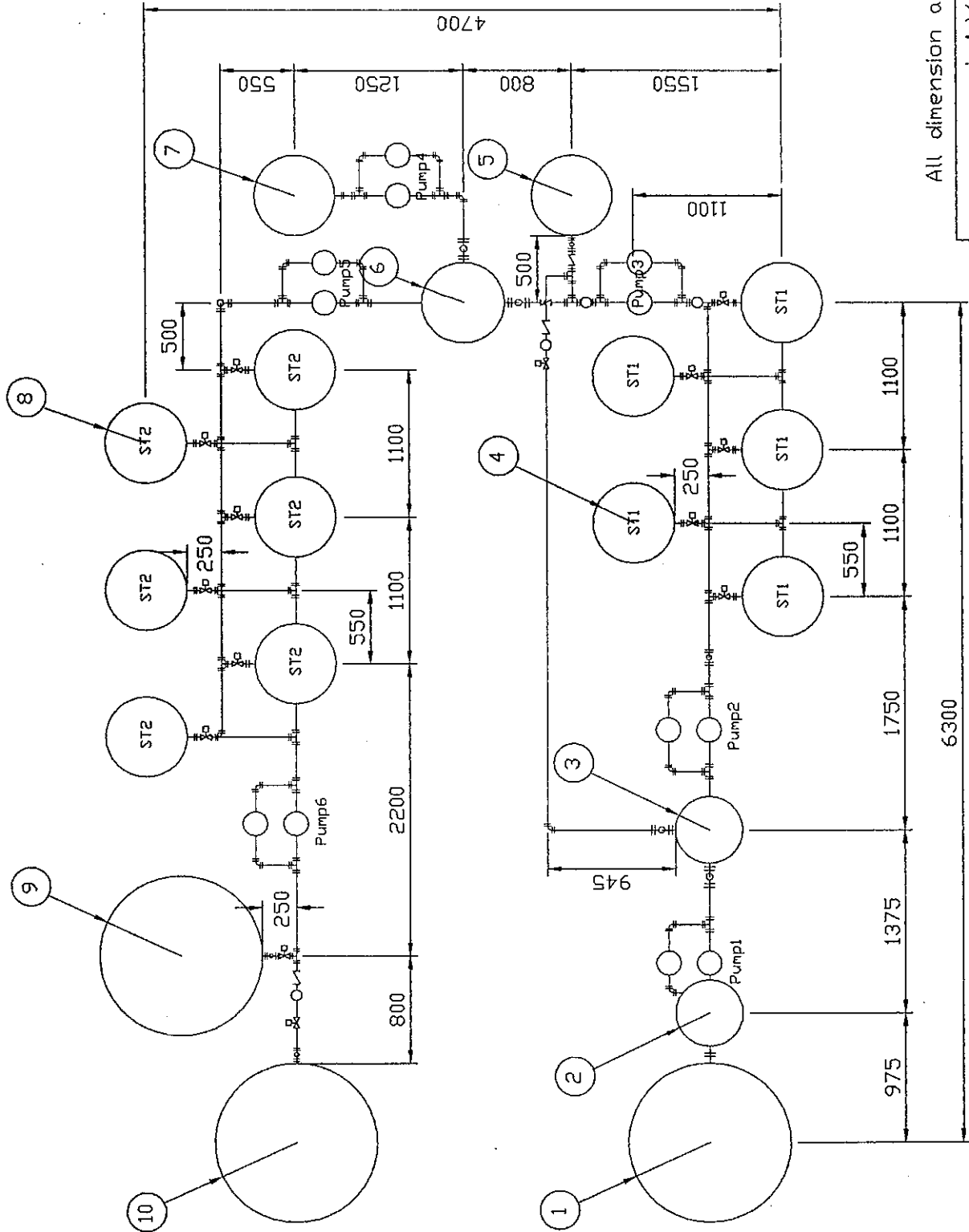
PROJECT : ESTER FROM COCONUT OIL
PLANT DESIGN
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NERASUAN UNIVERSITY
DATE : 24/02/03
PLATE : 1/1

PC.NO.	NAME	SIDE OF MATERIAL	MATERIAL	QUANTITY
1	Coconut oil tank	1000 L , R 600 mm	Stainless steel SUS 304 thickness 2 mm.	1
2	Catalyst mixing tank	150 L , R 250 mm	Stainless steel SUS 304 thickness 1.5 mm	1
3	Reaction tank	100 L , R 210 mm	Stainless steel SUS 304 thickness 1.5 mm	1
4	Seperation tank 1	150 L , R 300 mm	Stainless steel SUS 304 thickness 1.5 mm	5
5	Glycerine tank	200 L , R 300 mm	Stainless steel SUS 304 thickness 1.5 mm	1
6	Washing tank	100 L , R 300 mm	Stainless steel SUS 304 thickness 1.5 mm	1
7	Water storage tank	200 L , R 300 mm	Stainless steel SUS 304 thickness 1.5 mm	1
8	Seperation tank 2	200 L , R 300 mm	Stainless steel SUS 304 thickness 1.5 mm	6
9	Ester tank	1000 L , R 600 mm	Stainless steel SUS 304 thickness 2 mm.	1
10	Water tank	1000 L , R 600 mm	Stainless steel SUS 304 thickness 2 mm.	1
11	Tube	∅ 12.5 mm , 1.5 mm	Stainless steel SUS 304	9
12	Pump	CEAM 70/3 0.5 HP		12
13	Senser		CALEX MODEL : STRAIN GAGE SINAL	4
14	Check valve		STEEL ∅ 12.5 mm , 1.5 mm	4
15	Control valve		ARMATUREN MODEL : ARI-PREMIID	1
16	On-Off valve		TEFLON ∅ 6.25 mm.	44
17	Bend 90	∅ 12.5 mm , 1.5 mm	Stainless steel SUS 304	33
18	TEE	∅ 12.5 mm , 1.5 mm	Stainless steel SUS 304	35

PART LIST

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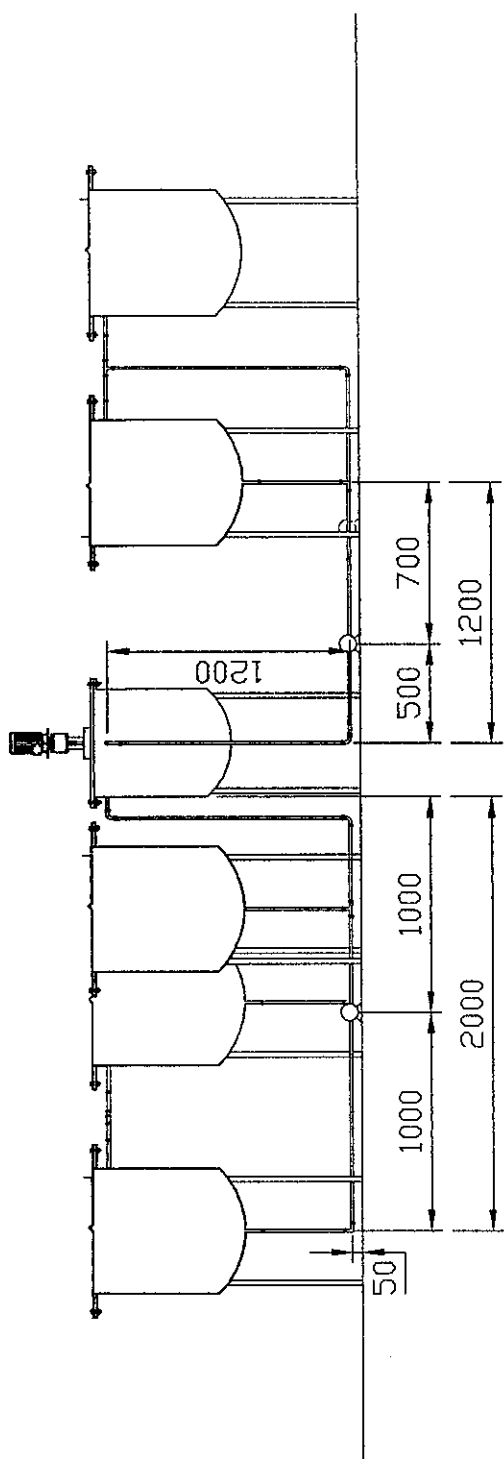
PROJECT : ESTER FROM COCONUT OIL
PLANT DESIGN
DATE : 24/02/03 | PLATE : 1/2



All dimension are in millimeter

LAY_OUT

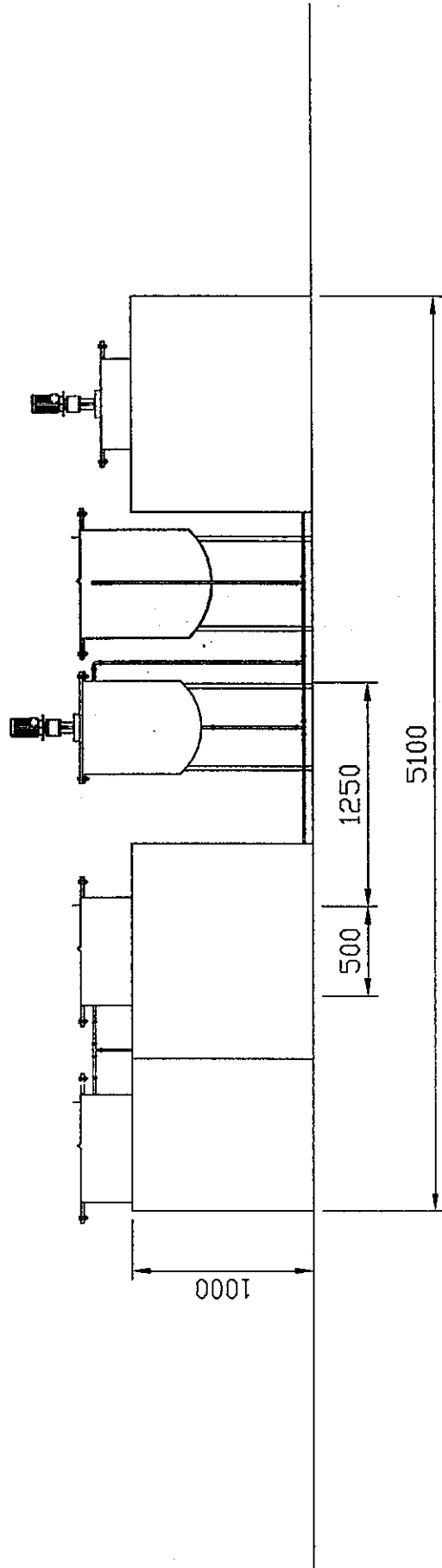
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All dimension are in millimeter

RIGHT SIDE VIEW

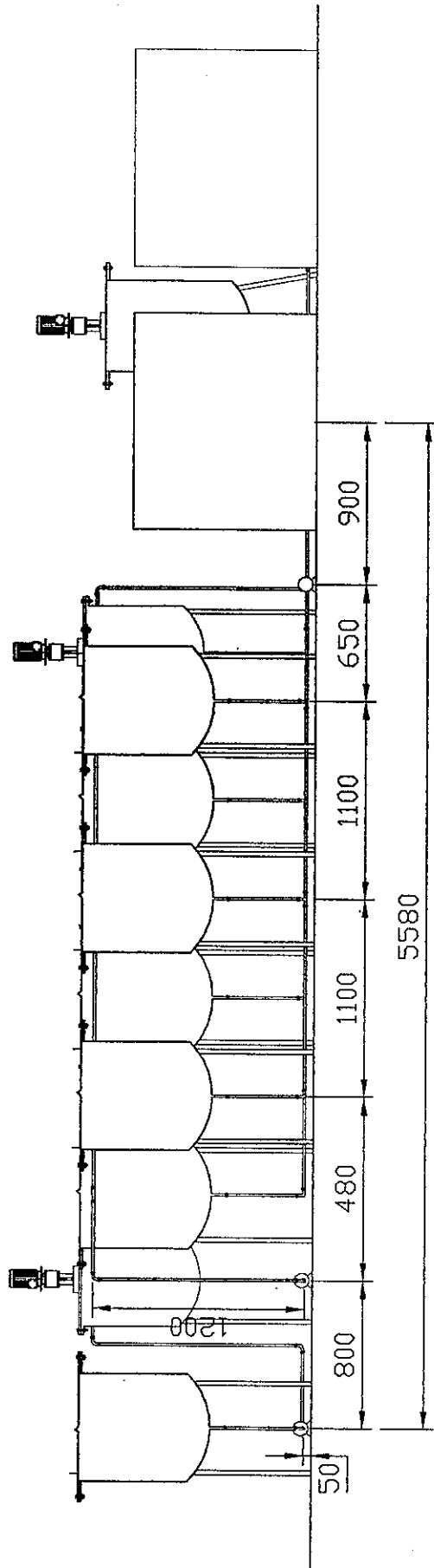
PROJECT : ESTER FROM COCONUT OIL	PLATE : 4
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All dimension are in millimeter

LEFT SIDE VIEW

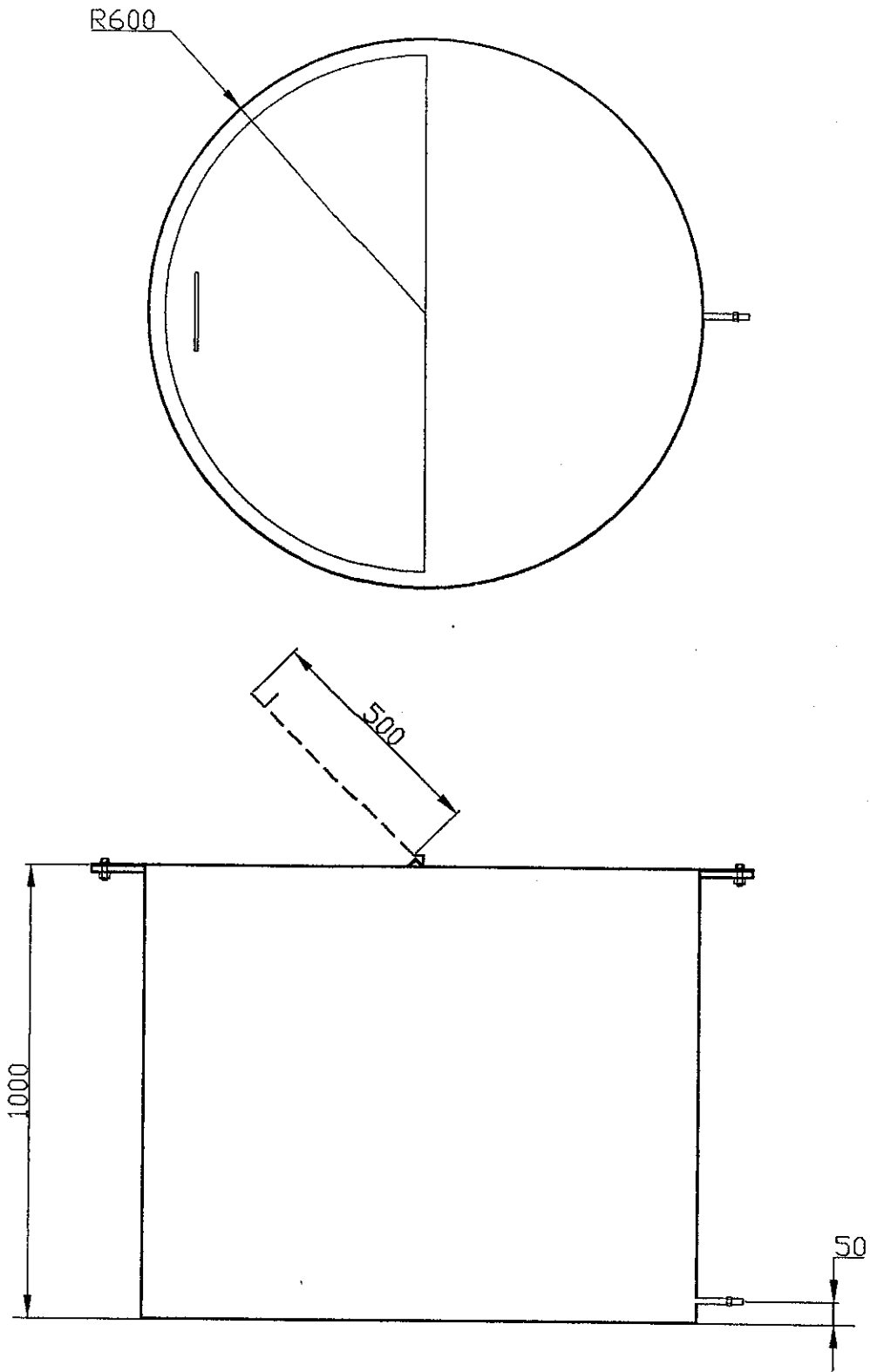
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DATE : 24/02/03 PLATE : 5	



All dimension are in millimeter

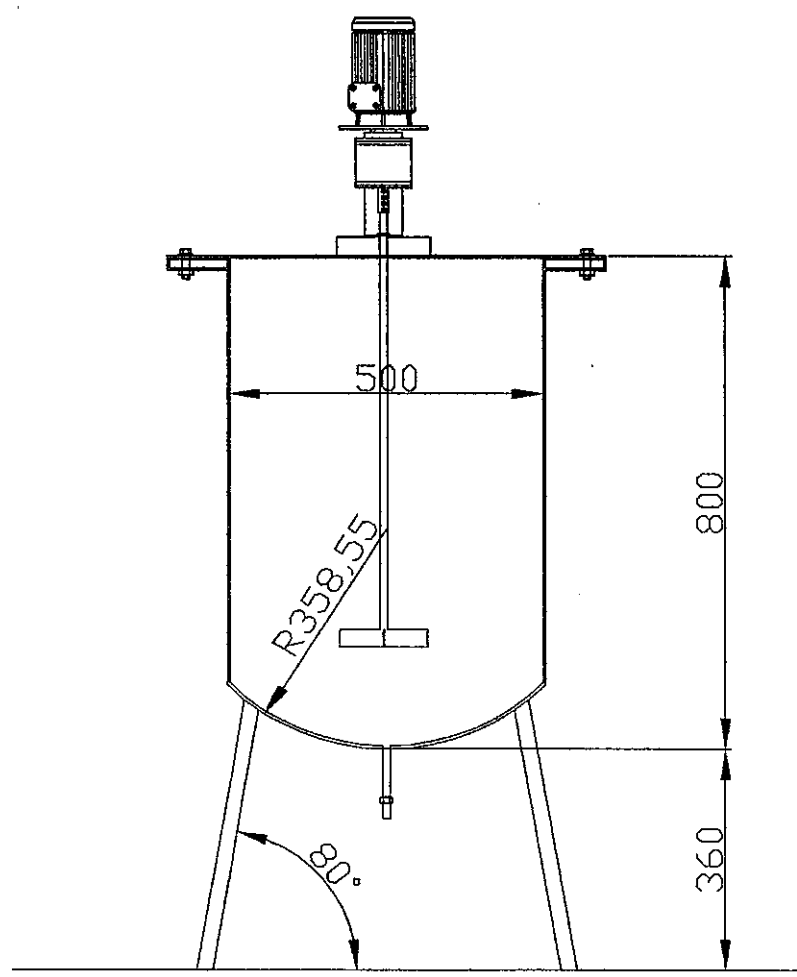
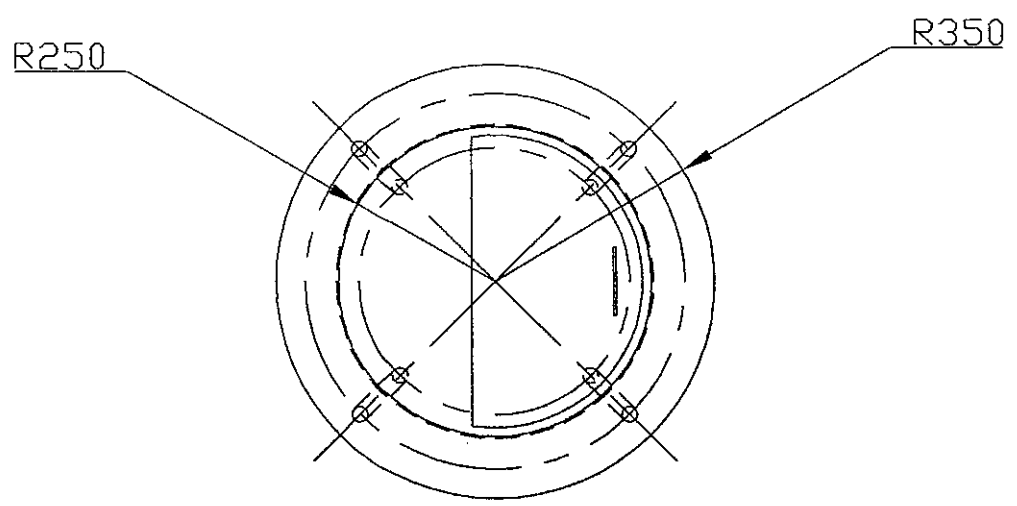
BACK VIEW

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All dimension are in millimeter

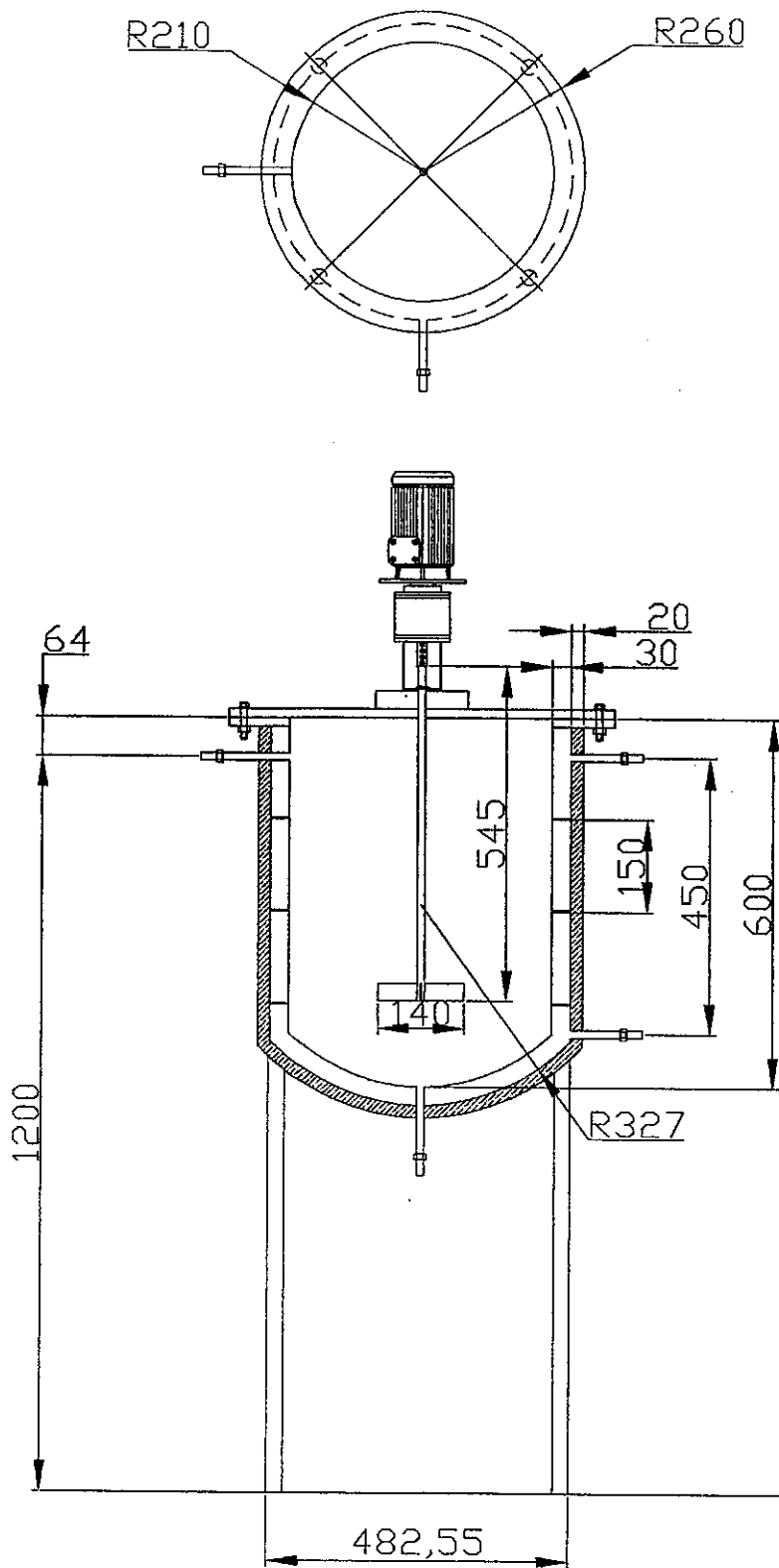
COCONUT_OIL_TANK	
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All dimension are in millimeter

CATALYST MIXING TANK

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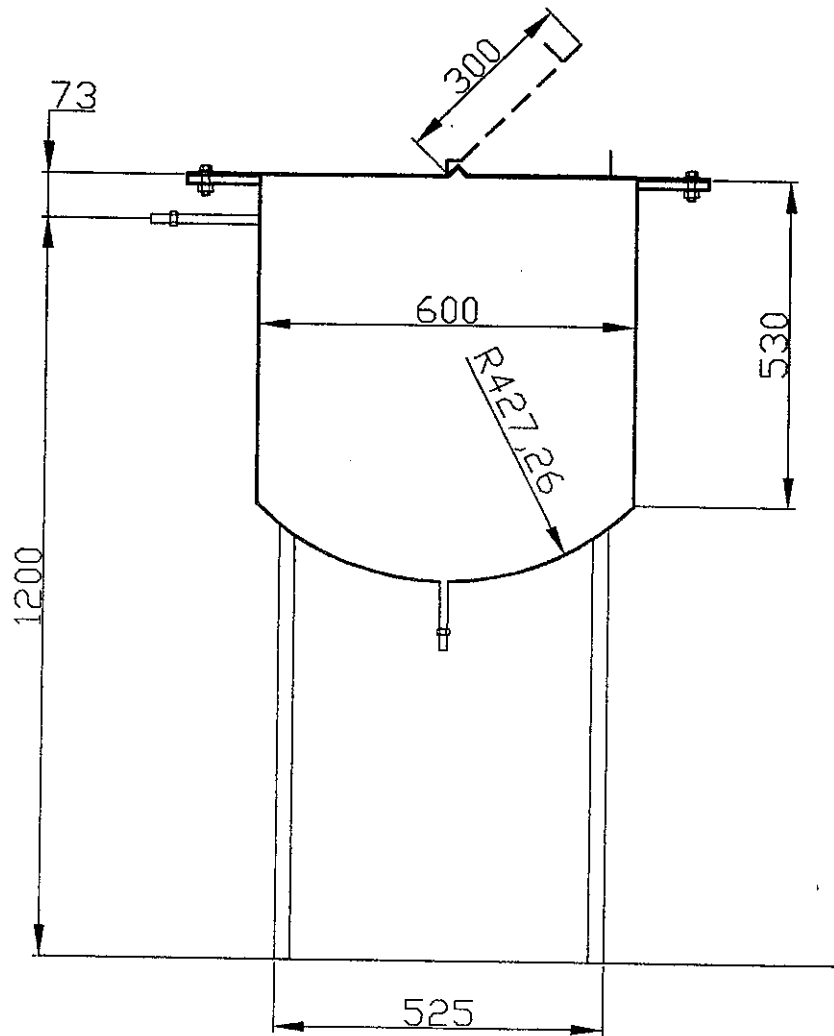
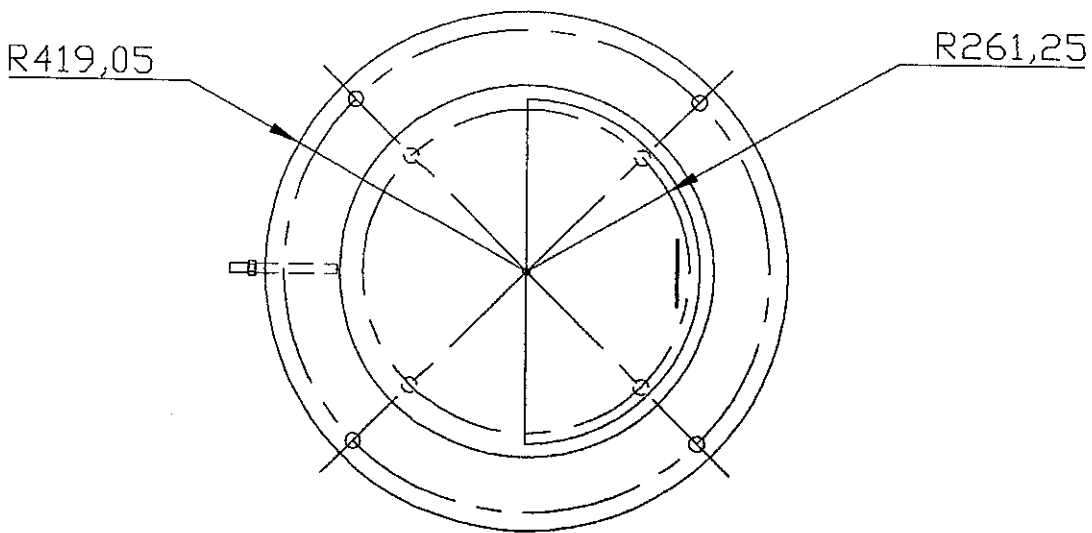


All dimension are in millimeter

REACTION_TANK

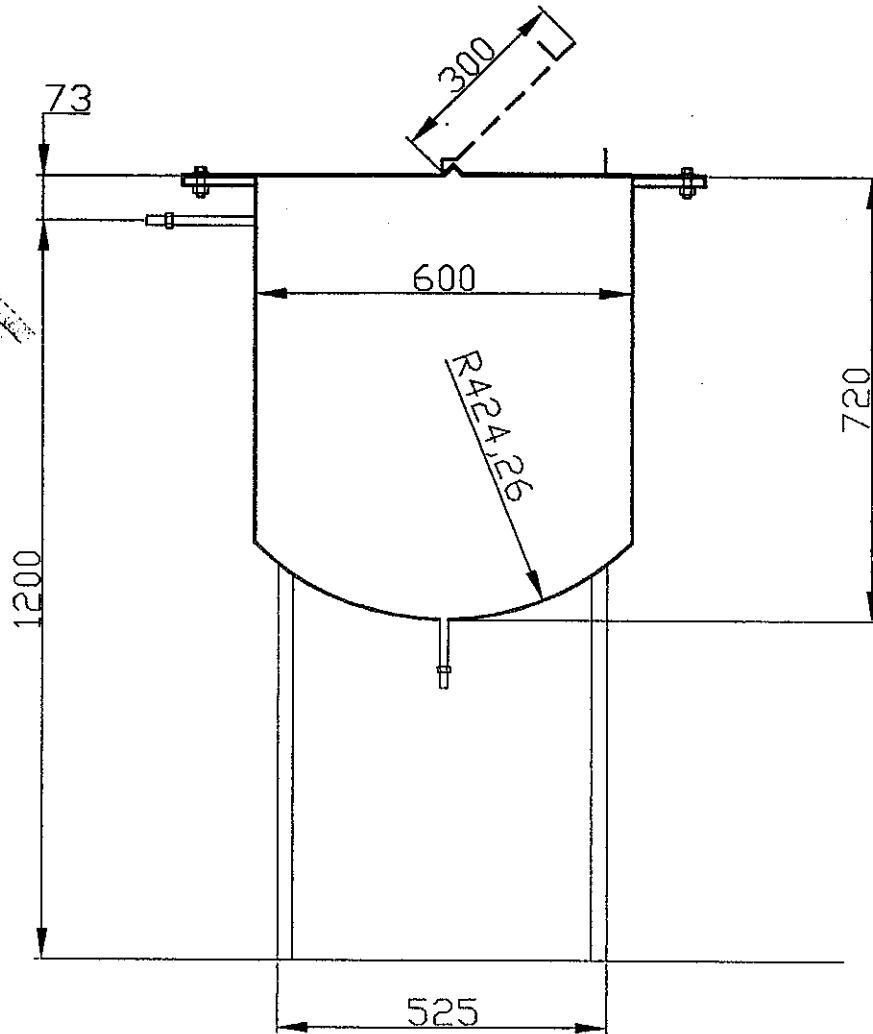
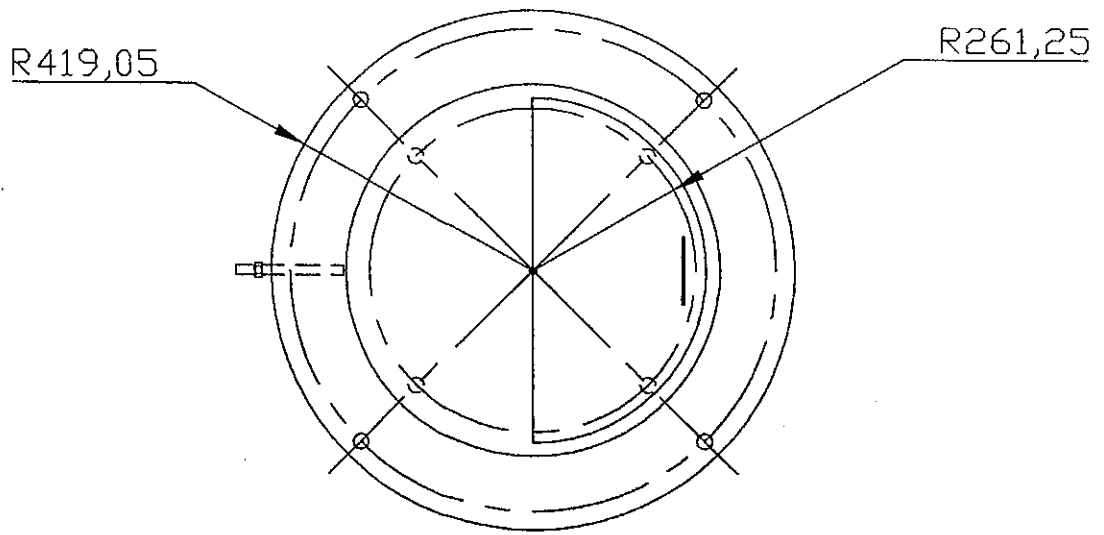
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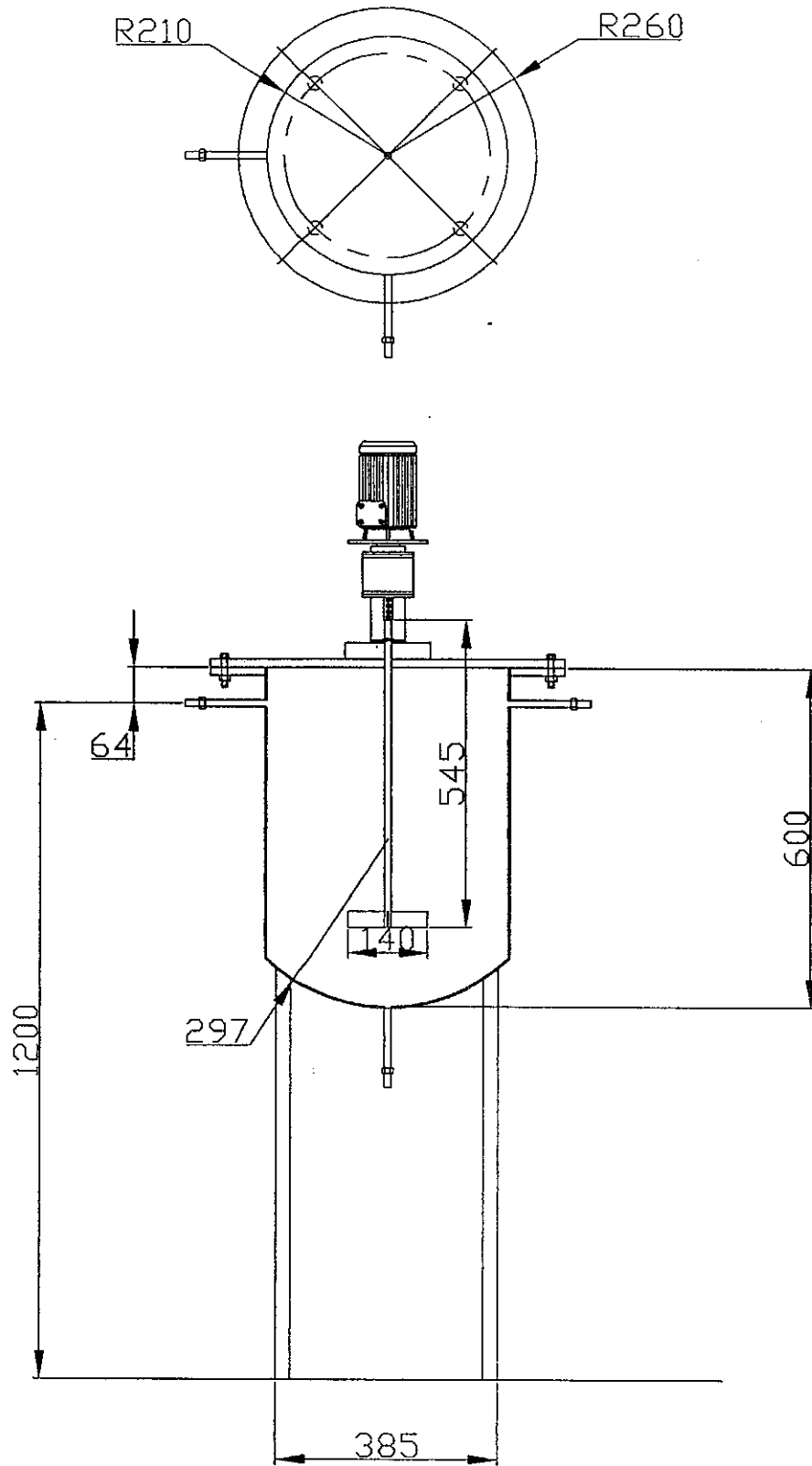
All dimension are in millimeter

SEPERATION_TANK_1		
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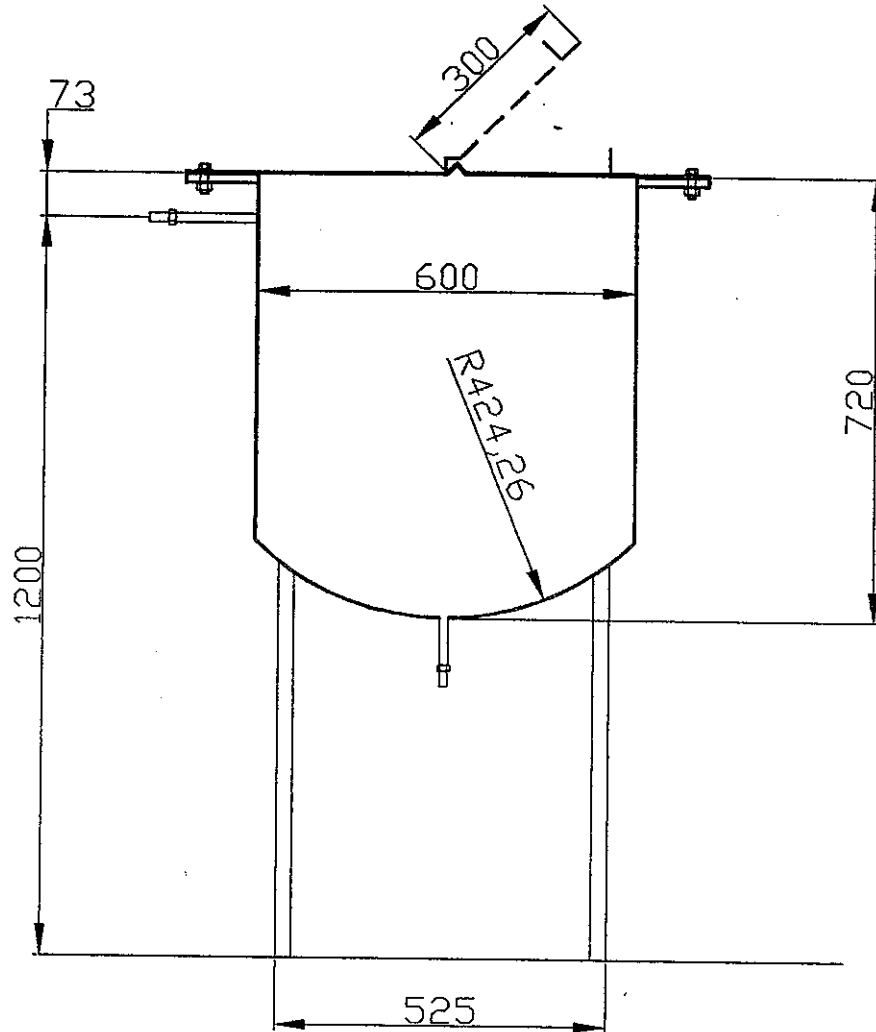
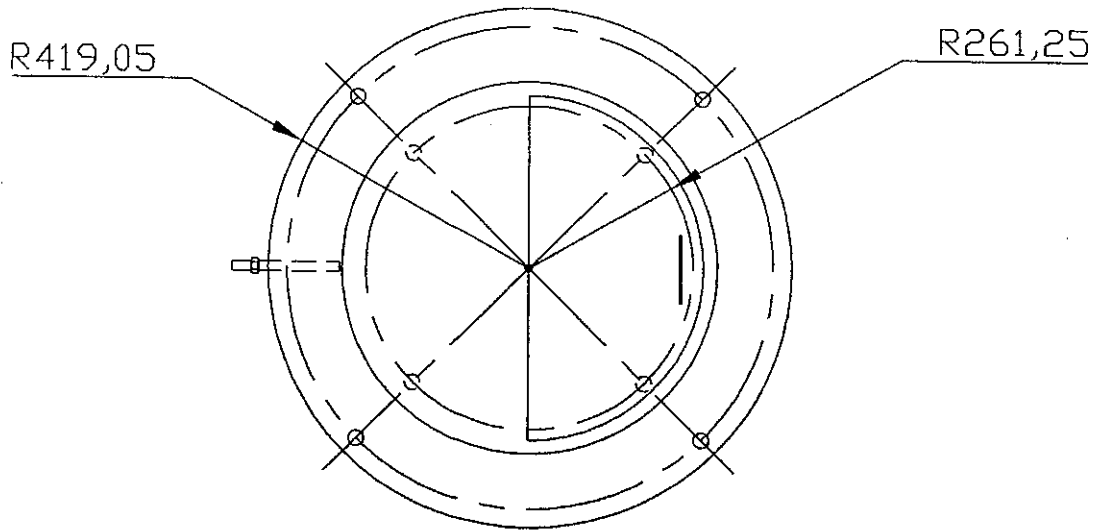
All dimension are in millimeter

GLYCERINE_TANK		
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All dimension are in millimeter

WASHING TANK		
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	DATE : 24/02/03	PLATE : 11

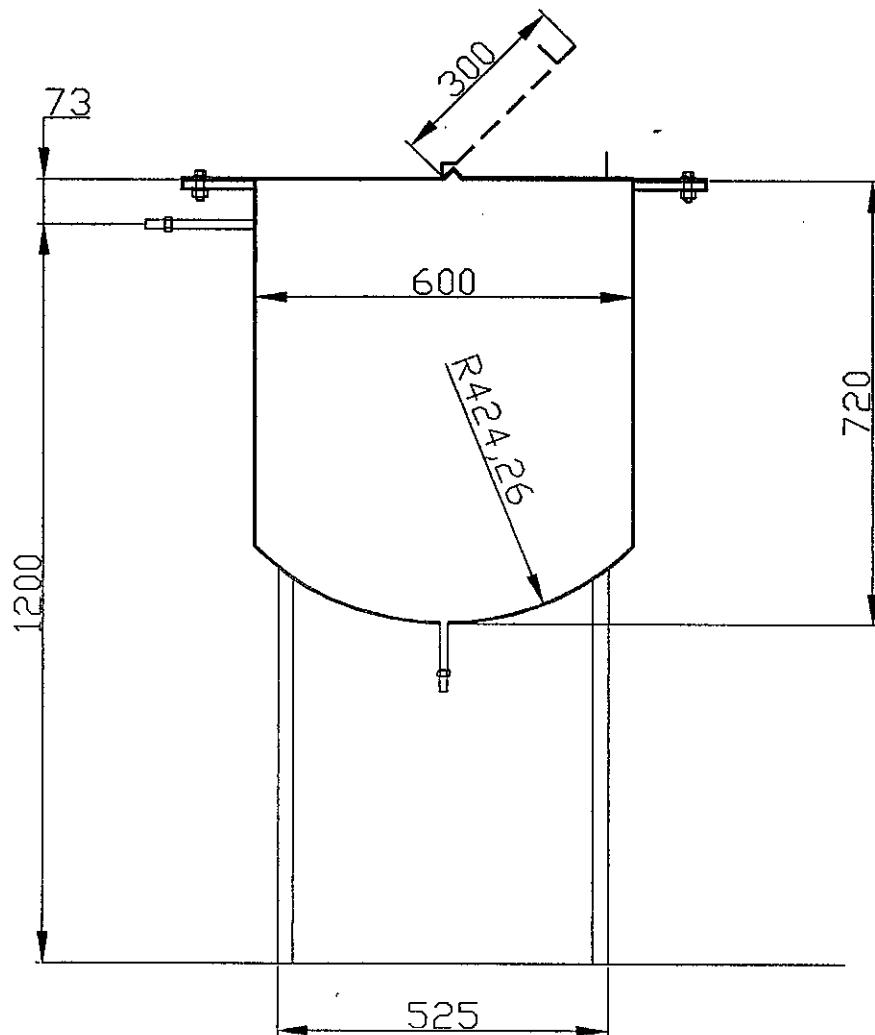
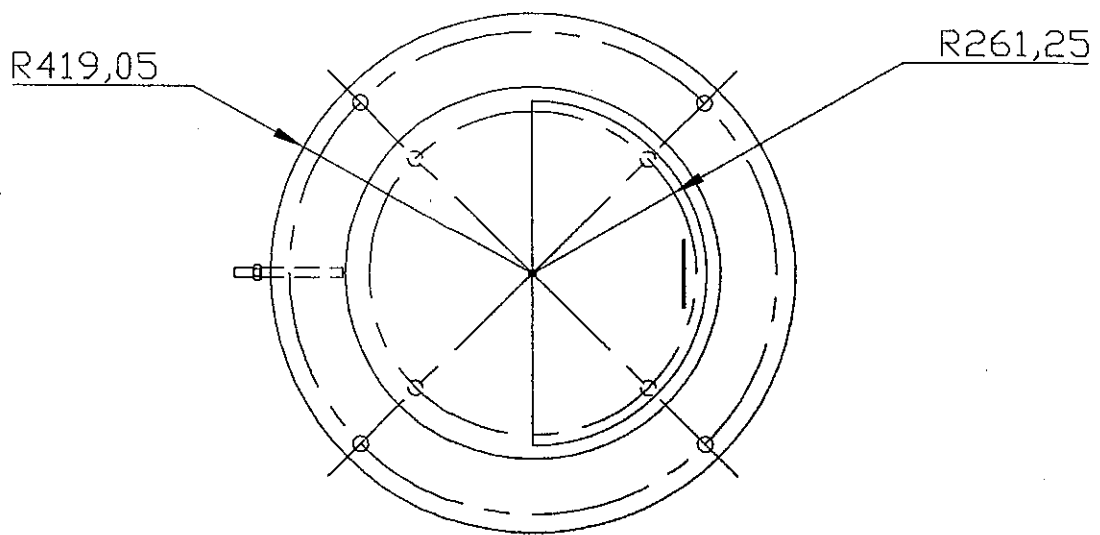


All dimension are in millimeter

WATER_STORAGE_TANK

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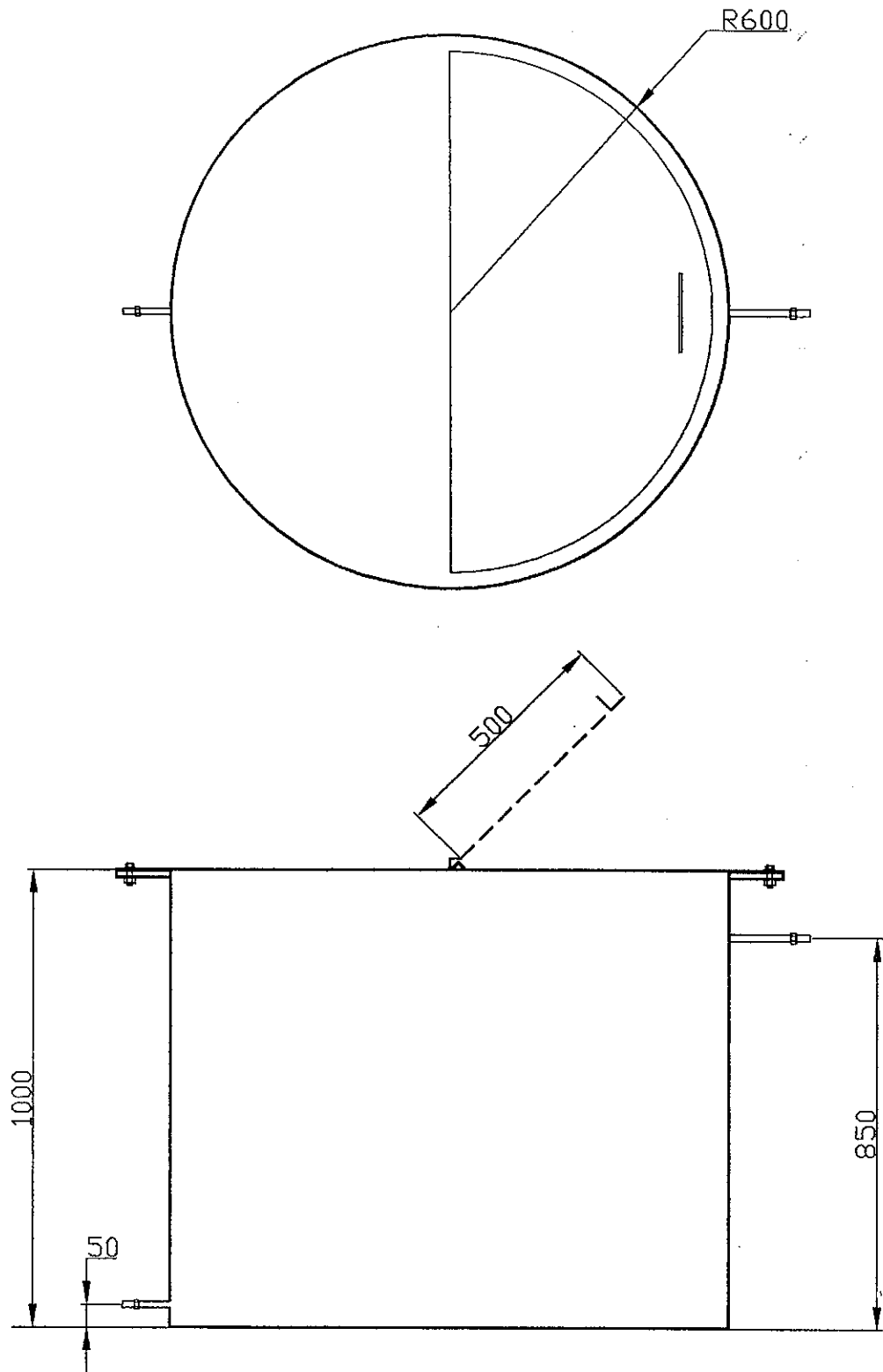


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SEPERATION_TANK_2

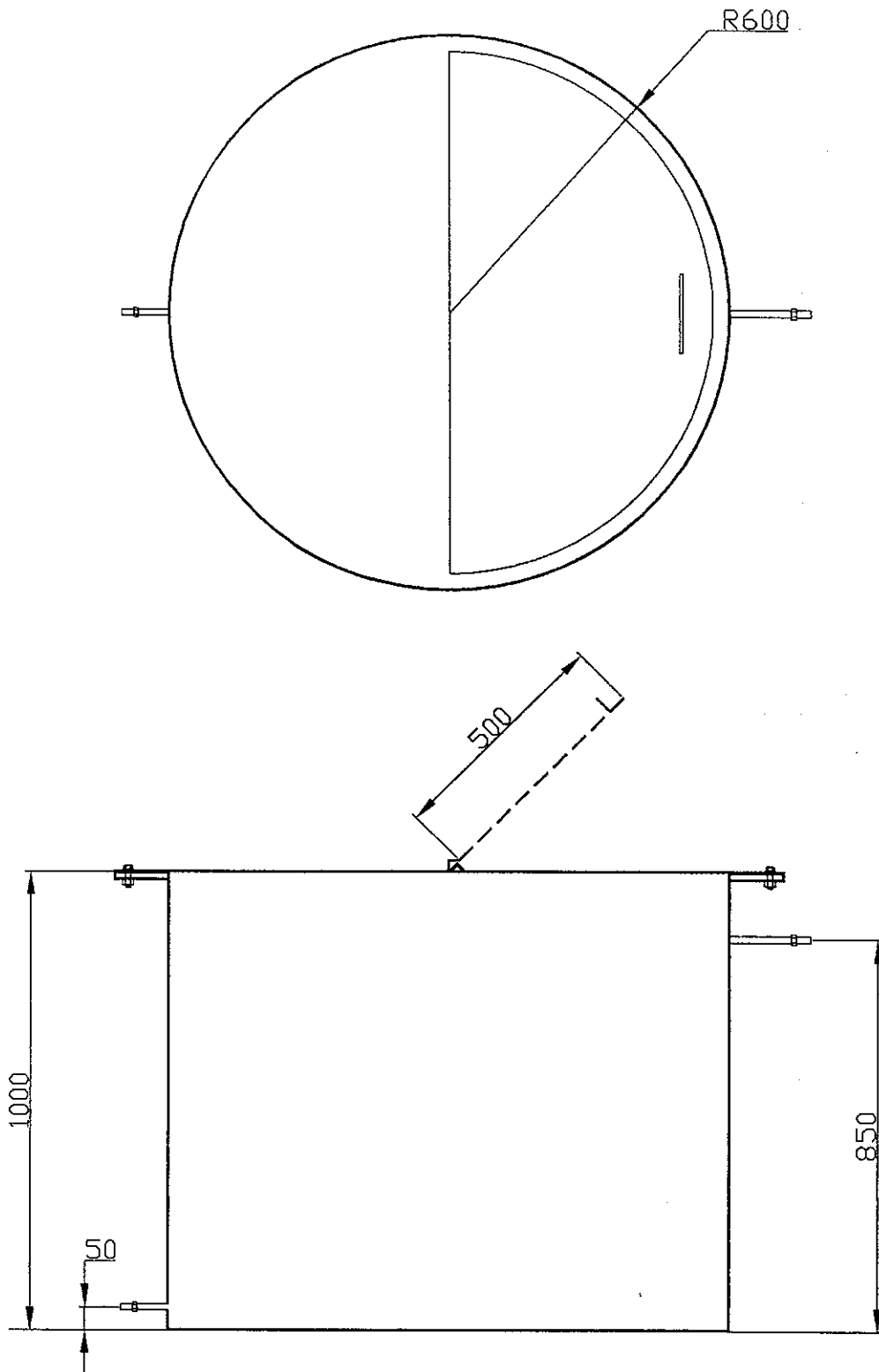
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All dimension are in millimeter

ESTER_TANK		
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All dimension are in millimeter

WATER_TANK

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