



Production Throughput Chart

Parts per minute	10	20	30	40	50	60	70	80	90	100	200	300	400	500	600
Parts per hour	600	1,200	1,800	2,400	3,000	3,600	4,200	4,800	5,400	6,000	12,000	18,000	24,000	30,000	36,000
Parts per 2 hours	1,200	2,400	3,600	4,800	6,000	7,200	8,400	9,600	10,800	12,000	24,000	36,000	48,000	60,000	72,000
Parts per 3 hours	1,800	3,600	5,400	7,200	9,000	10,800	12,600	14,400	16,200	18,000	36,000	54,000	72,000	90,000	108,000
Parts per 4 hours	2,400	4,800	7,200	9,600	12,000	14,400	16,800	19,200	21,600	24,000	48,000	72,000	96,000	120,000	144,000
Parts per 5 hours	3,000	6,000	9,000	12,000	15,000	18,000	21,000	24,000	27,000	30,000	60,000	90,000	120,000	150,000	180,000
Parts per 6 hours	3,600	7,200	10,800	14,400	18,000	21,600	25,200	28,800	32,400	36,000	72,000	108,000	144,000	180,000	216,000
Parts per 7 hours	4,200	8,400	12,600	16,800	21,000	25,200	29,400	33,600	37,800	42,000	84,000	126,000	168,000	210,000	252,000
Parts per 8 hours	4,800	9,600	14,400	19,200	24,000	28,800	33,600	38,400	43,200	48,000	96,000	144,000	192,000	240,000	288,000
Parts per 9 hours	5,400	10,800	16,200	21,600	27,000	32,400	37,800	43,200	48,600	54,000	108,000	162,000	216,000	270,000	324,000
Parts per 10 hours	6,000	12,000	18,000	24,000	30,000	36,000	42,000	48,000	54,000	60,000	120,000	180,000	240,000	300,000	360,000
Parts per 11 hours	6,600	13,200	19,800	26,400	33,000	39,600	46,200	52,800	59,400	66,000	132,000	198,000	264,000	330,000	396,000
Parts per 12 hours	7,200	14,400	21,600	28,800	36,000	43,200	50,400	57,600	64,800	72,000	144,000	216,000	288,000	360,000	432,000
Parts per 13 hours	7,800	15,600	23,400	31,200	39,000	46,800	54,600	62,400	70,200	78,000	156,000	234,000	312,000	390,000	468,000
Parts per 14 hours	8,400	16,800	25,200	33,600	42,000	50,400	58,800	67,200	75,600	84,000	168,000	252,000	336,000	420,000	504,000
Parts per 15 hours	9,000	18,000	27,000	36,000	45,000	54,000	63,000	72,000	81,000	90,000	180,000	270,000	360,000	450,000	540,000
Parts per 16 hours	9,600	19,200	28,800	38,400	48,000	57,600	67,200	76,800	86,400	96,000	192,000	288,000	384,000	480,000	576,000
Parts per 17 hours	10,200	20,400	30,600	40,800	51,000	61,200	71,400	81,600	91,800	102,000	204,000	306,000	408,000	510,000	612,000
Parts per 18 hours	10,800	21,600	32,400	43,200	54,000	64,800	75,600	86,400	97,200	108,000	216,000	324,000	432,000	540,000	648,000
Parts per 19 hours	11,400	22,800	34,200	45,600	57,000	68,400	79,800	91,200	102,600	114,000	228,000	342,000	456,000	570,000	684,000
Parts per 20 hours	12,000	24,000	36,000	48,000	60,000	72,000	84,000	96,000	108,000	120,000	240,000	360,000	480,000	600,000	720,000
Parts per 21 hours	12,600	25,200	37,800	50,400	63,000	75,600	88,200	100,800	113,400	126,000	252,000	378,000	504,000	630,000	756,000
Parts per 22 hours	13,200	26,400	39,600	52,800	66,000	79,200	92,400	105,600	118,800	132,000	264,000	396,000	528,000	660,000	792,000
Parts per 23 hours	13,800	27,600	41,400	55,200	69,000	82,800	96,600	110,400	124,200	138,000	276,000	414,000	552,000	690,000	828,000
Parts per 24 hours	14,400	28,800	43,200	57,600	72,000	86,400	100,800	115,200	129,600	144,000	288,000	432,000	576,000	720,000	864,000

250 days/6 hours	900,000	1,800,000	2,700,000	3,600,000	4,500,000	5,400,000	6,300,000	7,200,000	8,100,000	9,000,000	18,000,000	27,000,000	36,000,000	45,000,000	54,000,000
250 days/8 hours	1,200,000	2,400,000	3,600,000	4,800,000	6,000,000	7,200,000	8,400,000	9,600,000	10,800,000	12,000,000	24,000,000	36,000,000	48,000,000	60,000,000	72,000,000
250 days/12 hours	1,800,000	3,600,000	5,400,000	7,200,000	9,000,000	10,800,000	12,600,000	14,400,000	16,200,000	18,000,000	36,000,000	54,000,000	72,000,000	90,000,000	108,000,000
250 days/18 hours	2,700,000	5,400,000	8,100,000	10,800,000	13,500,000	16,200,000	18,900,000	21,600,000	24,300,000	27,000,000	54,000,000	81,000,000	108,000,000	135,000,000	162,000,000
250 days/24 hours	3,600,000	7,200,000	10,800,000	14,400,000	18,000,000	21,600,000	25,200,000	28,800,000	32,400,000	36,000,000	72,000,000	108,000,000	144,000,000	180,000,000	216,000,000

300 days/6 hours	1,080,000	2,160,000	3,240,000	4,320,000	5,400,000	6,480,000	7,560,000	8,640,000	9,720,000	10,800,000	21,600,000	32,400,000	43,200,000	54,000,000	64,800,000
300 days/8 hours	1,440,000	2,880,000	4,320,000	5,760,000	7,200,000	8,640,000	10,080,000	11,520,000	12,960,000	14,400,000	28,800,000	43,200,000	57,600,000	72,000,000	86,400,000
300 days/12 hours	2,160,000	4,320,000	6,480,000	8,640,000	10,800,000	12,960,000	15,120,000	17,280,000	19,440,000	21,600,000	43,200,000	64,800,000	86,400,000	108,000,000	129,600,000
300 days/18 hours	3,240,000	6,480,000	9,720,000	12,960,000	16,200,000	19,440,000	22,680,000	25,920,000	29,160,000	32,400,000	64,800,000	97,200,000	129,600,000	162,000,000	194,400,000
300 days/24 hours	4,320,000	8,640,000	12,960,000	17,280,000	21,600,000	25,920,000	30,240,000	34,560,000	38,880,000	43,200,000	86,400,000	129,600,000	172,800,000	216,000,000	259,200,000



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Useful Conversions

To change:	To:	Multiply by:
Area:		
Pounds	ounces	16
Sq. feet	sq. meters	.0929
Distance:		
Centimeters	inches	.3937
Centimeters	feet	.03281
Feet	meters	.3048
Inches	millimeters	25.4
Inches	centimeters	2.54
Meters	feet	3.2808
Millimeters	inches	.0394
Volume:		
Cubic feet	cubic meters	.0283
Cubic meters	cubic feet	35.3145
Gallons	liters	3.7853
Liters	gallons	.2642
Weight:		
Grams	pounds	.002205
Ounces	pounds	.0625
Power:	BTU, watts, horsepower ([hp] = 745.7 watts)	
Pressure:	Atmosphere (atm) = 1.01325 x 10 ⁵ N/m ² bar = 10 ⁵ N/m ²	
	1 microbar = 0.75 microns	
	1 micron = 1.33 Pa	
	1 Pa = 7.5 microns	
	1 microbar = 0.1 Pa	
	1 micron = 1.33 microbar	
	1 Pa = 10 microbar	
	[microbar (cgs units) = dyns/cm ²]	
	[microns = micrometers of mercury]	
	[Pa (SI units) = Pascals (M/m ²)]	
Water vapor	at -30°C = 0.38 mbar	
Pressure	at -40°C = 0.13 mbar	
Above ice	at -50°C = 0.04 mbar	
	at -60°C = 0.011 mbar	
	at -70°C = 0.002 mbar	

Temperature:
 To convert Fahrenheit to Celsius (Centigrade), subtract 32 and multiply by 5/9 (.5556).
 To convert Celsius (Centigrade) to Fahrenheit, multiply by 9/5 (1.8) and add 32.

CIP Coverage:
 Piping: Volume of water required = 1.5-2 times pipe volume
 Tanks: Flow to .1 - .3 gpm/sq. ft. surface area
 Or Flow of 2.5-3 gpm per foot of circumference
 Pressure: 25-30 psig need @ spray ball. Head Loss = approx. 5 PSIG per 100 ft. length.

Sterilization:
 121.21°C corresponds to a steam pressure of 1.05 bar g
 124.90°C corresponds to a steam pressure of 1.30 bar g
 127°C corresponds to a steam pressure of 1.45 bar g
 135.88°C corresponds to a steam pressure of 2.20 bar g

Vial Capacity per Square Foot:

Vial size	diameter	quantity/m ²	quantity/f ²
3ml	14mm	5600	520.26
5ml	16mm	4100	380.90
10ml	23mm	1900	176.52
20ml	27mm	1400	130.06
30ml	40mm	1150	106.84

Freeze Drying:

Vacuum: 1 mm Hg = 1 torr = 133 pascal = 1.33 mbar = 1000 microns Hg
 Pressure: 1 atm = 1.013 bar = 760 mm Hg = 14.7 psig
 Energy: 1 kW = 860 kcal/h
 Leak rate: UF standard ≤ 1 x 10⁻² mb liter/sec

Vapor Pressure of Ice:

Temp	Pascal	Microns	Micro bars	Temp	Pascal	Microns	Micro bars
0	611.2	4584	6112	-42	10.2	76.5	102
-2	517.7	3883	5177	-44	8.08	60.6	80.8
-4	437.5	3282	4375	-46	6.374	47.8	63.7
-6	368.7	2765	3687	-48	5.001	37.5	50
-8	310	2326	3100	-50	3.936	29.5	39.4
-10	259.9	1949	2599	-52	3.053	22.9	30.5
-12	217.3	1630	2173	-54	2.363	17.7	23.6
-14	181.2	1359	1812	-56	1.84	13.8	18.4
-16	150.7	1130	1507	-58	1.416	10.6	14.2
-18	124.9	936.8	1249	-60	1.08	8.1	10.8
-20	103.3	774.8	1033	-62	0.822	6.2	8.2
-22	85.1	638.3	851	-64	0.621	4.7	6.2
-24	69.91	524.4	699.1	-66	0.467	3.5	4.7
-26	57.25	429.4	572.5	-68	0.35	2.6	3.5
-28	46.73	350.5	467.3	-70	0.261	2	2.6
-30	38.01	285.1	380.1	-72	0.193	1.4	1.9
-32	30.82	231.2	308.2	-74	0.142	1.1	1.4
-34	24.9	186.8	249	-76	0.105	0.8	1.1
-36	20.04	150.3	200.4	-78	0.077	0.6	0.8
-38	16.07	120.5	160.7	-80	0.055	0.4	0.6
-40	12.84	96.3	128.4	x	x	x	x

Shelf spacing: vial height + tray height + seated stopper height + clearance

Stainless Steel Surface Finish:

RA (Micro Inch)	Designation
#2B	-
White Pickle	-
E.P.*	-
30-35	150 Grit
12-20	150 Grit + E.P.
20-25	180 Grit
10-16	180 Grit + E.P.
15-20	240 Grit
8-12	240 Grit + E.P.
8-12	320 Grit
6-12	320 Grit + E.P.
6-10	320 Grit + Buff
4-8	320 Grit + Buff + E.P.
7-12	320 Grit + Grease + Buff
5-12	320 Grit + Grease + Buff +E.P.
4-8	+E.P. = *Electropolish

Viscosity:

Acetone	0.3 cP
Air @ 18°C	0.018 2 cP
Ammonia @ 20°C	0.009 82 cP
Benzene @ 20°C	0.652 cP
Corn oil	72 cP
Ethyl alcohol	1.2 cP
Glycerin @ 20°C	1,490 cP
Glycol @ 20°C	19.9 cP
Honey	3,000 cP
Hydrogen	0.008 6 cP
Ketchup @ 20°C	50,000 cP
Mercury @ 20°C	1.554 cP
Methyl alcohol @ 20°C	0.597 cP
Water @ 20°C	1.002 cP
Water @ 99°C	0.2848 cP
Water Vapor @ 100°C	0.125 5 cP

Important Phone Numbers:

ISPE: National: 813.960.2105
 FDA: 800.638.2041
 NIH: 301.496.4000
 PDA: 301.656.5900
 ISPE: National: 813.960.2105
 ISPE Great Lakes: 610.797.8381
 ISPE Midwest: 816.741.9484
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