

广州市从化区暴雨公式及计算图表

广州市水务局

广东省气候中心

二零一四年三月

广州市从化区暴雨公式及计算图表

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说 明

1. 本计算图表以从化国家地面气象观测站 22 年(1991~2012 年)连续自记雨量记录为基础,利用国内先进的“降水数字化处理系统”得到高精度的原始数据而进行编制。

2. 以重现期 0.25、0.33、0.5、1、2、3、5、10、20、50、100(年)相应的单一重现期暴雨强度公式制表。设计暴雨强度可按选定设计重现期直接查用表列数值(单一重现期暴雨强度公式见表一)。

3. 若采用其它重现期,设计暴雨强度可用重现期区间参数公式计算:

$$q = \frac{167A}{(t+b)^n}$$

式中: q —设计暴雨强度(升/秒·公顷)

t —降雨历时(分钟)

A —雨力

b 、 n —地方常数

(A 、 b 、 n 按重现期区间参数公式计算,公式见表二)

4. 考虑到绘制全国城市暴雨公式等值线图,列出包含重现期在内的暴雨强度总公式:

$$q = \frac{2690.403(1 + 0.388LnP)}{(t + 7.897)^{0.748}}$$

因总公式精度不及重现期区间参数公式,故建议推求其它重现期设计暴雨强度时使用区间参数公式。

应用重现期区间参数公式计算暴雨强度实例:求 $P=25$ 年, $t=50$ 分钟的暴雨强度 q 。

从重现期区间参数公式 III, 得:

$$n = 0.785 - 0.05Ln(P - 6.409)$$

$$= 0.63887 \text{ (取 } 0.639)$$

$$b = 12.757 - 1.699Ln(P - 8.321)$$

$$= 7.97576 \text{ (取 } 7.976)$$

$$A = 30.004 - 2.399Ln(P - 8.697)$$

$$= 23.30755 \text{ (取 } 23.308)$$

配得 $P=25$ 年的暴雨强度计算公式如下:

$$q = \frac{167 \times 23.308}{(t + 7.976)^{0.639}}$$

可按上式计算 1~200 分钟中任何时段的暴雨强度。

当 $t=50$:

$$q = \frac{3892.436}{(t + 7.976)^{0.639}} = 290.741 \text{ (升/秒/公顷)}$$

5. 公式误差

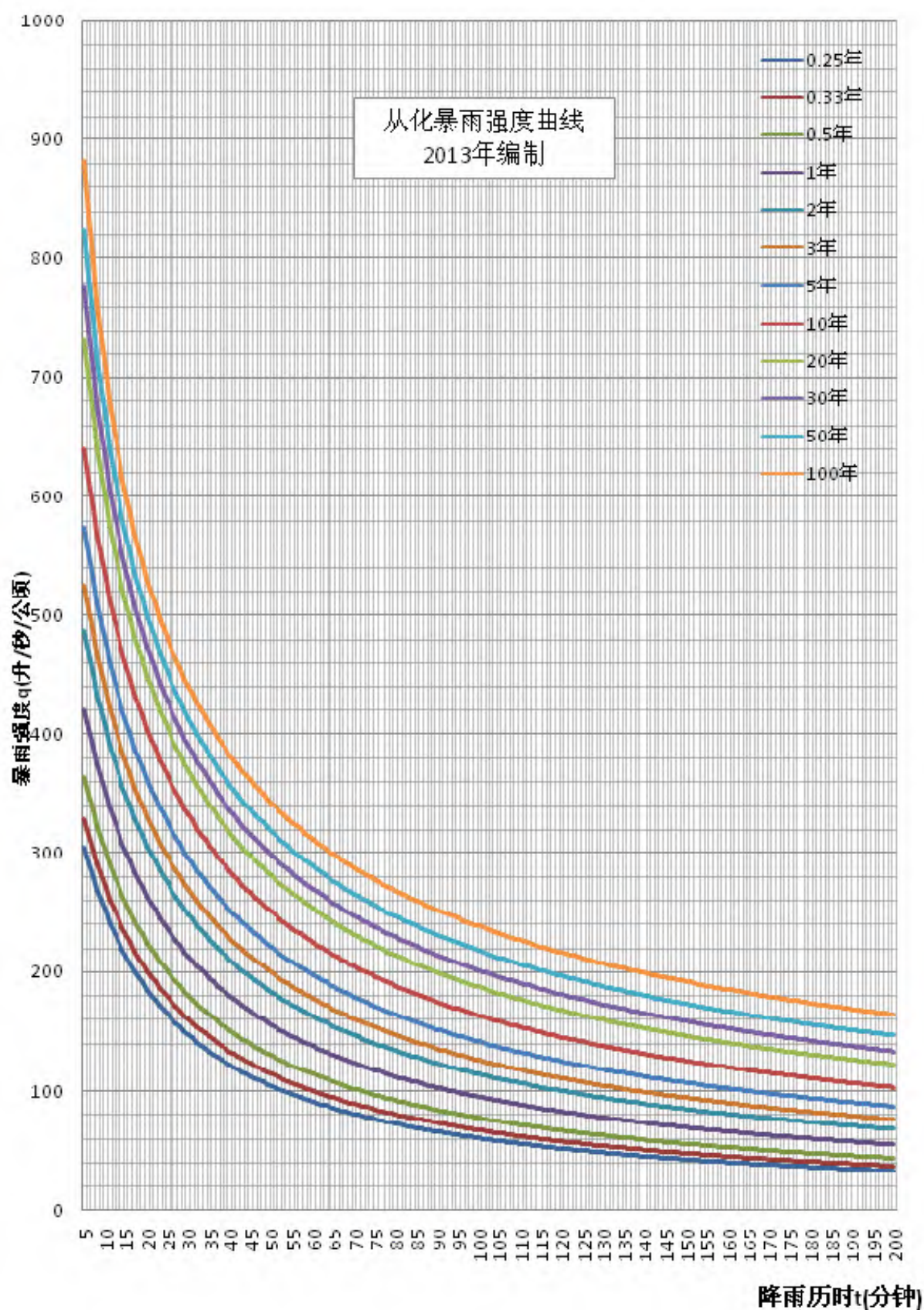
重现期 0.25~10 年的暴雨强度公式算得的平均绝对均方差为: 0.044 (mm/min), 平均相对均方差为: 4.16%。精度基本符合《室外排水设计规范》(GB50014—2006, 2011 年版)提出的要求。

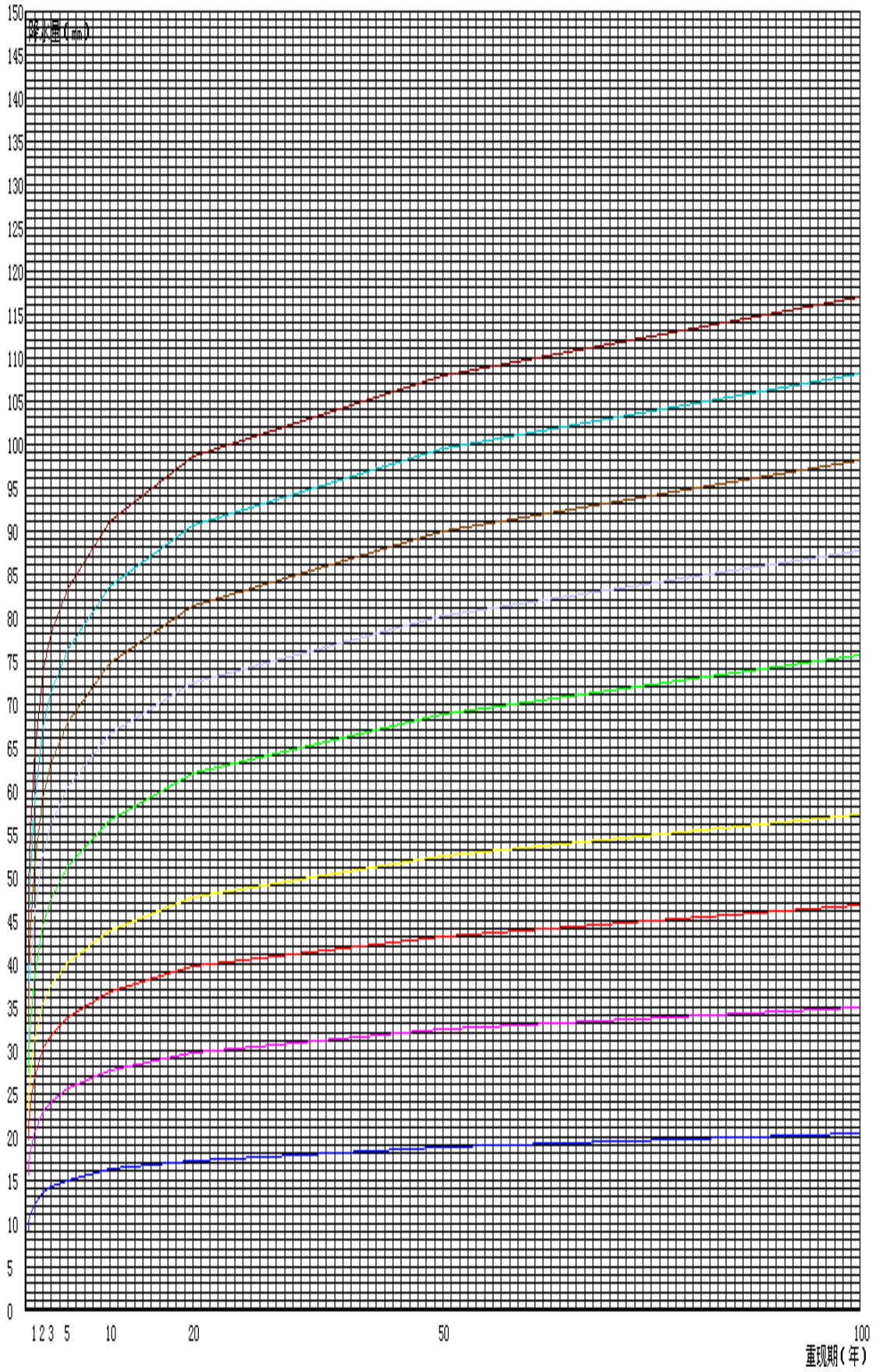
表一 单一重现期暴雨强度公式

重现期 P (年)	公 式
P=0.25	$6721.595 / (t+17.912)^{0.988}$
P=0.33	$6548.462 / (t+17.506)^{0.961}$
P=0.5	$6398.109 / (t+17.044)^{0.927}$
P=1	$6222.308 / (t+16.424)^{0.879}$
P=2	$5777.148 / (t+14.893)^{0.827}$
P=3	$5545.311 / (t+14.093)^{0.799}$
P=5	$5267.628 / (t+13.133)^{0.765}$
P=10	$4904.754 / (t+11.877)^{0.721}$
P=20	$4039.106 / (t+8.581)^{0.655}$
P=30	$3785.193 / (t+7.530)^{0.627}$
P=50	$3519.938 / (t+6.420)^{0.596}$
P=100	$3202.137 / (t+5.080)^{0.558}$

表二 重现期区间暴雨强度公式

P (年)	区间	参数	公 式
0.25—1	I	n	$0.872 - 0.057\text{Ln}(P-0.119)$
		b	$16.312 - 0.701\text{Ln}(P-0.148)$
		A	$37.019 - 1.071\text{Ln}(P-0.201)$
1 — 10	II	n	$0.860 - 0.061\text{Ln}(P-0.269)$
		b	$15.820 - 1.735\text{Ln}(P-0.294)$
		A	$36.181 - 2.998\text{Ln}(P-0.302)$
10—100	III	n	$0.785 - 0.050\text{Ln}(P-6.409)$
		b	$12.757 - 1.699\text{Ln}(P-8.321)$
		A	$30.004 - 2.399\text{Ln}(P-8.697)$





延长样本资料后的降水量与重现期曲线图

P=0.25(年)

t: 分钟; q: 升/秒/公顷

t	q	t	q	t	q	t	q	t	q	t	q	t	q	t	q
1	368.176	26	160.177	51	102.621	76	75.583	101	59.862	126	49.576	151	42.320	176	36.925
2	349.902	27	156.653	52	101.171	77	74.796	102	59.368	127	49.238	152	42.074	177	36.738
3	333.366	28	153.281	53	99.761	78	74.026	103	58.883	128	48.905	153	41.830	178	36.552
4	318.331	29	150.053	54	98.390	79	73.271	104	58.406	129	48.576	154	41.590	179	36.369
5	304.600	30	146.958	55	97.057	80	72.531	105	57.937	130	48.251	155	41.352	180	36.187
6	292.011	31	143.989	56	95.760	81	71.807	106	57.475	131	47.931	156	41.118	181	36.008
7	280.428	32	141.139	57	94.496	82	71.097	107	57.020	132	47.615	157	40.885	182	35.830
8	269.733	33	138.399	58	93.266	83	70.401	108	56.573	133	47.303	158	40.656	183	35.654
9	259.828	34	135.765	59	92.068	84	69.718	109	56.132	134	46.996	159	40.429	184	35.479
10	250.629	35	133.230	60	90.901	85	69.049	110	55.699	135	46.692	160	40.204	185	35.306
11	242.062	36	130.788	61	89.763	86	68.392	111	55.272	136	46.392	161	39.982	186	35.135
12	234.065	37	128.434	62	88.653	87	67.748	112	54.851	137	46.097	162	39.762	187	34.966
13	226.583	38	126.165	63	87.570	88	67.116	113	54.437	138	45.804	163	39.545	188	34.798
14	219.566	39	123.974	64	86.514	89	66.496	114	54.030	139	45.516	164	39.330	189	34.632
15	212.974	40	121.859	65	85.483	90	65.887	115	53.628	140	45.231	165	39.118	190	34.467
16	206.768	41	119.815	66	84.476	91	65.289	116	53.232	141	44.950	166	38.908	191	34.304
17	200.915	42	117.839	67	83.493	92	64.702	117	52.842	142	44.672	167	38.700	192	34.143
18	195.387	43	115.927	68	82.533	93	64.126	118	52.458	143	44.398	168	38.494	193	33.983
19	190.156	44	114.077	69	81.595	94	63.560	119	52.080	144	44.127	169	38.291	194	33.824
20	185.200	45	112.285	70	80.678	95	63.004	120	51.707	145	43.859	170	38.090	195	33.667
21	180.497	46	110.550	71	79.781	96	62.457	121	51.339	146	43.595	171	37.890	196	33.512
22	176.028	47	108.867	72	78.904	97	61.920	122	50.976	147	43.334	172	37.693	197	33.358
23	171.777	48	107.235	73	78.047	98	61.392	123	50.619	148	43.076	173	37.498	198	33.205
24	167.727	49	105.651	74	77.208	99	60.873	124	50.266	149	42.821	174	37.305	199	33.054
25	163.864	50	104.114	75	76.387	100	60.363	125	49.919	150	42.569	175	37.114	200	32.904

P=0.33(年)

t: 分钟; q: 升/秒/公顷

t	q	t	q	t	q	t	q	t	q	t	q	t	q	t	q
1	396.508	26	174.379	51	112.721	76	83.592	101	66.569	126	55.384	151	47.464	176	41.555
2	376.953	27	170.612	52	111.162	77	82.741	102	66.034	127	55.016	152	47.195	177	41.350
3	359.271	28	167.007	53	109.646	78	81.909	103	65.507	128	54.653	153	46.929	178	41.147
4	343.202	29	163.555	54	108.172	79	81.093	104	64.989	129	54.294	154	46.666	179	40.945
5	328.534	30	160.245	55	106.738	80	80.293	105	64.479	130	53.940	155	46.406	180	40.746
6	315.091	31	157.069	56	105.342	81	79.510	106	63.977	131	53.591	156	46.149	181	40.549
7	302.725	32	154.019	57	103.983	82	78.742	107	63.484	132	53.247	157	45.894	182	40.354
8	291.310	33	151.087	58	102.659	83	77.989	108	62.997	133	52.907	158	45.643	183	40.160
9	280.741	34	148.267	59	101.370	84	77.250	109	62.519	134	52.571	159	45.395	184	39.969
10	270.925	35	145.552	60	100.112	85	76.526	110	62.048	135	52.240	160	45.149	185	39.779
11	261.785	36	142.937	61	98.887	86	75.815	111	61.583	136	51.913	161	44.906	186	39.591
12	253.254	37	140.416	62	97.691	87	75.118	112	61.126	137	51.590	162	44.665	187	39.405
13	245.270	38	137.984	63	96.525	88	74.434	113	60.676	138	51.271	163	44.427	188	39.221
14	237.784	39	135.636	64	95.386	89	73.762	114	60.233	139	50.956	164	44.192	189	39.038
15	230.750	40	133.369	65	94.275	90	73.103	115	59.796	140	50.645	165	43.959	190	38.857
16	224.128	41	131.178	66	93.190	91	72.455	116	59.365	141	50.338	166	43.729	191	38.678
17	217.883	42	129.058	67	92.130	92	71.819	117	58.941	142	50.035	167	43.501	192	38.501
18	211.982	43	127.008	68	91.094	93	71.194	118	58.523	143	49.735	168	43.276	193	38.325
19	206.399	44	125.023	69	90.082	94	70.581	119	58.111	144	49.439	169	43.053	194	38.151
20	201.108	45	123.100	70	89.092	95	69.978	120	57.705	145	49.147	170	42.832	195	37.978
21	196.086	46	121.237	71	88.125	96	69.385	121	57.304	146	48.858	171	42.614	196	37.807
22	191.314	47	119.430	72	87.179	97	68.803	122	56.910	147	48.572	172	42.398	197	37.638
23	186.773	48	117.677	73	86.253	98	68.230	123	56.520	148	48.290	173	42.184	198	37.470
24	182.446	49	115.977	74	85.347	99	67.667	124	56.136	149	48.011	174	41.972	199	37.304
25	178.319	50	114.325	75	84.460	100	67.114	125	55.758	150	47.736	175	41.763	200	37.139

P=0.5(年)

t: 分钟; q: 升/秒/公顷

t	q	t	q	t	q	t	q	t	q	t	q	t	q	t	q
1	437.957	26	195.621	51	127.954	76	95.736	101	76.783	126	64.259	151	55.346	176	48.669
2	416.597	27	191.500	52	126.236	77	94.792	102	76.185	127	63.845	152	55.042	177	48.436
3	397.294	28	187.556	53	124.564	78	93.868	103	75.597	128	63.437	153	54.742	178	48.206
4	379.762	29	183.777	54	122.938	79	92.961	104	75.018	129	63.034	154	54.445	179	47.978
5	363.765	30	180.152	55	121.355	80	92.073	105	74.448	130	62.637	155	54.152	180	47.752
6	349.109	31	176.674	56	119.814	81	91.202	106	73.887	131	62.244	156	53.862	181	47.528
7	335.628	32	173.332	57	118.314	82	90.348	107	73.334	132	61.857	157	53.575	182	47.307
8	323.187	33	170.119	58	116.851	83	89.511	108	72.790	133	61.475	158	53.291	183	47.088
9	311.667	34	167.027	59	115.426	84	88.689	109	72.255	134	61.097	159	53.010	184	46.871
10	300.969	35	164.050	60	114.037	85	87.883	110	71.728	135	60.725	160	52.733	185	46.656
11	291.007	36	161.181	61	112.682	86	87.092	111	71.208	136	60.357	161	52.458	186	46.442
12	281.707	37	158.414	62	111.359	87	86.316	112	70.696	137	59.994	162	52.186	187	46.231
13	273.005	38	155.745	63	110.069	88	85.554	113	70.192	138	59.635	163	51.918	188	46.022
14	264.843	39	153.167	64	108.810	89	84.806	114	69.696	139	59.280	164	51.652	189	45.815
15	257.172	40	150.676	65	107.580	90	84.071	115	69.206	140	58.930	165	51.389	190	45.610
16	249.950	41	148.268	66	106.378	91	83.350	116	68.724	141	58.585	166	51.128	191	45.407
17	243.136	42	145.939	67	105.204	92	82.641	117	68.249	142	58.243	167	50.871	192	45.206
18	236.698	43	143.685	68	104.057	93	81.944	118	67.780	143	57.906	168	50.616	193	45.006
19	230.604	44	141.501	69	102.936	94	81.260	119	67.318	144	57.572	169	50.364	194	44.808
20	224.828	45	139.386	70	101.839	95	80.588	120	66.862	145	57.243	170	50.114	195	44.612
21	219.344	46	137.335	71	100.766	96	79.927	121	66.413	146	56.917	171	49.867	196	44.418
22	214.132	47	135.346	72	99.717	97	79.277	122	65.970	147	56.596	172	49.622	197	44.226
23	209.170	48	133.416	73	98.690	98	78.638	123	65.534	148	56.278	173	49.380	198	44.035
24	204.442	49	131.543	74	97.684	99	78.009	124	65.103	149	55.963	174	49.141	199	43.846
25	199.930	50	129.723	75	96.700	100	77.391	125	64.678	150	55.653	175	48.903	200	43.659

P=1 (年)

t: 分钟; q: 升/秒/公顷

t	q	t	q	t	q	t	q	t	q	t	q	t	q	t	q
1	504.641	26	230.824	51	153.611	76	116.420	101	94.327	126	79.607	151	69.058	176	61.107
2	480.484	27	226.145	52	151.636	77	115.324	102	93.626	127	79.119	152	68.698	177	60.829
3	458.672	28	221.664	53	149.715	78	114.249	103	92.937	128	78.637	153	68.341	178	60.554
4	438.872	29	217.369	54	147.844	79	113.196	104	92.258	129	78.162	154	67.989	179	60.281
5	420.814	30	213.248	55	146.023	80	112.164	105	91.590	130	77.692	155	67.640	180	60.011
6	404.273	31	209.290	56	144.250	81	111.151	106	90.932	131	77.229	156	67.295	181	59.744
7	389.063	32	205.486	57	142.521	82	110.158	107	90.284	132	76.771	157	66.954	182	59.479
8	375.025	33	201.827	58	140.837	83	109.183	108	89.646	133	76.320	158	66.616	183	59.217
9	362.028	34	198.305	59	139.194	84	108.227	109	89.017	134	75.873	159	66.282	184	58.957
10	349.957	35	194.911	60	137.592	85	107.289	110	88.398	135	75.433	160	65.952	185	58.700
11	338.715	36	191.639	61	136.028	86	106.367	111	87.788	136	74.998	161	65.625	186	58.445
12	328.218	37	188.483	62	134.503	87	105.463	112	87.187	137	74.568	162	65.302	187	58.192
13	318.392	38	185.435	63	133.013	88	104.575	113	86.595	138	74.143	163	64.982	188	57.942
14	309.175	39	182.491	64	131.558	89	103.702	114	86.011	139	73.724	164	64.665	189	57.694
15	300.510	40	179.645	65	130.137	90	102.845	115	85.435	140	73.309	165	64.352	190	57.448
16	292.348	41	176.892	66	128.748	91	102.003	116	84.868	141	72.900	166	64.041	191	57.205
17	284.645	42	174.228	67	127.390	92	101.176	117	84.308	142	72.495	167	63.734	192	56.963
18	277.364	43	171.648	68	126.063	93	100.363	118	83.757	143	72.095	168	63.430	193	56.724
19	270.470	44	169.149	69	124.765	94	99.563	119	83.213	144	71.700	169	63.130	194	56.487
20	263.932	45	166.726	70	123.495	95	98.777	120	82.677	145	71.310	170	62.832	195	56.252
21	257.723	46	164.376	71	122.253	96	98.005	121	82.148	146	70.923	171	62.537	196	56.020
22	251.817	47	162.095	72	121.036	97	97.245	122	81.626	147	70.542	172	62.245	197	55.789
23	246.194	48	159.882	73	119.846	98	96.497	123	81.111	148	70.165	173	61.956	198	55.560
24	240.833	49	157.732	74	118.680	99	95.762	124	80.603	149	69.792	174	61.670	199	55.333
25	235.715	50	155.642	75	117.538	100	95.039	125	80.102	150	69.423	175	61.387	200	55.108

P=2 (年)

t: 分钟; q: 升/秒/公顷

t	q	t	q	t	q	t	q	t	q	t	q	t	q	t	q
1	586.565	26	268.460	51	180.940	76	138.678	101	113.433	126	96.512	151	84.317	176	75.076
2	557.699	27	263.149	52	178.700	77	137.429	102	112.630	127	95.949	152	83.899	177	74.752
3	531.795	28	258.065	53	176.520	78	136.205	103	111.839	128	95.394	153	83.486	178	74.432
4	508.408	29	253.194	54	174.398	79	135.004	104	111.060	129	94.845	154	83.077	179	74.114
5	487.179	30	248.520	55	172.332	80	133.826	105	110.294	130	94.303	155	82.672	180	73.799
6	467.814	31	244.033	56	170.320	81	132.671	106	109.539	131	93.769	156	82.272	181	73.488
7	450.071	32	239.722	57	168.358	82	131.538	107	108.795	132	93.240	157	81.876	182	73.179
8	433.750	33	235.575	58	166.446	83	130.425	108	108.062	133	92.719	158	81.484	183	72.873
9	418.681	34	231.583	59	164.581	84	129.334	109	107.341	134	92.203	159	81.096	184	72.570
10	404.723	35	227.738	60	162.761	85	128.262	110	106.629	135	91.694	160	80.712	185	72.269
11	391.752	36	224.031	61	160.985	86	127.210	111	105.928	136	91.191	161	80.333	186	71.972
12	379.666	37	220.454	62	159.252	87	126.176	112	105.238	137	90.695	162	79.957	187	71.677
13	368.374	38	217.002	63	157.559	88	125.161	113	104.557	138	90.204	163	79.585	188	71.384
14	357.798	39	213.666	64	155.906	89	124.164	114	103.885	139	89.719	164	79.217	189	71.095
15	347.870	40	210.442	65	154.290	90	123.185	115	103.223	140	89.240	165	78.853	190	70.808
16	338.532	41	207.324	66	152.711	91	122.222	116	102.571	141	88.766	166	78.492	191	70.523
17	329.729	42	204.305	67	151.167	92	121.275	117	101.927	142	88.298	167	78.135	192	70.241
18	321.417	43	201.383	68	149.658	93	120.345	118	101.292	143	87.835	168	77.782	193	69.962
19	313.554	44	198.550	69	148.181	94	119.430	119	100.666	144	87.378	169	77.432	194	69.685
20	306.104	45	195.805	70	146.736	95	118.531	120	100.049	145	86.925	170	77.085	195	69.410
21	299.034	46	193.142	71	145.322	96	117.646	121	99.440	146	86.478	171	76.742	196	69.138
22	292.315	47	190.557	72	143.937	97	116.776	122	98.839	147	86.036	172	76.402	197	68.868
23	285.920	48	188.048	73	142.582	98	115.920	123	98.245	148	85.599	173	76.066	198	68.600
24	279.827	49	185.611	74	141.254	99	115.078	124	97.660	149	85.167	174	75.733	199	68.335
25	274.013	50	183.242	75	139.953	100	114.249	125	97.082	150	84.740	175	75.403	200	68.072

P=3 (年)

t: 分钟; q: 升/秒/公顷

t	q	t	q	t	q	t	q	t	q	t	q	t	q	t	q
1	633.993	26	290.452	51	197.202	76	152.099	101	125.068	126	106.891	151	93.748	176	83.759
2	602.314	27	284.790	52	194.815	77	150.764	102	124.207	127	106.285	152	93.296	177	83.409
3	573.990	28	279.372	53	192.491	78	149.454	103	123.359	128	105.687	153	92.850	178	83.062
4	548.498	29	274.179	54	190.229	79	148.170	104	122.523	129	105.096	154	92.408	179	82.718
5	525.421	30	269.200	55	188.026	80	146.911	105	121.701	130	104.513	155	91.972	180	82.377
6	504.421	31	264.419	56	185.880	81	145.675	106	120.890	131	103.937	156	91.539	181	82.039
7	485.221	32	259.825	57	183.788	82	144.463	107	120.092	132	103.368	157	91.112	182	81.705
8	467.591	33	255.408	58	181.748	83	143.272	108	119.305	133	102.806	158	90.688	183	81.374
9	451.341	34	251.155	59	179.758	84	142.104	109	118.530	134	102.251	159	90.269	184	81.045
10	436.310	35	247.059	60	177.817	85	140.957	110	117.767	135	101.703	160	89.855	185	80.720
11	422.361	36	243.111	61	175.923	86	139.831	111	117.014	136	101.161	161	89.445	186	80.397
12	409.377	37	239.301	62	174.073	87	138.725	112	116.272	137	100.626	162	89.039	187	80.078
13	397.258	38	235.624	63	172.267	88	137.638	113	115.540	138	100.097	163	88.637	188	79.761
14	385.919	39	232.071	64	170.502	89	136.570	114	114.819	139	99.574	164	88.239	189	79.447
15	375.283	40	228.637	65	168.777	90	135.521	115	114.108	140	99.057	165	87.845	190	79.136
16	365.285	41	225.315	66	167.091	91	134.490	116	113.406	141	98.547	166	87.455	191	78.827
17	355.868	42	222.100	67	165.443	92	133.476	117	112.715	142	98.042	167	87.069	192	78.522
18	346.980	43	218.986	68	163.831	93	132.479	118	112.032	143	97.543	168	86.687	193	78.219
19	338.576	44	215.969	69	162.253	94	131.499	119	111.359	144	97.050	169	86.308	194	77.918
20	330.618	45	213.044	70	160.710	95	130.535	120	110.695	145	96.562	170	85.933	195	77.620
21	323.069	46	210.206	71	159.199	96	129.587	121	110.040	146	96.080	171	85.562	196	77.325
22	315.897	47	207.453	72	157.720	97	128.654	122	109.393	147	95.603	172	85.195	197	77.032
23	309.073	48	204.779	73	156.271	98	127.736	123	108.755	148	95.131	173	84.830	198	76.742
24	302.573	49	202.181	74	154.852	99	126.833	124	108.126	149	94.665	174	84.470	199	76.454
25	296.373	50	199.657	75	153.462	100	125.944	125	107.504	150	94.204	175	84.113	200	76.168

P=5 (年)

t: 分钟; q: 升/秒/公顷

t	q	t	q	t	q	t	q	t	q	t	q	t	q	t	q
1	694.522	26	318.654	51	218.372	76	169.760	101	140.506	126	120.751	151	106.412	176	95.475
2	659.132	27	312.562	52	215.803	77	168.317	102	139.572	127	120.091	152	105.919	177	95.090
3	627.643	28	306.732	53	213.302	78	166.903	103	138.651	128	119.440	153	105.431	178	94.709
4	599.422	29	301.147	54	210.867	79	165.515	104	137.745	129	118.796	154	104.948	179	94.332
5	573.966	30	295.792	55	208.495	80	164.154	105	136.852	130	118.161	155	104.470	180	93.958
6	550.872	31	290.650	56	206.184	81	162.818	106	135.972	131	117.533	156	103.997	181	93.588
7	529.816	32	285.711	57	203.932	82	161.507	107	135.106	132	116.913	157	103.529	182	93.221
8	510.528	33	280.961	58	201.735	83	160.220	108	134.252	133	116.301	158	103.066	183	92.857
9	492.787	34	276.389	59	199.592	84	158.957	109	133.410	134	115.696	159	102.607	184	92.496
10	476.406	35	271.986	60	197.501	85	157.716	110	132.580	135	115.098	160	102.154	185	92.139
11	461.230	36	267.741	61	195.459	86	156.498	111	131.762	136	114.507	161	101.705	186	91.785
12	447.124	37	263.646	62	193.466	87	155.301	112	130.956	137	113.923	162	101.260	187	91.434
13	433.976	38	259.692	63	191.519	88	154.125	113	130.161	138	113.346	163	100.820	188	91.086
14	421.686	39	255.873	64	189.617	89	152.969	114	129.377	139	112.775	164	100.384	189	90.741
15	410.171	40	252.180	65	187.757	90	151.833	115	128.604	140	112.212	165	99.953	190	90.399
16	399.356	41	248.609	66	185.939	91	150.716	116	127.841	141	111.654	166	99.526	191	90.060
17	389.177	42	245.152	67	184.162	92	149.618	117	127.089	142	111.103	167	99.103	192	89.724
18	379.578	43	241.804	68	182.423	93	148.539	118	126.347	143	110.558	168	98.684	193	89.391
19	370.508	44	238.559	69	180.721	94	147.477	119	125.615	144	110.020	169	98.269	194	89.060
20	361.923	45	235.414	70	179.056	95	146.432	120	124.893	145	109.487	170	97.859	195	88.733
21	353.783	46	232.362	71	177.425	96	145.405	121	124.180	146	108.960	171	97.452	196	88.408
22	346.053	47	229.400	72	175.829	97	144.394	122	123.476	147	108.439	172	97.049	197	88.086
23	338.703	48	226.524	73	174.265	98	143.399	123	122.782	148	107.924	173	96.650	198	87.767
24	331.702	49	223.730	74	172.733	99	142.419	124	122.096	149	107.415	174	96.254	199	87.450
25	325.027	50	221.014	75	171.232	100	141.455	125	121.419	150	106.911	175	95.863	200	87.136

P=10(年)

t: 分钟; q: 升/秒/公顷

t	q	t	q	t	q	t	q	t	q	t	q	t	q	t	q
1	777.035	26	356.951	51	247.688	76	194.573	101	162.438	126	140.619	151	124.700	176	112.500
2	736.245	27	350.307	52	244.886	77	192.992	102	161.409	127	139.888	152	124.151	177	112.071
3	700.219	28	343.951	53	242.159	78	191.442	103	160.394	128	139.166	153	123.607	178	111.645
4	668.133	29	337.863	54	239.503	79	189.921	104	159.395	129	138.453	154	123.070	179	111.223
5	639.348	30	332.027	55	236.915	80	188.428	105	158.411	130	137.749	155	122.538	180	110.805
6	613.356	31	326.425	56	234.393	81	186.963	106	157.441	131	137.053	156	122.011	181	110.390
7	589.752	32	321.044	57	231.935	82	185.525	107	156.485	132	136.366	157	121.490	182	109.979
8	568.207	33	315.870	58	229.537	83	184.113	108	155.542	133	135.686	158	120.973	183	109.572
9	548.449	34	310.890	59	227.197	84	182.726	109	154.614	134	135.015	159	120.463	184	109.168
10	530.257	35	306.094	60	224.914	85	181.364	110	153.698	135	134.352	160	119.957	185	108.768
11	513.441	36	301.471	61	222.684	86	180.027	111	152.795	136	133.696	161	119.456	186	108.372
12	497.845	37	297.011	62	220.507	87	178.712	112	151.905	137	133.048	162	118.960	187	107.979
13	483.333	38	292.706	63	218.380	88	177.420	113	151.027	138	132.407	163	118.470	188	107.589
14	469.793	39	288.546	64	216.301	89	176.150	114	150.161	139	131.774	164	117.984	189	107.202
15	457.124	40	284.525	65	214.268	90	174.902	115	149.306	140	131.148	165	117.502	190	106.819
16	445.241	41	280.635	66	212.281	91	173.674	116	148.464	141	130.529	166	117.026	191	106.439
17	434.069	42	276.870	67	210.337	92	172.467	117	147.632	142	129.917	167	116.554	192	106.063
18	423.545	43	273.223	68	208.435	93	171.280	118	146.812	143	129.311	168	116.086	193	105.689
19	413.609	44	269.688	69	206.574	94	170.112	119	146.002	144	128.713	169	115.623	194	105.319
20	404.213	45	266.261	70	204.752	95	168.963	120	145.203	145	128.121	170	115.164	195	104.952
21	395.310	46	262.936	71	202.967	96	167.832	121	144.414	146	127.535	171	114.710	196	104.587
22	386.862	47	259.709	72	201.220	97	166.719	122	143.636	147	126.956	172	114.260	197	104.226
23	378.832	48	256.574	73	199.508	98	165.624	123	142.867	148	126.383	173	113.814	198	103.868
24	371.189	49	253.528	74	197.830	99	164.546	124	142.108	149	125.816	174	113.372	199	103.512
25	363.904	50	250.567	75	196.185	100	163.484	125	141.359	150	125.255	175	112.934	200	103.160

P=20(年)

t: 分钟; q: 升/秒/公顷

t	q	t	q	t	q	t	q	t	q	t	q	t	q	t	q
1	919.308	26	396.594	51	277.709	76	220.761	101	186.320	126	162.855	151	145.657	176	132.414
2	861.431	27	389.258	52	274.698	77	219.068	102	185.214	127	162.067	152	145.063	177	131.946
3	811.954	28	382.255	53	271.768	78	217.407	103	184.125	128	161.289	153	144.474	178	131.482
4	769.081	29	375.561	54	268.915	79	215.778	104	183.052	129	160.520	154	143.891	179	131.023
5	731.501	30	369.157	55	266.137	80	214.179	105	181.995	130	159.760	155	143.315	180	130.567
6	698.240	31	363.021	56	263.431	81	212.610	106	180.953	131	159.010	156	142.744	181	130.116
7	668.552	32	357.136	57	260.793	82	211.070	107	179.926	132	158.268	157	142.178	182	129.668
8	641.860	33	351.487	58	258.221	83	209.557	108	178.914	133	157.535	158	141.619	183	129.224
9	617.706	34	346.058	59	255.711	84	208.072	109	177.916	134	156.810	159	141.065	184	128.784
10	595.724	35	340.836	60	253.263	85	206.613	110	176.932	135	156.094	160	140.516	185	128.348
11	575.617	36	335.809	61	250.873	86	205.179	111	175.961	136	155.386	161	139.973	186	127.916
12	557.140	37	330.965	62	248.539	87	203.771	112	175.004	137	154.686	162	139.435	187	127.487
13	540.093	38	326.294	63	246.259	88	202.386	113	174.060	138	153.994	163	138.902	188	127.062
14	524.304	39	321.785	64	244.032	89	201.025	114	173.128	139	153.310	164	138.374	189	126.640
15	509.632	40	317.431	65	241.854	90	199.687	115	172.209	140	152.633	165	137.851	190	126.222
16	495.955	41	313.223	66	239.725	91	198.372	116	171.303	141	151.964	166	137.334	191	125.808
17	483.169	42	309.153	67	237.643	92	197.078	117	170.408	142	151.302	167	136.821	192	125.397
18	471.185	43	305.214	68	235.606	93	195.805	118	169.525	143	150.648	168	136.313	193	124.989
19	459.924	44	301.399	69	233.612	94	194.552	119	168.654	144	150.000	169	135.810	194	124.584
20	449.319	45	297.703	70	231.661	95	193.320	120	167.793	145	149.360	170	135.311	195	124.183
21	439.311	46	294.119	71	229.750	96	192.107	121	166.944	146	148.726	171	134.817	196	123.785
22	429.847	47	290.642	72	227.878	97	190.913	122	166.105	147	148.100	172	134.328	197	123.390
23	420.883	48	287.267	73	226.045	98	189.738	123	165.277	148	147.479	173	133.843	198	122.999
24	412.376	49	283.990	74	224.248	99	188.581	124	164.460	149	146.866	174	133.362	199	122.610
25	404.291	50	280.805	75	222.487	100	187.442	125	163.652	150	146.258	175	132.886	200	122.225

P=30(年)

t: 分钟; q: 升/秒/公顷

t	q	t	q	t	q	t	q	t	q	t	q	t	q	t	q
1	987.220	26	418.509	51	295.132	76	236.143	101	200.394	126	175.971	151	158.020	176	144.159
2	920.939	27	410.869	52	292.014	77	234.388	102	199.245	127	175.150	152	157.399	177	143.669
3	865.092	28	403.580	53	288.980	78	232.666	103	198.113	128	174.339	153	156.783	178	143.183
4	817.260	29	396.618	54	286.027	79	230.976	104	196.998	129	173.537	154	156.174	179	142.701
5	775.736	30	389.959	55	283.150	80	229.318	105	195.898	130	172.745	155	155.571	180	142.223
6	739.277	31	383.582	56	280.348	81	227.691	106	194.815	131	171.962	156	154.974	181	141.750
7	706.956	32	377.470	57	277.616	82	226.093	107	193.747	132	171.188	157	154.382	182	141.280
8	678.063	33	371.603	58	274.952	83	224.524	108	192.693	133	170.423	158	153.797	183	140.815
9	652.047	34	365.968	59	272.354	84	222.983	109	191.655	134	169.667	159	153.217	184	140.354
10	628.472	35	360.549	60	269.818	85	221.469	110	190.631	135	168.920	160	152.643	185	139.896
11	606.989	36	355.334	61	267.343	86	219.982	111	189.621	136	168.181	161	152.075	186	139.443
12	587.313	37	350.310	62	264.926	87	218.520	112	188.625	137	167.451	162	151.512	187	138.993
13	569.211	38	345.466	63	262.565	88	217.083	113	187.642	138	166.728	163	150.954	188	138.547
14	552.489	39	340.792	64	260.257	89	215.670	114	186.673	139	166.014	164	150.402	189	138.104
15	536.984	40	336.279	65	258.002	90	214.281	115	185.716	140	165.308	165	149.855	190	137.665
16	522.561	41	331.918	66	255.796	91	212.915	116	184.772	141	164.609	166	149.313	191	137.230
17	509.102	42	327.701	67	253.639	92	211.571	117	183.841	142	163.918	167	148.776	192	136.799
18	496.506	43	323.620	68	251.529	93	210.249	118	182.921	143	163.235	168	148.244	193	136.371
19	484.689	44	319.668	69	249.463	94	208.949	119	182.013	144	162.558	169	147.717	194	135.946
20	473.575	45	315.839	70	247.441	95	207.669	120	181.117	145	161.889	170	147.194	195	135.525
21	463.099	46	312.127	71	245.461	96	206.409	121	180.232	146	161.227	171	146.677	196	135.107
22	453.204	47	308.526	72	243.521	97	205.168	122	179.359	147	160.572	172	146.164	197	134.692
23	443.839	48	305.030	73	241.621	98	203.947	123	178.496	148	159.924	173	145.656	198	134.281
24	434.961	49	301.636	74	239.758	99	202.745	124	177.644	149	159.283	174	145.153	199	133.873
25	426.529	50	298.338	75	237.933	100	201.561	125	176.802	150	158.648	175	144.653	200	133.468

P=50(年)

t: 分钟; q: 升/秒/公顷

t	q	t	q	t	q	t	q	t	q	t	q	t	q	t	q
1	1066.042	26	442.681	51	314.872	76	253.851	101	216.775	126	191.360	151	172.618	176	158.101
2	988.665	27	434.738	52	311.648	77	252.033	102	215.581	127	190.504	152	171.968	177	157.587
3	924.700	28	427.165	53	308.511	78	250.250	103	214.404	128	189.658	153	171.325	178	157.077
4	870.735	29	419.936	54	305.458	79	248.499	104	213.245	129	188.822	154	170.687	179	156.572
5	824.453	30	413.025	55	302.484	80	246.782	105	212.102	130	187.996	155	170.056	180	156.071
6	784.221	31	406.411	56	299.586	81	245.095	106	210.976	131	187.179	156	169.431	181	155.574
7	748.849	32	400.073	57	296.762	82	243.439	107	209.865	132	186.372	157	168.813	182	155.081
8	717.450	33	393.992	58	294.008	83	241.813	108	208.770	133	185.574	158	168.200	183	154.593
9	689.345	34	388.154	59	291.321	84	240.216	109	207.690	134	184.785	159	167.593	184	154.108
10	664.007	35	382.541	60	288.699	85	238.646	110	206.625	135	184.005	160	166.992	185	153.628
11	641.018	36	377.140	61	286.139	86	237.104	111	205.574	136	183.234	161	166.397	186	153.152
12	620.044	37	371.939	62	283.639	87	235.588	112	204.538	137	182.472	162	165.808	187	152.679
13	600.812	38	366.926	63	281.197	88	234.098	113	203.515	138	181.718	163	165.224	188	152.211
14	583.098	39	362.089	64	278.810	89	232.632	114	202.506	139	180.972	164	164.645	189	151.746
15	566.717	40	357.420	65	276.477	90	231.191	115	201.511	140	180.234	165	164.072	190	151.285
16	551.514	41	352.908	66	274.195	91	229.774	116	200.528	141	179.505	166	163.504	191	150.828
17	537.355	42	348.546	67	271.963	92	228.380	117	199.558	142	178.783	167	162.942	192	150.374
18	524.129	43	344.325	68	269.779	93	227.008	118	198.601	143	178.069	168	162.384	193	149.925
19	511.741	44	340.239	69	267.641	94	225.658	119	197.655	144	177.362	169	161.832	194	149.478
20	500.107	45	336.279	70	265.548	95	224.329	120	196.722	145	176.663	170	161.284	195	149.036
21	489.155	46	332.441	71	263.499	96	223.021	121	195.800	146	175.971	171	160.742	196	148.596
22	478.823	47	328.718	72	261.491	97	221.733	122	194.890	147	175.287	172	160.204	197	148.160
23	469.055	48	325.104	73	259.524	98	220.465	123	193.991	148	174.609	173	159.672	198	147.728
24	459.803	49	321.595	74	257.595	99	219.216	124	193.103	149	173.939	174	159.144	199	147.299
25	451.024	50	318.186	75	255.705	100	217.986	125	192.226	150	173.275	175	158.620	200	146.873

P=100(年)

t: 分钟; q: 升/秒/公顷

t	q	t	q	t	q	t	q	t	q	t	q	t	q	t	q
1	1169.558	26	470.582	51	338.536	76	275.592	101	237.212	126	210.792	151	191.228	176	176.014
2	1074.290	27	462.340	52	335.214	77	273.713	102	235.973	127	209.900	152	190.548	177	175.474
3	997.940	28	454.488	53	331.981	78	271.870	103	234.752	128	209.019	153	189.874	178	174.939
4	935.035	29	446.998	54	328.834	79	270.061	104	233.549	129	208.147	154	189.208	179	174.408
5	882.082	30	439.842	55	325.768	80	268.285	105	232.363	130	207.286	155	188.547	180	173.881
6	836.733	31	432.997	56	322.781	81	266.541	106	231.193	131	206.435	156	187.893	181	173.359
7	797.346	32	426.442	57	319.870	82	264.829	107	230.040	132	205.593	157	187.245	182	172.842
8	762.733	33	420.156	58	317.030	83	263.147	108	228.903	133	204.761	158	186.604	183	172.328
9	732.014	34	414.123	59	314.260	84	261.494	109	227.781	134	203.938	159	185.968	184	171.819
10	704.518	35	408.325	60	311.556	85	259.871	110	226.674	135	203.124	160	185.339	185	171.314
11	679.724	36	402.749	61	308.916	86	258.275	111	225.582	136	202.320	161	184.715	186	170.813
12	657.221	37	397.380	62	306.338	87	256.706	112	224.505	137	201.524	162	184.098	187	170.317
13	636.683	38	392.206	63	303.819	88	255.163	113	223.442	138	200.737	163	183.486	188	169.824
14	617.842	39	387.216	64	301.357	89	253.646	114	222.393	139	199.958	164	182.879	189	169.335
15	600.479	40	382.399	65	298.950	90	252.154	115	221.358	140	199.188	165	182.278	190	168.850
16	584.413	41	377.746	66	296.596	91	250.686	116	220.336	141	198.426	166	181.683	191	168.369
17	569.493	42	373.248	67	294.293	92	249.242	117	219.327	142	197.672	167	181.093	192	167.892
18	555.590	43	368.896	68	292.039	93	247.821	118	218.331	143	196.926	168	180.509	193	167.418
19	542.595	44	364.683	69	289.832	94	246.422	119	217.347	144	196.188	169	179.929	194	166.948
20	530.414	45	360.601	70	287.672	95	245.045	120	216.376	145	195.457	170	179.355	195	166.482
21	518.968	46	356.645	71	285.556	96	243.689	121	215.417	146	194.734	171	178.786	196	166.020
22	508.185	47	352.807	72	283.483	97	242.354	122	214.469	147	194.019	172	178.222	197	165.561
23	498.006	48	349.083	73	281.451	98	241.040	123	213.533	148	193.310	173	177.663	198	165.106
24	488.376	49	345.466	74	279.459	99	239.745	124	212.608	149	192.609	174	177.109	199	164.654
25	479.249	50	341.952	75	277.507	100	238.469	125	211.695	150	191.915	175	176.559	200	164.205