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## Vessels and apparatus. Norms and methods of strength calculation. Heat-exchangers

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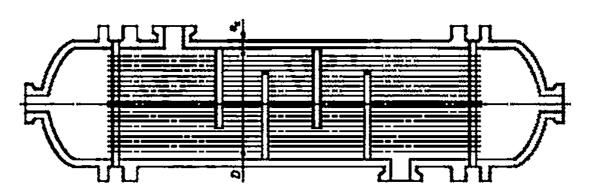


Рисунок 1 — Алпарат с неподвижными трубными решетками

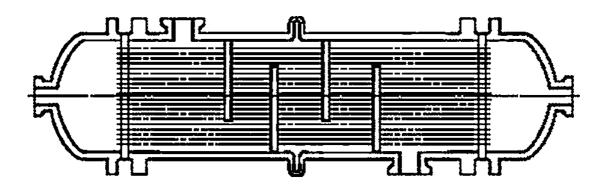


Рисунок 2 — Аппарат с компенсатором на кожухе

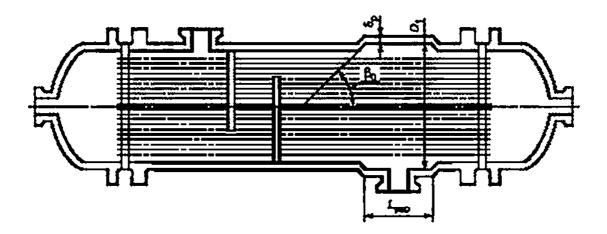


Рисунок 3 — Алпарат с расширителем на кожухе

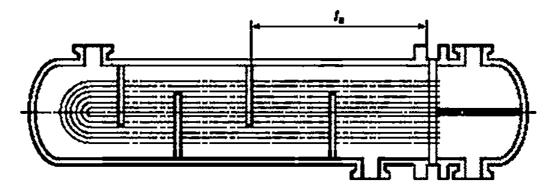
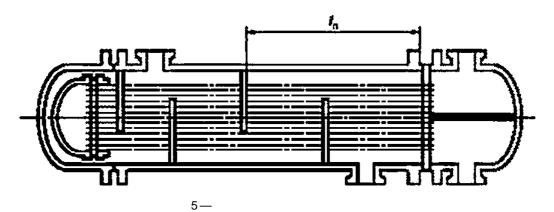


Рисунок 4 — Аппарат с U-образными трубами



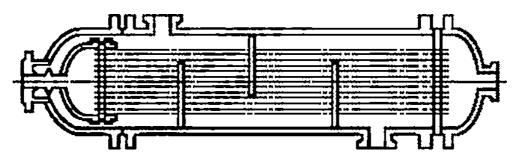


Рисунок 6 — Аппарат с компенсатором на плавающей головке

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5.2.1 5.2.1.1

5.2.1.2 : : :

$$^{*1}$$
  $\frac{td_1^2}{4s_1^2}$ : (2)

• :

$$\eta_{\rm T} = 1 - \frac{i(d_{\rm T} - 2s_{\rm T})^2}{4s_{\rm A}^2} \tag{3}$$

5.2.1.3

" £t(nt-n-) —/----- (4)

$$\rho = \frac{K_{\gamma} a_1 I}{E_{\kappa} s_{\kappa}}.$$
 (5)

<del>-</del> :

$$=1_{+} \quad . \tag{7}$$

0.

\*

•

$$\beta = \frac{1.82}{s_p} \left\{ \sqrt{\frac{K_y s_p}{v_0 E_p}} \right\}. \tag{8}$$

\* (i

$$\beta = 1.53 \sqrt[4]{\frac{K_y}{V_0} \left( \frac{1}{E_{p1} s_{p1}^3} + \frac{1}{E_{p2} s_{p2}^3} \right)}.$$

,. (10)

5.2.2.1

5.2.2

$$(**(-<))-(**(-<))-(**(-*))$$
 +  $(**(-*),*(-*))$  +  $(**(-*),*(-*))$  +  $(**(-*),*(-*))$  . (11)

<del>-</del> :

$$m_{cp} = 0.15 \frac{i(d_r - s_r)^2}{s_r^2}$$
 (12)

26—1SS9 10

5.2.2.2

(13)

5.2.2.3

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)	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5
,	2	2.0	2.06	2.28	2.79	3.58	4.5	5.39
2	0	0.02	0.19	0.62	1.32	2.16	2.94	3.59
	0	0.19	0,76	1.65	2,75	3.76	4.65	5.36

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	4	5	6	7	8	9	10	> 10
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	4.13	5.13	6.15	7.17	8.19	9.2	10.21	(D
	6.03	7.38	8.81	10.24	11.66	13.08	14.5	

5.2.2.4 , 2, 3

(16)

$$t-1+1,4 > (,-1).$$
 (17)

5.22.5

.. fe,) Pifo+PKJ-Pb<sup>7\*</sup>

$$^{n+}\sqrt{(r_{i}+pK_{e})(r_{3+Pi})}$$
-7-J'
(18)

:

$$( + |)- 12$$
 $n''a_i(WK_o)(W.)-rf$ 
(19)

$$v_2 = \sqrt{\frac{1}{2}}$$
. (22)

S.2.2.6 , -

;

$$M_e = M_0 > (a-a_1)Q_{,,:}$$
 (23)

•

5.2.2.7

• :

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/ — , 5.27.4. 5.2.2.8 :

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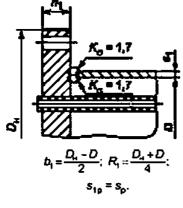
$$Q.=fp,-Q_n:$$
 (27)

• ;

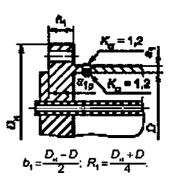
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$$F^*kD < X.$$
 (29)

5.2.3 5.2.3.1 7—10.

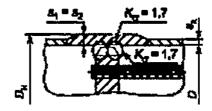






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$$_{t}^{t}D_{n}$$
- $D_{n}^{*}D_{n}^{*}D_{n}^{*}$ .

\*="5—: Ai»v

 $_{2}$ =0; = ,; ,= $s_{p}$ ;  $s_{1p}$ = $s_{p}$ .

5.2.3.2

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$$V \qquad \frac{Q_a}{s_p - c} \tag{33}$$

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 $\mathsf{ML}$ (36)(37)5.2.3.3 (38)(39)= <u>1»</u>\_ (40)(41) 5.2.3.4 (42)<\*1\*6,, + \( \text{rft} \big| \M\_r \big|. (43)W 5.2.4 5.2.4.1 { ₁: T^JsO.eioJp. (45)5.2.4.2 52857.6. 01 <\* 1. (46) $_{2}$  -  $_{3}$  = 0. (47)

**—** . 7**—**10;

•

$$O_2 = 0.$$
 (49)

5.2.4.3

, 5.6.

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$$S_p^o = \left(S_p - C\right) \frac{\sigma_{p2}}{2[\sigma_A]}. \tag{51}$$

5.2.5

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$$=^{1} 0 + 7 \quad |&( ].$$
 (52)

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5.2.6

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5.2.6.1 :

5.2.6.2.

52857.6. , , -

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+ (54)

(55)

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"<del>--</del> . 7—10.

5.2.6.3 5.2.6.1 5.2.6.2 -

. 2^Os,.

S.2.6.4 , F < 0, F 52857.2.

5.2.7 ,

5.2.7.1 :

maxfo^cj^Jslo],. (57)

5.27.2 52857.6.8 ,

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,= ,; (58)

 $_{2}$  -  $_{3}$  = 0; (59)

"= 1. (60)

5.2.7.3 , *N*, < 0. :

^ ],. (61)

, <del>-</del>

, 11. .

· , <del>-</del> (62)

, = 1.3 — :

 $f_{R}$ -1— ;

 $(_{R} = \max\{/,:0.7/,_{s}\}$  ...

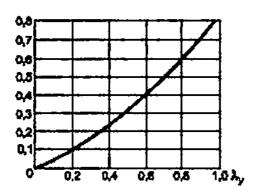


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5.27.4

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, , (63)



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| -  $(W)_{rp}$ 

[ */*),.,

 $_{T=}M^{N}N_{\mathfrak{L}(Pomin\ [olp})$  (66)

 $= \min \{0.5; (0.95 - 0.2 \text{ tg } N)\}. \tag{67}$ 

:

max < " { ,:[ } [ 0, . [Nit, | ai. (68)

SpZs£+ . (69)

 $\downarrow \underline{\mathbf{p}}\underline{\mathbf{f}} \tag{70}$ 

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5.3.2 ( . 13). 13 — 5.3.2.1 52857.4. 52857.4. 52857.4. ( ) 52857.4. haJOsT. 52857.4. 52857.4. 52857.2. (71)  $D_{e}$  ,, 52857.4. (72)

 $F_{n} = P_{6}^{p} - Q_{n}. \tag{73}$ 5.3.2.2 52857.2 ( 6.5).  $52857.2 , \tag{5}$ 

$$[\rho_1] = \frac{2\{s_{1nn} - c\} \varphi[\sigma]_1}{\left[D\beta_n + \{s_{1nn} - c\}\right]} \sqrt{\frac{[M] + [M]_{1p} - M}{[M]_{1p}}},$$
(74)

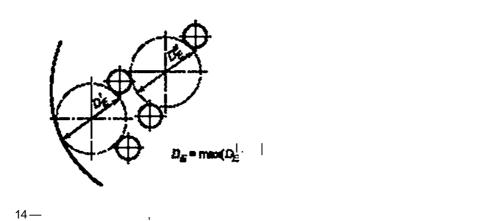
$$[M]_{\kappa\rho} = \frac{\pi D \left(s_{inn} - c\right)^2}{4} [\sigma]_i; \tag{75}$$

37—15»

		" 0.5* <del>'⊎</del> ′	(76)
		<u>)</u> 11 cosv	
	.\ )	52857.2 ( 6.5).	
	5.3.2.3	52857.2 ( 6.5).	
		, $h <_{\it 1} jDs_{\it i}$ .	
	0.	, 52857.2 ( 6.5).	,
		h < ^Dsi. 52857.4,	
(	6.3). 5.3.2.4	( . 13)	
		' ( -£>,)&, —t— + .	(77)
	5.3.2.5	52857.4.	
		f <sub>n&lt;</sub> »max – ; 26 )* .	(78)
	5.3.2.6	5.3.2.2—5.3.2.5	
		. » %, P <sub>e</sub> * <i>P'1.</i>	
	5.4 5.4.1	U- :	
		sȣs\$+c,	(79)
		<sup>s</sup> p= 3.4 [o Jj ,	t®°)
	 5.4.2	, U- ( ),	-
		$s^{\circ} = 0.82$ , max 1: $O_{eB}$ -2a,(I-4» <sub>f</sub> ) + >	(81)

5.5 5.5.1 ( . . 14) \*

$$s_p * 0_t 5D_e$$
  $\sqrt{\frac{\rho_p}{[\sigma]_p}} + c.$  (82)



5.5.2 U-

Sp,
$$^{\text{max}}$$
 [0'71 $^{\text{5}}$  0"-0" wd- [\* - (83)

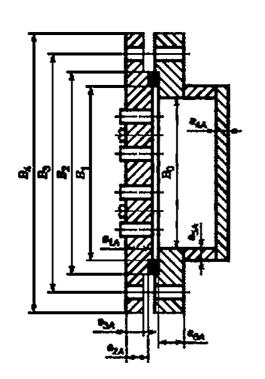
5.5.3

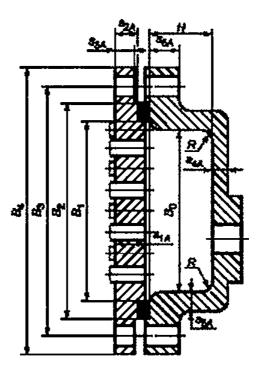
$$s_{,a}(s_{p}-c)\max 1 \qquad \sqrt{\frac{d_{0}\left(\frac{t_{n}}{t_{p}}-1\right)}{B_{n}\left(\frac{t_{n}}{t_{p}}-1\right)}} + c.$$
(84)

Vs0\* (87)

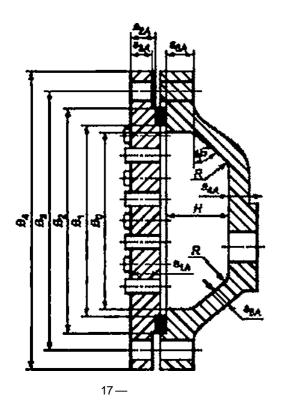
(88)

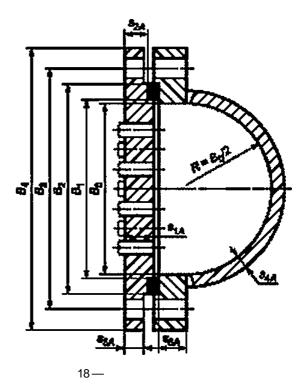
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6.2 6.2.1. 15—18. 6.2.2 6.2.2.1 · ( ) : 6.2 2.2  $F_a = p[L_v P_p + 2b_0 m\{L_9 + B_p)].$ (89)( ) .2.2.3  $F_0=max[-^F_e; [1 + 2_0(_+ )]].$ (90)L<sub>e</sub> 8 .2.2.4 © m— 52857.4. 2.

(91)

(92)

(<: [o)g — ( ) 52857.4.

6.2.3 6.2.3.1

> (93)

> > -p(^+£^)sf (94)

% = (>. +2). (95)

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£2 =  $\frac{-}{\text{lq F+}}$  \* (96)

><Prto)r:

 $\underline{p}^{2}\underline{*(pn-4\wedge rtolr)\{tolr-p(2-n)\}}$ (97)[<?} +>)

 $f_0$ ,

(98)

/|,6, .i) to)<sub>r</sub> < — 5.2.7.3. £2 > 1 £2 £1.

6.2.3.2

6.2.3.3

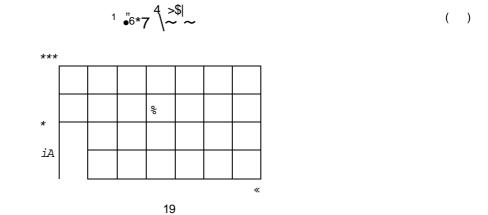
 $s_{2A}$  20,71 ini j4/i+16(<sub>0</sub>^+; (99)

S<sub>3A</sub> 20,71 (100)

F..-&\_\_\_\_ fi-(101)

 $F_t$ 

[ ), [ -+ ", (Ap + Vp)]. (102)  $Z_F$  , 19



v .2 . 6.2.4 6.2.4.1 ( . 15—17)

S\_\*0'71B\* [+15^ «. (104)

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$$V.> (\%) iio+flb"^4Ub$$
 (106)

, /, /<sub>2</sub>. :

$$f,= 1+$$
(107)

6.2.4.2 ( . 18)

$$\chi_{c} = \frac{0.8}{L_{\text{pac}}} \left[ 1.5 \left( B_{3} - B_{0} \right) - S_{6A} \right] \left( \frac{S_{6A}}{S_{5A}} \right)^{2}.$$
 (111)

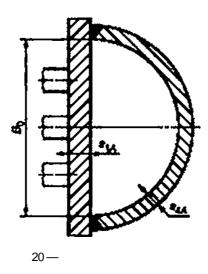
6.2.4.3

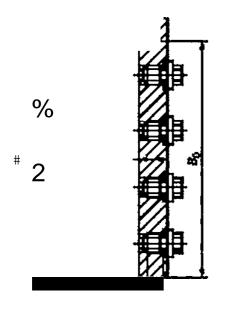
$$s_{5A} \ge 0.71 \sqrt{\frac{F_1}{\{\sigma\}_1}} \sqrt{\frac{4l_1}{\varphi + \chi_c}} + c, \tag{112}$$

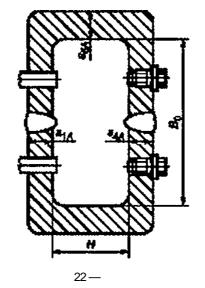
(113)

$$s_{7A} \ge \max \left\{ s_{5A} \quad 0.258_0 \quad \sqrt{\frac{\rho}{|\alpha|_*}} + c \right\}. \tag{114}$$

6.3 6.3.1 20—24.

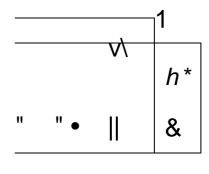


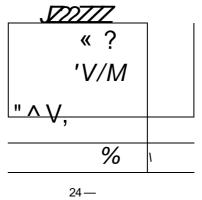




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6.3.1.1 :

\*« .^|'\*5 5 [1 £)  $J+c+\wedge$  (115)

2»—1559

 $f_{\mathfrak{F}}$  ,

$$6^* \qquad 2 + \left(\frac{2}{\frac{\mathbf{B}_{p}}{\mathbf{L}_{0}}}\right) + \left(\frac{\mathbf{B}_{p}}{\mathbf{L}_{0}}\right)^2 \tag{116}$$

( . 23.24)  $f_3 = 1$ .

\$1 -& - (117)

.3.1.2 , 21 23, -

$$s_{5A} \ge 0.5B_{\rho} \sqrt{\frac{p}{[\sigma]}} \max \left\{ \sqrt{\frac{1}{\phi} \cdot \left\{ f_{3} + \frac{p}{[\sigma]} \left[ \frac{1}{\phi} + 1.5 \left( \frac{2}{\phi} \frac{H^{2}}{B_{\rho}^{2}} - \frac{1}{\phi_{E}} \right) \right] \right\}} + c,$$

$$2\frac{H^{2}}{B_{\rho}^{2}} - f_{3} \left| + \frac{p}{[\sigma]} \left( 1 + \frac{1.5}{\phi_{E}} \right) \right|$$
(118)

, 22 24.— :

$$= s,a-$$
 (119)

6.3.1.3 ( . 23.24) -

$$s_R$$
, \*- + " (120)

6.3.1.4

$$s^{10.71W} = \sqrt{\frac{p}{\sigma}} \sqrt{f_4 + 1.5} + .$$
 (121)

 $f_4$ .

$$\begin{array}{c}
\star & \frac{1}{\left(\frac{H}{B_0}\right) + \left(\frac{H}{B_0}\right)^2}.
\end{array}$$
(122)

6.3.2 ( . 19).  $s_{14}$  (93)  $s_{19} = 0$ .

6.3.2.1  $s_{14}$  (93) ,, = 0. 6.3.2.2  $s_{14}$  52857.2, -

,

 $s_{7A}$  (114).

$$min\{[Q]_T; fol,\}^*p(1-Ti).$$
 (I<sup>23</sup>)

!) .2 .

( .7)

( ) .1 ( ) ( ) .2 /. ( .1)  $x(o^{\wedge}_{M}-d,^{2}_{CM})e,Ss_{l}$ ( .2) ٨ ( . ) ( .4) 4 PtOH - r, ( .5) 25. X ( .6)

Y --- ( Pipm )

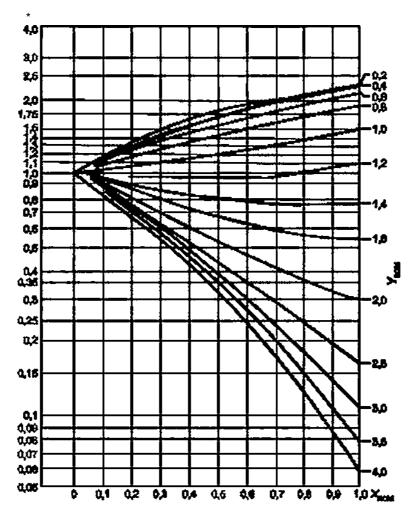


Рисунок 25 — Параметр жесткости компенсатора С,

. <sub>0</sub> = 90\*

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<del>-</del> .1

.1—

1	0.51	0.52	0.53	0.54	0.55	0.56	0,57	0.58
	23.4	26.0	29.0	32.3	35.9	40.1	44.8	50.0
	0.59	0.60	0.61	0.62	0.63	0.64	0.65	0.66
	56.0	62.7	70.3	78.9	88.8	100	113	128
1	0.67	0.68	0.69	0.70	0.71	0.72	0.73	0.74
	145	164	187	214	245	281	324	375
h	0.75	0.76	0.77	0.78	0.79	0.60	0.81	0.62
	436	509	597	704	834	996	1197	1451
1	0.83	0.84	0.85	0.86	0.87	0.88	0.89	0.9
	1770	2190	2740	3460	4450	5820	7770	10600

.4 15\*£ £60\*

$$Q = \frac{a\left(A_{p1} + A_{p2}\sqrt{\frac{D_1}{S_k}}\right) - 0.5(1 - \beta_p)L_p}{(.12)}$$

\_

1· 2· 2 0( . 3) . 2—

**»** 0.204 15\* 8.695 -1.452 0.488 30\* 5.600 0.899 -7.650 2.144 0.35 45\* 5.939 2.436 -20.866 5.813 -60.596 60\* 9.698 6.145 14.664 15\* 8.462 0.205 -1.525 0.457 30\* 5.449 0.903 -7.278 2.010 U.4D 45\* 5.779 2.449 -19.675 5.450 -56.996 60\* 9.438 6.177 13.748 15\* 8.235 0.207 -1.586 0.429 1.887 30\* 5.303 0.908 -6.932 0.37 45\* 5.624 2.461 -18.575 5.116 60\* 9.185 6.209 -53.677 12.906 15\* 8.014 0.208 -1.636 0.403 30\* 5.160 0.913 -6.608 1.774 0.38 2.474 -17.557 45\* 5.473 4.808 60\* 8.938 6.241 -50.609 12.129 15\* 7,799 0.209 -1.677 0.380 30\* 5.022 0.917 -6.306 1.669 0.39 45\* 5.327 2.486 -16.612 4.524 60\* 8.698 6.272 -47.768 11.412

	.2				
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	15*	7.589	0.210	-1.709	0.357
0.40	30*	4.887	0.922	-6.022	1.572
	45*	5.183	2.498	-15.733	4.260
	60*	8.464	6.303	-45.130	10.747
	15*	7.384	0.211	-1.733	0.337
0.41	30*	4.755	0.926	-5.755	1.481
	45*	5.044	2.510	-14.914	4.016
	60*	8.236	6.333	-42.678	10.131
	15*	7.185	0.212	-1.751	0.318
0.42	30*	4,627	0.930	-5.504	1.398
	45*	4.907	2.522	-14.149	3.789
	60*	8.014	6.363	-40.393	9.558
	15*	6.990	0.213	-1.762	0.300
0.43	30*	4.501	0.935	-5.267	1.320
	45*	4.774	2.534	-13.434	3.577
	60*	7.796	6.393	-38.260	9.024
	15*	6.800	0.214	-1.768	0.284
0.44	30*	4.379	0.939	-5.043	1.247
	45*	4.644	2.546	-12.764	3.380
	60*	7.584	6.422	-36.266	8.527
0.45	15*	6.613	0.215	-1.770	0.268
	30*	4.259	0.943	-4.831	1.179
	45*	4.517	2.557	-12.135	3.196
	60*	7.376	6.451	-1.768 -5.043 -12.764 -36.266 -1.770 -4.831 -12.135 -34.399 -1.767 -4.631 -11.544 -32.647 -1.760 -4.440 -10.987	8.062
	15'	6.431	0.216	-1.767	0.254
0.46	30*	4.141	0.947	-4.631	1.115
0.10	45*	4.393	2.568	-11.544	3.023
	60*	7.173	6.479	-32.647	7.627
	15*	6.253	0.216	-1.760	0.240
0.47	30*	4.027	0.952	-4.440	1.056
0.47	45*	4.271	2.580	-10.987	2.862
	60*	6.975	6.508	-31.001	7.220
_	15*	6.079	0.217	-1.750	0.227
0.46	30*	3.914	0.956	-4.258	1.000
0.40	45*	4.152	2.591	-10.463	2.711
	60*	6.780	6.536	-29.453	6.838
_	15*	5.908	0.218	-1.737	0.216
0.49	30*	3.805	0.960	-4.085	0.947
0.49	45*	4.035	2.602	-9.967	2.568
	60*	6.590	6.563	-27.995	6.479
ļ	15*	5.741	0.219	-1.721	0.204
0.50	30*	3.697	0.964	-3.920	0.898
	45*	3.921	2.613	-9.499	2.434
	60*	6.403	6.591	-20.619	6.141
Ĺ	15*	5.577	0.220	-1.702	0.194
0.51	30*	3.591	0.968	-3.763	0.852
0.01			2.623	-9.055	2.306

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		V		,	
	15*	5.416	0.221	-1.682	0.184
	30*	3.488	0.972	-3.612	0.808
0.52	45*	3.699	2.634	-8.635	2.190
	60*	6.041	6.645	-24.091	5.524
	15*	5.258	0.222	-1.659	0.174
0.52 0.53 0.54 0.55 0.56 0.57 0.56	30'	3.386	0.976	-3.468	0.766
	45*	3.591	2.645	-8.236	2.077
	60*	5.865	6.672	-22.927	5.241
	15*	5.103	0.223	-1.634	0.165
0.54	30*	3.286	0.979	-3.330	0.727
0.54	45*	3.486	2.655	-7.856	1,971
	60*	5.692	6.698	-21.824	4.973
	15*	4.951	0.224	-1.608	0.157
0.55	30*	3.188	0.983	-3.197	0.690
0.55	45'	3.382	2.665	-7.496	1.871
	60*	5.523	6.724	-20.778	4,720
	15*	4.802	0.225	-1.581	0.149
0.56	30*	3.092	0.987	-3.070	0.655
0.56	45*	3.290	2.676	-7.152	1.776
	60'	5.356	6.750	-19.784	4.481
	15*	4.656	0.225	-1.552	0.141
0.57	30*	2.998	0.991	-2.947	0.622
0.57	45*	3.180	2.686	-6.825	1.686
	60*	5.193	6,776	-18.839	4.254
	15*	4.512	0.226	-1.522	0.134
0.56	30*	2.905	0.995	-2.829	0.591
	45'	3.081	2.696	-6.512	1.601
	60'	5.032	6.801	-17.939	4.038
	15*	4.370	0.227	-1.491	0.128
0.59	30'	2.814	0.998	-2.716	0.561
	45*	2.985	2.706	-6.214	1.520
0.56	60'	4.874	6.826	-17.082	3.834
	15*	4.231	0.228	-1.459	0.121
0.60	30'	2.724	1.002	-2.606	0.532
0.00	45*	2.890	2.716	-5.929	1.443
	60*	4.719	6.851	-16.264	3.639
	15*	4.094	0.229	-1,426	0.115
	30*	2.636	1.006	-2.500	0.505
0.61	45*	2.796	2.726	-5.656	1.369
	60'	4.566	6,676	-15.484	3.454
	15*	3.959	0.230	-1.393	0.109
	30*	2.550	1.009	-2.398	0.479
0.62	45'	2.704	2.736	-5.394	1.300
	60*	4.416	6.901	-14.739	3.278
	15*	3.827	0.230	-1.359	0.103
0.63	30*	2.464	1.013	-2.299	0.455
	45'	2.614	2.745	-5.144	1.233
-	60*	4.268	6.925	-14.026	3.111

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	15*	3.696	0.231	-1.324	0.098
0.64	30*	2.380	1.016	-2.204	0.431
	45*	2.525	2.755	-4.903	1.170
	60*	4.123	6.950	-13.344	2.951
	15*	3.568	0.232	-1.289	(
0.65	30*	2.298	1.020	-2.111	0.409
0.00	45*	2.437	2.764	-4.672	1.109
	60*	3.979	6.974	-12.691	2.798
	15*	3.441	0.233	-1.253	0.088
0.66	30*	2.216	1.023	-2.021	0.388
	45*	2.351	2.774	-4.451	1.051
	60'	3.838	6.997	-12.065	652
	15*	3.317	0.234	-1.217	0.084
0.67	30*	2.136	1.027	-1.935	0.367
0.67	45"	2.265	2, '	-4.23/	
	60*	3.699	7.021	-11.465	2.513
	15*	3.194	0.234	-1.181	0.079
0.68	30*	2.057	1.030	-1.850	0.348
	45*	2.182	2.792	-4.032	0.943
	60*	3.563	7.045	-10.889	2.380
0.69	15*	3.073	0.235	-1.144	0.075
	30*	1.979	1.034	-1.768	0.329
	45*	2.099	2.802	-3.834	0.893
	60*	3.428	7.068	-10,336	2.253
	15*	2.954	0.236	-1.107	0.071
	30*	1.902	1.037	-1.689	0.312
0.70	45'	2.018	2.811	-3.644	0.845
	60*	3.295	7.091	-9,804	2.131
	15*	2.837	0.237	-1.070	0.067
0.71	30*	1.827	1.040	-1.611	0,294
0.71	45*	1.937	2.820	-3.460	0.798
	60*	3.164	7.114	-9.293	2.014
	15'	2.721	0.237	-1.033	(
0.70	30'	1.752	1.044	-1.536	51278
0.72	45*	1.858	2.829	-3.283	0.754
		3.035	7.137	-8.801	1.902
	15*	2.606	0,238	-0.995	0.060
0.70	30*	1.678	1.047	-1.463	0.262
0.73	45'	1.780	2.838	-3.112	0.711
	ਰ	2.907	7.160	-8.327	1.794
	15*	2.494	0.239	-0.958	0.056
0.74	30*	1.606	1.050	-1.391	0.247
0.74	45*	1.703	2.847	-2.946	0.670
ļ	60*	2.782	7.182	-7.870	1.691
	15*	2.383	0.240	-0.920	0.053
0.75	30*	334	1.054	-1.322	0.233
0.70	45*	1.627	2.856	-2.786	0.631
ļ	60"	2.658	7,204	-7.430	1.592

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	15*	2.273	0.240	-0,882	0.050
0.76	30	1.464	1.057	-1.254	0.219
5 5	45	1.552	2.865	-2.632	0.593
	60	2.535	7.227	-7.005	1.497
	15	2.165	0.241	-0.845	0.047
0.77	30*	1.394	1.060	-1.188	0.206
0.77	45"	1.479	2.873	-2.482	0.557
	60"	2.414	7.249	-6.595	1.406
	15"	2.058	0.242	-0.807	0.044
0.78	30"	1,325	1.063	-1.123	0.193
	45"	1.406	2.882	-2,337	0.522
	60*	2.295	7.271	-6.199	1.318
	15"	1.952	0.243	-0.769	0.041
	30"	1.257	1.066	-1.060	0.180
0.79	45"	1.333	2.891	-2.197	0.489
	60"	2.178	7.292	-5.817	1.233
	15*	1.848	0.243	-0.732	0.038
0.80	30"	1.190	1.070	-0.998	0.168
	45"	1.262	2.899	-2.060	0.456
	60*	2.061	7.314	-5.447	1.151
	15"	1.745	0.244	-0.694	0.036
U.ol <sup>4</sup>	30"	1.124	1.073	-0.938	0.157
U.OI	45*	1.192	2.908	-1.928	0.425
	60*	1.947	7.336	-5.090	1.073
	15"	1.644	0.245	-0.656	0.033
0.82	30"	1.058	1.076	-0.879	0.146
0.02	45*	1.123	2.916	-1.800	0.395
	60*	1.833	7.357	-4.743	0.997
	15"	1.543	0.245	-0.619	0.031
0.83	30*	0.994	1.079	-0.822	0.135
	45"	1.054	2.925	-1.676	0.366
	60*	1.721	7.378	-4.408	0.924
_	15"	1.444	0.246	-0.581	0.028
0.84	30"	0.930	1.082	-0,766	0.125
	45"	0.986	2.933	-1.555	0.339
	60"	1.611	7.399	-4.084	0.854
	15*	1.346	0.247	-0.544	0.026
0.85	30*	0.867	1.085	-0.710	0.115
0.65	45*	0.919	2.941	-1.437	0.312
	60*	1.501	7.420	-3.769	0.786

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$$\varphi_{\mathbf{p}} = 1 - \frac{d_{\mathbf{p}}}{l_{\mathbf{p}}}. \tag{1}$$

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$$\varphi_{\mathcal{E}} = 1 - \frac{d_{\mathcal{E}}}{I_{\mathcal{D}}} \tag{2}$$

 $\begin{aligned} d_E &= d_0\text{-}2\text{s}, \qquad & ; \\ d_e &\Rightarrow d_0\text{-}\text{s}_T\text{---} & , & ; \\ d_{\underline{e}} &= d_0\text{---} & ; & ; \\ d_g &= d\text{---} & ; & ; \end{aligned}$ 

 $\cdot$   $\rightarrow_0$  , .1.

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,	0.4	0.45	0.5	0.55	0.6	0,65	0.7	0.75	0.8	0.85
V <sub>0</sub>	0.12	0.15	0.2	0.25	0.3	0.37	0.44	0.51	0.59	0.68

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1.3 V<sup>SS</sup>t (B.t)

 $P2 = J_{as2}$  (-2)

 $\kappa_{\sim} S.5R_t$  ( . )

K\_5isrq~- ( .4)

( -5)

( .6)

 $= _{1+ 2}.$  ( .7)

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">	0	0.S	1.0	1.5	2.0	2.5		3.5	4.0	5.0	6.0	7.0	8.0	9.0	10,0
	Ŭ	0.0	1.0	1.0	2.0	2.0	•	0.0	1.0	0.0	0.0	7.0	0.0	0.0	10,0
1.0	2.00	2.00	2.06	2.28	2.79	3.58	4.50	5.39	6.19	7.65	9.08	10.5	11.9	13.4	14.8
1.1	2.20	2.35	2.59	3.07	4.02	5.51	7.39	9.44	11.6	16.2	21.6	28.1	35.6	44.3	54.3
1.2	2.40	2.73	3.21	4.04	5.61	8.14	11.5	15.5	19.8	30.2	43.4	60.0	80.4	105	134
1.3	2.60	3.14	3.92	5.22	7.64	11.6	17.1	23.9	31.6	50.8	76,3	109	151	202	263
1.4	2.80	3.59	4.74	6.65	10.2	16.0	24.4	35.0	47.5	79.2	122	179	251	341	450
1.5	3.00	4.07	5.67	8.35	13.3	21.6	33.7	49.3	68.0	116	183	273	387	529	703
		l	l				l	l	l						
1.0	0.00	0.02	0.19	0.62	1.32	2.16	2.94	3.59	4.13	5.13	6.13	7.17	8.19	9.20	10.2
1.1	0.00	0.02	0.22	0.75	1.69	2.92	4.18	5.36	6.46	8.75	11.3	14.2	17.4	20.9	24.6
1.2	0.00	0.02	0.24	0.88	2.06	3.68	5.43	7.13	8.79	12.4	16.6	21.3	26.7	32.5	39.0
1.3	0.00	0.02	0.27	1.01	2.44	4.44	6.67	8.90	11,1	16.0	21.8	28.4	35.9	44.2	53.4
1.4	0.00	0.03	0.30	1.14	2.81	5.21	7.91	10.7	13.4	19.6	27.0	35.5	45.1	55.9	67.8
1.5	0.00	0.03	0,32	1,28	3.18	5.97	9.16	12.4	15.8	23.2	32.2	42.5	54.4	67.6	82.2
1.0	0.00	0.19	0.76	1.65	2.75	3.76	4.65	5.36	6.03	7.38	8.81	10.2	11.7	13.1	14.5
1.1	0.00	0.21	0.64	1.81	3.02	4.14	5.11	5.90	6.63	8.12	9.69	11.3	12.8	14.4	15.9
1.2	0.00	0.23	0.91	1.98	3.30	4.51	5.58	6.43	7.24	8.86	10.6	12.3	14.0	15.7	17.4
1.3	0.00	0.25	0.99	2.14	3.57	4.89	6.04	6.97	7.84	9.59	11.4	13.3	15.2	17.0	18.8
1.4	0.00	0.27	1.06	2.31	3.85	5.26	6.51	7.50	8.44	10.3	12.3	14.3	16.3	18.3	20.3
1.5	0.00	0.28	1.14	2.47	4.12	5.64	6.97	8.04	9.04	11,1	13.2	15.4	17.5	19.6	21.7

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">	0.S	1.0	1.5	2.0		4.0	5.0	2 10
-1.0	0.726	0.754	0.783	0.813	0.858	0. 78	0.885	0.898
-0.9	0.656	0.683	0.712	0.740	0.781	0,797	0.802	0.811
-0.8	0.586	0.613	0.641	0.668	0.705	0.716	0.720	0.724
-0.7	0.516	0.543	0.570	0.596	0.628	0.636	0.637	0.637
-0.6	0.446	0.473	0.500	0.524	0.551	0.555	0.554	0.550
-0.5	0.376	0.403	0.429	0.451	0.474	0.474	0.471	0.463
-0.4	0.306	0.333	0.358	0.379	0.397	0.393	0.388	0.376
-0.3	0.236	0.262	0.287	0.307	0.320	0.313	0.305	0.289
-0.2	0,166	0.192	0.274	0.355	0.305	0.273	0.289	0.308
-0.1	0.096	0.216	0.338	0.408	0.337	0.319	0.338	0.359
0	0.144	0.284	0.402	0.461	0.376	0.370	0.392	0.414
0.1	0.214	0.353	0.466	0.514	0.420	0.426	0.450	0.474
0.2	0.284	0,422	0.530	0.567	0.470	0.485	0.511	0.537
0.3	0,354	0.491	0.593	0.620	0.523	0.546	0.575	0.603
0.4	0.424	0.559	0.657	0.672	0.580	0.610	0.641	0.671
0.5	0.494	0.628	0.721	0.725	0.639	0.677	0.709	0.742
0.6	0.564	0.697	0.785	0.778	0.701	0.745	0.779	0.814
0.7	0.634	0.766	0.849	0.831	0,765	0.814	0.851	0.888
0.8	0.704	0.834	0.913	0.884	0.830	0. 85	0.923	0.963
0.9	0.773	0.903	0.977	0.937	0.896	0.956	0.997	1.040
1.0	0.843	0.972	1.041	0.991	0.964	1.030	1.071	1.117

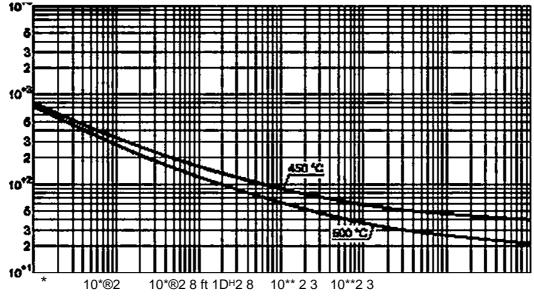
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	0.S	1.0	1.5	2.0		4.0	5.0	i 10				
1.0	0.843	0.972	1.041	0.991	0.964	1.029	1.071	1.117				
0.9	0.829	0.943	1.000	0.949	0.940	1.000	1.040	1,083				
0.8	0.815	( 4	0.960	0.908	0.910	0.971	1.009	1.051				
0.7	0.800	0.886	0.920	0.871	0.884	0.944	0.979	1.020				
0.6	0.786	0.858	0.880	0.836	0.860	0.918	0.951	0.990				
0.5	0.771	0.829	0.840	0.804	0.839	0.894	0.925	0.963				
0.4	0.757	0.801	0.799	0,777	0.819	0.871	0.900	0.938				
0.3	0.742	0.773	0.761	0.754	0.802	0.852	0.878	0.915				
0.2	0.728	0.744	0.732	0.737	0.789	0.835	0.860	0.896				
0.1	0.714	0.716	< 4	0.727	0.780	0.823	0.846	0.882				
0	0.700	0.702	0.709	0.725	0.776	0.816	0.837	0.874				
-0.1	0.703	0.707	0.716	0.732	0,778	0.815	0.835	0.873				
-0.2	0.705	0.712	0.723	0.741	0.787	0.821	0.841	0.876				
-0.3	0.708	0.717	0.730	0.750	0.796	0.828	0.846	0.879				
-0.4	0.711	0.722	0.738	0.759	0.805	0.835	0.852	0.882				
-0.5	0.713	0.728	0.745	0.768	0.814	0.842	0.857	0.884				
-0.6	0.716	0.733	0.753	0.777	0.823	0.850	0.863	0.887				
-0.7	0.718	0.738	0.760	0.786	0.832	0.857	0.869	0.890				
-0.8	0.721	0.743	0.768	0.795	0.841	0.864	0.874	0.893				
-0.9	0.723	0.748	0.775	0.804	0.849	0.871	0,880	0.895				
-1.0	0.726	0.754	0.783	0.813	0.858	0.878	0.885	0.898				

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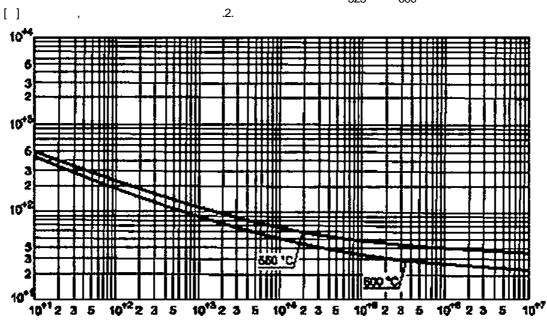
500 \* 420 ' | ]

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.1 — 2 - 10s

> 600 \* 525 \*



.2— 2 -10\*

360 \* . — 600 \* , — 500 \* [ ]=0.65[ ]. ( -1) [] — 52857.2

( )

 $[ \text{``J}_{tp} = 05i_t s_r (tf_l - s_r) minj A.: 1.6 jmln \{ [rt],; |o^* \}:$ ( .1)

 $IN],p = 0.e*s^<-Si)min\{[e]_i:[_OJ_p\}.$ ( .2)

( . ) -sjmin {[e],; (  $\mid$  }.

52857.7—2007

( )

.1

.1.1 ( . 15—18):

( .1)

( . 20—22):

( .2)

( . 23-24):

8 max {6,}. < .)

.1.2

( . 15—18):

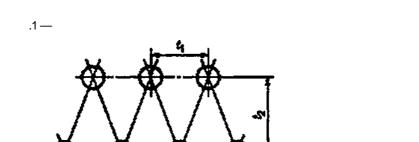
( .4) ,= - <sub>0</sub>: ( . 20—24):

( .5)

.1.

( .6)  $_{7}$  = min { $zt_{2}$ : Sj}.

 $t_2$ — . .1 .2.



.2—

41

. 1.4

\*\*=~ -

2 :

=-1\*2

 $\begin{array}{c}
R \\
=1 - 7 \\
Mr \bullet
\end{array}$ 

f,— . .1 2. .3 .3.1

:

 $[q] = \upsilon \left( 1 - \frac{d_{\tau} - s_{\tau}}{2s_{\tau}} \frac{\rho}{[\sigma]_{\tau}} \right) [\sigma]_{\tau}. \tag{10}$ 

.3.2

- :

 $[t_{0}] = \text{Mtp}_{1}$  ( .11)

- :

 ${}^*{}_e min\{l0]_t; [oJ_p\}sd?S$   $iQl-lQla \qquad ( \ \ \, .12)$ 

- :

 ${OI, =max{[[g]_{S2} +0.6[q]_{11}; [g]_s, J.}}$  ( . 13)

< -- , 5.2.7.5. .4 ( . 15—18) ;

0.5 ( <sub>}</sub> - flp). ( .14)

 $0.5(S_j - B_2)$ . ( .15)

30—15» 42

52857.7—2007

( )

.1 :

 $y > \frac{103}{664}$   $y > \frac{103}{100}$   $y > \frac{103}{100}$   $y > \frac{103}{100}$   $y > \frac{103}{100}$ 

• :

 $= 10.9 - ... - 5 - ... + (5 - 6) | \frac{\text{Six}}{\text{ssa}} )] i,.$  (-2)

< .=1+0.85-^-1255^-13.70-£ R\*
Bg », 8\*

( . )

»4-1-1 \_ ( .6)

<sub>5</sub>=<sup>2</sup>^ ( .7)

<sub>6</sub> = 2 ( -8)

( .3). ( .4), ( .6). ( .7) 15 X, — , 8 / , , , , .1. — , Lq fSj> , , , .2,

\* =4.4^-

— , (106).

\_ .

/S-0.23 ?  $+1^{-7}(v_p , +4 _2$  ( .10)

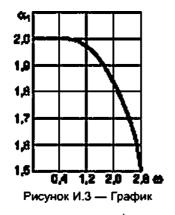
43

$$= 27 \sum_{2^{n}(1, +^{n})}^{+} * \bullet (£) * *$$
 ( .11)

0,04 3,0



.5



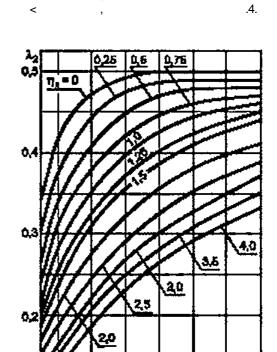
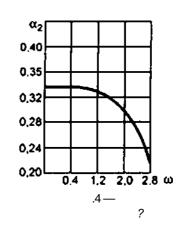


Рисунок И.2 — График коэффициента  $\lambda_2$ 



( .5). (95) (103). 52857.4. )

( -12,

30\*

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52857.7-2007
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( )  $v_0 = nV^3$ : =y\*-|ber2to+bei2to+^-{bere}beice-bei'tobera>)|; = < ' + betca be7a>); <sub>3</sub> = ^-|ber ^ < 0 + bei '2 (uj;  $A=-^i\{/,\{u>\}bei^x-1_2(wjber^x+m_A(ber'wber^7x+be/oibei^xjj;$  $6 = - \stackrel{\wedge}{-} [ /_{\!\! (} \ ) \quad /\!\!/ \ - \ _{\!\! 2} ( \ ) \quad \ \ \, | \ \ + \quad \ \ \, | \ \ + \quad \ \ \, > \quad \ \ ; \ \}.$  $-i_2$ («) bet¹'®-fj(to)ber'ox Vta)=^'ber'ta+beia);  $/_2$ (<0)=5Zbei'{fl-ber(a x [O.co] to 23 [0.(-3)] >> 3.x ber". be?", ber. bet. -JU \* 1 - cos^7 <sup>COS</sup> ijK \*p-= 13.8 1-K1-Pp}+S(1-Pp 20' (L > 0.9; Mp)n sinftjcos<sup>2</sup>^ % (cosM\*

1 |  $(0.3\cos^* p_0 + 1.5 \sin^2 p_0 - 0.5 \cos^2 p_0 + \sin^x p_0 + 1.5 \sin^2 p_0 + 1.5 \cos^2 p_0 +$ 

45

-1,06

®P1= sin Po cos 80 lnC+

 $Y_4 = -j(cho > s*nco-sh{flCOSCo}).$ 

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: , , , -