

52857.2– 2007

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    : 13445-3:2002 «
pressure vessel — Part 3: Design»)
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Vessels and apparatus. Norms and methods of strength calculation. Calculation of cylindric and oonic. sheds convex and flat bottoms and covers

--2008---04---01 1 52857.1. 2 52857.1-2007 52857.3-2007 52857.6—2007 52857.8-2007 ') 52857.6

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S_{t} — S_{y} — S_{p} — S_{tp} — S_{2p} — S_{zp} — S
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4.4 5 5.1 5.1.1 1—4. 1— 2— 3— 5.2 5.2.1 < 0.1 D 200 : 5.3.2:5.3.4—5.3.7 5.4.2. 5.2.2 ,

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52857.2—2007
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5.2.3
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5.2.4
        5.3.4.5.4.3.
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            (15) (17).
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                                             S2S_p + .
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S.3.1.2
                                               2(o)<V>(»-c)
                                                                                                      (3)
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5.3.1.3
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5.3.2.1
                                                               (4)
                                                                      (5)
               (7)
                                              s 2 s,, .
                                                                                                      (4)
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 $Sp = \max \ 106^{\frac{10^2}{60^{15}}} \left(\frac{12}{12} \right)^{\frac{12}{2}}$ $= \max \qquad (5)$ $= \max \qquad (6)$ $= \max \qquad (6)$

5.3.2.2

$$[\rho] = \frac{[\rho]_0}{\sqrt{1 + \left(\begin{bmatrix} \rho \end{bmatrix}_0 \right)^2}} \tag{7}$$

$$(Pin \quad \frac{2[ol(s-c>}{D+(s-c)'} \quad (\)$$

$$W * n_y S, I [o ----- J^1]$$
 (9)

/ L (

/₃ = — ;

- () , -

:

 $/3 = \max|\text{rsina};$ — () . -

5.3.3

5.3.3.1

$$s^*s_p + c, (11)$$

5.3.3.2

$$tF] = n(D + s - c)(s - 1)(.$$
 (13)

5.3.4 , 5.3.4.1

$$[F] = \frac{[F]_0}{\sqrt{1 \cdot \left(\frac{|F|_0}{|F|_0}\right)^2}},$$
(14)

$$[FI_n = (£> + s - c)(s -)(],$$
 (15)

1—

$$[£ = 1£ ± ^{ \Lambda } (-)^{2}.$$
 (18)

Расчетная схема 2/ 0.7/ 0.5/ 0 2,00/ 0,2 1.73/ 0,4 1,47/ 1,23/ 0,6 0,8 1.06/ 1,0 1,00/ 0 2,00/ 0,2 1,70/ 0,4 1,40/ 0,6 1,11/ 8,0 0,85/ 0.70/ 1,0

5.3.4.2 (= 2.4)

5.3.5.1

*
$$\frac{1*0.}{1+}$$
 2' (21)

[],
$$-*D(D+s-c)(s-)(]-fIFI$$
,. (22)

(23)

$$(| * &D(D+s-c)(s-)[<] < _3.$$
 (24)

5.3.6 , 7.

$$[Q] = \frac{[Q]_{h}}{\sqrt{1 + \left(\frac{[Q]_{h}}{[Q]_{E}} \right)^{2}}}$$
(25)

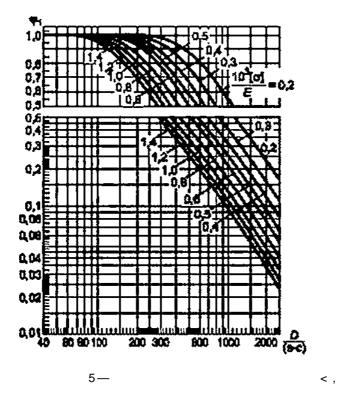
$$[Q]_{,,} = 0.25 () 0 (s -).$$
 (26)

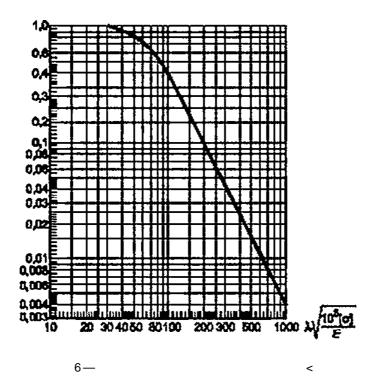
(0)
$$\frac{2.4 \, \text{E(s-)}^2}{1}$$
 0.18+3. $3 \frac{D(s-c)}{l^2}$ (27)

5.3.7 , *

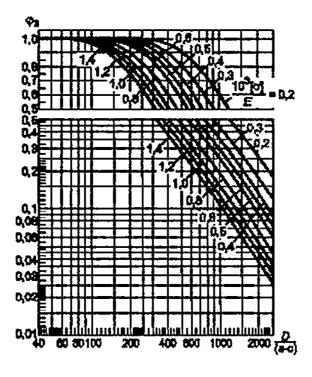
, ,

(]— (7); [F]— (14); []— (21); (Q)— (25).





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7— < 3

5.4 , 5.4.1 , S.4.1.10

s ,

$$\frac{p(D + s^{-})}{42 [)(\$^{-})} - 1 \tag{29}$$

(30)

. > 2¹ - 1 , - 4 %

:

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5.4.1.2

 $[] = min \{[];: lpb\}.$ (32)

 $2| < J^{(s-)} + (s-)$ (33)

,

Ini $2(g)p_{c}(-)2+X^{*}$ 1 D+(s_c> 7^5'

5.4.2 5.4.2.1

1 * min{/,:/ + 1.1 </£>(s-c)}. (35)

<u>-</u>

,

-)?*

5.4.2.2

 $[] = min \{[],; () \}.$ (38)

5.4.2.2.1

(Pli $\sqrt{1 + \left(\left[\frac{\rho_{\ln}}{\rho_{\ln}} \right]^2} \right)$ (39)

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(33)
$$\begin{bmatrix} 1 \\ -1.0 \\ 1_{£} \end{bmatrix}$$

$$e_2 = min\{_W 9.450_{i} / JL_{j}.$$
 (41)

{ ^.

/= max | ;/ --£j. () () (. 5.3.2.2). [] . (8), ()2 (34) $< , ^{\pounds} 1, 0.$

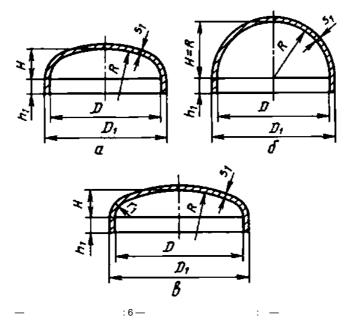
5.4.3

(13). (14), (21), (25) *f-b*.

L. 5.4.4 , 5.3.7. 5.4.2.2.

6

6.1 6.1.1 ,



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12—17
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    6.2.1
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                                          0,26g£0,5;
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               ,20,095 ,;
R-O.90,. ,&0.170D,;
                R*0.8O,., .1500,.
                                                                                         (s,-c)/RS0.1
0.85DZRZD.
                               ( .
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    6.2.2
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                                                   380 ® ,
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    6.3
    6.3.1
    6.3.1.1
                                         ,S .
                                                                                                  (42)
                                                                                                 (43)
    6.3.1.2
                                                                                                 (44)
   6.3.1.3
                                                                                                 (45)
```

. 0.5 D.

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(

R-D — R 0.5 — 6.3.1.4 /1,>0.8^D(s, -)
ft, > 0.3 -) ,

5.3.1 < = 1.

6.3.1.5. , < = 1.

6.3.2 , 6.3.2.1 , (46). (47)

$$s, *s,_p + c_t$$
 (46)

\$,
$$* \max \frac{K_3 R}{161} \sqrt{\frac{n_y p}{10^{-5} E}} : \frac{12pR}{2[\sigma]}$$

$$0.9 1.0 --$$

, 0.0

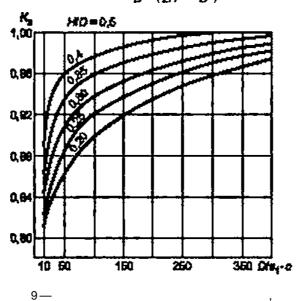
6.3.2.2

$$2M(sj-c)$$
 (Pin $R + 0.5(s, -c)$) (49)

IpJf
$$\frac{2,610 \times £ [100(8, -))1}{, K^*R}$$
 (50)

6.3.2.3 , 9. (51) D/s,-c *HID* :

$$x = 10 \frac{\mathbf{s_1} - \mathbf{c}}{D} \left(\frac{D}{2H} - \frac{2H}{D} \right). \tag{52}$$



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6.4 6.4.1 6.4.1.1

> (53) $s, Ss_{1e} + c,$

_ PQtfr (54)

s, i s, + .(55)

= 2)~ 0.5 ' t^{56*}

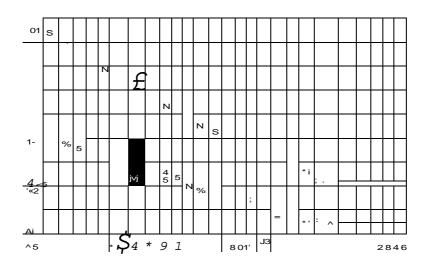
(53) (55). 6.4.1.2

(57)

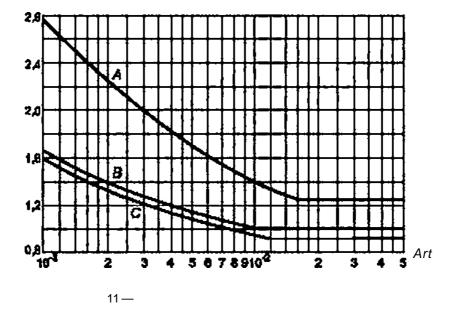
[] = R * 0.5(\$i -)(58)

(57). (58).

11. 10, ₂— , 6.4.1.3



10 —



 $= \max | 125; 0.25 + t00 j j;$

 $_2$ = max 0,90:0- $^12[^{\wedge \wedge} + 3.20jj$.

6.4.1.4 , , < = 1. 6.4.1.5 , 0.8 -),

(1). (2) « = 1. 6.4.2 ,

6.4.2.1 , , -

(46). (47) (48) K_i -^.

(57).

6.5 6.5.1 , -

6.5.1.1

$$si^*$$
 2 , - ' (60)

. $S_{t}^{\star} \hspace{1cm} S, \hspace{1cm}$

(66) 5%.

, (60) (61).

 $S_t^*S_{iP} + C. (62)$

6.5.1.2

 $|pj = min (lp,]; [p_2D.$ (63)

[pi|—

 $(1 = \frac{2(s, -) > }{Dp + (s, -c)}$ (64)

[]—

 $[] = \frac{2(s, -)}{Re + (s, -c)}.$ (65)

6.5.1.3 p *MZ[M]* no

 $p = 0.5 + \frac{tg^*}{Z_{K} 0(8, -< W^{1} \sim E < 1 + 3^{1})}$ (Si ^C / \(\frac{1}{3} \) \(\frac{1}{2} \) \(\frac{1}{3} \) \(\frac{1}{3}

6.5.1.3.1

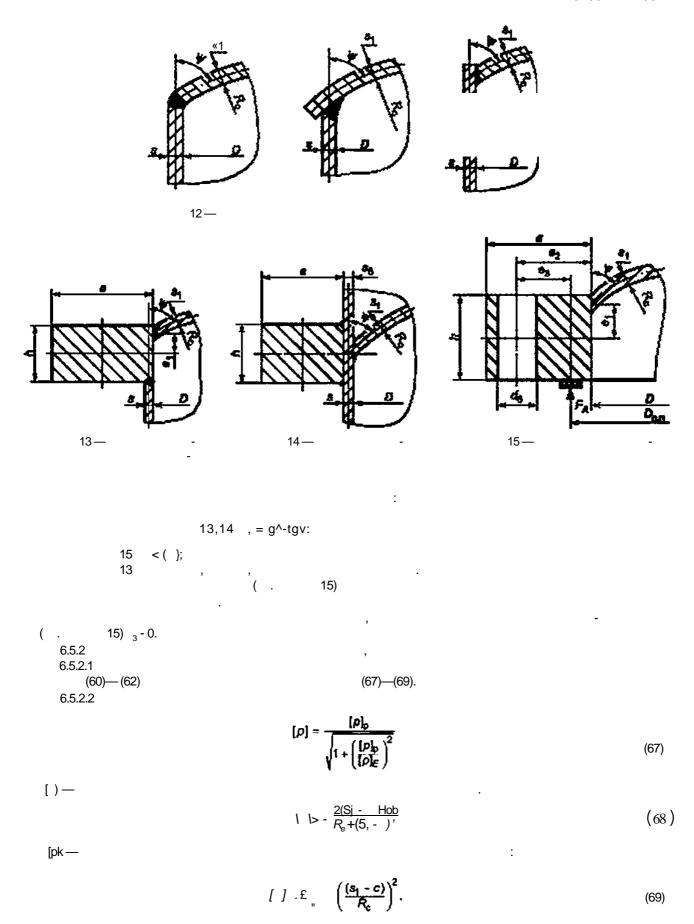
 $\cos v$ $\frac{JL}{2\#v}$ -1.

6.5.1.3.2 :

 $X^* = Nt.$ = -, *5 .

6.5.1.3.3 ,, . [\ ,

12	_	_	_
13	p^e,tgv	/)² 2	ah
14	0		(+ S _s)
15		nloUa-tfeV» ² 2	(a-djh



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6.5.2.3 3 $R_c/(s, -)$.

3

	R _c 1 (s, -)								
	25	50	75	100	ISO	200	250	300	350
(12 —14)	0.33	0.19	0.17	0.15	0.13	0.12	0.12	0.11	0.11
(15)	0.46	0.30	0,25	0.22	0.19	0.17	0.16	0.13	0.12

7

7.1 7.1.1 :

7.1.2 *1~->0.11. , -

(75) (84).

7.2.1 7.3.1 ,

*1" > 0,11, 7.2.7 7.3.8

() <

7.1.3

:

 $\frac{> \bullet <?}{2 \text{ ft}} > 5.0;$; <1.0; $\frac{4 \text{ eg}}{} \text{Sto}.$

7.2 7.2.1 ,

. (71)

\$, $-KK_0D_p$ (72)

7.2.2

Twn	Рисунок	Условия закрепления днищ и крышек	к
1	- D	a ≥ 1.7s D _p = D	0,53
2		a ≥ 0,85s D _p = D	0,50
3	10 D	$\frac{s-c}{s_1-c} < 0.25$ $\frac{s-c}{s_1-c} \ge 0.25$ $D_p = D$	0,45 0,41
4	\$ D	$\frac{s-c}{s_1+c} < 0.5$ $\frac{s-c}{s_1+c} \ge 0.5$ $D_{\rho} = D$	0,41 0,38
5	- D	$\frac{s-c}{s_1-c} < 0.25$ $\frac{s-c}{s_1-c} \ge 0.25$ $D_{\rho} = D$	0,45 0,41
6		a > 0,85s D _p = D	0,50
7	- 3 ⁵	$\frac{s-c}{s_1 \cdot c} < 0.5$ $\frac{s-c}{s_1 - c} \ge 0.5$ $D_p = D$	0,41 0,38
8	2	$\frac{s-c}{s_1-c} < 0.5$ $\frac{s-c}{s_1-c} \ge 0.5$ $D_{\rho} = D$	0,41 0,38

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4

max{s: 0.25s,}Sr* min(s,; 0.10} A, 2r Op = 0 - 2f $= maxjo.41^1 - 0.23^1 0.3sJ$ $\frac{s - c}{|| - c||} < 0.5$ $\frac{s \wedge *0.5}{s, - c}$ Op = 0 0.25s, srss, -s₂ 30*SyS 90*

°p

12

 $0 = 0_{p e. n}$ 0.41

7.2.3 K_c ,

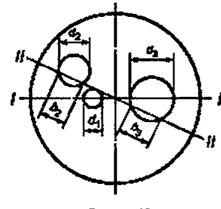
$$K_{o} = \sqrt{1 + \frac{d}{D_{p}} + \left(\frac{d}{D_{p}}\right)^{2}}.$$
 (73)

7.2.4 tfp , ,

$$*0 = \sqrt{\frac{1 - \left(\frac{\sum d_i}{D_p}\right)}{1 - \left(\frac{\sum d_i}{D_p}\right)}}$$
(74)

0

19 - max ((of, + d_3): (b₂ ⁴ b₃)}. 16.17.



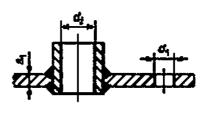


Рисунок 16

Рисунок 17

7.2.5 ₀ 1.0. 7.2.6

, 5.3. 7.2.7

$$[\] \quad \left(\frac{s_1-c}{KK_oD_p}\right)^2 [\sigma]\phi. \tag{75}$$

7.2.8 s₂ 10.11 12 (. 4) :

• 10:

5 2 max 1.1s: $\frac{\text{si}-}{1+1.2\{S,--\}} + \frac{1+1.2\{S,--\}}{1+1.2\{S,--\}} + \frac{1+1.2\{S,--]}{1+1.2\{S,--]} + \frac{1+1.2\{S,--]}{1+1.2\{S,--$

7.3 7.3.1 (18) -

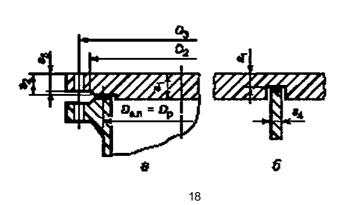
 $\mathfrak{L} \mathbf{s}_{1p}$, (77)

me ®ip (78)

7.3.2 no

$$= 0.41 \sqrt{\frac{1 + 3\psi \begin{pmatrix} D_3 & -1 \\ D_{cn} & -1 \end{pmatrix}}{D_{cn}^3}}$$
(79)

, 19. 0₅/ .



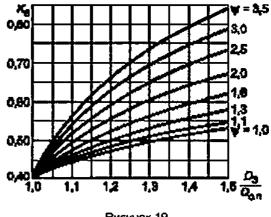


Рисунок 19

V»?#-. (0) $= 0.785 \text{ £}>^2$, |, 52587.4

7.3.3 0,7 0^ (73) (74). Id, 7.3.4), 186)

> -I] 9.6 0.41 (81) "5!

7.3.5 S_2 18)

> $_{\text{\tiny e}2}$ 2 max $_{7}$ >/ : 0.6 < . (82)

 $_{\underline{\ }}$ max

* (« . j' (82)

7.3.6

₇=0.8^-(83)

20

7.3.7 s_3 (. 18) (82). (82)(83)7.3.8

(84)

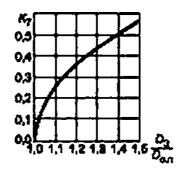


Рисунок 20

7.4 7.4.1

21 — 24.

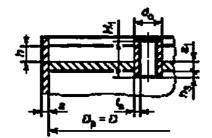


Рисунок 21

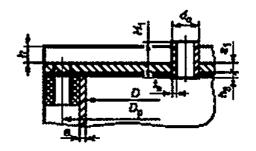
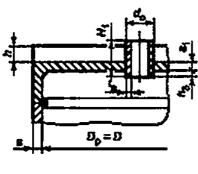
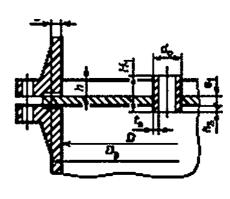


Рисунок 22







24

7.4.2

• :

ftp - min{ft₃; 027j(d_o -
$$t$$
,) t ,}: (85)

• : s min (,; (ft s, ftp)); ()

.

 $\rho_{\mathbf{o}} = \frac{\sigma_{\mathbf{o}}}{O_{\mathbf{p}}}; \tag{87}$

 $4-2 \quad _0 \mathcal{I}$ (88)

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7.4.3

-«• -hp -f + (e' * 'V * *1 J (89)

7.4.4

,-[] **-)** (90)

7.4.5

· <-+***}

7.4.6 .

- min { ,;). (92)

7.4.7

 $(1 - 0) + 0 \dots$ (93)

(, = 0).

, :

7.4.8 , (), -

q>so,9fi^. (95)

7.4.9 , (),

() = min {(PiJ; ($_2$)}. (96)

o , -

8

8.1

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 $= 0.7 JD\{s_2 -):$

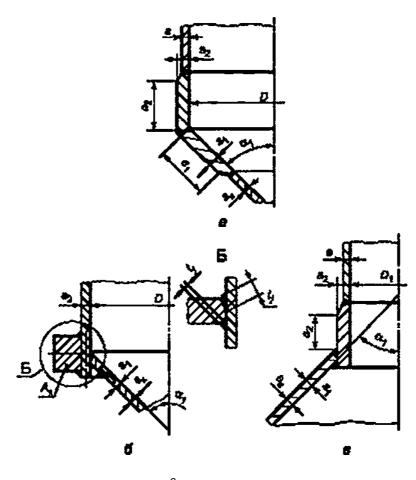
• (. 26):

$$a_{1p}=0.7\sqrt{\frac{D}{\cos\alpha_1}(s_{\tau}-c)},$$

*, = 0-):

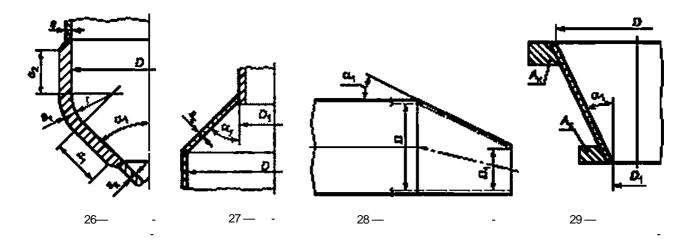
(. 25):

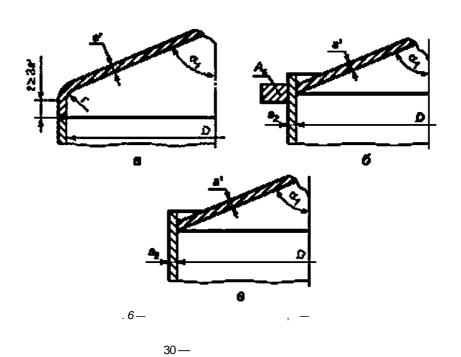
®2 = 1-25^0, (S₂ -).



_ .6—

25 —





8.1.2.2

• (. 25):

£>, = £>- 1.4 ,sin ,;

• (. 26):

£>, = D - 2 [(1 - cos ,) + 0.7 , sin ,];

,

8.2.1 0,001 o.OSO. (,>70)

28

8.2

```
8.2.2
                                                                                     8.3.10.8.4.2
                                                                                                             8.5.1.
                                                                                                                                                                    380
                                        — 480 *
                                                                                <del>---</del>525
          8.2.3
                                                                           52857.8.
          8.2.4
8.1.2.1.
          8.2.5
5, s<sub>2</sub>
                                                 s_{1s} = \max\left\{\frac{a_1}{a_{1p}}s_1; s_k\right\}; \qquad s_{2s} = \max\left\{\frac{a_2}{a_{2p}}s_2; s\right\};
    (114)
                                                  s_{1s} = \max \left\{ \frac{a_1}{a_{1p}} s_{\tau} : s_{t} \right\}; \qquad s_{2s} = \max \left\{ \frac{a_2}{a_{2p}} s_{\tau} : s \right\};
                                                                                                ( .
                                                                                                                   25.26).
        8.2.6
                                                                                                                                                                   ,. s<sub>2</sub>
8.8.1,
         8.2.7
                                                                                                                                                          8.4.2
                                                                            s_t.
                                                                                                                8.3.1
                                                                                                                                 8.3.2.8.4.1
                                                                                                                                     5.
          6.2.8
                                                                                                                                                     52857.3.
          8.2.9
          8.2.10
                                                                                                      28.
          8.3
          8.3.1
          8.3.1.1
                                                                                        S.ZS^* + .
                                                                                                                                                                               (99)
```

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 $^{\circ}$ 0 $\frac{-}{2}$ [<)- coset. (100)8.3.1.2 (1) 8.3.2 ,£70. 8.3.2.1 8.3.2.2 (104). S. = S, · (102)s, = max $1.06 \frac{10^{2}}{}$, $10^{\text{se}} \text{ eight} \frac{12}{}$, $\frac{!}{}$ (103)/.D_e., (107) — (109). 8.3.2.3 $[1 = \frac{[\rho]_{h}}{\sqrt{1 + \left(\begin{bmatrix} \rho \\ \rho \end{bmatrix}}} 2$ (104)ML-g^{Q(∆C)} > (105)(106)(107)(108)(109)(. 25) 8.3.3

« £70; (s, -) a (s₂ -).

30

6.3.3.1

(s, -) (s₂ -),

$$s, - - s_2 - .$$

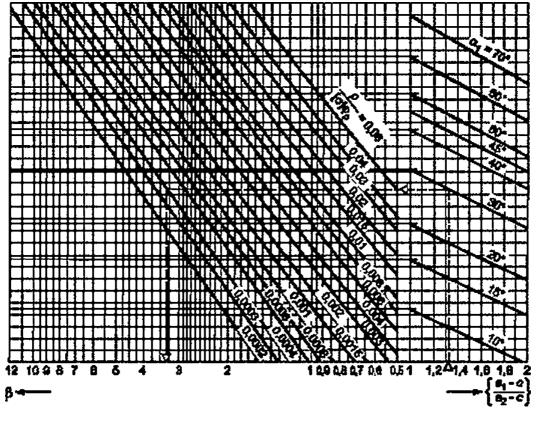
8.3.3.2

$$\mathfrak{E} \, \mathfrak{S}_{3(t)} \quad . \tag{111}$$

, (114)

(. 31).

8.3.3.3



31— 8

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$$\beta = 0.4 \sqrt{\frac{0}{s_2 - c}} \qquad J22I \qquad 0.25.$$

$$1 + X \stackrel{*1}{$_2^-} = \chi \left(\frac{s_1 - c}{s_2 - c}\right) \qquad (114)$$
8.3.3.4

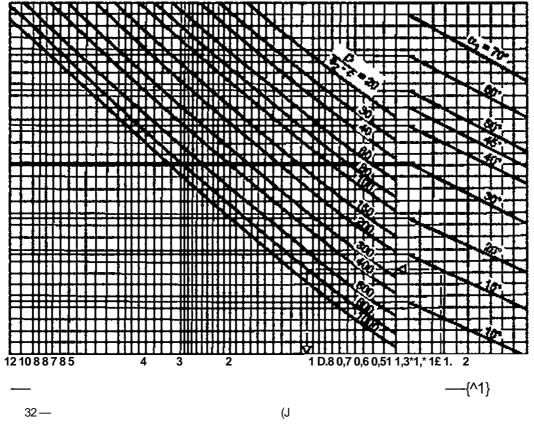
fni $\frac{2 - 9}{1}$," $| \{s_2 - \}^{-1}$ (115) 8.3.3.3. 8.3.4

(. 256.29) 8.3.4.1

> , 70 (. 256):

> > <S,-C)>(Sj-C).

$$(s, -) < (s_2 -),$$
 $s, - -s_2 -$



8.3.4.2 256.

$$\frac{-}{8} | \frac{pP*W}{+0.25} | \frac{fb+0.25}{j'}$$
 (116)

n.-(a\$b-i)lara-<117> (. 32). (114). * 0 29: (118)8.3.4.3 256: (119)29: tPI-Ac _{O^ga,} (120)8.3.4.4 = {0.5; 0). (121)(122)1-84 $\Lambda = 1\Delta'$) = 0.25' (123) 8.3.4.5 (124)256).

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8.3.5.2

$$s_t s s_{,p} + c.$$
 (125)

тм (126)

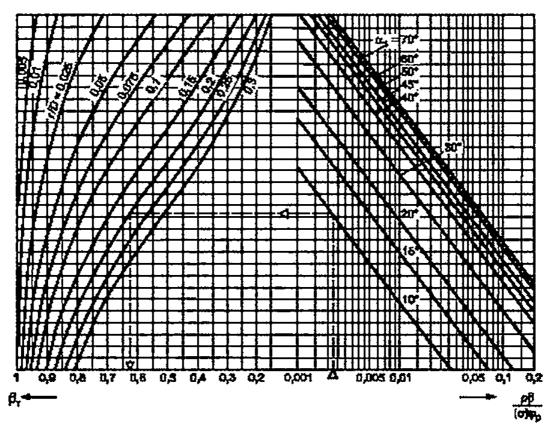


Рисунок 33 — Диаграмма для определения коэффициента β_1 при расчете толщин стенок — переходов обечаек

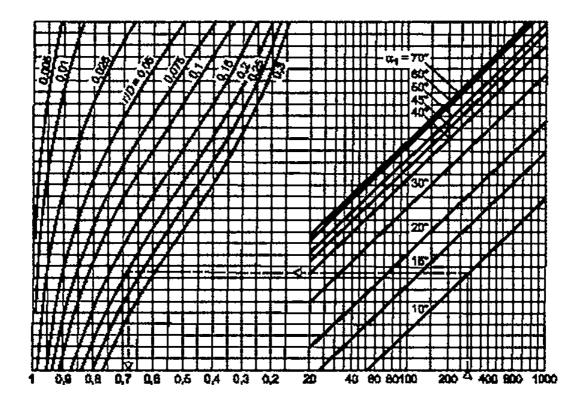
no 8.3.5.4. 8.3.5.3

$$(127)$$
 (128) . (114) (129)

32.34. 8.3.5.4 Pj :

(114)

$$= \max \{0.5; \bullet PJ,$$
 (128)



34— ,

, (129) , -34:

, =
1 * 0_028"^0(129)
//cosa,

8.3.6 (25) 8.3.6.1

, & 70 .

8.3.6.2

 $s_2 2s_{,p} + c.$ (130)

 ^{f}A ® 5 = 2 vN-p- 4 no 8.3.6.4.

(132)

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8.3.6.3

8.3.64

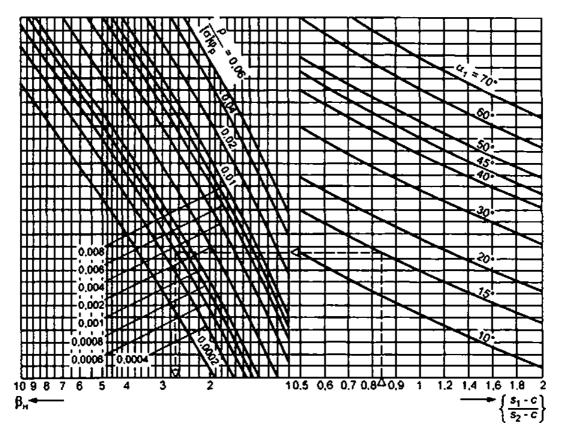
$$_{4}$$
 = {1,0; , {134}

$$= +0.75$$
 (|^) 21. (135)

(114) D ,:

\2 <1

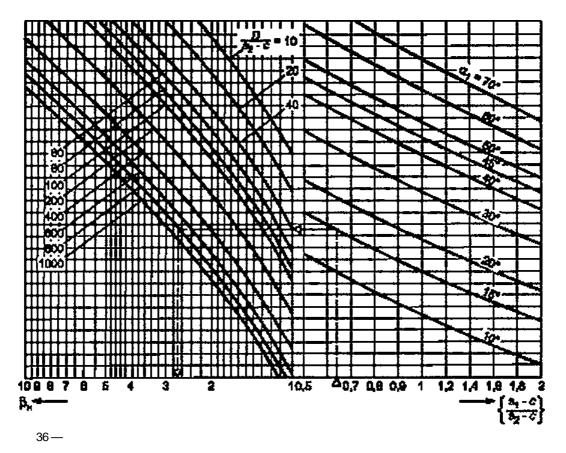
-0.4 + 0.5.
$$\frac{Si - CjCOSU}{(Sj - CjCOSU)}$$



35 —

$$s' \min \{ \max\{s,; s, \}; s_p' \};$$
 (137)

* 8.3.1 * = D s, 8.3.5.



8.3.7.3

```
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```

```
8.3.9
              )
    8.3.9.1
   , > 70 .
    8.3.9.2
                                                                                                                          (140)
                                              s' £ min {max{s<sub>4</sub>; s,}; s<sub>e</sub>' + }.
    Sp'
                                 (13d)
                                            r=0;
                   no
                   no 8.3.1
                                 = D:
    S,
                      8.3.3.
                                                                                                                    [ ]. -
s, = s'
    8.3.9.3
                                                                                                          8.3.1
                           (139)
                                         - 0.
                                                                              [].
, = D 8.3.3.
    8.3.10
    8.3.10.1
                                                            , > 70*.
    8.3.10.2
                                                                                           (104).
                                            (105)
                                                                                                                           (141)
                                              = min\{0,36; maxj^{0}^{5}; 0,12\}J;
                                                                                                                          (142)
                                                 £ 2(s'c)coSa_1'--
                                                                                                                          (143)
    8.4
    8.4.1
    8.4.1.1
                                                                                                                          (144)
                                                                  |] /
                                                     S,p =
                                                                                                                           <145)
    8.4.1.2
                                               (F] - kD, \{s^* - \} », () \cos ,.
                                                                                                                          (146)
    8.4.2
    6.4.2.1
                                                             , £70°.
    8 4,2.2
                                                                                                                           (147)
```

 $[] = D_f (s, -c) lo] cos a,$ (148) »2.5 100(8, -) [Fig* — • <r<u>*</u>e(Cfcoosa₁? (149) 0.90^0.1, Df (150)OOSU, 8.4.3 25) (. 8.3.3.1. 8.4.3.1 () 8.4.3.2 (151)Ps (1.0; (2 1.2)}. (152)(114)30. 8.4.4 25). 8.4.4.1 8.3.4.1. 8.4.4.2 () (153)** (1. ;2 ₀}. (154)3 -- 0.35. 8.3.4.5. 26\ (122). 8.4.4.3 8.4.5 26) 8.3.5.1. 8.4.5.1 8.4.5.2 () []= (155) (1.0; , (2 * 1.2)}. (156)(114) (129) 32 33. 8.4.6 (. 8.4.6.1 25) 8.3.6.1. 8.4.6.2 [] [] (157)

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```
= \max (1,0: (2 ,-1)).
                                                                                                          (158)
                                   (136)
                                              (135)
36.
    8.5
    8.5.1
                                                                                                           (159)
                                                   • ?~1 ].
                                           27);
                        (146).
                                                                                                           (160)
                                                                                                           (161)
                                                                                                          (162)
D_P
                          (150).
                              [F]_n [F]_e
                                                    8.4.2.2.
    8.5.2
    8.5.2.1
                                                                                                           (163)
                                                              (151), (153), (155)
                               [F]
                                                                                    (157).
                                                                                                            [F)
                                                        D.
                          (163)
                                               0,
          (157)
    8.6
    8.6.1
                                                                                                    *= <<1 >
                  10 %
    8.6.2
                    8.6.1
                                                              8.6.2.1
                                                                         .6.2.2.
                                                                   (165)
                                                                           (167)
                                                                           F.
    8.6.2.1
                                              (Pi[ ) (MJ-1-
                                                                                                          <165>
```

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,

<1)

[]. [F]. (] 8.3.2.3. .4.2.2 8.5.1. , 8.6.1

(165) = 0.

S.6.2.2 (166). -

 $\overline{[}]$ (167)

[]. [F]. () - . . . , 8.6.1 = D.

66.023:006.354 71.120 02 36 1500 75.200

, ,

. . . . 3. .