Software by SANT'AMBROGIO S.I. srl - Milano, Italy - EN Rev.1.07-auOB/aUs

HORIZONTAL VESSELS ON SADDLE SUPPORTS position :9

According to EN 13445-3 Ed. 2002 - up to issue 17 (Clause 16.8, 16.14)

***** NORMAL OPERATING CASE *****

VESSEL TEMPERATURE T = 150.00 C.

* MATERIALS:

Vessel, head (Record Nr 119) SA 516 Gr. 60 PMA REQUIRED

NOMINAL DESIGN STRESS (MPa)	Vessel,heads(fS)	Reinf. plate(fP)	Reinf.Rings(fR)
OPERATING CASE	129.91	--	--

SYMMETRICALLY EQUIDISTANT SADDLES

INTERNAL PRESSURE	p' =	1.40	MPa
INTERNAL OVERPRESSURE DUE TO STATIC HEAD	ph =	0.00	MPa
INTERNAL CALCULATION PRESSURE	p=p'+ph =	1.40	MPa
EXTERNAL PRESSURE	pe =	0.00	MPa
Total vessel weight including content	W =	61901	N
Total fluid weight	Wf =	18247	N
* SHELL / HEAD			
MODULUS OF ELASTICITY at T	E =	193002	MPa
Rp0.2/T	Rp0.2/T =	194.87	MPa
Shell inside diameter	Di =	610.00	mm
Shell thickness	ea =	10.00	mm
Length of cylindrical part + cylindical part of heads	L =	5932.00	mm
Shell corrosion allowance	cor =	3.00	mm
Shell thickness undertolerance	ts =	0.00	mm
Shell weld efficiency	zs =	1.00	
Shell deviation from perfect shape ratio	w/l =	0.0010	
Head internal height	Hi =	156.43	mm
Dic=Di+2*cs+2*ts	Dic =	616.00	mm
Dit=Di+2*ts	Dit =	610.00	mm
eac=ea-cs-ts	eac =	7.00	mm
eat=ea-ts	eat =	10.00	mm
* SADDLES			
Number of equidistant saddles	n =	2	
Distance from saddle support to end of cylindrical part	a1 =	1243.60	mm
Axial width of saddle	b1 =	250.00	mm
Included angle of saddle support	δ =	81.000	Deg
No reinforcing plate			

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------------------------- Condition of applicability -------------------------

ea/Di = 0.016393 >=0.001 and <= 0.05

Min. distance to any other local load = √(Di*ea) = 78.1 mm

----------------------- Forces, moments and shear forces -----------------------

q= W/(L+4*Hi/3)	q =	10	N/mm
M0= q*WF/W*Dic²/16	M0 =	70472	N*mm
Forces on the saddles	Fi= W/n =	30951	N
Support type : A			
a3=a1+2*Hi/3	a3 =	1347.9	mm
l1=(L-2*a1)/(n-1)	l1 =	3444.8	mm
M1=M2= q*a3²/2-M0	M1=M2 =	9086802	N*mm
Qi= Fi*(L-2*a1)/(L+4*Hi/3)	Qi =	17363	N
M12= M0+F1*(L/2-a1)-(q/2)*(L/2+2*Hi/3)²	M12 =	5866168	N*mm

------------- Load limit at the saddle (Without a reinforcing plate) -----------

(clause 16.8.7)

γ= 2.83*a1/Dic*√(eac/Dic)	γ =	0.609039
ß= 0.91*b1/√(Dic/eac)	ß =	3.464512
K3=max(2.718282^(-ß)*sin(ß)/ß; 0.25)	K3 =	0.250000
K4=(1-2.718282^(-ß)*cos(ß))/ß	K4 =	0.297205
K5=(1.15-0.0025*δ)/sin(δ/2)	K5 =	1.458931
K6=max(1.7-0.011667*δ; 0)/sin(δ/2)	K6 =	1.162484
K7=(1.45-0.007505*δ)/sin(δ/2)	K7 =	1.296632
K8=min(1.0; (0.8*√(γ)+6*γ)/(0.017453*δ))	K8 =	1.000000
K9=1-0.65/(1+(6*γ)²)*√(60/δ)	K9 =	0.961025
K10=1/(1+0.010472*³√(Dic/eac)*b1/Dic*δ)	K10 =	0.395068

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--------------------------- Checking at location 2 ---------------------------

$\nu1=-0.23*K6*K8/K5/K3$	=	-0.733061
$\nu2,1$ (P=0)$=-4*M1/\pi/Dic^2/eac/K2/f$	=	-0.026822
$\nu2,2 =(P*Dic/4/eac-4*M1/\pi/Dic^2/eac)/K2/f$	=	0.162840
$K1(P=0)=\dfrac{1-\nu2,1^2}{1/3+\nu1*\nu2,1+\sqrt{((1/3+\nu1*\nu2,1)^2+(1-\nu2,1^2)*\nu1^2)}}$	=	0.856735
K2	K2 =	1.25
$\sigma b,all(P=0)=K1*K2*f$	=	139.13 MPa
$K1(p=p'+ph)=\dfrac{1-\nu2,2^2}{1/3+\nu1*\nu2,2+\sqrt{((1/3+\nu1*\nu2,2)^2+(1-\nu2,2^2)*\nu1^2)}}$	=	1.005434
K2	K2 =	1.25
$\sigma b,all(p=p'+ph)=K1*K2*f$	=	163.28 MPa
$\sigma b,all,2=min(\sigma b,all(P=0);\ \sigma b,all(p=p'+ph))$	=	139.13 MPa
$F2,max=0.7*\sigma b,all,2*\sqrt{(Dic*eac)}*eac/K3/K5$	=	122737 N

------------------------- Checking at location 3 -----------------------------

$\nu1=-0.53*K4/K7/K9/K10/sin(\delta/2)$	=	-0.492680
$\nu2,1$ (P=0)	=	0.00
$\nu2,2 =P*Dic/2/eac/K2/f$	=	0.379325
$K1(P=0)=\dfrac{1-\nu2,1^2}{1/3+\nu1*\nu2,1+\sqrt{((1/3+\nu1*\nu2,1)^2+(1-\nu2,1^2)*\nu1^2)}}$	=	1.077375
K2	K2 =	1.25
$\sigma b,all(P=0)=K1*K2*f$	=	174.96 MPa
$K1(p=p'+ph)=\dfrac{1-\nu2,2^2}{1/3+\nu1*\nu2,2+\sqrt{((1/3+\nu1*\nu2,2)^2+(1-\nu2,2^2)*\nu1^2)}}$	=	1.369227
K2	K2 =	1.25
$\sigma b,all(p=p'+ph)=K1*K2*f$	=	222.35 MPa
$\sigma b,all,3=min(\sigma b,all(P=0);\ \sigma b,all(p=p'+ph))$	=	174.96 MPa
$F3,max=0.9*\sigma b,all,3*\sqrt{(Dic*eac)}*eac/K7/K9/K10$	=	147026 N
Fi= 30951 N < Fmax=min(F2,max; F3,max)	=	122737 N

------------------------------- Instability check -------------------------------

$Feq=Fi*\pi/4*\sqrt{(Dic/eac)}*K6*K8$	=	265086 N
$R=(Dic+eac)/2$	R =	311.50 mm
$Qmax =1/1.5*0.75*\pi*R*eac*E*(eac/R)^{1.25}*\sqrt{(R/L*(1+42*(R/L)^3*(eac/R)^{1.5}))}=$	Qmax =	1318016 N
Maximum allowable compressive stress	$\sigma c,all$ =	115.86 MPa
$Mmax=\pi/4*(Dic+eac)^2*eac*\sigma c,all$	Mmax =	247225830 N*mm
$Fmax=\pi*(Dic+eac)*eac*\sigma c,all$	Fmax =	1587325 N
$\lvert Mi\rvert/Mmax+Feq/Fmax+(Qi/Qmax)^2$	=	0.204 <=1