ISSN 1392 - 1207. MECHANIKA. 2005. Nr.4(54)

Comparison of pipe internal pressure calculation methods based on design pressure and yield strength

M. Bereiša*, A. Žiliukas, V. Leišis***, A. Jutas****, R. Didžiokas*******

**Kaunas University of Technology, Kęstučio 27, LT-44025 Kaunas, Lithuania, E-mail: mbereisa@mail.lt*
***Kaunas University of Technology, Kęstučio 27, LT-44025 Kaunas, Lithuania, E-mail:antanas.ziliukas@ktu.lt*
****Kaunas University of Technology, Kęstučio 27, LT-44025 Kaunas, Lithuania, E-mail: vitalis.leisis@ktu.lt*
*****Kaunas University of Technology, Kęstučio 27, LT-44025 Kaunas, Lithuania, E-mail: audrius.jutas@ktu.lt*
****** Klaipėda University, Bijūnų 17, LT-92294 Klaipėda, Lithuania, E-mail: rididz@lrs.lt*

1. Introduction

The aim of this study is to compare design pressure calculation methods of different standards with Von-Mises and Tresca criteria and to try to make an equation based on safety factors and Von-Mises criteria for any pipe thickness design pressure calculation. This equation will be conservative but universal and simple to use for thick and thin wall pipes.

This is important for industrial companies, because of huge amount of standards and methods. Quite often engineers wonder which standard and what safety factors to use. It is easier if you know how far it is to Von-Mises criteria.

There is about 1 million km gas and crude oil pipelines in the world and all of them have to be time by time assessed by different methods. In many countries, the methodology of design pressure is based on the country regulations. Some of the countries have there own standards, but some of them use other countries standards, or international standards.

There are many discussions which standard is the best one. The main difference in standards is the safety factor, which depends on material, diameter, wall thickness, environment, loads, pipe manufacturing procedures and industrial experiences.

The second part of the equation is based on hoop stress as a yield strength and internal pressure. This part is very similar among standards for thin wall pipes.

There are many scientists, who works on developing standards as much exact as possible. To be conservative it means to have extra costs for early pipe replacement. To be less conservative it means to have some accidence with extra costs for accidence damages.

The pipelines are widely used in USA (500000 km pipeline network), Europe (400000 km pipeline network) and Russia (300000 km pipeline network).

Lithuanian gas pipelines were built in 1961 year. There are 1620 km long main gas pipelines and 1915 km distribution pipelines, which were built of steel 3, 4 category.

Most of the steel pipes are in operation for 15 - 40 years. Gas pipelines, which are built of fourth category steel are in operation for more than 20 years.

Crude oil pipelines in Lithuania are about 400 km long and they are 5-30 years old.

2. Pipe internal design and yield pressure limit calculation methods

In this study it was used 4 main ASME, DNV, ISO and СНиП different standards for simple design pressure calculations based on wall thickness, diameter and yield stress for thin pipes.

It is quite complicated to analyse generally these standards, because the equations are based on the hoop stress and safety factor that is related with many other factors and best practices. The best way is to divide hoop stress calculation methodology and safety factor and then compare them.

In all of these norms design pressure in pipes is based on:

- wall thickness,
- diameter,
- specified minimum yield strength.

Safety factors based on:

- material characteristics,
- environment,
- loads,
- temperature,
- type of pipe manufactory,
- other integrated correction factor.

The equation could be structured as follows

$$p_{design} = F_{safety} \times p_{hoopstress}$$

where p_{design} is pipe design pressure, F_{safety} is safety factor, related on fabrication and operation factors, $p_{hoopstress}$ is pressure limit based on hoop stress for thin pipe (Von-Mises criteria for thick pipes) as a yield stress.

For comparison of standards in general case it is useful to make equation as a function where the pressure and yield stress ratio is related with wall thickness and outside diameter ratio function.

The American standard ASME B31.13 is used for piping in industry [1]. The DNV–OS–F101 standard is used for underwater pipelines [2] and ISO /FDIS 11960 is for petroleum and gas pipes industries – steel pipes for use as casing or tubing for wells [3]. СНиП is for under ground or on ground pipelines [4], therefore it is complicated to compare standards to each other, but it is possible to compare with classical methods as Von-Mises and Tresca criteria.

The most changeable safety factor is in СНиП standard, because of this standard bright use in different environments.

Additionally to these standards for the check how far it is the design pressure from yielding stress was used the additional 5 classical methodologies and Finite Element Method:

- analytical Tresca criteria for yield stress calculation, which is classical two dimensional method;
- analytical Von-Mises criteria for thick wall pipes yield stress calculation for a pipe with open valves which is classical three dimensional method;
- analytical Von-Mises criteria for thick wall pipes yield stress calculation for a pipe with closed valves which is classical three dimensional method;
- analytical Von-Mises criteria for thin wall pipes yield stress calculation for a pipe with open valves which is classical three dimensional method;
- analytical Von-Mises criteria for thin wall pipes yield stress calculation for a pipe with closed valves which are classical three dimensional method;
- Von-Mises criteria based on Finite Element Method (Software ANSYS) for yield stress calculation for a pipe with open valves, which is three dimensional method.

The main equations of standards are shown in Table 1 and classical methods are shown in Table 2.

The universal equation based on Von-Mises criteria for thick pipes p_y (Table 2, equation 8) and the standard safety factor F (Table 1) is shown in Eq. 10.

Table 1

Straight pipe internal design pressure limit calculation by different standards

Standards	Straight pipe internal design pressure limit p_d calculation equation and comments	$\frac{p_d}{\sigma_y} = f\left(\frac{t}{D}\right)$
ASME-B3.13-1999 “Process piping” [1]	$p_d = F\frac{2t\sigma_y}{D-2tY}$, $(t \le D/6)$, $Y = 0.4-0.7$ and $(t > D/6)$, $Y = \frac{d+2c}{D+d+2c}$	$\frac{p_d}{\sigma_y} = 2F\frac{\frac{t}{D}}{1-2Y\frac{t}{D}}$ (1) Safety factor $F = 0.8-1.0$
DNV–OS–F101 “Submarine pipe systems” [2]	$p_d = F\frac{2t(\sigma_y - f_{Y.temp})}{(D-t)}$, $F = \frac{2}{\sqrt{3}}\frac{a_u}{\gamma_m\gamma_{SC}\gamma_{inc}}$	$\frac{p_d}{\sigma_y} = 2F\frac{\frac{t}{D}}{\left(1-\frac{t}{D}\right)}$ (2) Safety factor $F = 0.670-0.838$
ISO /FDIS 11960:2004(E) “Petroleum and natural gas industries – steel pipes for use as casing or tubing for wells” [3]	$p_d = F\frac{2t\sigma_y}{D-2t}$	$\frac{p_d}{\sigma_y} = 2F\frac{\frac{t}{D}}{1-2\frac{t}{D}}$ (3) Safety factor $F = 0.875$ (Max)
СНиП 2.04.12-86 [4]	$p_d = F\frac{2t\sigma_y}{D-2t}$, $F = \frac{m}{k_2 k_n n}$	$\frac{p_d}{\sigma_y} = 2F\frac{\frac{t}{D}}{1-2\frac{t}{D}}$ (4) Safety factor $F = 0.518-0.826$

In Table 1: p_d is design pressure based on yield strength; F is safety factor; t is wall thickness; D is outside diameter; σ_y is yield strength; d is inside diameter; c is sum of mechanical allowances (corrosion, and erosion); $a_u = 0.96-1.00$ is material and temperature factor, material strength factor; $\gamma_m = 1.15-1.00$ is material resistance factor, $\gamma_{sc} = 1.040-1.308$ is safety class resistance factor; $\gamma_{inc} = 1.1$ is conditional load effect factor; $f_{Y.temp}$ is yield strength derating value related on temperature; $m = 0.8-1.1$ is factor related on pipe environment; $k_2 = 1.1-1.2$ is factors related on pipe characteristics; $k_n = 1.00-1.15$ is factor related on pipe diameter and pressure; $n = 0.8-1.5$ is factor related on loading.

Table 2

Straight pipe internal yield pressure limit calculation by different method

Classical methods	Straight pipe internal yield pressure limit p_y calculation equation and comments	$\frac{p_y}{\sigma_y} = f\left(\frac{t}{D}\right)$
TRESCA criteria for thick wall pipes [5]	$\sigma_y = \sqrt{(\sigma_\theta - \sigma_r)^2}$, $p_y = \sigma_y \frac{(k^2-1)}{2k^2}$, $k = \frac{D}{D-2t}$	$\frac{p_y}{\sigma_y} = 2\left[\frac{t}{D} - \left(\frac{t}{D}\right)^2\right]$ (5)
Von-Mises criteria for thin wall pipe with open valves based on principal stresses [6]	$\sigma_y = \sqrt{\frac{1}{2}\left[(\sigma_1 - 0)^2 + (0-0)^2 + (0-\sigma_1)^2\right]} = \sigma_1$, $p_y = \sigma_y \frac{2t}{D-2t}$, $\sigma_3 = 0$	$\frac{p_y}{\sigma_y} = 2\frac{\frac{t}{D}}{1-2\frac{t}{D}}$ (6)
Von-Mises criteria for thin wall pipe with closed valves based on principal stresses [6]	$\sigma_y = \sqrt{\frac{1}{2}\left[(\sigma_1 - \sigma_2)^2 + (\sigma_2 - 0)^2 + (0-\sigma_1)^2\right]} = \sqrt{3}\sigma_2 = \frac{\sqrt{3}}{2}\sigma_1$ $\sigma_2 = \frac{\sigma_1}{2}$, $\sigma_3 = 0$, $p_y = \sigma_y \frac{\sqrt{3}t}{(D-2t)}$.	$\frac{p_y}{\sigma_y} = \frac{4}{\sqrt{3}}\frac{\frac{t}{D}}{1-2\frac{t}{D}}$ (7)
Von-Mises criteria for thick wall pipe with open valves based on principal stresses [5]	$\sigma_y = \sqrt{\frac{1}{2}\left[(\sigma_\theta - \sigma_r)^2 + (\sigma_r - 0)^2 + (0-\sigma_\theta)^2\right]} = \sqrt{\sigma_r^2 + \sigma_\theta^2 - \sigma_r\sigma_\theta}$, $p_y = \sigma_y \frac{(k^2-1)}{\sqrt{3k^4+1}}$, $k = \frac{D}{D-2t}$	$\frac{p_y}{\sigma_y} = \frac{4\left[\frac{t}{D} - \left(\frac{t}{D}\right)^2\right]}{\sqrt{3+\left[1-4\left[\frac{t}{D} - \left(\frac{t}{D}\right)^2\right]\right]^2}}$ (8)
Von-Mises criteria for thick wall pipe with closed valves based on principal stresses [5]	$\sigma_y = \sqrt{\frac{1}{2}\left[(\sigma_\theta - \sigma_r)^2 + (\sigma_r - \sigma_z)^2 + (\sigma_z - \sigma_\theta)^2\right]}$, $p_y = \sigma_y \frac{4(k^2-1)}{\sqrt{3}k^2}$	$\frac{p_y}{\sigma_y} = \frac{4}{\sqrt{3}}\left[\frac{t}{D} - \left(\frac{t}{D}\right)^2\right]$ (9) $p_{Mises\ closed\ valves} = \frac{2}{\sqrt{3}} p_{Tresca}$

In Table 2: p_y is yield pressure; t is wall thickness; D is outside diameter; σ_y is yield strength; σ_1 is hoop stress for thin pipes; σ_2 is axial stress for thin pipes; σ_r is radial stress for thick pipes; σ_θ is hoop stress for thick pipes; σ_z is longitudinal stress thick pipes.

The object of this study is the straight pipe internal pressure limit. The bending and external forces conditions are not included.

The final universal equation for conservative design pressure express information depending on design standards in any wall thickness would be

$$p_d = F\sigma_y \frac{4\left[\frac{t}{D} - \left(\frac{t}{D}\right)^2\right]}{\sqrt{3+\left[1-4\left[\frac{t}{D} - \left(\frac{t}{D}\right)^2\right]\right]^2}}, \qquad (10)$$

3. Pipe internal design pressure calculation methods comparison with Von-Mises and Tresca criteria

The first step is to compare yield pressure limits based on Tresca and Von-Mises calculation methods and FEM ANSYS software results, as it is shown in Fig. 1.

Tresca method is more conservative than Von-Mises and can be used additionally for conservative yield pressure calculation.

For thin pipes the Tresca and Von-Mises criteria calculation results are very similar but for thick pipes it can be quit conservative.

As it is known Von-Mises criteria which is more exact method and can be used for thin and thick pipes for yield stress calculation was used as a main equation for comparison with standards.

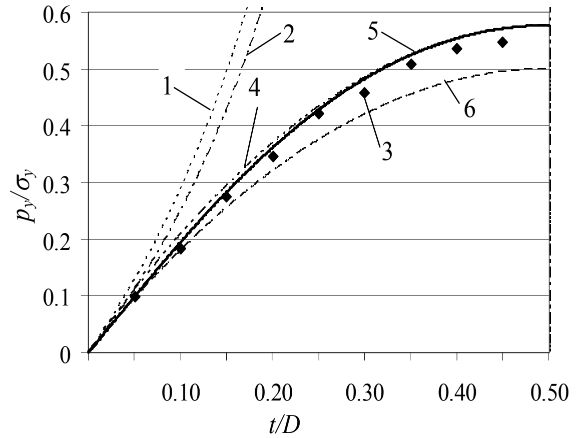

Fig. 1 Comparison of different yield pressure calculation methods: *1* - Von-Mises criteria for thin pipes with closed valves; *2* - Von-Mises criteria for thin pipes with open valves; *3* - Finite Element Method based ANSYS Software calculation results; *4* - Von-Mises criteria for thick pipes with closed valves; *5* - Von-Mises criteria for thick pipes with open valves; *6* - Tresca criteria

The finite element calculation method results for Von-Mises yielding pressure are between the results of analytical methods Von-Mises for thick wall pipes and Tresca.

The more accurate finite elements meshing brings results near to Von-Mises analytical line for thick wall pipes.

The next step is to compare the standards with Von-Mises criteria and try to show the limits where the standard reaches the Von-Mises yield stress stage.

As an example the ASME-B3.13-1999 "Process piping" [1] standard design pressure calculation is divided to thin wall pipes $\left(t/D<6\right)$ and thick wall pipe $\left(t/D\geq 6\right)$.

The comparison results of ASME design pressure and Von-Mises yielding stress stage for thick wall pipes is shown in Fig. 2.

The ASME standard design pressure reaches the Von-Mises criteria in wall thickness and diameter ratio values 0.05, but usually the safety class was used in the calculation as a normal class and then the design pressure reaches the yield strength in ratio 0.173 (see Table 3).

In case of using high safety class for welds calculation the design pressure limit reaches the yield strength in ratio 0.4.

The DNV standard design pressure comparison with yield pressure based on Von-Mises criteria is showed in Fig. 3

The low safety class DNV design pressure reaches the Von-Mises criteria in wall thickness and diameter ratio value 0.127, but usually the safety class is used in calculation as a normal class and then the design pressure reaches the yield strength in ratio 0.170 (see Table 3).

In case of using high safety class calculation the design pressure limit reaches the yield strength in 0.233.

The ISO standard design pressure comparison with yield pressure based on Von-Mises criteria is shown in Fig. 4. The normal safety class is design maximum safety factor 0.875 and then the design pressure reaches the yield strength in ratio 0.059 (see Table 3).

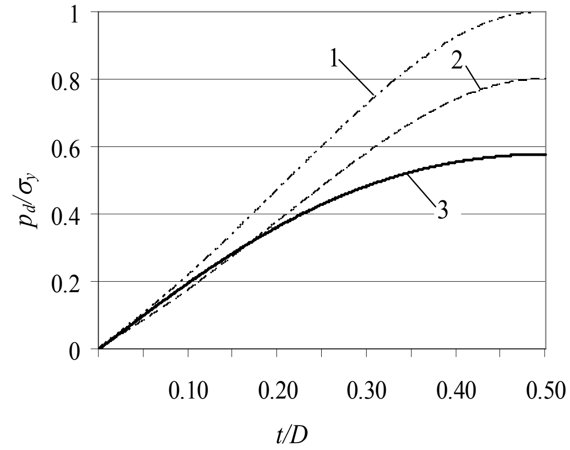

Fig. 2 ASME standard design pressure and Von-Mises yield pressure comparison: *1* - ASME "Low safety lass"; *2* - ASME" Normal safety class"; *3* - Von-Mises criteria for thick pipes with open valves

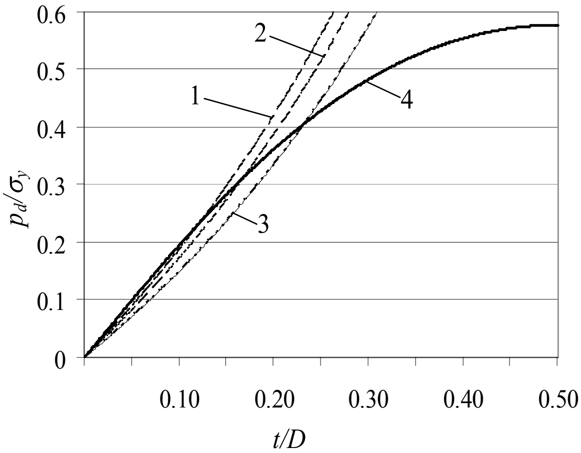

Fig. 3 DNV standard design pressure and Von-Mises yield pressure results comparison: *1* - DNV "Low safety class"; *2* - DNV "Normal safety class"; *3* - DNV "High safety class"; *4* - Von-Mises criteria for thick pipes with open valves

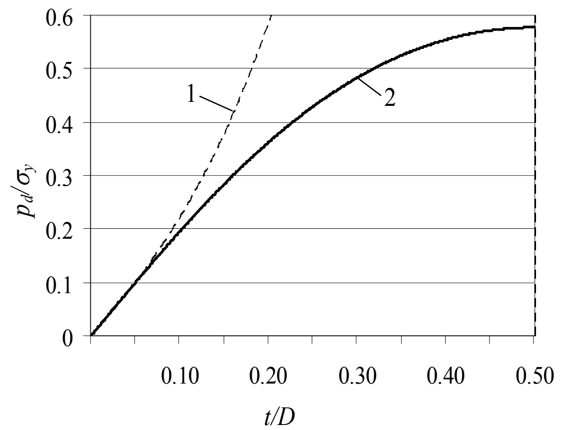

Fig. 4 ISO standard design pressure and Von-Mises yield pressure results: *1* - ISO "Normal safety class"; *2* - Von-Mises criteria for thick pipes with open valves

СНиП is the Russian standard used for underground and on ground pipes is very popular in Post Soviet countries. The standard is made for very bright use in different environments and conditions. The comparison of СНиП design pressure and Von-Mises yield pressure values are shown in Fig. 5.

СНиП (for wall thickness 12 mm) reaches the Von-Mises criteria if wall thickness and diameter ratio is equal 0.08 and if R_t/R_y=<0.8 than t/D=0.128 (see Table 3), and R_t/R_y >0.8 than 0.141.

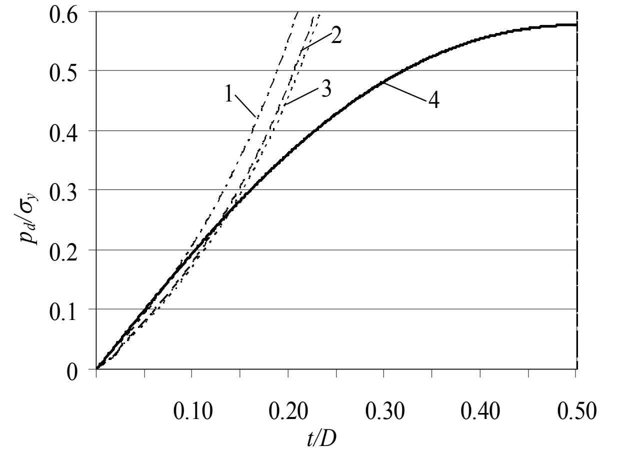

Fig. 5 СНиП standard design pressure and Von-Mises yield pressure results: *1* - СНиП "Low safety class"; *2* - СНиП "Normal safety class"; *3* - СНиП "High safety class"; *4* - Von-Mises criteria for thick pipes with open valves

Table 3

Wall thickness and diameter ratio limits for standards *t/D*

Standard	Wall thickness and diameter ratio maximum limit (p_d/σ=t/D) by normal safety class	
	Safety factor	Reaches the Von-Mises value *t/D*
ASME	0.800	0.173
DNV	0.770	0.170
ISO	0.875	0.059
СНиП	0.540	0.128

4. Design pressure calculation based on Von-Mises criteria for any pipe wall thickness and diameter ratio

The very useful information is to compare normal safety class design pressure values and Von-Mises values. Based on international standard ISO/FDIS 11960 the design pressure should be with minimum safety case 0.875 of the yielding pressure [3]. Yield limit based by Von-Mises multiply on safety factor would be an approximate design pressure. The other interesting fact is that the results of corrected figure is very near to Tresca values, but if to decrease the safety factor to 0.866 we get even more similar value of Von-Mises to Tresca.

The universal equation for design pressure express information in any wall thickness would be very useful for approximately calculation and one of the solutions could be the Von-Mises equation with safety factors 0.866 which is very similar to Tresca criteria.

The conservative normal safety class design pressure results based on Von-Mises criteria and the safety factor for comparison with standards are shown in Figs. 6-9.

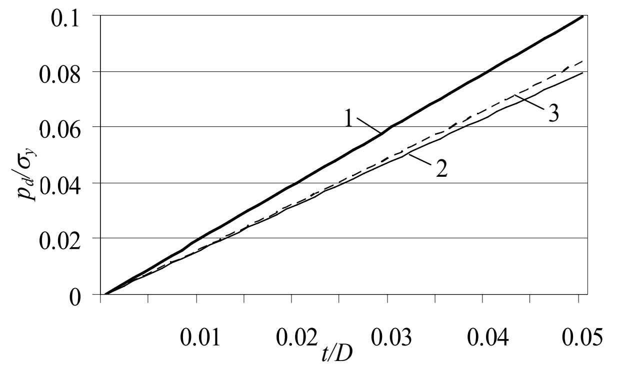

Fig. 6 ASME standard design pressure (normal safety class) and Von-Mises based design pressure calculation method: *1* - Von-Mises criteria for thick pipes with open valves; *2* - Von-Mises criteria for thick pipes with open valves with ASME safety factor; *3* - ASME "Normal safety class"

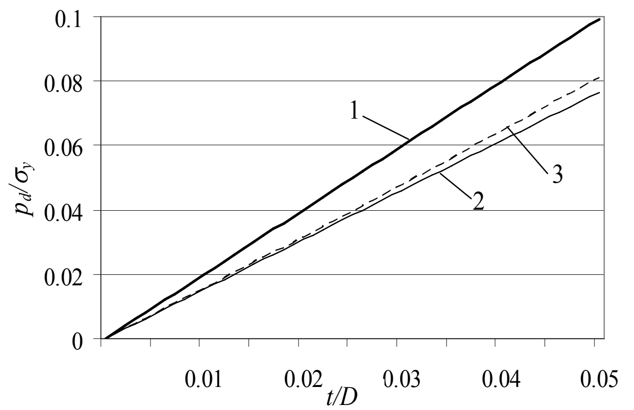

Fig. 7 DNV standard design pressure (normal safety class) and Von-Mises based design pressure calculation method: *1* - Von-Mises criteria for thick pipes with open valves; *2* - Von-Mises criteria for thick pipes with open valves with DNV safety factor; *3* - DNV "Normal safety class"

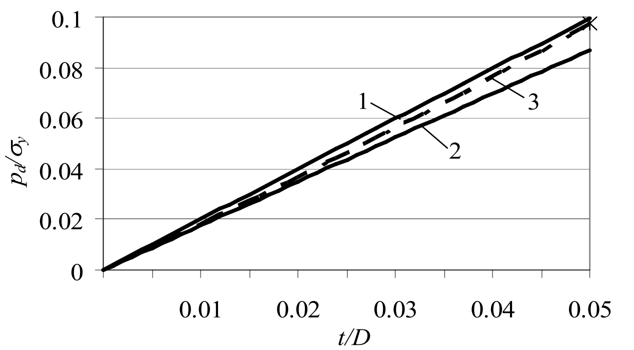

Fig. 8 ISO standard design pressure (normal safety class) and Von-Mises based design pressure calculation method: *1* - Von-Mises criteria for thick pipes with open valves; *2* - Von-Mises criteria for thick pipes with open valves with ISO safety factor; *3* - ISO "Normal safety class"

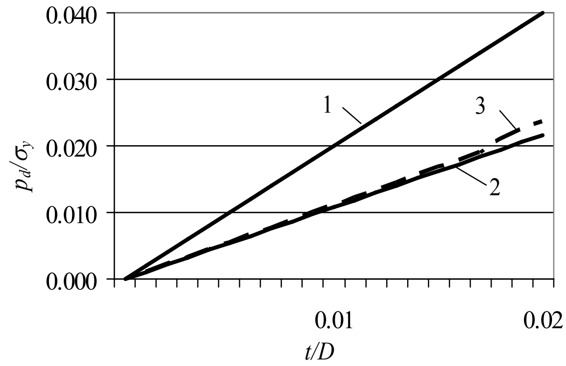

Fig. 9 СНиП standard design pressure (normal safety class) and Von-Mises based design pressure calculation method: *1* - Von-Mises criteria for thick pipes with open valves; *2* - Von-Mises criteria for thick pipes with open valves with СНиП safety factor; *3* - СНиП “Normal safety class”

5. Example of pipe internal design pressure calculation by standards and their comparison with purposed equation

To compare the results the popular steel 17ГС for 720mm diameter and 12mm wall thickness pipe was used.

The chemical composition the pipe material is shown in Table 4 and mechanical characteristics are shown in Table 5.

The pipe belongs to “Normal safety class”. Calculation results and the comparison are shown in Table 5.

Based on the real data example the results of pressure limit Von-Mises criteria for a pipe with open valves analytical equation was the same as by the finite element calculation method in ANSYS software.

Table 4

Steel 17ГС pipe chemical composition

C	Mn	Si	S	P
0.15-0.2	1.15-1.55	0.4-0.6	Min 0.035	Max 0.035

Table 5

Pipe geometry and mechanical characteristics

Diameter, mm	Wall thickness, mm	Max pressure, MPa	Yield strength, MPa	Ultimate strength, MPa
720	12	11.8	353	510-630

The yielding pressure limit Von-Mises criteria with open valves should be the most exact pressure limit calculation method. Additionally to this it should be added the safety factor and assessed the pipe, fluid, ground or water weight, bending appearance and distance between props.

The results of the proposed method are shown in Table 6.

Table 6

Pressure limit calculation results based on real data for normal class pipe (Table 4 and 5)

Method	Safety factor	Valid interval, *t/D*	The error by interval,		Von-Mises yield pressure, MPa	Purposed Von-Mises based design pressure method, MPa	Design pressure by standards, MPa	Difference, %
			Max, %	Average, %				
ASME	0.800	0.000 - 0.050	4.6	2.3	11.8	9.4	9.5	1.05
DNV	0.770	0.000 - 0.050	5.6	2.8	11.8	9.1	9.2	1.09
ISO	0.875	0.000 - 0.050	5.6	5.3	11.8	10.3	10.7	3.74
СНиП	0.540	0.000 - 0.020	8.3	2.8	11.8	6.4	6.6	3.03

Tresca yield pressure 11.6 MPa,
Von-Mises yield pressure 11.8 MPa (for thick wall pipes with open valves),
Von-Mises with yield pressure 13.4 MPa (for thick wall pipes with closed valves),
Von-Mises based on principal stress yield pressure 12.2 MPa (for thin wall pipes with open valves),
Von-Mises based on principal stress with yield pressure 14.1 MPa (for thin wall pipes with closed valves),
Von-Mises criteria based on ANSYS software by Finite Elements Method with “open valves” yield pressure 11.8 MPa

The Von-Mises criteria for “pipe with open valves” has no axial stress for internal and the Von-Mises criteria for “pipe with closed valves” axial stress for internal pressure is not equal to zero.

The thin wall pipe is the pipe with wall thickness less than 0.05 pipe diameter value and the thick wall pipe is the pipe with wall thickness over the 0.05 pipe diameter value.

6. Conclusions

1. All standards design pressure for thin pipe calculation methods are based on safety factor and hoop stress. The design pressure depends on: wall thickness, diameter, specified minimum yield strength, safety factors (based on material characteristics, environment, loads, temperature, type of pipe manufacture, integrated correction factor).

2. The most conservative and complicated standard is Russian norms СНиП 2.04.12-86. This standard has a lardge amount of factors and values of the factors can be very different depending on situation.

3. The most simple for use and least conservative standard is ISO /FDIS 11960:2004 Edition, because of main rule that design pressure should have a minimum safety reserve 12.5% of minimum specified yielding stress.

4. The study showed us that all standards ASME, DNV, ISO and СНиП can be over calculated value of

Von-Mises criteria for thick wall pipes with open valves depends on wall thickness and diameter ratio.

5. Calculation methods of thick wall pipe yielding pressure are more exact than for thin wall pipes because of radial stress that is included for thick wall pipe.

6. Calculation methods of the Von-Mises criteria pressure yielding limit for thick wall pipe with open valves (instead of hoop stress) with safety factor could be used as universal design pressure calculation method, because it is accurate for thick and thin wall pipe internal pressure calculation.

7. The proposed method (equation 10) is universal for any wall thickness and pipe diameter and is very useful.

References

1. Process Piping, ASME Code for Pressure Piping, B31 an American National Standard. ASME-B31.13-1999, Edition 2001.-321p.
2. Submarine Pipe System. DNV – OS –F101 2003.-166p.
3. Petroleum and Natural Gas Industries – Steel Pipes for use as Casing or Tubing for Wells. ISO /FDIS 11960:2004 Edition.-293p.
4. Строительные нормы и правила расчет на прочность стальных. СНиП 2.04.12-86.-51с.
5. **Žiliukas A**. Energomechanika.-Kaunas, Technologija, 2003.-196p.
6. **Banham, P.P. Crowford, R.I. Armstrong, G.G.** “Mechanics of Engineering Materials”.-2nd ed. Harlow, Longman, 1996.-627p.

M. Bereiša, A. Žiliukas, V. Leišis, A. Jutas, R. Didžiokas

VAMZDŽIO PROJEKTINIO BEI TAKUMO RIBOS SLĖGIO SKAIČIAVIMO METODIKŲ PALYGINIMAS

R e z i u m ė

Tyrimas parodė, kad Mizeso storasienių vamzdžių vidinio slėgio, prie kurio pasiekiama takumo riba, skaičiavimo metodika, atsižvelgiant į atsargos koeficientą, galėtų būti taikoma tiek plonasienių, tiek storasienių vamzdžių projektinio slėgio skaičiavimui.

Analizė parodė, jog nagrinėti standartai ASME, DNV, ISO ir СНиП yra skirti plonasieniams vamzdžiams ir gali viršyti Mizeso kriterijaus vertę skaičiuojant pagal storasienių vamzdžių metodiką. Tai paaiškinama tuo, kad plonasienių vamzdžių stiprumo skaičiavimuose neatsižvelgiama į radialinius įtempius.

Pasiūlyta metodika gali būti taikoma storasieniams ir plonasieniams vamzdžiams.

Siūlomoje metodikoje projektiniam slėgiui apskaičiuoti atsargos koeficientas parenkamas pagal atitinkamą standartą.

M. Bereiša, A. Žiliukas, V. Leišis, A. Jutas, R. Didžiokas

COMPARISON OF PIPE INTERNAL PRESSURE CALCULATION METHODS BASED ON DESIGN PRESSURE AND YIELD STRENGTH

S u m m a r y

Von-Mises pressure yielding limit calculation method for thick wall pipe with safety factor could be used as a design pressure calculation method and would be universal for any wall thickness and diameter ratio pipes.

The study showed us, that ASME, DNV, ISO and СНиП standards are designed for thin wall pipes and can be over thick wall pipes Von-Mises criteria. It happens because in methodology for thin wall pipes is no radial stress.

The purposed method can be used for thin and thick wall pipes.

The safety factor for design pressure in the purposed method is used from appropriate standard.

М. Берейша, А. Жилюкас, В. Лейшис, А. Ютас, Р. Диджекас

СРАВНЕНИЕ МЕТОДИК РАСЧЕТА ТРУБ НА ПРОЧНОСТЬ ПО ПРЕДЕЛУ ТЕКУЧЕСТИ И ПРОЕКТНОМУ ДАВЛЕНИЮ

Р е з ю м е

В статье показано, что методика расчета внутреннего давления труб по Мизесу учитывая коэффициент запаса прочности, может использоваться при расчете проектного давления, как для тонкостенных, так и для толстостенных труб.

Проведенный анализ показал, что при расчете согласно стандартам ASME, DNV, ISO и СНиП полученные предельные значения могут превышать значения текучести по критерию Мизеса. Это объясняется тем, что при расчете тонкостенной трубы согласно стандартной методике не учитываются радиальные напряжения.

Предложенная методика может быть использована как для тонкостенных, так и для толстостенных труб, а коэффициент запаса принимается согласно соответственному стандарту.

Received November 08, 2004