SANT'AMBROGIO Newsletter – January 2012

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The European Pressure Equipment standardisation system: state of the art

Following to the remarks made by many different sources, I was recently involved in a **comparison among the different EN standards dealing with Pressure Equipment** in order to identify possible differences. Among the topics in which the main harmonised standards (**EN 12952 – Water Tube Boilers, EN 12953 – Shell Boilers, EN 13445 – Unfired Pressure Vessels, EN 13480 – Piping**) show remarkable differences, I have selected **the method for high temperature design** (in the so called **"creep range"**, where materials start behaving like liquids, increasing their strain under constant stress) and the **hydrostatic test pressure** (the value of the test pressure is prescribed, or at least recommended, in the Pressure Equipment Directive, however the prescriptions are not completely clear and may give raise to different interpretations). Without going too much into details about the reasons of the differences, I will only mention the most significant results of these comparisons.

Example 1 - Thicknesses (mm) of a cylindrical shell having an I.D. = 1000 mm, made of Low Alloy steel 2,5Cr-1Mo at 100 bar and 500℃

Standard	EN 12952.3		EN 13445.3		EN 13480.3	
Lifetime (hours)	100000	200000	100000	200000	100000	200000
Monitoring in service required	49	55	49	55	59	55
Monitoring in service not required	49	55	59	67	59	55

Example 2 - Thicknesses (mm) of a cylindrical shell having an I.D. = 1000 mm made of Austenitic Stainless Steel ASME SA 240 304 at 100 bar and 600℃ (1)

Standard	EN 12952.3	EN 13445.3	EN 13480.3
Lifetime (hours)	100000	100000	100000
Monitoring in service required	84 mm	69 mm	84 mm
Monitoring in service not required	84 mm	84 mm	84 mm

(1) The equivalent EN steel has no tabulated value of high temperature creep characteristics

From the two examples presented above, it is evident that **the thickness of the same cylindrical shell operating in the creep range (at 100000 or at 200000 hours) is not the same when it is part of a water tube boiler, of a pressure vessel or of a piping system**. In example 1, with a service life of 100000 hours (11 years), the boiler standard is the one which gives the minimum thickness (49 mm), while the maximum thickness (59 mm) is obtained with the piping standard. In example 2, for the same service life, the minimum thickness (69 mm) is for a pressure vessel (provided it is monitored in service!), all other standards give 84 mm. Well, let's hope that cylindrical shells for high temperature applications are clever enough to understand to which kind of pressure equipment they are belonging, and possibly to make a reasonable forecast about the designer's ideas about future monitoring in service: in this way they will be able to develop the necessary strength characteristics! I personally must confess that I am not clever enough to understand why a piece of piping working at 100 bar and 500℃ may be thinner when its lifetime is 200000 hours (22 years) than in the case of a shorter lifetime (100000 hours = 11 years). If this were true, it could be extremely dangerous to interrupt after 11 years the life of a pipe originally designed for a lifetime of 22 years!

Dealing with the **hydrostatic test pressure**, I have considered 3 different examples:

Example 1: cylindrical shell, 1 m inside diameter, 40 mm thickness, joint efficiency 100%, corrosion allowance 1 mm, material **fine grained carbon steel P355 NH EN 10028.3**, **design pressure 100 bar, design temperature 350℃.**

Example 2: cylindrical shell, 1 m inside diameter, 20 mm thickness, joint efficiency 100%, no corrosion allowance, material **austenitic stainless steel 1.4571 EN 10028.7**, **design pressure 50 bar**, **design temperature 200℃** .

Example 3: cylindrical shell, 1 m inside diameter, 8 mm thickness, joint efficiency 85%, corrosion allowance 1 mm, material **carbon steel P355 GH EN 10028.2, design pressure 10 bar**, **design temperature 200℃** . The shell is closed by an elliptical end, 5 mm thick, with no corrosion allowance, material **austenitic stainless steel 1.4571 EN 10028.7.**

For all the three cases I have calculated the hydrostatic test pressure according to the prescriptions of the harmonised standards for pressure equipment mentioned above (note **that a harmonised standard, by definition, should be a standard giving the so called "presumption of conformity"** with the reference directive, in our case the Pressure Equipment Directive). **It is surprising to see the amount of disagreement about the interpretation of the same PED requirement among the different EN standards**, prepared of course by different CEN Technical Committees. By the way, in the comparison I have also included the values of the test pressures which should be reasonably obtained if we try to give the same interpretation of the PED with the use of a different (non harmonised) standard (ASME Section VIII division 1).

Test Pressure Summary for the 3 different examples

	DESIGN PRESSURE	EN 13445	EN 12952	EN 12953	EN 13480	ASME VIII div. 1
EXAMPLE 1	100	184,7	207,3	207,3 (1)	184,7	143
EXAMPLE 2	50	82,9	71,5	N.A.	82,9	71,5
EXAMPLE 3	10	14,5	16,1	N.A.	17,2	17,4 (2)

NOTES: (1) limited to 143 bar if tubes are expanded only (2) imposed by ASME, PED would require 14,3 bar only

At the end I must say that **the situation of EN standards for Pressure Equipment is an excellent mirror of the actual political situation of the European Union: everyone is trying to bring forward his own ideas, without looking too much at other people's ideas, and possibly ignoring the final goal of the work**. But please, **do not blame too much European standardisers**: differently from European politicians, **they are not paid at all** (moreover, **they have to pay some contribution to their relevant standard bodies** in order to have the great honour to work for CEN). However, if you look at the mess European politicians are now doing with the Euro, you will have to recognize that **possible problems concerning the stability of pressure equipment are certainly negligible if compared to problems concerning the future financial stability of Europe**.

Fernando Lidonnici

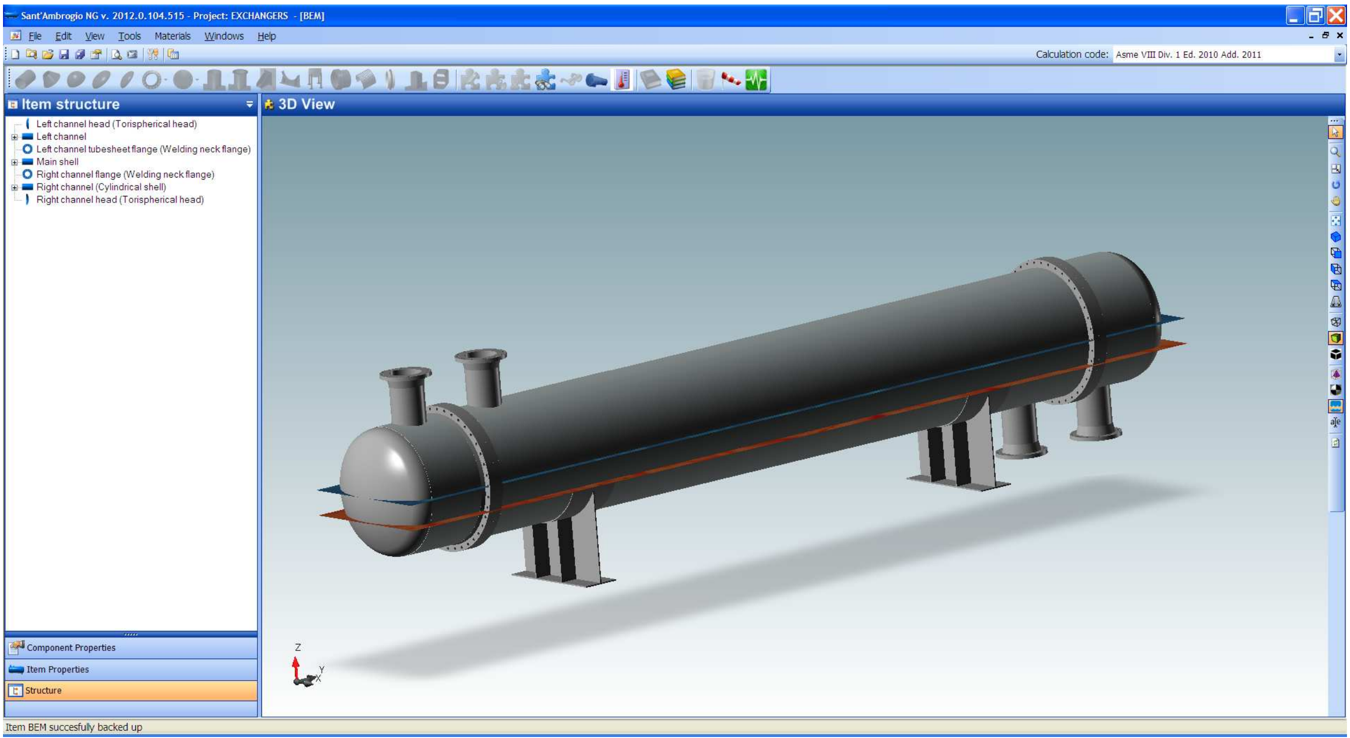
What's being cooked up?

Our new software **NextGen** (**"Next Generation"**) is growing: It covers now the **2010 Edition of ASME Section VIII division 1 and 2 and all the subsequent addenda. Addenda 2011** of ASME VIII division 1 will still be released **also in the classic edition**, well known by all our licensees. This in order to give them the possibility to use also the older version for the purpose of completing possible works already started, without changing the presentation of the calculation reports. Note that **the new division 1 software is able to convert the component input files of the classic edition into input cards for Next Generation** components, to be used in the construction of a given item. Note also that the most important feature of our software, that is the **ability to give an optimized design of every component and also of the vessel as a whole**, has been transferred also in the Next Generation software: in other words our idea is that **the software has to be considered not only a useful tool to certify the compliance of a vessel with a given design standard, but also the first and most important part of its production chain**. In fact the design of a vessel has a sensible influence on all the subsequent fabrication steps and therefore on its final cost: **the purpose of the software is therefore to reduce this final cost at the minimum level compatible with the requirements of the selected standard**. Moreover, **the man hours spent in pressure vessel design are also considered as production man hours**: since these engineering man hours are more expensive than the ones spent for the fabrication, **it is also important to minimize the time spent for design and calculation**. This goal is achieved taking into account the following points.

1. The input must be self explanatory: each input line must be easily understandable, possibly with the use of figures (where specific input dimensions may be outlined when the cursor is placed into the relevant input field) or adding help text taken from the reference standard. Heavy program manuals are useless: if the software is correctly made, in case of doubts it takes less time to test each possible solution than to search a specific topic into the program manual.

2. The time spent by the designer in order to look for missing information must be reduced to a minimum: the designer must find all the information needed for his work on the screen of his PC, without being obliged to leave his desk to get data from the standard or from material specifications .

3. The designer must get enough intermediate information in order to arrive quickly at the most economic solution: when the optimization of a specific component is not possible



automatically, the PC monitor must guide the designer in order to let him find manually the best solution. This guidance may hardly be achieved using the final report, which is generally stuffed with a great quantity of data: in fact the purpose of this report is to show all the calculation details, so that the inspector who has to approve it is able to check the specific formulae prescribed by the standard. Therefore **intermediate screen shots have to be provided, where only the data needed in order to make a decision are shown**. Just to make an example, in the calculation of a fixed tubesheet exchanger the minimum tubesheet thickness can be determined automatically by the software with a trial and error calculation: however **the designer must know whether the resulting thickness depends on the pressure (or temperature) load acting on the tubesheet itself, or comes from the need to avoid overstressing of adjacent components (shell, channel, tubes)**. In fact, when the tubesheet is welded to the channel, it is sometimes possible to get a sensible reduction of its thickness with a slight increase of the channel thickness. It is also important to give the designer the possibility of **testing different possible configurations**, minimizing the time needed for changing one or more input data and repeating the calculation.

4. Particularly after the coming into force of the Pressure Equipment Directive, it is necessary to make a **calculation report which takes into account the stability of all the vessel components, including the ones not specifically considered in the standard**. Therefore the software must provide calculation methods also for these components, taking them from different sources (this is for example the case of **supports**, where the standard may give methods to check the stresses transmitted to the shell where the support is welded, but doesn't give anything to check the stability of the support itself).

At the end, **our aim is to provide a tool which is able to make in the least possible time the most economic design of an entire vessel of any type** (tank, reactor, column or heat exchanger) for all the possible loads (**pressure, static head, weight, wind, earthquake, local loads, etc.**)

Waiting for the finalization of **NextGEN** with wind and earthquake loads, we have now **updated our classic software for calculation of towers** (the program **COLOAS** based on ASME Section VIII division 1). It is now possible to consider **different allowable stresses either for tensile or for compressive loads**, for all the possible conditions (**service, exceptional and hydraulic test**), to be calculated on the basis of the wind/earthquake standards commonly used (a specific reference has now been made to the **ASCE** standard). A **better model for the seismic analysis** has also been used.

In order to make the same update also for the software in accordance with EN 13445, we have to **wait the issue of the future Clause 22 of the standard, which shortly will be launched for the CEN Public Inquiry.** In the new Clause 22 **(Tall Vertical Vessels) WG53** (**SG "Non Pressure Loads"**) **of CEN TC54** has tried to **integrate the calculation philosophy used for pressure loads by EN 13445.3 with the calculation philosophy used for buildings by Eurocode 3 for Steel Structures (EN 1993)**. This integration must necessarily be made in the calculation of tall vertical vessels, where wind and earthquake are deciding for the determination of the thickness. For the time being **the actual version of the column module contained in the software to EN 13445 can also be used**, however the coherence of the various load coefficients provided by EN 13445 for the pressure load and by the Eurocodes for weight, wind and earthquake is left to the user's judgement.

Updates are being made also for **VSR** and **AD 2000** programs, particularly in order to include also into these packages the possibility of considering all the components together for the calculation of the hydrostatic test pressure.

For the **STEMEC** program, which is capable to make a **pressure design of TEMA Shell and Tube Exchangers in accordance with ASME Section VIII division 1, together with a complete price evaluation, a setting plan and a scantling drawing**, we are now supplying also the **standard drawings for AEW exchangers**.

On the 4th October of last year, following to the requests coming from many of our licensees, we have organized a **webinar**, that is a conference made through the web, on the following subject:

The European Pressure Equipment Directive: differences between European and American requirements - Codes and Standards that can be used with the PED

Participation was **free of charge**. We had more than 50 participants from 21 different countries, a lot of them raised questions, showing that not only in Europe, but all over the World there is particular interest for the PED. The problem is that **many people are accustomed to use the ASME Boiler and Pressure Vessel code and they want to use it also in the case of vessels to be installed in Europe and therefore subject to the Pressure Equipment Directive:** that is theoretically possible, however paying the due attention to the proper solution of **a series of not negligible problems**, of which the manufacturer should be made aware. The experiment was positive, and we are now examining the possibility to use the same tool either to **organize training courses via web on Pressure Vessel Design or to make demonstrations of our software**.

We welcome our new licensees:

CAVARZAN Srl – Altivole (Treviso) - **ITALY**
C.SERVICE Srl - Presezzo (Bergamo) - **ITALY**
DUE EMME SpA - Piombino (Livorno) - **ITALY**
PIETRO FIORENTINI SpA – Arcugnano (Vicenza) - **ITALY**
SCHÖLLER-BLECKMANN NITEC GmbH – Ternitz - **AUSTRIA**
SERING ITALIA Srl – Gela (Caltanisetta) - **ITALY**
STEP TRUTNOV - Trutnov - **CZECH REPUBLIC**
TECNIM Srl - Codogno (Lodi) - **ITALY**
TECNOVAPOR Srl – Marano (Parma) – **ITALY**
TURBO Srl – Cesano Maderno (Monza) - **ITALY**
UNICAL AG SpA - Castel D'Ario (Mantova) – **ITALY**

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