How to design a double tubesheet heat exchanger

By following the TEMA RCB-7.1.2 requirements it is possible to calculate heat exchangers equipped with double tubesheets.
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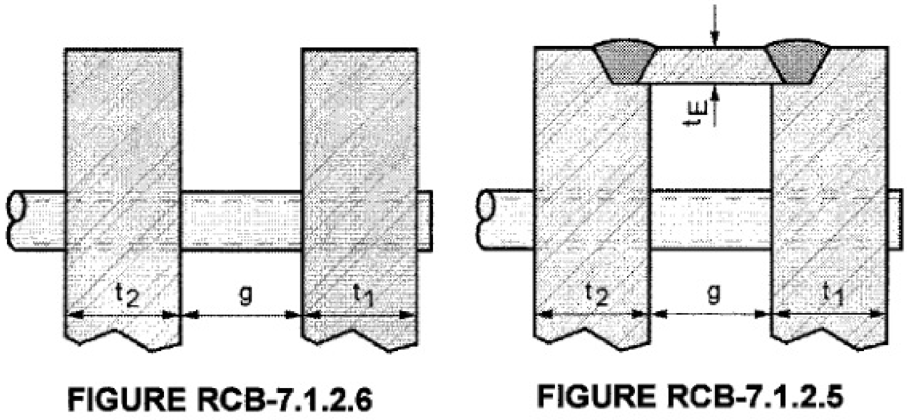


Simplified analysis

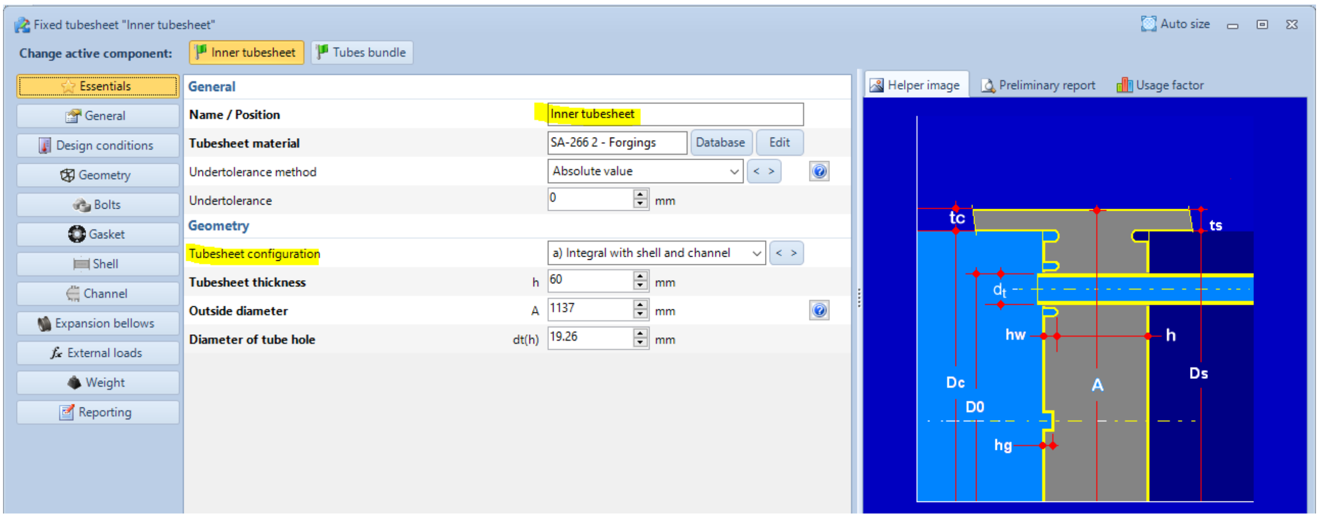
The calculation in NextGen assumes the presence of a single tube plate. The simplest approach is to calculate the single plate that needs greater thickness within the 3D model; generally, this plate corresponds to the external, flanged one: the same thickness will be adopted for the tube plate welded during construction.

Complete analysis

This assumption is valid for tubesheets of the same material and without substantial geometric differences and design conditions between the two sides: for a more complete verification, which covers more complex scenarios, you can use the following approach.

You can model the exchanger via the Heat Exchanger Wizard with the configuration welded on the shell side and bolted on the tube side; the design condition for this configuration will be that with full pressure on both the tube side and the shell side.

Next, you can add an additional tube sheet as additional component, which you will configure as an integral tube sheet on both sides.

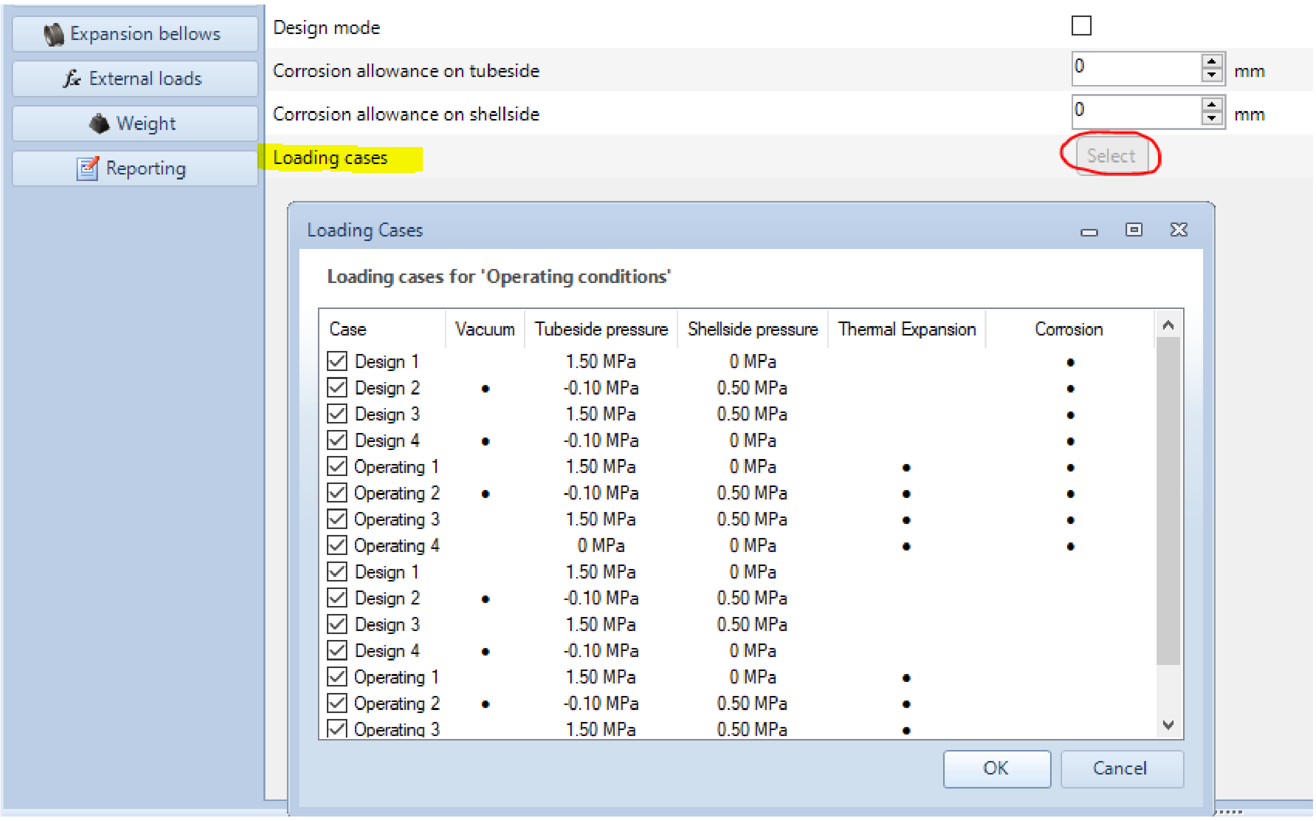


This tubesheet will automatically use the tube bundle defined in the 3D view and may have different geometric and material characteristics from the "external" plate.

> *In some cases it is not possible to completely exclude the presence of shell or channel in the calculation of the tubesheet, since there are (for example in ASME) minimum dimensions for these components. It will therefore be necessary to make some assumptions in this regard.*

Further refinements

The presence of two separate plates entails the lack of some scenarios foreseen by the Loading Cases present in the standards (ASME, EN 13445): if you deem it appropriate, you can manage to exclude the non-applicable Loading Cases by modifying the characteristics of the tubesheet:



This option is to be evaluated in particular with the presence of the vacuum, in cases where the Loading Case that considers the vacuum becomes the determining one.

A further tool available to cover more complex cases is the possibility of defining different design conditions within the Item Properties: NextGen will verify all the conditions simultaneously and you will give you the possibility to print the reports of the entire item or individual components corresponding to a specific design condition.

> *The procedure reported here is to be understood as a suggestion, derived from the Sant'Ambrogio experience: you should evaluate it according to your own experience and the opinion of your Authorized Body.*

Additional calculations

NextGen does not natively cover all the calculations you need to perform in this scenario.

TEMA requires a minimum distance between the two plates (distance "g") according to RCB-7.1.2.5.2 and RCB-7.1.2.6.2 equal to:

RCB-7.1.2.5.2 MINIMUM SPACING BETWEEN TUBESHEETS

The minimum spacing g, in. (mm), between tubesheets required to avoid overstress of tubes resulting from differential thermal growth of individual tubesheets is given by:

$$g = \sqrt{\frac{d_0 \Delta r E_T}{0.27 Y_T}}$$

where

d_0 = Tube OD between tubesheets, in. (mm).

Y_T = Yield strength of the tube material at maximum metal temperature, psi (kPa).

Δr = Differential radial expansion between adjacent tubesheets, in. (mm). (Measured from center of tubesheet to D_{TL}).

$$\Delta r = \left| \left(\frac{D_{TL}}{2} \right) \left(\alpha_2 \Delta T_2 - \alpha_1 \Delta T_1 \right) \right|$$

where

D_{TL} = Outer tube limit, in. (mm).

In the same way, it defines the calculation of the minimum thickness of the joining element between the tubesheets, when present. Please refer to the norm for the details of the calculation, remembering that it is possible to insert calculation notes in NextGen reporting the results of these equations, by modifying the component in its "Reporting" section.