APRIL 2020 ISSUE 02

XCHANGER XPRESS

The official company newsletter of Precision Equipments

Expansion Bellows in Shell & Tube Heat Exchangers

PRECISION EQUIPMENTS

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An Expansion Bellow is a specially-designed component of compact dimensions with convolutions that allow differential movement between Shell & Tubes in a Heat Exchanger. These bellows simultaneously withstand the coincident Pressure and Temperatures at all the operating conditions of the Exchanger. They are essentially designed for required fatigue cycle life.

Expansion Bellows are classified into Two types namely, Thick wall Expansion Bellow & Thin wall Expansion Bellow. Thick wall type are usually called as Expansion Joints.

Thick-wall bellows are used on the shell of Fixed Tube Sheet Heat Exchangers where lesser Axial expansion is expected and **a**re fabricated into convolutions from a plate of generally the same material and thickness as the Shell.

Thick Wall Bellow

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Thin wall Bellows are used when larger axial movements are expected. They are used at internal tail pipe assembly of a AES TEMA Type Single pass Floating Head Heat Exchanger, ref figure-1. As well as on the shell of Fixed Tube Sheet Heat Exchanger, ref figure-2. Thin wall bellows convolutions are generally hydro / roll formed. These can be single ply or multi ply of light gage to suit design requirement. They are generally made from Stainless Steel or Incoloy.

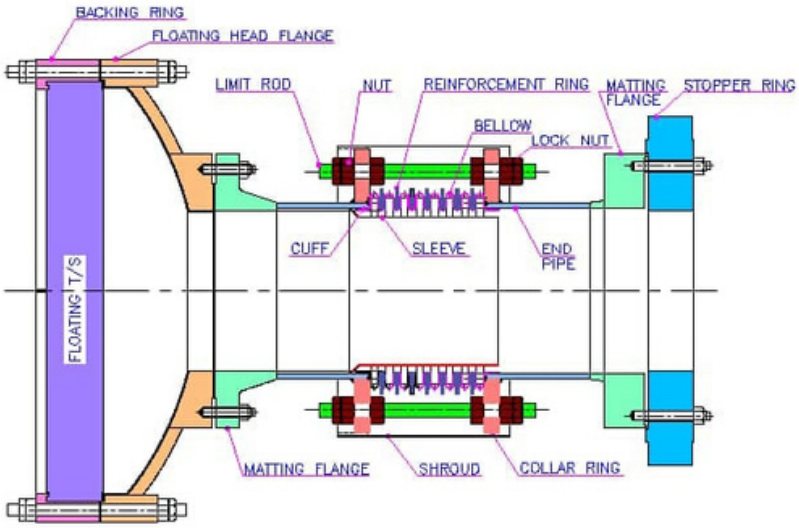

Figure. 1

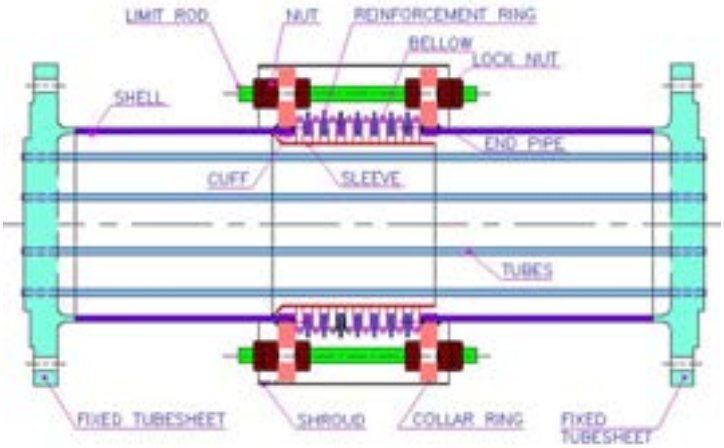

Figure. 2

Thin Wall Bellow

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Thick wall Expansion bellows are designed as per TEMA (Tubular Exchanger Manufacturers Association) & Appendix-5 of ASME Sec.VIII Div.1 whereas Thin wall expansion bellows are designed as per EJMA (Expansion Joint Manufacturers Association) & Appendix-26 of ASME Sec.VIII Div.1.

In a Fixed Tube Sheet Heat Exchanger, Shell and Tubes are fixed between Tube Sheets. If there is large Temperature difference between operating fluids during various operating conditions, there is a chance of over stressing of Shell / Tubes / Tube To Tube Sheet joints due to differential expansion / contraction of Shell & Tubes.

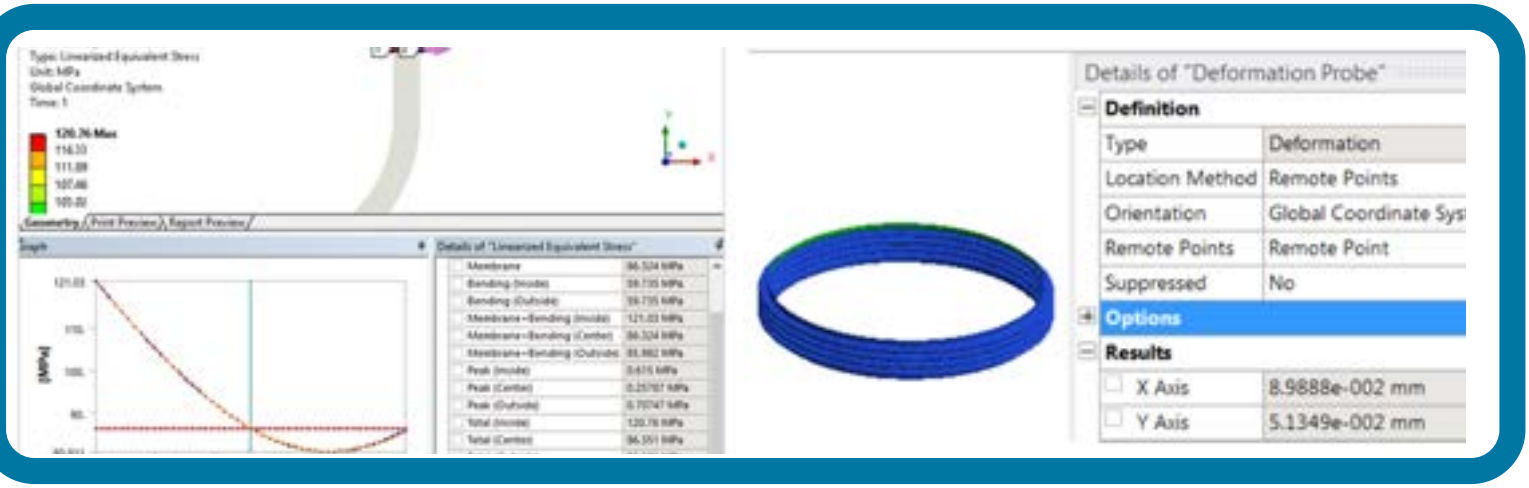
If Tubes are hotter than Shell, tube tends to Expand relatively & Shell may try to contract or vice versa. This expansion/contraction will create bending Stress in Tube Sheets, Tensile stress / Compressive stress in Shell / Tubes. Expansion Bellow will reduce all these stresses and provide an optimized design.

In case of a thick wall bellow in a fixed tube-sheet Heat Exchanger, Finite Element Analysis (As per TEMA) shall be performed to get the Spring rate (Corroded & Uncorroded) and the same has to be checked in Tube-sheet Calculation for optimized design. Whereas for Thin wall bellows the Spring rate calculation shall be performed as per EJMA and the same shall be checked in Tube-sheet Calculation for optimized design.

More over different operating conditions like Normal Operation, Shell side Start-up, Tube side Start-up, Shell side Shut down, Tube side Shut down, Steam out Conditions or other upset conditions also decides the requirement of Expansion Bellow in Shell and Tube Heat Exchangers. Larger the Temperature difference, more likely the requirement of Expansion Bellow.

Finite Element Analysis

FEA (Finite Element Analysis) of thick wall bellows are done to investigate and validate its behaviour. Bellow are some examples of FEA work down on thick wall bellows.



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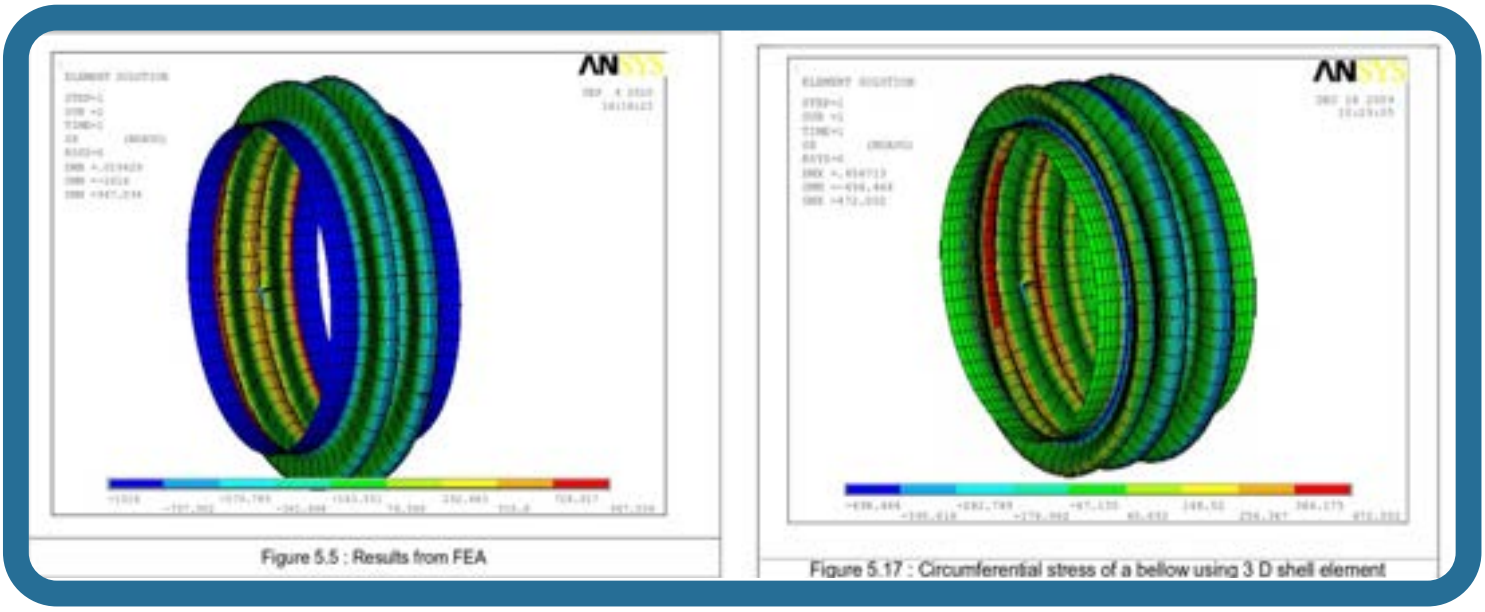

Figure 5.5 : Results from FEA

Figure 5.17 : Circumferential stress of a bellow using 3 D shell element

Hope you enjoyed the news letter and please stay safe !!

Safety During COVID-19

WASH HANDS WITH WATER AND SOAP/SANITIZER,

AVOID CONTACT WITH SICK PEOPLE

DON'T TOUCH EYES, NOSE OR MOUTH WITH UNWASHED HANDS

DON'T EAT RAW FOOD, THOROUGHLY COOK MEAT AND EGGS

AVOID CONTACT WITH ANIMALS AND ANIMAL PRODUCTS

STAY AT HOME

AVOID CONTACT WITH OTHERS

COVER YOUR NOSE AND MOUTH WHEN

KEEP OBJECTS AND SURFACES CLEAN

WEAR A SURGICAL MASK