The temperature distribution on the flange is shown in Figure [8] for a temperature range from 100̊C up to 500̊C. The equations for thick cylinder analysis and its temperature distribution are applicable only away from the end caps. These equations are not applicable near the junction on thick walled caps. This is usually treated by experimental approaches or by finite element methods [12].

6. Conclusions

- The flange stress is reduced with the increase of its thickness up to 30 mm, however, the stress is found to increase again for thicknesses higher than 30 mm.
- For the same flange thickness, when the temperature increases the flange stress is reduced.
- For the same temperature, the flange displacement is reduced with the increase of the flange thickness.
- For the same thickness, the flange displacement increases slightly for temperatures up to 200˚C and reduces slightly for temperatures higher than 200̊ C up to 400˚C. However, for temperatures higher than 400˚C the displacement reduces greatly.
- The bolt stresses are found to reduce with the increase of thickness up to 20 mm. and reduce slightly for thicknesses higher than 20 mm.
- The increase of temperature reduces the bolt stresses because of both the pressure-temperature rating and the joint relaxation due to the joint thermal expansion.
- The flange temperature distribution increases near to the cap and diminishes near to the flange side.
- The temperature distribution shows lower temperature in the inner surface than the internal fluid temperature because of the low thermal resistance on the flange, which shows that the flange acts as a cooling fin on the joint.
- The joint can perform up to 400˚C with a safe operating behavior under different operating conditions of internal pressure and bolt preloading.

References:

[1] Nash D.H., Spence J., Tooth A.S., Abid M. and Power D.J., “A parametric study of metal-to-metal full face taper-hub flanges,” Int. J. Pressure Vessels and Piping, 77,791–797 (2000).

[2]Abid M. and Nash D.H., “Comparative study of the behaviour of conventional gasketed and compact non-gasketed flanged pipe joints under bolt up and operating conditions,” Int. J. Pressure Vessels and Piping, 80,831–841 (2004).

[3] Abid.M and Nash D.H., “A parametric study of metal-to-metal contact flanges with optimized geometry for safe and no-leak conditions,” Int. J. Pressure Vessels piping, 81, 67–74 (2004).

[4] Abid.M., “Determination of safe operating conditions for gasketed flange joint under combined internal pressure and temperature: A finite element approach,” Int. J. Pressure Vessels piping, 83, 433–441 (2006).

[5]Couchaux M., Hjiaj M., Ryan I.and Bureau A.,“Effect of contact on the elastic behaviour of bolted connections” NSCC , 288-295 (2009).

[6] Chavan U.S., Dharkunde R. B. and Joshi S.V., “Parametric study of flange joint and weight optimization for safe design and sealability FEA approach” International Journal of Advanced Engineering Technology, Vol.I, Issue III, 266-276 (2010).

[7] Zasiah Tafheem and Khan Mahmud Amanat “Investigation on bolt tension of flanged pipe joint subjected to bending” 4th Annual Paper Meet and 1st Civil Engineering Congress, December 22-24 (2011).

[8]Abdel-Ghany W.E., Ebied, S.J. and Salama M., “Design of Metal-To-Metal Contact Flanges of the Pressure Vessels Using Finite Element Analysis” Int. J.Alazhar university JAEUS, Vol 9, Number 32, 925-935 July (2014).

[9] American Society of Mechanical Engineers, ASME boiler and pressure vessel code. Section II, Part D (2004).

[10]American Society of Mechanical Engineers, ASME pipe flanges and flanged fittings B16.5 (2003).

[11] ABAQUS 12, Abaqus Analysis User's Manual.

[12]Ansel C. Ugural, “Mechanical Design an Integrated Approach” 1st edition (2004).