Thermal Analysis of ITER VVTS Flange Area

Objectives

The objectives of the thermal analysis presented in this section is to evaluate an impact of the actively cooled pipe position on to the VVTS insulation performance.

Initial data

The boundary conditions, properties and surface emmisivities are taken the same to those, which have been used in calculation presented in the previous sections.
Only baking regime has been selected for the analysis, i.e. the vacuum vessel temperature - 200 °C.

Two possible positions of the actively cooled pipes have been considered:
case #1 - active cooling pipe is at the maximum distance from the flange;
case #2 - active cooling pipe is close to the flange.

Results of analysis

A temperature state for different cases are shown:
for Case # 1 in Fig. 4.26 and for Case # 2 in Fig. 4.27.
A temperature distribution in the thin fin are shown:
for Case # 1 in Fig. 4.28 and for Case # 2 in Fig. 4.29.
Heat flux to the TFC distribution along thin fin –
for Case # 1 in Fig. 4.30 and for Case # 2 in Fig. 4.31.
The basic results of the performed analysis are presented in Table 4.3.

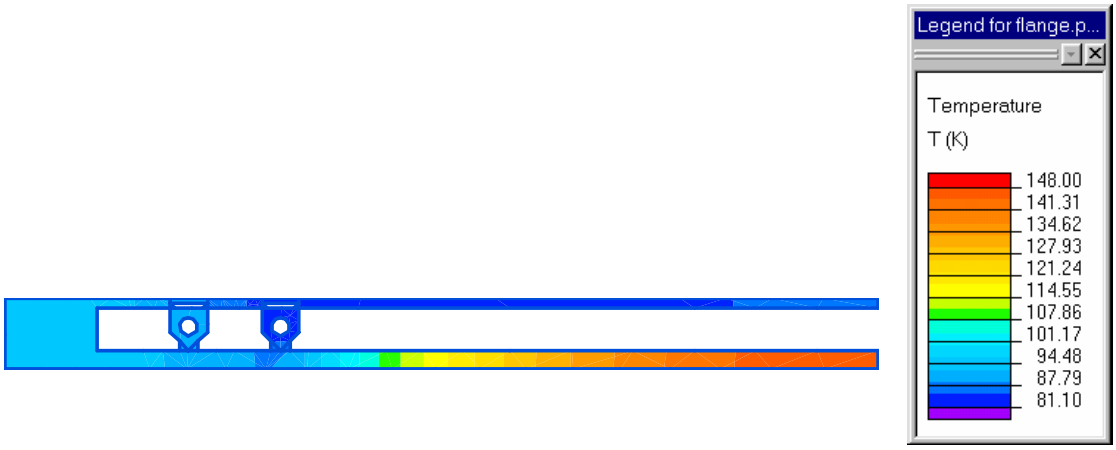

Fig. 4.26. VVTS panel temperature state.
Case #1

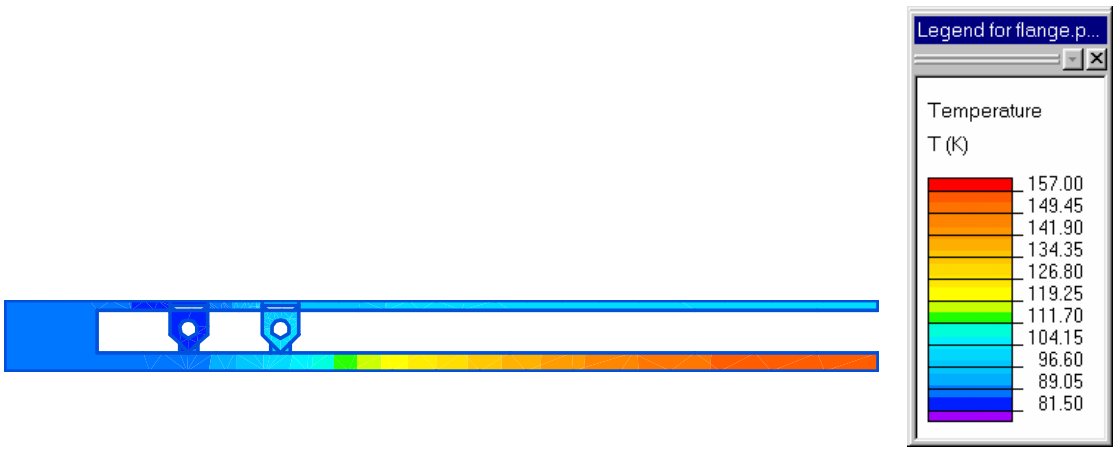

Fig. 4.27. VVTS panel temperature state.
Case #2

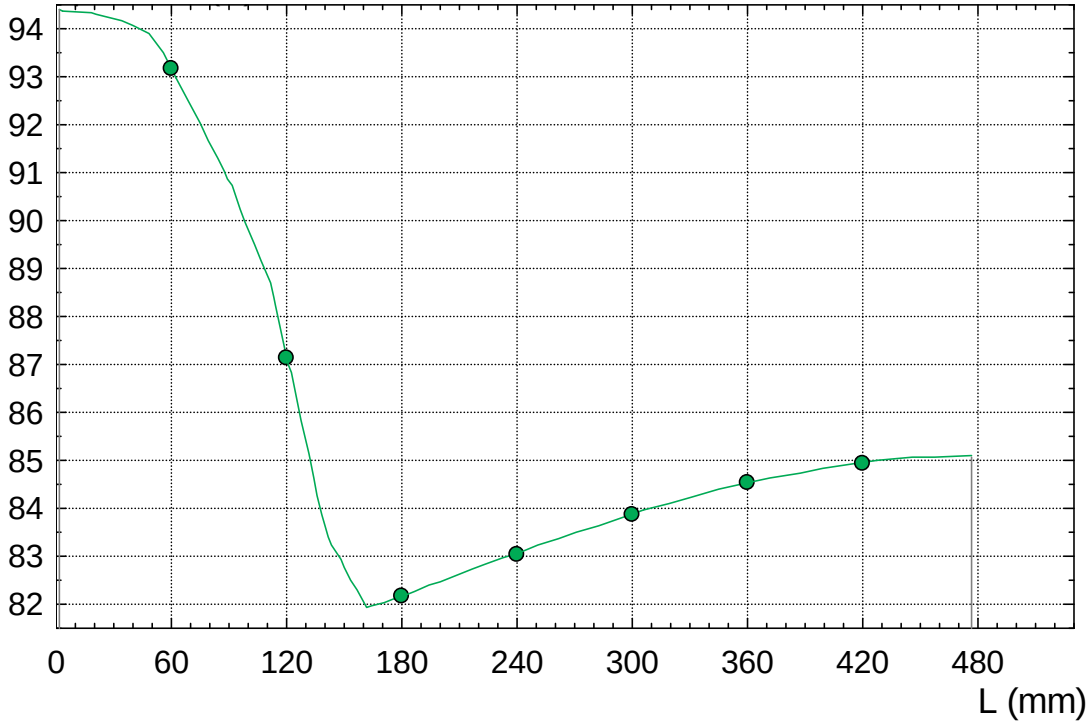

Fig. 4.28. Temperature distribution along thin fin.
Case #1

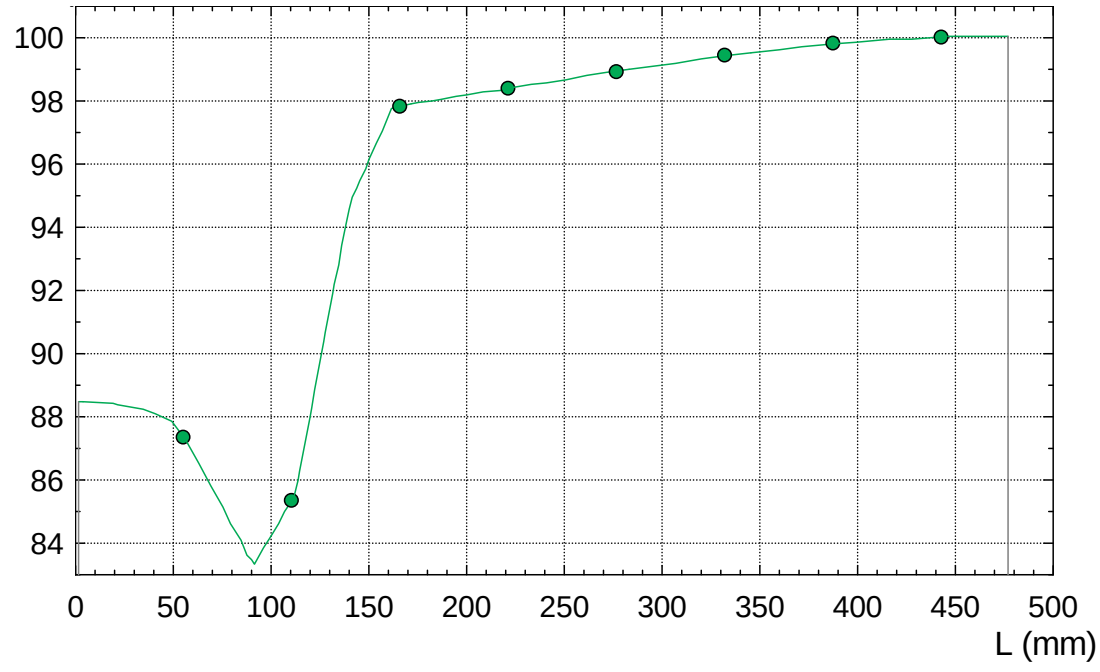

Fig. 4.29. Temperature distribution along thin fin.
Case #2

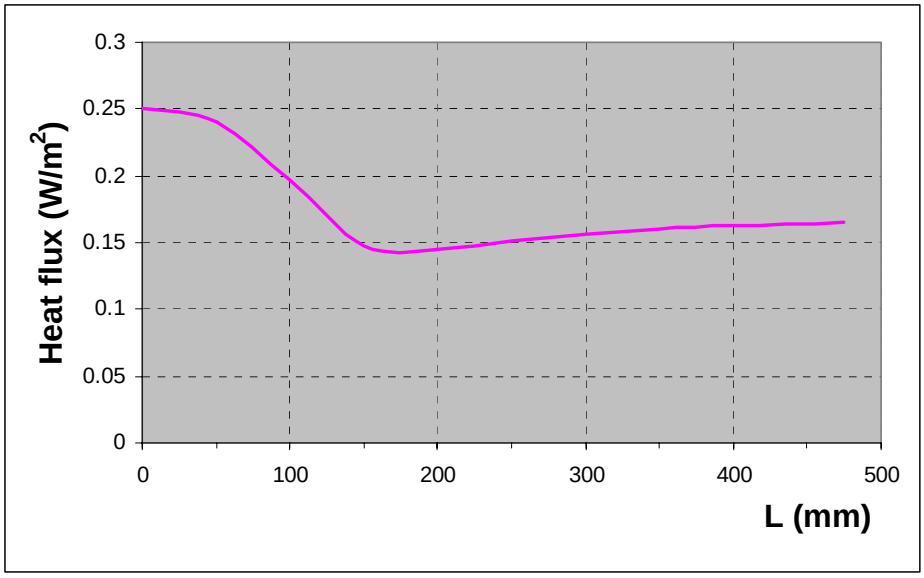

Fig. 4.30. Heat flux to TFC distribution along fin.
Case #1

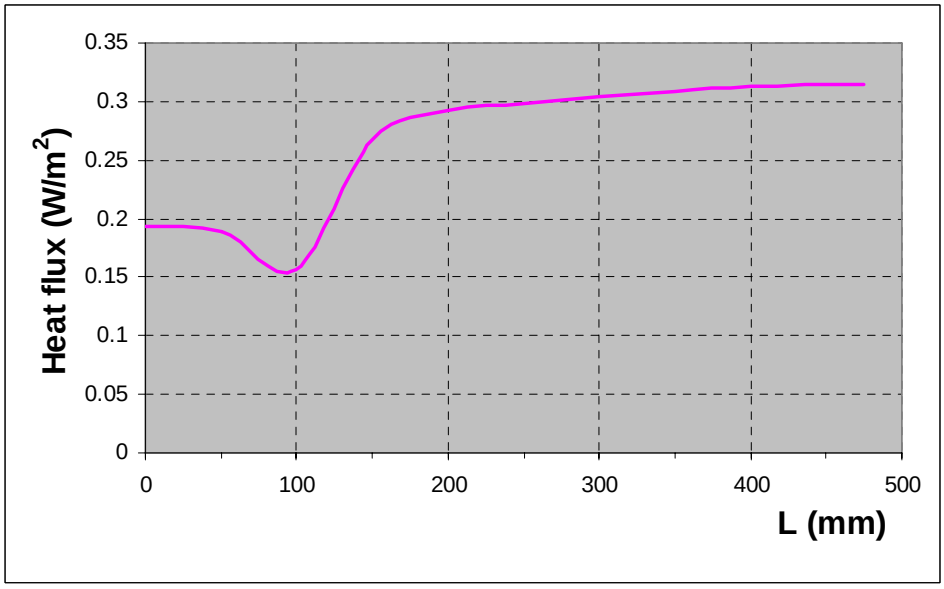

Fig. 4.31. Heat flux to TFC distribution along fin.
Case #2

Table. 4.3

Case	Active cooling tube	VV tempera-ture	Max tempera-ture	Heat flux		
				Max local	Ave-rage	Exceeding the base radiation
		°C	K	W/m^2	W/m^2	
#1	Distant from flange	200	148	0.25	0.17	1.47
#2	Nearest to flange	200	157	0.31	0.27	2.32

Conclusion

Based on the obtained results of the comparative analysis the following conclusions could be declared:

- cooling of the panel by the closest to a flange pipe causes in 24 % and even in 59 % increasing of maximal and average heat influx to the TFC respectively;

- at the panel cooling by the closest to the flange pipe the second (redundant) pipe will serve as a thermal bridge between thick and thin panels and by doing so leads to increase of the temperature level of the thin fins. The later results in the heat influx to the TFC increasing from 0.17 W/m^2 to 0.27 W/m^2;

- at the panel cooling by the distant from the flange pipe, it serves as a thermal anchor which reduces the thin fin temperature, but in the same time the surface temperature of the flange faced to the TFC increases from 88.5 °C to 94.5 °C.