For each of the ten frequency pairs, by interchanging the dependent and independent variables we obtained two β values for each pair and the mean value of these results is adopted as the radio spectral index, as suggested in Uyaniker et al. (2004). Regarding only three frequencies (because their spectrum lies on straight line, see Figure 7) 1420, 820 and 408 MHz, the average value of spectral index from $T-T$ is $<\beta_{TT}>_3 = 2.78 \pm 0.41$. Taking into account all five frequencies, we get $<\beta_{TT}>_5 = 2.63 \pm 0.30$. It can be noticed that, as expected, this value agrees well with the corresponding value obtained from the spectrum (see Uyaniker et al. 2004).

Then we calculated the mean value of the spectral index: regarding spectrum and $T-T$ graphs. Between 1420, 820 and 408 MHz we obtained $<\beta>_3 = 2.77 \pm 0.22$, and between 2720, 1420, 820, 408 and 34.5 MHz we obtained $<\beta>_5 = 2.64 \pm 0.20$.

4. DISCUSSION

The spectral index variations with position of more spatial features within the Cygnus loop can be found in the paper by Leahy (1999). He studied radio spectral indices by the $T-T$ plot method between 2695, 1420 and 408 MHz and found that the bright radio filaments all show negative curvature (steeper at higher frequency), and that regions dominated by diffuse emission show positive curvature (flatter at higher frequency).

It can be noticed that the mean value of spectral index for the Cygnus loop is a little higher then the corresponding value obtained from the literature (see Uyaniker et al. 2004 or Leahy & Rogers 1998). The reason for this is the different areas used for data of the Cygnus loop in these papers. In both papers they used square areas (see page 917 from Uyaniker et al. 2004, and page 786 from Leahy & Roger 1998). In these square areas they took into account parts of the Cygnus loop and parts of the background radiation near the loop (these parts we do not take into account). We take in account only higher intensity regions from these areas (see Figures 1–5).

In order to compare our values for the brightnesses with results for the fluxes given in other papers, we transform their calculated fluxes into brightnesses at 1000 MHz. Knowing the loop size Ω we reduce the flux densities given in Jy to brightnesses given in $10^{-22}\,\mathrm{W/(m^2\ Hz\ Sr)}$ by means of equation (2) and then, using the spectral indices, the brightnesses are extrapolated to 1000 MHz according to relation (3).

In our previous paper (Borka Jovanović & Urošević 2009a) we transformed the flux densities for the Cygnus Loop given in Roger et al. (1999) at 22 MHz ($S_\nu = 1378$ Jy) and Reich et al. (2003) at 863 MHz ($S_\nu = 184$ Jy) into Σ_{1000} using the loop size $\Omega = 240' \times 170'$ from Reich et al. (2003) and the spectral index $\beta = 2.49$ from Trushkin (2002). We obtained that the values from Borka Jovanović & Urošević (2009a) agree with previous data. In this paper, we use our derived value for the spectral index $\beta_5 = 2.66 \pm 0.09$, and obtain even better agreement. From the flux densities given in the paper mentioned, we calculated the following values for radiation intensities: $\Sigma_{1000} = 3.22 \times 10^{-22}\,\mathrm{W/(m^2\ Hz\ Sr)}$ from the flux given in Roger et al. (1999) and $\Sigma_{1000} = 4.84 \times 10^{-22}\,\mathrm{W/(m^2\ Hz\ Sr)}$ from the flux given in Reich et al. (2003).

Using our calculated β_5 and applying relation (3) to our calculated values of Σ_ν at 2720, 1420, 820, 408 and 34.5 MHz, for Σ_{1000} we obtain the values given in Table 3. Absolute errors for brightnesses at 1000 MHz are calculated in this way: $\Delta\Sigma_{1000} = (\Sigma_{1000}/\Sigma_{\nu 1})\,(\Delta\Sigma_{\nu 1} + \Sigma_{\nu 1} \cdot \ln(\nu_1/1000) \cdot \Delta\beta)$, where ν_1 takes values 2720, 1420, 820, 408 and 34.5 MHz.

Information about variations of the brightness and the spectrum over the radio image is presented by Leahy & Roger (1998) and by Uyaniker et al. (2002). The average values reduce the information imprinted in variations of brightness and spectrum over the radio image but give us other interesting information, like the explosion energy, the surface brightness and the distance to the Cygnus radio loop.

With regard to the loop borders in Figures 1–5, we derived the loop area at each frequency, as well as the corresponding angular radii (see Table 4). An angular radius is obtained in this way: our derived loop area, when approximated with a circle of the same area, gives the possibility of determining the angular radius as $\theta = \sqrt{\Omega/\pi}$. These areas can be compared to the areas calculated by other authors, e.g., $9(^\circ)^2.80$ at 1420 MHz (Leahy 2002) and $11(^\circ)^2.33$ at 863 MHz (Reich et al. 2003). When their areas are recalculated into angular radii in the way we described, the result are: $1^\circ.77$ at 1420 MHz (Leahy 2002) and $1^\circ.90$ at 863 MHz (Reich et al. 2003). It can be noticed that we obtained somewhat smaller values, but it has to be taken into account that other authors estimated only the rectangular map size while we estimated the loop size (inside its contour borders) exactly.

The relation between surface brightness (Σ) and diameter (D) for supernova remnants (SNRs) –so-called the $\Sigma - D$ relation– is appropriate for the description of the radio brightness evolution of these sources. The empirical relations should be used