

Appendix 6: Equations for the Curves of Figures 3.38 to 3.40

When greater accuracy is required, the following equations can be used to represent the curves plotted in Figures 3.38 to 3.40. The various symbols used are presented in [Figure A6.1](#). The subscript T is for the truncated compound parabolic collector (CPC) design.

The following equations apply for a full and truncated (subscript T) CPCs ([Welford and Winston, 1978](#)):

$$f = \alpha'[1 + \sin(\theta_c)] \quad (\text{A6.1})$$

$$\alpha = \frac{\alpha'}{\sin(\theta_c)} \quad (\text{A6.2})$$

$$h = \frac{f \cos(\theta_c)}{\sin^2(\theta_c)} \quad (\text{A6.3})$$

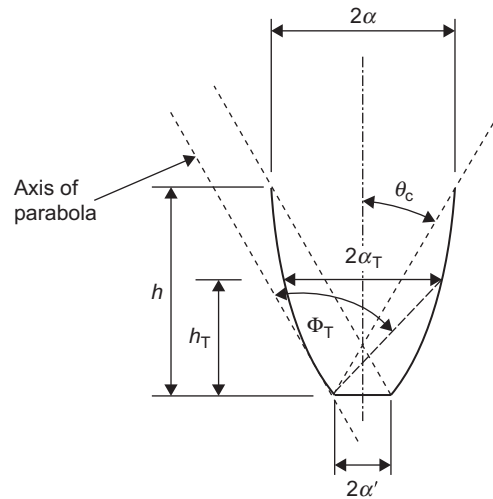


FIGURE A6.1

A truncated CPC. Its height-to-aperture ratio is about one half the full height of a CPC.

$$\alpha_T = \frac{f \sin(\Phi_T - \theta_c)}{\sin^2\left(\frac{\Phi_T}{2}\right)} - \alpha' \quad (\text{A6.4})$$

$$h_T = \frac{f \cos(\Phi_T - \theta_c)}{\sin^2\left(\frac{\Phi_T}{2}\right)} \quad (\text{A6.5})$$

For a truncated CPC,

$$C = \frac{\alpha_T}{\alpha'} \quad (\text{A6.6})$$

For a full CPC,

$$C = \frac{\alpha}{\alpha'} \quad (\text{A6.7})$$

By replacing α from Eq. (A6.2),

$$C = \frac{1}{\sin(\theta_c)} \quad (\text{A6.8})$$

The reflector area per unit depth of a truncated CPC, A_{RT} , is given by:

$$\frac{A_{RT}}{2\alpha_T} = \frac{f}{2} \left[\frac{\cos(\Phi/2)}{\sin^2(\Phi/2)} + \ln \cot\left(\frac{\Phi}{4}\right) \right] \Bigg|_{\theta_c + \pi/2}^{\Phi_T} \quad (\text{A6.9})$$

For Eq. (A6.9), if $\Phi_T = 2\theta_c$, then $A_{RT} = A_R$.

The average number of reflections, n , is given by (Rabl, 1976):

$$n = \max \left\{ C \frac{A_{RT}}{4\alpha_T} - \frac{x^2 - \cos^2(\theta)}{2[1 + \sin(\theta)]}, 1 - \frac{1}{C} \right\} \quad (\text{A6.10})$$

where

$$x = \left[\frac{1 + \sin(\theta)}{\cos(\theta)} \right] \left\{ -\sin(\theta) + \left[1 + \frac{h_T}{h} \cot^2(\theta) \right]^{1/2} \right\} \quad (\text{A6.11})$$

References

- Rabl, A., 1976. Optical and thermal properties of compound parabolic concentrators. *Sol. Energy* 18 (6), 497–511.
- Welford, W.T., Winston, R., 1978. *The Optics of Non-imaging Concentrators*. Academic Press, New York.