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INSTITUTE OF ENGINEERING; UNIVERSITY OF ALGARVE; CAMPUS DA PENHA; FARO-PORTUGAL

**Box Cooker Glazing: Sloped or Horizontal?**  
**A Study of the Optical Efficiency**  
Daniel Feuermann

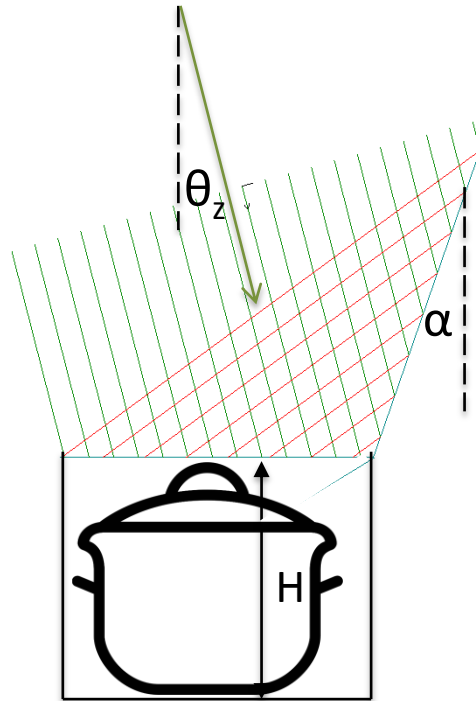
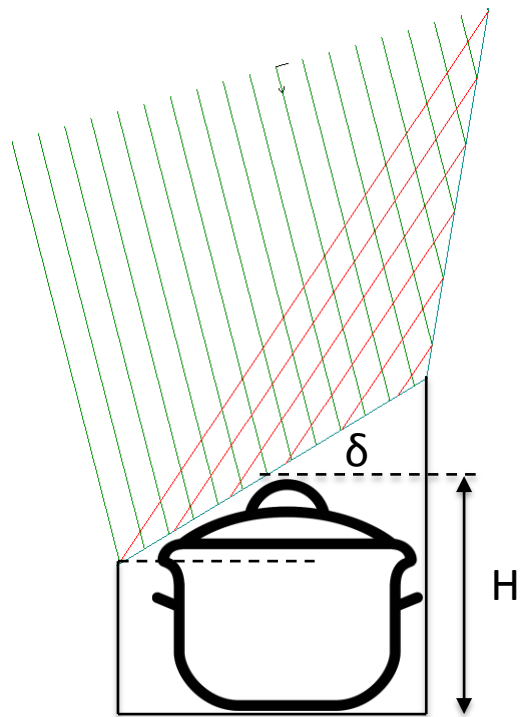
**Ben-Gurion University of the Negev,  
Blaustein Institute for Desert Research,  
Israel**

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Typical box cooker





## Basis for comparison and assumptions:

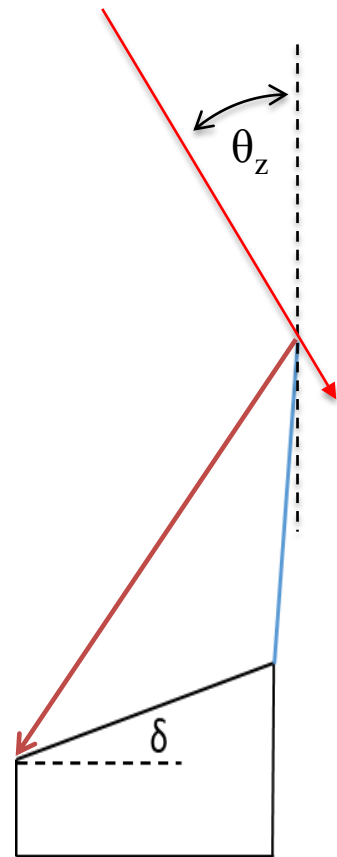
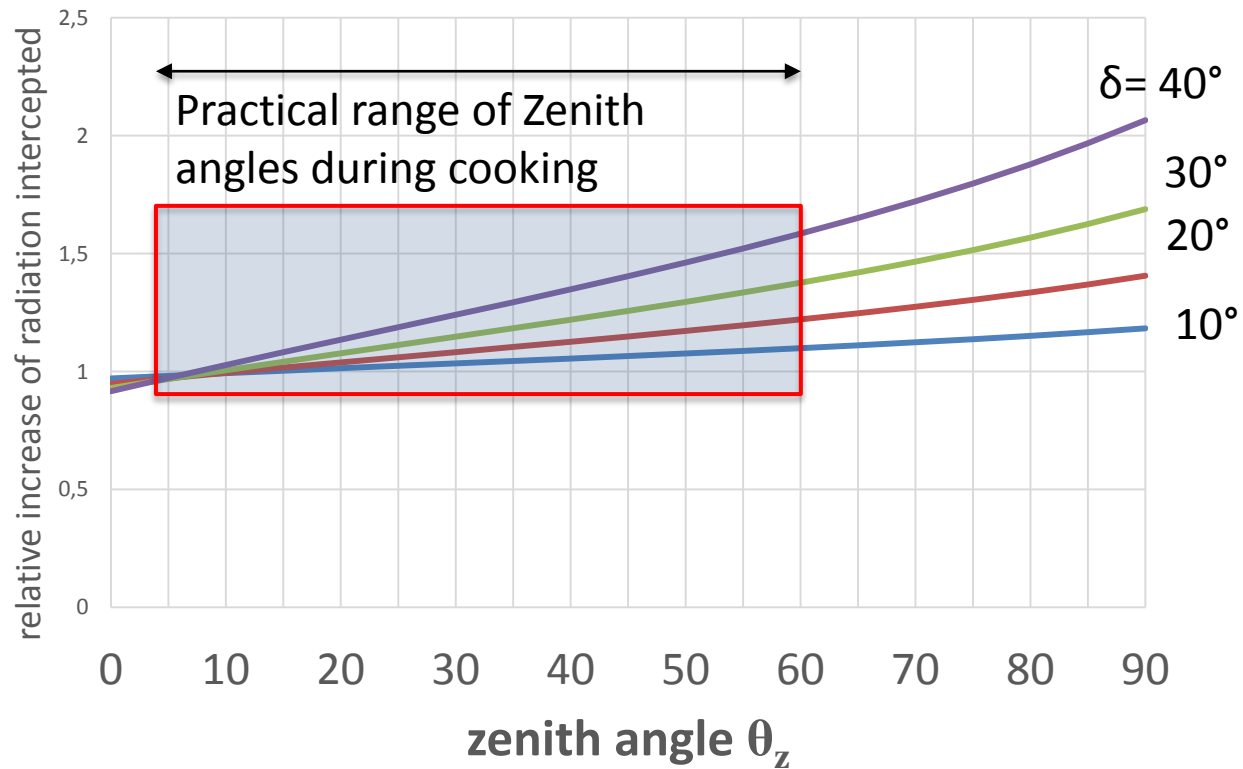
- Identical footprint, variable slope angle  $\delta$
- Cooker is aligned azimuthally (i.e., facing the sun at all times)
- Mirror is size of glazing, its reflectivity  $\rho = 0.9$
- Two 4 mm clear glass panes (abs. coeff.  $K=9.25\text{m}^{-1}$ )
- Mirror is always tilted ( $\alpha$ ) to maximize radiation input  
( $\alpha=30^\circ-\delta/3-2/3 \theta_z$ )
- Negligible increase in heat loss due to change in glazing area (see later)

Example:

Slope angle  $\delta = 30^\circ$

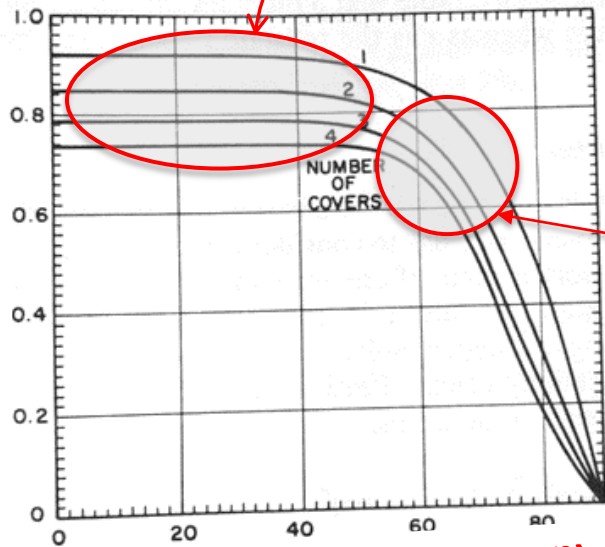
Zenith angle  $\theta_z=15^\circ$

enhancement due to slope  $\delta$ ,  
purely geometric

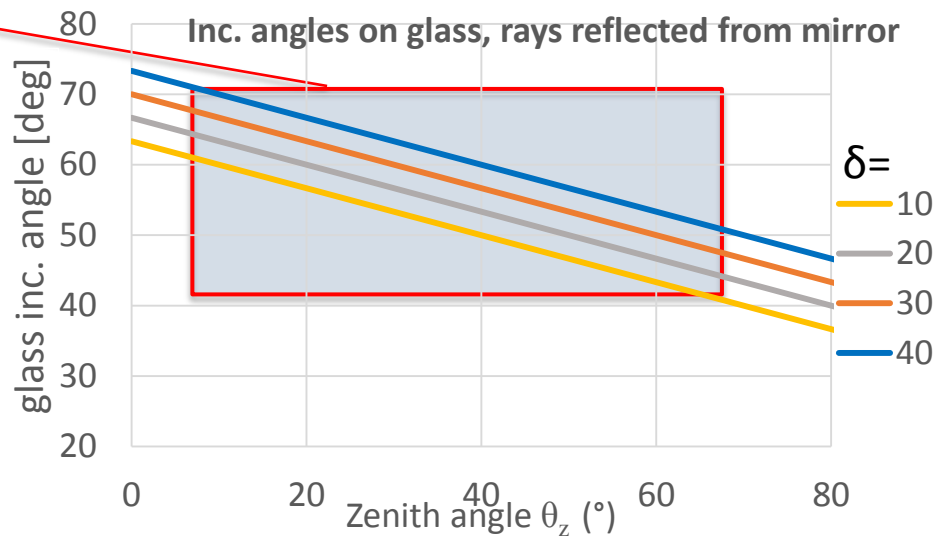
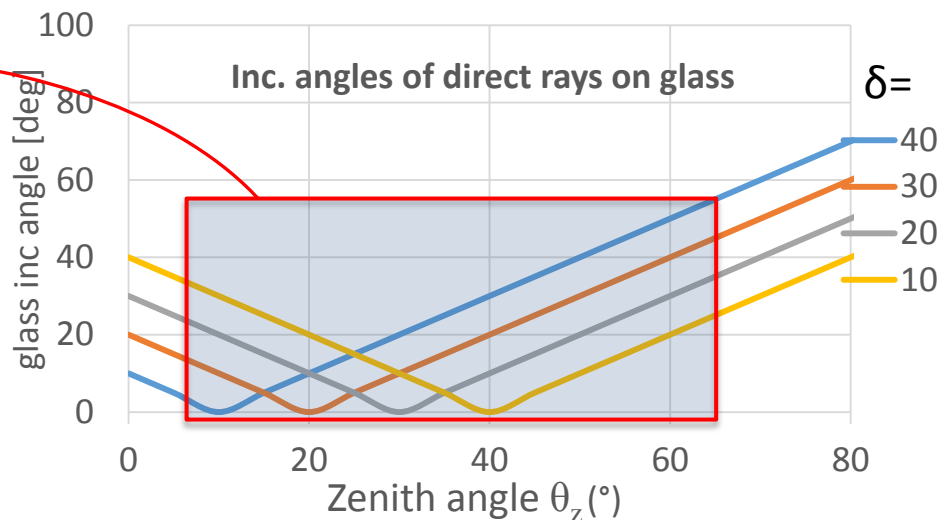
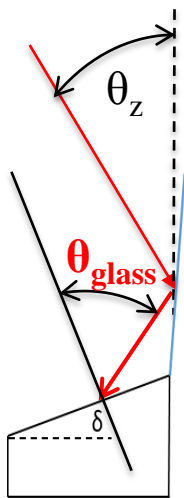
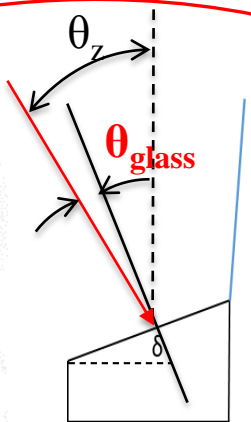


# Effect of Fresnel reflections

Transmittance

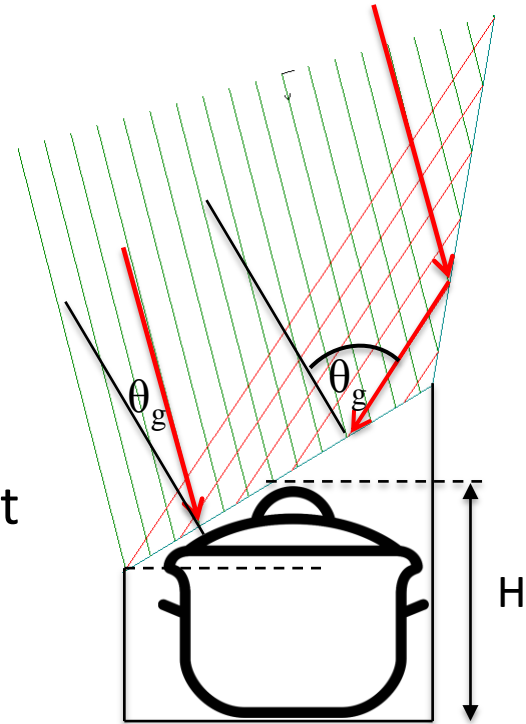


Glass incidence angle  $\theta_{\text{glass}}$  (°)

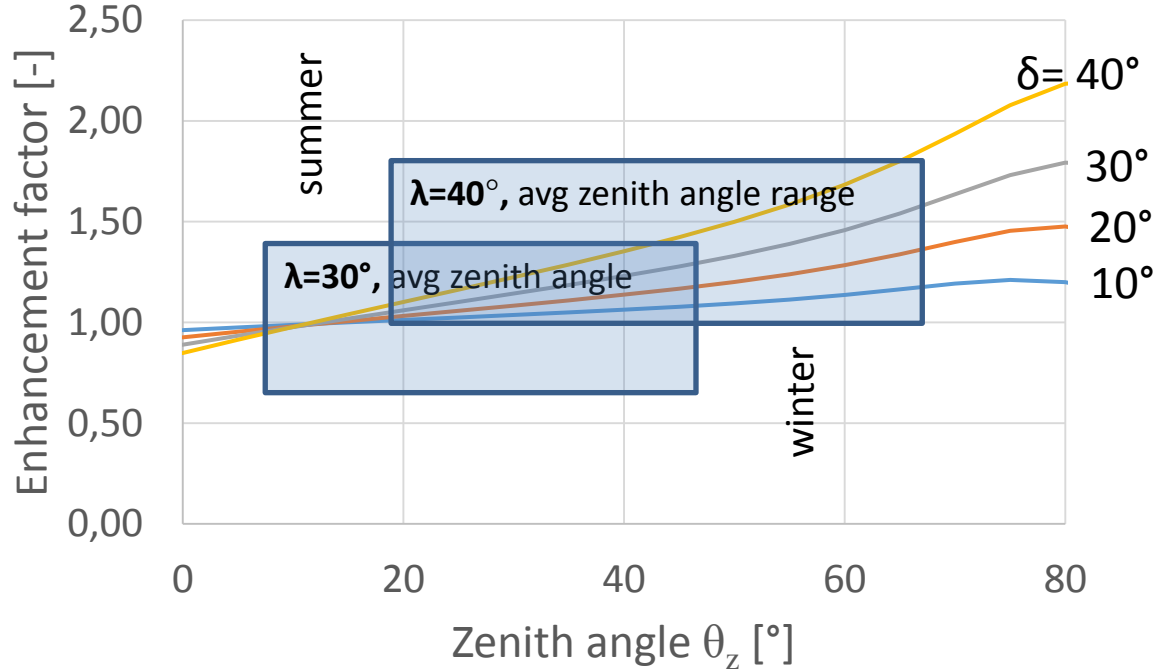


Points to observe:

- The glazing and mirror areas increase by  $1/\cos(\delta)$ .
- Sloped glass causes higher incidence angles  $\theta_g$  of **reflected** rays,
- causing larger Fresnel reflections, and higher absorption in the glass. But it is better for direct radiation (smaller angle on the glass).
- The total intercepted beam radiation increases with  $\delta$  (and to good approximation also the diffuse radiation, but not by the same factor).
- The possible advantage varies with the zenith angle, higher Zenith angle demands higher  $\delta$ .



## Relative energy input for sloped aperture glass compared to horizontal glass, same footprint

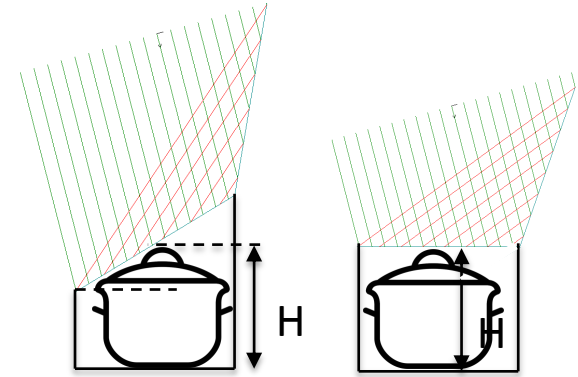


- Includes mirror reflectivity of 90%
- 4mm glass,
- Extinction coeff.  $K=9.25\text{m}^{-1}$
- $\lambda$ : Latitude

# Comments

- Additional heat loss:

Letting the **average box height** constant, only the larger Glazing area adds to the heat loss: for typical values of side insulation and glazing loss coefficients, the additional loss when  $\delta=30^\circ$  is ~6 to 10%, while at medium zenith angles, the energy input is 25-35% higher in summer, and up to 50% higher in winter.



- Diffuse radiation

Assuming it is ~20% of radiation (clear days), its contribution is not increased by the mirror but it does increase with glazing area. Due to the slope, the view factor to the sky is reduced a bit. So all in all it will hardly affect the energy balance.

- Conclusion:

Sloped glass is better for higher zenith angles, i.e., for early morning/late afternoon cooking and, of course, for **higher latitudes**.