Above literature describes that with use of uniform tube receiver, total heat loss from the receiver due to convection and radiation obtained is more and efficiency obtained by uniform receiver tube is less. Figure 3 and 4 presented by Lof et al [3] show the distribution of incident beam solar energy into useful heat gain and various losses for two receiver tube sizes, the first for 0.060m diameter receiver tube and the second for 0.027m diameter receiver tube. The relative magnitudes of the losses are evident. The graphical results show the efficiency of the collector is affected by variations in receiver size.

The intercept factor is a function of receiver size, which leads to increase of energy intercepted by the receiver. However, heat loosing area depends on the receiver diameter. The effect of large receiver diameter is predominant on the thermal performance for low temperature. However, for higher temperature as the heat loss is more, the efficiency decreases. On the other hand, for small receiver diameter (higher CR) although the energy intercepted is less, the loss of heat at higher temperature is comparatively low because of less surface area of the receiver. Hence it is necessary to optimize the CR for varying fluid temperature and receiver temperature to obtain better performance.

While evaluating performance of PTC all the references are available for temperature of receiver. However receiver temperature (Tr) and water temperature (Tw) they go hand in hand. This relation is proved and evident from graph (Figure 5). Authors have a set up of a line concentrator system, it consists of reflector aperture 0.6 m, length 6 m, having different diameter (without transparent cover) bare receiver tubes of black coating. Figure 5 shows experimental performance of this set up using 0.029m receiver. The difference in receiver temperature (Tr) and water temperature (Tw) is evident for given length. Initially temperature difference is less and goes on increasing with the length of receiver. Maximum temperature difference (Tr- Tw) at the end was 140C.

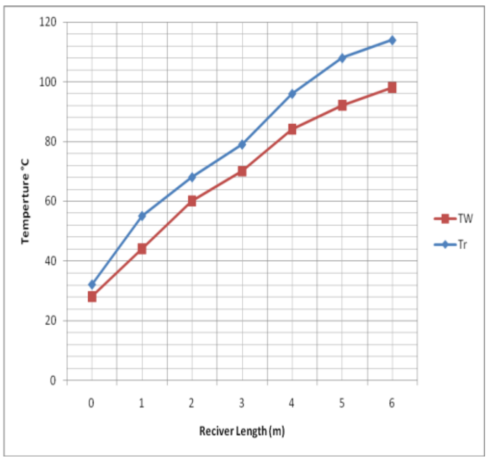

Figure 5: Difference in receiver temperature and water temperature

3. Comparison of Graphs (Figure 3 and 4)

Figure 6 shows superimposed resultant drawn by referring experimental observation values from (Figure 3 and 4) presented L of et al [3], this shows lower performance by using 0.060 receiver, up to temperature 170^{0}C, further higher temperature by using receiver of diameter 0.027m.Authors used this superimposed graph (Fig.6) to develop a new concept of variable concentration ratio concentrator system for improving performance of concentrator system. Presently constant concentration ratio (CR) systems are used which are having less performance. However, this work proves that whenever substantial outlet and inlet temperature differences in fluid are expected, a variable concentration ratio system as discussed in this paper may offer higher performance of concentrator system

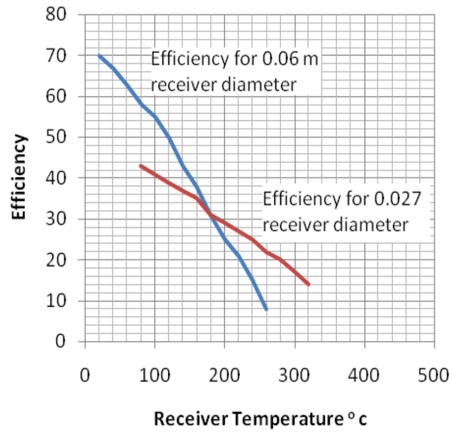

Figure 6: Superimposed graph form figure 3 and 4. [3]

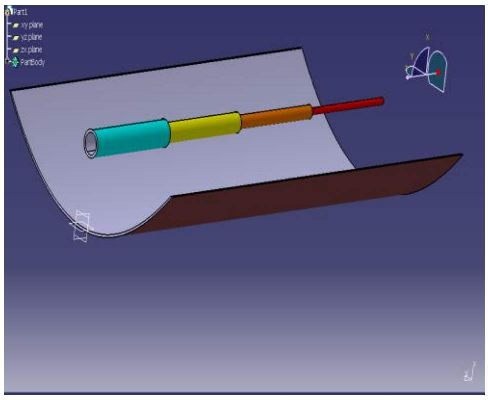

Figure 7: Proposed stepped tube receiver for obtaining variable C.R.

4. Conclusion

The resultant Figure 6 shows, the efficiency of these two receivers of diameter 0.06 m and 0.027 m intersect point at ‘A’. This proves that higher the diameter, higher is the energy intercepted by the receiver. While, the heat loss from the receiver, for a given receiver temperature increases with receiver diameter. Hence to enhance the performance optimization of the concentrator system is necessary by balancing energy intercepted and the heat loss. This can be done using lower concentrator ratio higher receiver diameter at the initial portion of the concentrator where the fluid temperature is low. Further portion of the concentrator where fluid temperature is higher, a high concentrator ratio can be used to reduce the loss of heat through reduction of area of the receiver tube (shown in Figure 7). Thus, the concentrator system will have different diameter receivers offering variable concentration ratio receiver is useful for enhancing performance of solar line concentrator The efficiency of 0.06

m diameter receiver is higher up to receiver temperature of 1700C. However for higher temperature of 0,027m offers higher efficiency. Hence, it can be concluded that use a stepped receiver with diameter of 0.06m up to 1700C and thereafter 0.027m can offer higher efficiency. Hence one can propose a multistepped receiver depending upon the temperature range and the fluid for the system in reference.

Nomenclature

A_a	Aperture area (m^2)	q_u	Rate of useful heat gain (w)
A_r	Area of receiver (m^2)	T_r	Surface Temperature of receiver (^0C)
γ	Intercept factor	T_W	Temperature of water (^0C)

References

[1] J. Krieth and F. Kreder." Principles of solar energy" McGrawHill Book Co.1978
[2] Magal B.S. "Solar power engineering" Tata McGrawHill Book Co.1990
[3] G.O.G.LOF "Energy balance on a parabolic cylindrical solar collector" ASME PP.24-32, Jan1962
[4] Balbir Singh Mahinder Singh, Fauziah Sulaiman, "Designing A Solar Thermal Cylindrical Parabolic trough Concentrator By Simulation "International Rio3 Congress, World Climate and Energy Event, pp. 1-5,December2003.
[5] Houtan Moaveni, "Numerical Analysis and Experimental Study in Design and Operation of Three Solar Parabolic Thermal Power Plants" ,powering, pp.12-14, April 2007,
[6] Prof.G. S. Tasgaonkar, "Studies of Solar Parabolic trough Collector for Air Heating", 1995.P.Hd.Thesis
[7] John A. Duffie, William A. Beckman, "Solar Engineering of Thermal Processes", John Wiley and Sons INC, pp. 324-373, 2006.
[8] Sukhatme S., "Solar Energy, Principles of thermal collection and storage," Tata McGraw Hill-Publication, pp.71-257, 2010.

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