An Extended Application of Solar Vacuum Tube Collectors for Candle Making

Hardik Bhaliya
Vyom Technocrat Parth, Silver Park 1, Near Navneet Hall, Harighava Marg, Kothariya Main Road, Rajkot Gujarat 360 002 India

Rakshit Tank
Vyom Technocrat Parth, Silver Park 1, Near Navneet Hall, Harighava Marg, Kothariya Main Road, Rajkot Gujarat 360 002 India

Dr S. T. Rajan
Sustainable Technologies Consultant213, "Jayashree", Swapna Srushti Society. Near Top 3 Cinema, Talaja Road. Bhavnagar Gujarat 364 002 INDIA

Abstract

Vacuum tube solar energy collectors have been traditionally used to heat water. Here we present an extended use of the collectors in candle making industryand its advantages over conventional candle making processes. The new application is expected to promote both candle making as a cottage industry and conservation of conventional fuels.
Keywords: vacuum tube collectors, renewable energy, solar energy, candle making

I. INTRODUCTION

Solar evacuated tube collectors (ETC) have traditionally been used in water heating and over the last two decades they have nearly completely overtaken and outdated flat plate solar thermal energy collectors which had selectively coated fins. Here the authors suggest a new application for ETCs in candle making industry.

II. CANDLES

Candles meet the following social needs: As an alternative source of light in non-electrified rural and remote areas; as a back up in places facing frequent scheduled or unscheduled power cuts; lighting needs at camping sites, during emergency relief exercises at natural disaster struck zones, during people's protest marches with candles and for decorative purposes or for social events like parties. Aroma and designer candles are much sought for types in hotels, restaurants and at homes to adorn the dining tables and bed rooms to provide an enjoyable and memorable ambience of the space. They are decorated with pearls, buttons, leaves and flowers. Production of variety of candles as a cottage or small industry provides an appreciable level of employment in rural and suburban areas.

III. CANDLE MAKING INDUSTRY

India is one of the important exporters of handicrafts to the world market. The Indian handicrafts industry is highly labor intensive and is a cottage based industry. It is decentralized being spread in rural and urban areas all over the country. The industry including carpet trade gives employment to over six million artisans among women and people from the weaker sections of the society. Small scale candle making is an important cottage industry in rural areas. This happens to be the best job for rural women who want to work from home.

According Association European Candle Makers [1] half of about 350,000 tons of paraffin wax produced in Europe each year is used by the European candle industry. This shows that even in advanced nations candle making is a wide spread cottage industry. Candle making also serves social justice. For example, in Lithuania, a charity and support fund called " Caritas Candles" runs candle production facilities so as to create as many more jobs as possible for socially disabled people and it specializes in scented pillar candle [2].

A. Investment:

Candle making does not require much investment in equipment. Small instruments like moulds, wick, boiler, brush, oils and the main ingredient wax are adequate to begin with. For Indian producers Chinese wax is available cheap and in abundance in the market.

B. Training:

There are many institutes spread across India offering training in the art of **candle making.** The duration can be as short as 15 days only.

C. Paraffin Wax, the Raw Material:

Paraffin wax , the raw material which is mostly used in candle making is sold as slabs, beads or powder. It may also be transported in liquid form in tank trucks.

Paraffin wax is either white or colorless soft solid material derived from coal, petroleum, or oil shale. It is a mix of hydrocarbon molecules having between twenty and forty carbon atoms. Its density is between 0.88-0.92 g/cm3 @ 20^{o}C. It stays solid at room temperature and melts in the range of 47-65^{0}C. According to [3, 4] which lists properties paraffin wax, it has a boiling point above 370 °C lists various properties of paraffin wax .

Common uses for paraffin wax are for lubrication, electrical insulation, and candles. It is different from kerosene, another petroleum product which is sometimes referred to as paraffin

D. Candle Making Methods:

Candle production methods are described in existing literature, for example see [5,6,7,8]

In brief traditional candle making essentially consists of heating the raw material, say paraffin wax, to melt it, add optionally color and scent as may be required and then pour the melt in mould of desired shapes. Heating needs precautions to avoid direct contact of the inflammable melt with solid, liquid or gas fuel flame. For safety the wax melting pot, instead of being put directly over the flame, is placed in a larger pot containing water which is heated by flame. The wax is molten with the heat of hot water surrounding it. This arrangement is called double boiler.

E. Candle Making Test Set Up:

The test set up is shown in Fig 1 and Fig 2. The ETCs were bound to the slotted angle supports with Velco fasteners and supported at the bottom with soft Thermocol (Expanded polystyrene foam) pieces to protect the sensitive sealing end from mechanical damages. The supports were suspended in the middle on a frame in such a way that the tubes would remain inclined at an angle equal to the latitude of the location and can be manually tilted to pour the melt in holders. The specifications of the solar evacuated tubes follow.

F. Candle Making Tests:

The tests were carried out on 15th February 2015 in Junagadh in Gujarat, India.

G. Location Data:

Junagadh: Latitude (Deg) = 21.51 N; longitude (Deg) = 70.46 E; elevation (m) = 90m

Table – 1:
The Specifications of Evacuated Tubes

Length	*1800 mm*
Outer Dia.	*58 mm*
Inner Dia.	*47 mm*
Weight	*2 kg.*
Material	*BOROSILICATE GLASS 1.6mm*
Selective Coating	*CU\SS\AL N*
Absorptance	*95%*
Emissivity	*5%*
Vacuum	*5X10-3 Pa*
Thermal Expansion	*3.3X10-6 /Deg C'*
Heat Loss	*0.8W/M2 Deg C'*

Calculated volume, nominal value = 3 litre

H. Test Procedure:

Paraffin wax which was in slab form as shown in Fig 3 were cut into small pieces. The ETCs were mounted on the frame and the set up was turned so that ETCs faced the sun, as shown in Fig 4. Wax pieces were filled in the tubes and as they melted and settled towards the bottom, more pieces were loaded to fill the tubes slightly below the brim.

IV. RESULTS AND DISCUSSIONS

The tests were started at 10:00 am and all wax melted in 50 min. To ensure that wax in the entire tube melted the melt was held for 10 min more until melt's temperature reached 75^{0}C. The melt was poured into holding pots as shown in Fig 5 which was then poured into candle moulds of different sizes. Some sample candles thus made are shown in Fig 6.

Computed estimates indicate that even after allowing for about 10% wastage in pouring which may be recycled, at least 125 candles of 12.5 mm X 180 mm can be made per melt from one ETC. If one assumes a bank of 10 ETCs per frame which size still can be manually handled easily, one can produce at least 5000 candles per day can be produced in 4 batches of 90 min duration each on a sunny day. This translates into at least 1,000,000 candles in a year with 200 sunny days which is adequate to run this unit as home industry. The same can be scaled up easily to any size.

It was further observed that if the melt is left in the tube overnight after capping it with insulating cover the melt remains as such. The ETC incidentally also acts like a thermos flask. So any leftover molten wax material can be stored as hot material with minimum loss of heat overnight, for continuing the process the next day.

A. Benefits of using ETCs for Candle Making:

1) Safety. Since there is no direct flame involved, this method is far more safe than traditional methods using solid, liquid or gas fuels.
2) Conservation. Significant fuel savings and environmental conservation can be effected by replacing conventional fuels with solar thermal energy.
3) Profits. To the extent conventional fuel is saved, profits would rise.
4) Simpler equipment. Since no direct flame is used, need for double boiler set up is eliminated and to that extent capital investment is reduced
5) Reliability. Since no externally sourced fuel or electricity is used industrial reliability is enhanced.

V. SUGGESTIONS FOR FUTURE WORK

Better safety and operational convenience is possible through future work. To avoid sudden gushing out of molten wax during manual tilting some cap made of heat resistant plastics or rubber, on the ETC may be provided with a narrow opening for inserting and holding thermometer and the same opening may be used for pouring out the melt.

VI. CONCLUSION

In conclusion it may be noted that using solar evacuated tube collectors for candle making is feasible, desirable and economical. This method can substantially save fuel cost and improve energy security for the candle making industry.

ACKNOWLEDGMENT

The authors appreciate and thank Prof Dipak D. Patel of Dr Subhash Technical Campus, Junagadh, Gujarat INDIA and the campus management for facilitating experimental work at their site and Mr Jasmin Bhimani, Laboratory Assistant in the Campus for assisting in fabrication and testing jobs.

REFERENCES

[1] http://europecandles.org/pages/uk/an-everlasting-history/raw-materials-and-candles-production-processes.php?lang=FR (accessed on 10th Apr 2015)
[2] http://www.free-press-release.com/news-candle-production-which-helps-socially-disabled-people-1375705843.html (accessed on 30th Mar 2015
[3] http://www.chemicalbook.com/ProductMSDSDetailCB2854418_EN.htm (Accessed 25 Mar 2015).
[4] Thirugnanam.C and Marimuthu.P, Experimental Analysis of Latent Heat Thermal Energy Storage using Paraffin Wax as Phase Change Material, International Journal of Engineering and Innovative Technology (IJEIT) Volume 3, Issue 2, August 2013
[5] http://www.wikihow.com/Make-Homemade-Candles (accessed on 24th Dec 2014)
[6] Traditional Candlemaking: Simple Methods of Manufacturing by Deborah Millington, IT Publications, 1993
[7] http://answers.practicalaction.org/our-resources/item/candlemaking (accessed on 10th Apr 2015)
[8] http://www.appropedia.org/Candlemaking (accessed on 21st March 2015)

Fig. 1: Solar evacuated tube collector (ETC) set up for paraffin wax Melting

Fig. 2: Tilting arrangement for molten wax

Fig. 3: Raw commercial paraffin wax sold as slabs

Fig. 4: Heating paraffin wax in ETC

Fig. 5: Molten paraffin wax

Fig. 6: Sample candles made using ETC