A STUDY ON THERMAL STRAINS IN PLATE GLASS DURING THERMAL CUTTING USING HOT AIR JET

E.S. Prakash[1] K. Sadashivappa[1] Vince Joseph[2] M. Singaperumal[3]
[1]Bapuji Institute of Engineering and Technology, Davangere-577004.
[2]University BDT College of Engineering, Davangere-577004.
[3]Indian Institute of Technology, Chennai-600036, India.
[1]Fax: (08192) 31261, E-mail: biet@dvgbiet.kar.nic.in
Keywords: Thermal strains, plate glass cutting, thermal cutting, strain measurement, crack propagation.

1. Introduction

Glass is widely used in both domestic and industrial applications. Fabrication of glass blanks is very important in the case of optical lens, opthalmic lens and orthodental photographic mirrors. Cutting of glass is invariably the first step in any of the glass fabrication methods. Profile generation without internal flaws and obtaining smoother profiles is difficult by conventional diamond cutting.

A new method of glass cutting by the above authors has been reported earlier[1]. This method makes use of a hot air jet for cutting plate glass. Plate glass is kept on the X-Y table which can be moved at required speed under a stationary hot air jet issuing from the hot air gun. The cutting speed depends upon the thickness of the plate glass and the air temperature at the nozzle tip. Complex profile cutting by the above method on plate glasses is easier and economical. Profiles generated by the new method are smoother as compared to that by diamond cutting.

A compact portable hot air jet gun was designed and fabricated to study the parameters which influence the crack propagation. Experimental studies have shown that the thermal cutting time increases with the plate glass thickness[2].

2. Experimental details

Thermal stresses are setup in glass due to heating. Thermal strains are required to be measured for computing these thermal stresses. Experimental setups were fabricated for measuring temperature distribution and thermal strains on the plate glass surface during thermal cutting using hot air jet.

2.1 Temperature measurement

Fig. 1 shows photograph of experimental setup for temperature measurement. It consists of a hot air blower with 2 mm diameter nozzle, X-Y table to move the plate glass under the stationary hot air jet, a plate glass with thermocouples mounted on it, a millivoltmeter to indicate the thermocouple output.

Four iron-constantan thermocouples, keeping a distance of 10 mm apart, were mounted on the glass surface for measuring temperature during cutting. Mountings were at a distance of 20 mm away from the cutting path. Thermocouple outputs were measured using a millivoltmeter and then the readings were converted into temperature in °C. Fig. 2 shows thermocouple mountings on plate glass surface. The glass plate (2 mm thick) was moved under a stationary hot air jet and the thermocouple outputs were measured and recorded during cutting.

Fig.1 Experimental setup for temperature measurement

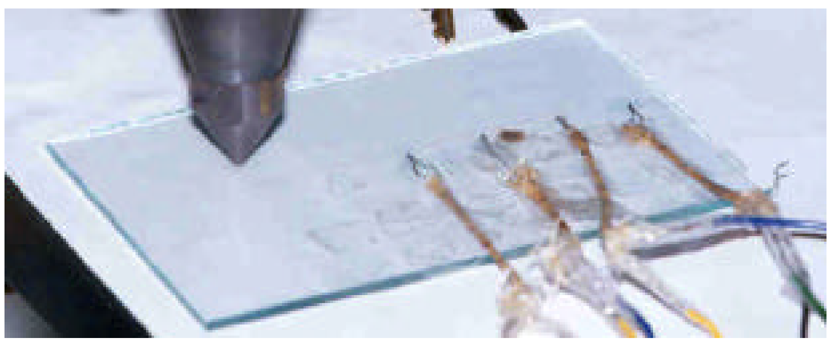

Fig. 2 Thermocouple mountings on plate glass

2.2 Strain measurement

An electrical strain gage was mounted on the plate glass surface, at 45° with respect to the cutting path, using suitable adhesive. Fig.3 shows photograph of the strain gage mounting. The strain gage leads were connected to the digital microstrain indicator. The plate glass (2 mm thick) with strain gage mounting was placed on the X-Y table. The table was moved under a stationary hot air jet and the plate glass was cut. The cutting path was at 20 mm away from the strain gage location. Thermal strain variations at the gage location were measured and recorded.

Fig. 3 Photograph of the strain gage mounting on glass surface at 45°

3. Results and Discussion

Temperature variations on the plate glass surface during cutting as the jet advances is shown in Fig. 4. It is observed from the figure that glass surface temperatures are higher nearer to the jet positions. Temperatures on glass surface at 20 mm away from the cutting path vary from 39°C to 55°C as the jet advances from position J1 to J4.

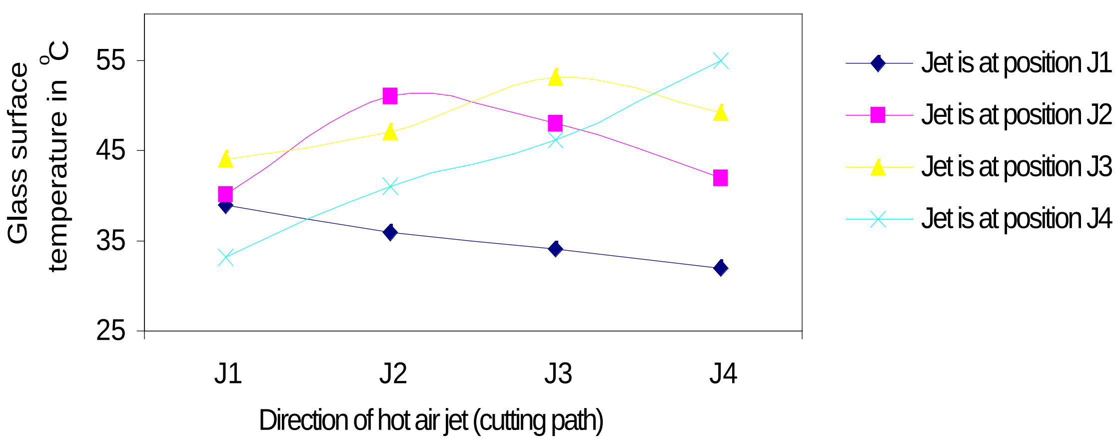

Fig. 4 Temperature variations on glass surface during thermal cutting of glass as jet advances.
J1 to J4 – Successive jet positions during cutting, Stand off distance = 1.6 mm

Fig. 5 shows thermal strain variations at the gage location during cutting. It is observed from the figure that the thermal strains gradually increase as the hot air jet passes nearer to the gage and then starts decreasing as the nozzle moves past the strain gage location. Maximum strains (647 microstrains) were observed when the jet was nearest to the strain gage.

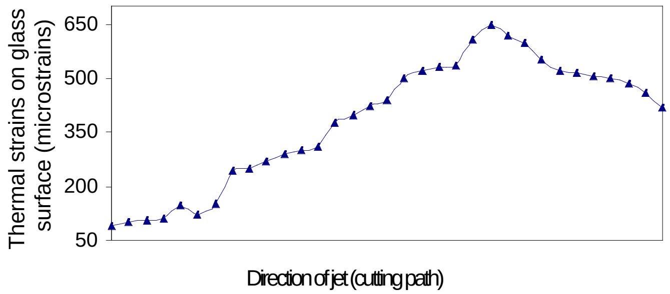

Fig. 5 Strain variations at the gage location (45°) during cutting.
Stand off distance = 2 mm, Nozzle diameter = 2 mm

Strain measurements at 0° and 90° orientations of strain gage are under progress and will be reported. A photograph of sinusoidal cut on a plate glass of 3 mm thick is shown in Fig. 6.

Fig. 6 Photograph showing sinusoidal cut on plate glass

4. Conclusions

Experimental setups for the temperature measurement and thermal strain measurement on plate glass surface during thermal cutting were fabricated. Experiments were conducted and results are reported. It is observed that temperature and thermal strains are highest nearest to the jet positions and increase along the cutting path as the jet advances.

Acknowledgement

The authors wish to thank the AICTE New Delhi for sponsoring this research work.

References

1. K.Sadashivappa, C. S.Bhaskar Dixit, M. Singaperumal, Thermal cutting of plate glass, Proc. 11th Annual Meeting, ASPE, Vol. 14, Monterey, USA, 1996, 551-556.
2. K. Sadashivappa, E.S.Prakash, M. Singaperumal, Compact portable air jet gun for thermal cutting of plate glass, Proc. 13th Annual Meeting, ASPE, St. Louis, Missouri, USA, 1998.
3. R.S.Sirohi, H.C. Radhakrishna, Mechanical Measurements, III Edn., New age Int.(P) Ltd., New Delhi, 1996.

* * *