ABSTRACT

India being one of the populace countries of the world, the protection from fire hazards and prevention of fire fatalities becomes essential. During such fire accidents, the burning behaviour of textile clothing plays an important role. In case of India, the limited textile related fire statistics is available. Government regulations are also not inflicted on the garment manufactures to meet any norms for flammability of garments. The consumers are not even informed about the flammability characteristics of cloth they use. In many countries the garment manufacturers are compelled to use specific parameters in designing the various garments for considering the safety of the people. These garments are well listed and labeled for ease and awareness for the users. Therefore it is the need of the hour that, India also should have certain regulations in this regard to prevent the fire accidents and accidental causalities. The causalities and hazards posed by fires are not yet studied comprehensively, so that specific groups can be located and precautionary measures be adopted to avoid these fire incidences. Interests have therefore grown in analysing fire statistics in India and detail study pertaining to the contribution of factors catalyzing the fire to take safety precautions.

In the present study an extensive survey on the burn injury is carried out with references to 360 cases of fire accident victims. The study reveals the potential cause of fire accidents, place of fire accidents, fuel involved in an accident, age group of the people suffered, gender wise type of garments involved, type of raw material of garments and the level of burn injuries on different body parts of the victims. The study revels that more proportion of females mainly wearing saree affected maximum with severe burns injuries causing death in many cases. Hence, the burning behaviour of the saree fabric along with supporting garments has been studied in detail.

As the saree is wrapped on the body with multiple layers on different posture of the body, burning behaviour of saree becomes complex phenomenon. As type of textile material affects the burning behaviour, various types of fabrics of different constituent fibres including their blends have been selected in case of saree and supporting garments. Ten different types of saree fabrics i.e. cotton, cotton:polyester (50:50), cotton:polyester (67:33), cotton:polyester (33:67), polyester, silk, viscose, nylon, polyester:viscose (67:33) and polyester:viscose (33:67). Two types of petticoat fabrics of cotton varying in their mass (gsm); Three types of blouse fabrics i.e. cotton, polyester:cotton (67:33) and polyester; cotton knitted fabrics one each for bra and underwear. Thus in all total 17 different fabrics were used for the experiment.

Each type of saree sample is subjected to flammability test on Burn Hazard Potential Tester (samples in combination of blouse, petticoat, bra and underwear). Altogether each saree fabric makes six different combinations with these supporting garments. According to their burning hazard potentiality, each saree along with its supporting garments was estimated in terms of Time for Ignition (T_{ig}), and Average Incident Heat Flux (AIHF) to rank them suggesting the best combination of saree along with its supporting garments.

These incident heat fluxes are correlated to burn injury, depending upon the absorbed heat fluxes for a given time. The data obtained due to several tests, were finally used to train the Artificial Neural Network (ANN) software to investigate the correlations between the thermal properties. All the saree are ranked as per their time for ignition values, cotton ignites first and nylon ignites last.

To determine the effect of weaves, dyes and pick density on the burning behaviour of fabric, samples of Plain, Matt, Twill and Satin weaves are prepared with varying pick densities like 30, 40, 50, 60 and 70 picks per inches from 34^s cotton combed yarns. All these samples were dyed with direct, reactive and vat dyes. All weaves shows that pick density increases the AIHF values. This trend is not limited to only bleached samples but similar results are obtained for dyed samples. The matt, satin, twill and plain weaves are in descending order of flame resistance and ascending order of heat flux values. Similarly, vat dye showed highest values.

For determining burning behaviour of textiles due to Aftercare practices like, washing, ironing, exposure to light and blueing on cotton, polyester and polyester:cotton (30:70) blend fabrics, all samples were washed and tested after several washing cycles (5, 10, 15, 20 and 25), several ironing cycles (5,10, 15, 20 and 25), Number of hours of light exposure (3, 6, 9, 12 and 15) and blueing with two different concentrations. Washing, ironing, exposure to light and blueing increase the Flame Propagation Rate (FPR) and AIHF of cotton fabric. Washing and more Number of hours of light exposure increases the FPR and AIHF of polyester:cotton blend fabric. High concentration of blueing increases the FPR and AIHF values of cotton fabric sample significantly.

Equipment under the name "Burn Hazard Potential Tester" (BHPT) is specially developed and fabricated to study the flammability of saree. It works on simple principle of measuring incident heat flux released during burning of a particular fabric and other flammability parameters when fabric specimen is ignited. This provides the real fire situation, where the skin is exposed to the incident heat flux released during the burning of the fabric. The BHPT is designed to test small fabric samples at different positions from 45° to 90° angles of inclination. The software code developed by C programming enables to use the measured thermal properties and finally plots a time and incident heat flux profile for complete test time. The circuit uses supporting integrated circuits like IC 74573, IC7490, and ICADC 0809 for sensing and storing data.

Realizing the difficulties in existing methods of prediction of burn injuries, a Three Dimensional Mathematical Model is proposed to study the heat transfer process in human skin. The technique is intended for the prediction of temperature and burn injury at various layers of human skin at different heat fluxes on the surface of the skin. A finite differential discretisation scheme is used to discreatize the governing partial differential equation.