

Design and Fabrication of Gloves for Cold Temperature Field Work



Anupama, Chandan Kumar, Vijay Bhutani, R. K. Ranjan

Abstract: Conducting field work in cold temperature was a difficult task. The most important safety consideration for field work was to maintain normal body temperature and the proper flexibility of the hand. Heat production and insulation was done through multiple thin layers needed for different temperature and activity level. This work had been focused on the design and fabrication of gloves with minimum thickness and minimum heat loss. The multilayered construction is 44% thinner and 17.5% lighter than the existing materials.

Keywords: Multilayered construction, Heat loss, Insulation, Dexterity, Thermal insulation

I. INTRODUCTION

In the modern era of growing and developing technology there are lots of advancement are being developed in the field of engineering. The industries are looking forward for new and improved technique. With the development of technology, new material came into existence and to fabricate gloves. But the problem associated with these technologies such as less flexibility, high manufacturing cost, bulky have led to development which can minimize these losses up to an extent.

Glove is a multilayered fabrication of different fabrics and materials that are used in cold temperature environment and industries to protect the hand from cold and maintaining the body temperature.

Field personnel working in cold environment are subjected to unique and difficult challenges faced by them in their daily activities. Several insulating materials had been developed by different fiber manufacturers. It focused on minimizing heat loss from the body to the environment; allowed evaporation of sweat from the body.

The performance of the multilayer gloves depends on its thermal insulation. Design and fabrication of gloves experiment had been done to evaluate materials combination in the fabrication of gloves for cold temperature. For all new fabrication processes comparison to conventional processes was an important factor.

The application areas of gloves are many which are in cold region, cold working environment, industries, medical and aerospace etc.

Fabrication method for gloves needed materials having high thermal insulating values, less heat loss. Fabrication of gloves are cheaper, eco-friendly and easier.

Along with its advantages it has disadvantages too. Controlling the rate of heat loss and heat transfer inside the layers of gloves was difficult and maintaining the body temperature for long duration.

II. LITERATURE REVIEW

[1] Nishkam Kasturiya explained Primaloft is an insulating material with insulation properties in wet condition also with excellent thermal insulation. Gore-Tex a moisture permeable waterproof otherwise called breathable fabric. Microencapsulated phase change materials are fluid filled capsules change their phase has insulation performance 400 percent higher than those of conventional lofted insulation materials. Polyurethane is polymer having elastic memory effect and it respond at molecular level.

[2] Dr. Dragon and Dr. Michel B. Duchrame explained Finger dexterity performance and extremity comfort during cold exposure while an attempt was made to prevent or minimize hand cooling. It will remove their mitts to improve finger dexterity and will work with thin contact gloves to do a task more effectively. Jon C. Denner explained the most important safety consideration for field personnel is to maintain normal body temperature and avoid hypothermia. Heat production is enhanced by increases in the rates of basal metabolism, specific dynamic action, physical exercise, heat loss is reduced by vasoconstriction. Hypothermia can be avoided primarily by the proper selection and intelligent use of cold weather clothing systems. Anne Marie Helmenstine explained stretched Teflon have stable structure of microscopic pore which is 700 times larger than water vapor and 20,000 times smaller than water droplet which allows water to repel. Mylar has high tensile strength that reflects back up to 97% of heat and minimizes the heat loss. Primaloft absorbs and spreads the sweat across the maximum area of fabric that can retain up to 98% insulation in mild wet climate. Zeinab S. Abdel-Rehiml and I. Hanafy explained Thermal insulating value represents the efficiency of the textile fabric as an insulator. It is defined as the percentage reduction in heat loss from a hot surface maintained at a given temperature.

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III. GAPS IN LITERATURE REVIEW

It was observed that temperature resistance up to -20 degree Celsius was available and it was not effective for lower temperatures. Fabrication cost was high and flexibility in gloves were lacking as the weight and thickness of gloves were more.

IV. METHODOLOGY

Testing of different fabrics thermal conductivity, its heat loss percentage per minute by the help of probes in the negative temperature, calculating its thickness and amount of heat trapped by the layers of fabric. Metalized-biaxial oriented polyethylene terephthalate had reflective property back up to of 97% of heat. It had maximum insulation value and single sheet thickness is 0.085 mm. Polyester yarn was lighter than other materials. A single layer was of 0.55 mm thickness. It had very good insulation properties up to

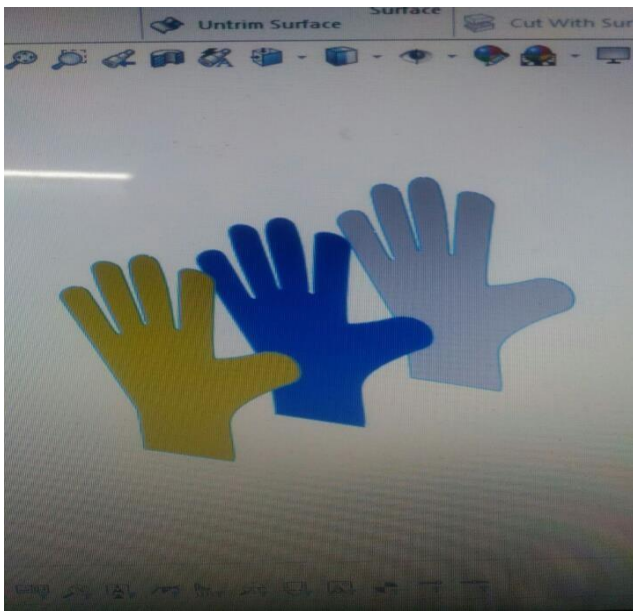


Fig. 1: Design of multilayered glove

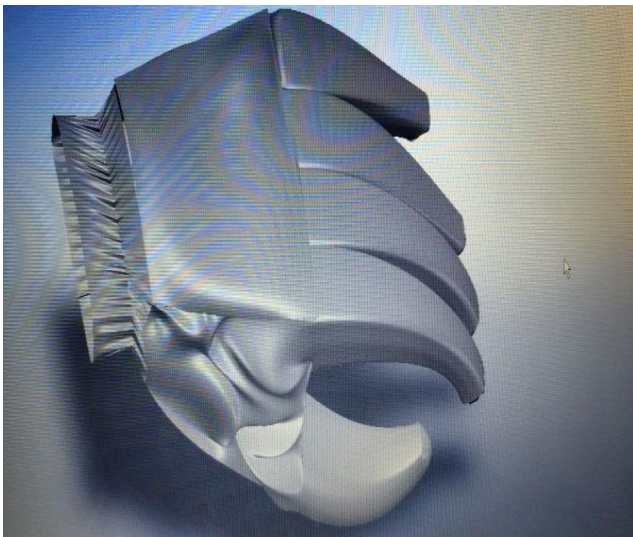


Fig. 2: Design of fabricated glove

98%. Heat loss in multilayered construction was calculated using the formula $[(T_i - T_f)/t]$ where, T_i is initial temperature

and T_f is final temperature and t is total time taken. Heat loss calculated was 0.25 degree Celsius per minute. Weight of multilayered fabrication was 17.5% lighter than polyester and thickness of multilayered fabrication was 44% thinner than the polyester.

Table 1. Insulation with multilayered fabrication of Polyethylene terephthalate and Polyester yarn

S.NO.	Time(min)	$T_s(^{\circ}C)$	$T_{in}(^{\circ}C)$
1	0	-20	43.9
2	1	-20.1	43.7
3	2	-20.1	43.4
4	3	-20.1	43
5	4	-20.1	42.8
6	5	-20	42.5
7	6	-20	42.2
8	7	-19.9	42

This table shows the heat trapped between the multilayered fabrication test sample having insulation with the increase in surrounding temperature keeping the surface area of 1192cm². The heat loss calculated for the same at -200C is 0.250C/min.

Table 2. Insulation with polyester yarn (Bulk insulation)

S.NO.	Time(min)	$T_s(^{\circ}C)$	$T_{in}(^{\circ}C)$
1	0	-20	40.7
2	1	-20	40.3
3	2	-21	40.0
4	3	-21	39.7
5	4	-21	39.4
6	5	-20	39.2
7	6	-20	39.0
8	7	-20	38.7

This table shows the heat trapped by the polyester having insulation with the increase in surrounding temperature keeping the surface area of 1192 cm². Heat loss calculated for the same at -20⁰C is 0.25⁰C/min.

Table 3. Warm water pouch with no insulation

S.NO.	Time(min)	$T_s(^{\circ}C)$	$T_{in}(^{\circ}C)$
1	0	-20	34.5
2	1	-19.6	33.7
3	2	-19.4	33.1

This table shows the heat trapped without insulation with the increase in surrounding temperature. The heat loss is more when there is no insulation and it is 0.59⁰C/min.

V. RESULT

The thickness of the multilayered fabrication is 44% thinner and 17.5% lighter in weight in comparison to the available products. The heat loss from the multilayered fabrication is 0.25 degree Celsius per minute.

VI. CONCLUSIONS

- Research in variety of materials can be done to check the thermal conductivity of materials.
- The most recent development in the area of gloves manufacturing was microencapsulated phase change materials which had insulation performance 400% higher than those of conventional lofted insulating materials.
- Gloves with minimum thickness high flexibility and less heat loss were achieved.

VII. FUTURE SCOPE

The main highlights of this project were that this product on completion could a very viable solution to multiple situations where people have to deal with extreme cold temperatures. This product could be used in many areas like used in extreme cold industrial applications. For working in extreme cold weather conditions, used in medical industries where liquid nitrogen is used ,applicable for low temperature lab conditions. Future scope with some modifications included use in aerospace applications (Extreme low temperature at high altitudes), use in safety gloves for soldiers serving in cold weather.

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AUTHORS PROFILE



Dr. Anupama, is working as Associate professor at Galgotia University, gr. noida and having experience of 15 years in teaching at UG and PG level. She has published almost 10 research papers in various Journal. She has recd. Gold Medal in her Master Degree.



Dr. Chandan Kumar, is working as Professor at Noida institute of Engineering and Technology, greater Noida has published more than 30 papers in various journals and proceedings of conferences. He has recd grant from AICTE and DST. He has total experience of 19 years. He is life member of ISTE , Fellow IE and Founder member of SFST.



Mr. Vijay, is in the teaching since last 7 years. He had 15 plus research contribution. He has received gold Medal in Master Degree. His area of interest is thermal engineering and renewable and sustainable energy.



Dr R. K. Ranjan, is working as principal at Govt. polytechnic, lakhisari, having 25 plus years of experiences in teaching. Has supervised four Ph.D and 20 M.tech scholars. He has published approx 60 research articles in journals and conference proceedings. He is life member of IE, ISTE.