THERMOELECTRICALLY HEATED / COOLED WHEELED STRETCHER

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ABSTRACT

The objective of this work is to design a typical wheeled stretcher which can prevent soldiers from extreme environmental conditions, i.e. either from cold injury or from heat stress. Realizing the need of such requirements, R&D Division of MECON, Ranchi, India initiated the work as national interest.

Thermoelectric heated / cooled wheeled stretcher is mainly consisted of two parts:

Part – 1 Consist of stretcher; made of series & parallel connection of conducting tubes to circulate hot or cold fluids across the stretcher to prevent soldiers from casualty.

Part – 2 Consist of thermoelectrically cooling / heating unit, which is thermomechanical assembly of heat pump i.e. thermoelectric modules, heat & cold sinks, one positive displacement pump and one axial fan to dissipate heat from the system. This thermoelectric stretcher may be able to provide adequate heating or cooling to the soldier depending upon their requirements by changing the polarity of thermoelectric array.

INTRODUCTION

In hot natural environments, humans blood flow through the skin increases. The body's heat balance is destroyed and pent-up metabolic heat increases body temperature. If correct work-rest regiments are not followed, individuals can suffer impaired concentration, fatigue, and possibly heat stroke.

In cold environments, the human body responds by reducing blood flow to the skin, the hands, and the feet. The body also shivers to increase metabolic heat production. It is often difficult to prevent a gradual lowering of overall body temperature, which causes the cold injuries.

When the body's natural cooling mechanisms are ineffective, cool liquid flows through liquid circulating stretcher, creating a cool 'microclimate' to isolate the body from the heat. For applications where warming is required, liquid circulating stretcher can be used with warm liquid. This produced a warm microclimate at the surface of the skin, protecting the soldiers from casualty.
MECON's solid state cooling / heating wheeled stretcher provides powerful solutions to the problems presented by demanding thermal conditions.

PRINCIPLE INVOLVED

1. Peltier effect – Thermoelectric Cooling / Heating is based on the Peltier effect in which a current is passed around a circuit of a different materials, one junction gets heated while the other junction is cooled.
By reversing the direction of current, flow the heating and cooling of the two junctions is mutually interchanged.

2. Design of components using thermal impedance matching principle.
The cooling & heating system,
employing this technology are solid state and CFC free devices. Performance of the system has been ensured by our innovating design, assembly, made possible by software developed from our mathematical modeling. Thermal impendence matching of all the components of the unit treated as discrete thermal models with discrete characteristics has been ensured.

TECHNICAL APPROACH

Thermoelectric technology is one of the many disciplines in MECON. MECON's scientists / technologists have developed thermoelectric cooling / heating devices for many Industrial and Government clients. [1, 2, 3, 4]

The solid state cooling / heating wheeled stretcher are liquid based system. In a liquid-based system a fluid such as water is chilled in a cooler assembly and circulate through a stretcher. Cooling is achieved by conduction. After removing heat from soldier's body, the liquid returns to the cooler assembly. Thus the system operates on a closed loop. By reversing the direction of current, the water is heated in the cooler assembly and hot water circulated through the stretcher and soldier's body gets heated.

The heating / cooling stretcher consist of series & parallel connection of conducting tubes to circulate hot & cold water across the stretcher to prevent soldiers from casualty. Over and below there are vinyl / silicon filled cushion mainly consisted of fine flexible braided copper wire, dipped on vinyl / silicon gel. This is not only providing a comfortable interior for the stretcher but also served as heat transfer medium. Top surface of the stretcher is covered by conductive foam, which having high conductivity, shielding attenuation, high abrasion and shear resistance.

Thermoelectrically heated / cooled stretcher is shown in figure 1.

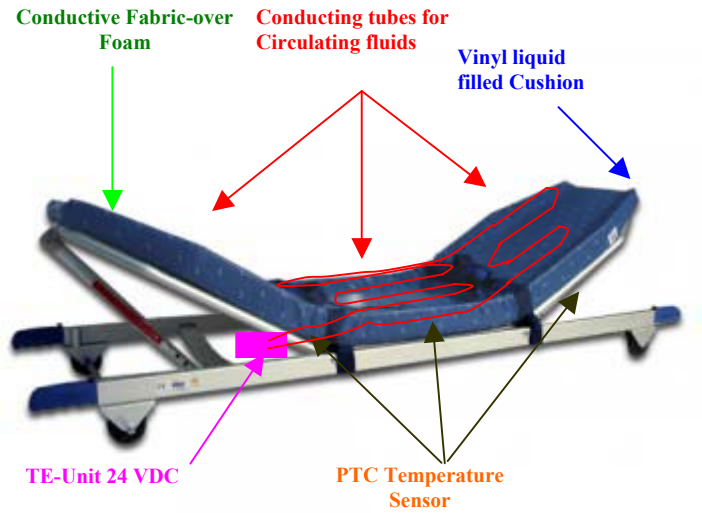

Figure 1 :- Thermoelectrically heated / cooled wheeled stretcher.

The Cooling / Heating unit consists of 36 nos. of thermoelectric modules of geometric factor 0.121 & 0.170, connected in series and parallel with 24 V DC source, one positive displacement pump and one axial fan to dissipate heat from the system.

The thermoelectric modules are sandwiched between the heat sinks on one side, and the spacers and cold plate on the other side. Each cold plate is in turn sandwiched between two sub assemblies. Each of these subassemblies is made up of a set of thermoelectric modules, heat sinks and spacers. A number of sandwich assemblies can be stacked together to remove the required amount of heat from water flowing through the cold plate. Total 4 nos. of heat exchangers (2 nos. top and 2 nos. bottom), each of width 3", length 7" height 2", no. of fins = 30, made of copper is required to dissipate the heat from the system. We proposed to send 99 CFM air along the fines at an air speed of 1680 ft/min. at one side of the unit i.e through two heat exchanger and from this we expect to

achieve thermal resistance of 0.042°C/W.

A typical schematic sandwiched TE-Core system is shown in Figure 2.

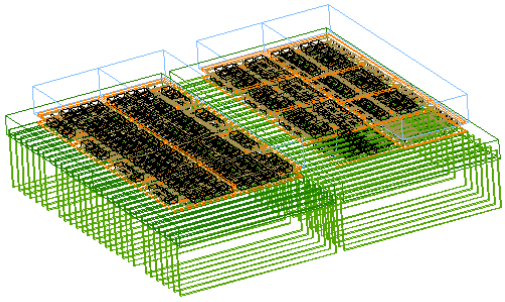

Figure 2 : Typical schematic sandwiched sub-assemblies of TE- Core.

A positive displacement micro-pump Model No. : MS 030 – 0024, flow rate 600 ml/min, at 5 bar may be able to provide water flow through the cold / hot plate in tandem, or parallel as required. The cold / hot plate has a spiral hole with obstructions in the flow path, to provide maximum heat transfer area as well as turbulence in flow.

One axial fan of Model No. : 6424H, size 6.77" x 5.91" x 2.00", power input 26 Watts, nominal speed 4000 rpm is proposed to mounted at suitable location to carry the heat away from the heat exchanger efficiently. The heat exchangers have the optimum design of fins, to provide maximum area of heat transfer.

The desired temperature of the stretcher is proposed to control by PTC temperature sensors. System could be able to extract or provide 250 Watts of heat by considering an ambient of (+) 60°C or (-) 20°C.

CONCLUSION

From our mathematical modeling / simulation; a concept and schematic diagram has been developed. It is concluded that thermoelectrically heated / cooled stretcher may be able to provide adequate heating or cooling to the soldier depending upon their requirements. Fabrication & assembly of first prototype is in process. Experiments will start after successful assembly of the system and positive results will be reported elsewhere.

ACKNOWLEDGE

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