

The Power of Cool

In a series of articles Metkel Yebiyu and Graeme Maidment of SIRACH are reviewing individual heating and cooling technologies on a bimonthly basis. We describe the technology, its principle of operation, main applications, the challenges and opportunities in penetrating the market and what's needed for that to happen. This month we will describe a new cooling technology for vaccine and food storage in developing countries.

Basic working principles

Large areas of many developing countries have no grid electricity. According to the International Energy Agency's (IEA) World Energy Outlook (2015) report, 1.2 billion people lacked access to electricity in 2013, which is equivalent to more than 16 percent of the world population. The research reported by IEA (2015) showed that more than 95 percent of those living without electricity live in rural areas, mainly in sub-Saharan Africa and developing Asia where there is no distribution grid for electricity, and there are no prospects of the grid reaching them in the near future see Figure 1. Even in areas with grid power, the demand for electricity has outpaced supply resulting in unreliable electricity availability, insufficient for continuous refrigeration.

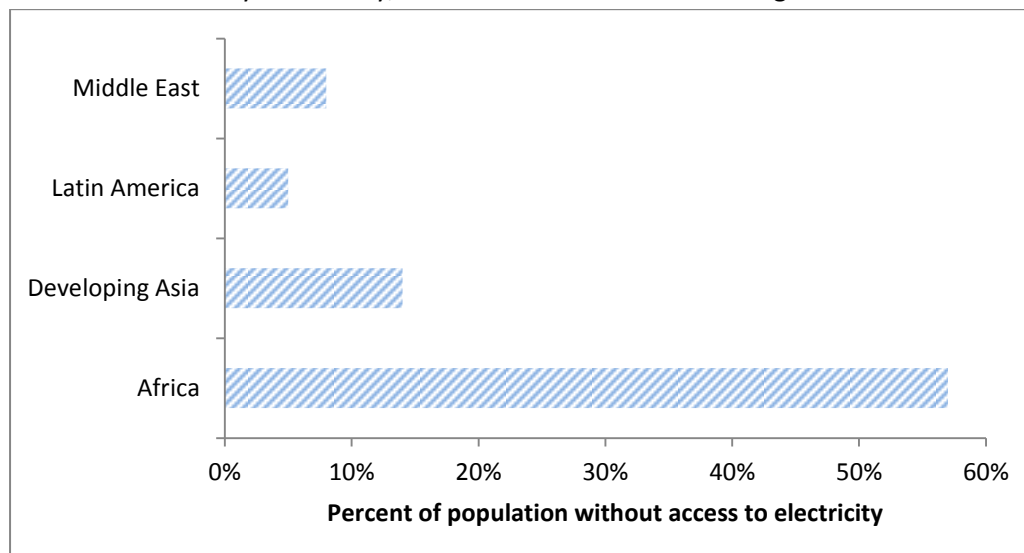


Figure 1 Share of developing-country population without access to electricity, 2013.

“Sure Chill” is a solar powered cooling technology which harnesses a unique property of water to create a standalone cold store to overcome intermittent energy supply. Traditional solar refrigerators have relied on relatively expensive battery systems, which have short lives compared to the life of the refrigerator. This technology does not require a continuous electricity source and does not rely on a battery. Sure Chill technology works on a simple law of nature: that water is most dense at 4°C. This means that at 4°C it sinks, and at any other temperature it rises. Sure Chill has harnessed this idea by creating a refrigeration compartment that is completely surrounded by water. When it has power (either mains or solar direct drive), the water cools and forms ice above the compartment leaving only water at four degrees cooling the contents. When the power is switched off, it stays cold for days as the water regulates itself at 4°C.

The technology consists of a hollow chamber with a block of ice at the top and water underneath. The ice is made using solar or intermittent power such as unreliable grid supply. Heat from the inside

of the chamber is extracted by warming the water in the chamber walls –this warmer water rises it comes into contact with ice and cools causing the liquid sink to the bottom again. Sure Chill technology uses this unique property of water through the creation of a constant temperature chilled environment of 4°C, surrounding a refrigeration compartment. Figure 2 below helps to demonstrate this principle.

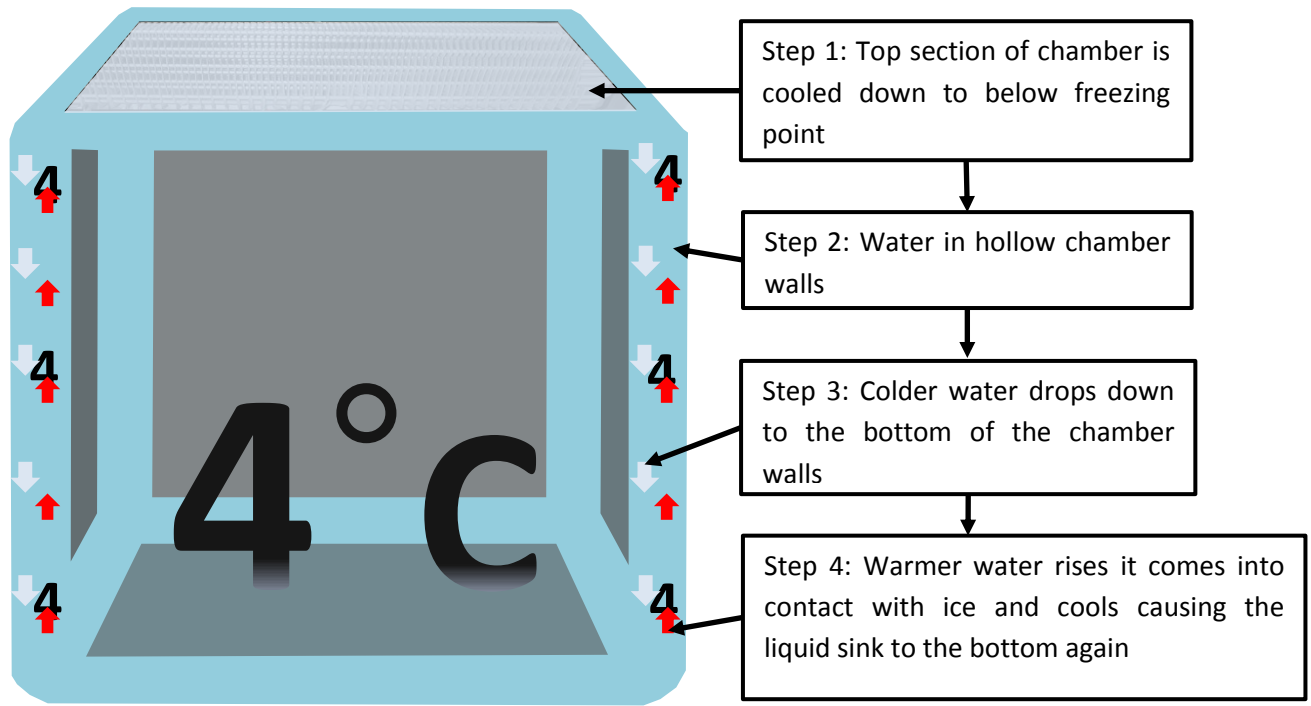


Figure 2 Schematic showing basic working principle of the Sure Chill cooling technology

Potential Applications

- The technology is already being used by medical practitioners all over the world to ensure that life-saving vaccines are stored at safe temperatures between 2°C - 8°C, until the point of use. The technology maintains a completely steady temperature within the vaccine refrigerator for up to 14 days, without any further power input. The technology can be adapted to many other refrigeration applications including domestic refrigeration and for food and beverage coolers.
- Spoiled vaccines cost lives; this technology provides a way of protecting the potency of vaccines ensuring successful immunisation programmes in the developing world and supporting the eradication of preventable diseases worldwide.
- Studies suggest that as much as 50% of the world's food is wasted before it is consumed. Therefore if this technology were scaled to a size suitable for providing agri-tech cooling solutions, it would help to keep food fresh even in the harshest environments.
- In developed countries, the technology can tap into Smart Grid systems in order to use energy when it's cheaper, or when the demand is lower; reducing the pressure on the electricity grid at peak times.

Benefits

There are significant benefits from using on the Sure Chill technology, these include:

- Laboratory testing has confirmed higher performance for several critical parameters, most importantly temperature control.
- System reliability has been adequate where The World Health Organisation (WHO) recommendations have been followed and a regular maintenance and repair service has been sustained.
- The lifetime cost of direct-drive solar refrigeration remains lower than for alternative absorption refrigeration systems and is increasingly competitive with grid-powered systems.
- Solar refrigeration systems may be considered an environmental improvement over absorption refrigerators, eliminating the need to burn fossil fuels. In fact, absorption-cycle refrigeration is fundamentally less efficient than solar or grid-electric vapour compression refrigeration, consuming more energy to provide the same cooling.

Key Challenges

Sure Chill technology inventor, Ian Tansley, recognised there was a challenge and decided he would find a solution. Solar vaccine refrigerators traditionally relied on rechargeable batteries to provide power through the night. However these batteries were costly, unreliable and hard to replace in remote locations. If the battery or power failed, vaccines were at risk of being exposed to temperatures outside of the safe range.

The challenge set by the WHO sparked Ian's motivation to develop a refrigeration method that offered consistent safe temperatures while operating in high ambient temperatures in locations with little or no grid power.

- Opportunities exist for this technology to link with renewable energy technologies however, these may require energy storage. This would provide improved performance/cost ratio.
- In parallel with the system development, new standards will also need to be developed.
- During extreme physical damage, as any other refrigeration systems there is potential for refrigerant leakage, which could result in some environmental impact.
- There is a need to incorporate a monitoring and feedback process into each country's supply chain management system where the technology is used to ensure high performance is maintained and problems are resolved.

Current market development

The last 12 months has seen the launch of a new generation of medical refrigerators using this technology and the ongoing development of a new cold chain device that can keep vaccines cold for more than a month without power. The company is also developing agri-tech cooling solutions, and exploring its potential for food and drink refrigeration for commercial and domestic coolers.

Verdict

The technology has great potential to solve many cooling issues, including for bringing reliable refrigeration to areas of the world where these have previously been impossible.

To find out more about heating and cooling technology please come to one of the regular SIRACH meetings held throughout the country at leading universities and at businesses who engage in research in this area. On the 14th June the SIRACH Network will be visiting ebmpapst, who are leading manufacturer of high efficiency fan and motor products. The event will focus on efficiency in the retail environment. **For more information or to be included on the SIRACH mailing list please register at www.sirach.org.uk or email info@sirach.org.uk**