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Cooling India

India's only Monthly dedicated to the growth of HVACR Industry

Cooling India is now a *Monthly*

Solar Assisted Cooling

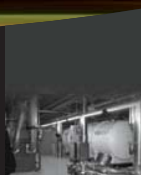
A Charv Publication®

Keeping eye on the market trend and going for expansions

Hence is our tagline - Choose Your Air

Compressed Air Treatment System Scope for energy saving

Eco-Friendly Air Conditioning Methods



Publisher's Letter

Since the last three issues Cooling India has been a monthly magazine. Thus we are pleased to serve you in a more elaborate fashion. with quality content that pertains to the HVACR industry.

The optimum sizing and selection of an Air conditioner plays a major role in overall energy consumption and environmental impact. Achieving solutions to environmental problems that we face today requires long-term potential actions for sustainable development. In this regard, renewable energy resources appear to be the one of the most efficient and effective solutions. That is why there is an intimate connection between renewable energy and sustainable development. Anticipated patterns of future energy use and consequent environmental impacts focusing on ozone depletion and greenhouse effect are comprehensively discussed in 'Role of Renewable Energy Sources in HVAC' wtrite up.

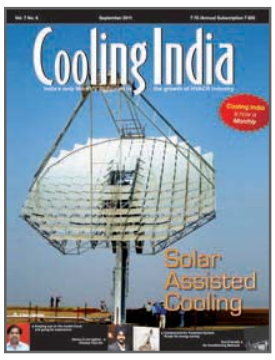
> **"Technology that helps to save energy in cooling & AC applications can help to reduce India's power shortage"**

Change of state from liquid to gas requires energy – fuelled by taking heat from the surroundings. As the refrigerant water evaporates on entering the evaporator, it takes heat energy away from the process water in the coil, thus producing a cooling effect. Combining generation of electricity with refrigeration, heating and hot water services, provides a total energy service, which can dramatically reduce overall running costs is detailed in an article 'Eco-friendly Air conditioning Methods' that also talks about various Adsorption Heat Pumps, ACs, cooling systems etc.

Any technology that helps to save energy in cooling & AC applications can help to reduce India's power shortage burden to a great extent. To contain HVAC usage of 30% of a building energy; a recent development in solar assisted cooling systems, solar heat is used to drive the cooling process is a prominent development depicted in 'Solar Assisted Cooling' study.

Do enjoy the issue containing wide variety of articles including case studies and interactions. We express gratitude to our patrons, authors and well wishers who besides providing overwhelming support are our partners on a long way.

Please do send your comments at pravita@charypublications.in



Pravita Iyer
Publisher & Director

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Articles

Central Karakorum National Park Pakistan

E + +, an expert company in energy technology, focused on renewable sources and energy efficiency and ILA studio architects, have worked together to successfully evaluate & improve the energy efficiency of an integrated environmental design for the proposed head office building of the Central Karakorum National Park in Pakistan. Using the IES Virtual Environment (IES VE), the analysis allowed them to assess the actual sustainability of the model and the possible improvements that could be made to make it a much more energy efficient and high performing design.

Compressed Air Treatment System Scope for energy saving

A careful observation at the operating characteristics of two different types of compressed air dryers – compressed air treatment system, revealed that the adsorption dryer make significance contribution in CO_2 emission due to energy loss of more than 70% over refrigerated air dryers. The process of regeneration by purging with dried air is the root cause for high energy loss and thus emission. The analysis revealed an electrical energy saving of 129.78 MWH per annum.

Editorial

Evolving Focus on Research into Priorities for Optimized Cooling Technologies

Michael Faraday, a British scientist happened to discover in 1820, that compressing and liquefying ammonia would chill air when the liquefied ammonia was allowed to evaporate. Since then several innovative methods and evaporation techniques evolved to create cool air, in 1902, the first modern electrical air conditioning unit was invented by Willis Haviland Carrier from New York. The persistent endeavour to improve cooling systems and refrigerants that would suit the environment encompasses HVACR. The simplest natural phenomenon observed is - when humans perspire to provide natural cooling by evaporation of perspiration from the skin and ample opportunity is present in India for research to acquire prominence.

Comfort conditioning and refrigeration have become a necessity. Sustainable development techniques in the context of global warming and changing environment need research more in terms of green technology - for systems to work accurately, efficiently and to influence the reduction of energy consumption. Green technology is synonymous with HVACR systems. It implies maximizing the energy efficiency of existing equipment and cost savings. Replacement of old central air conditioning units with new technology would also ameliorate upon AC energy use.

There is an impending need to have a powerful vision and a platform to discuss opportunities and challenges coupled with research to optimize efficiency for all variant cooling with a green touch that would go for cost saving in HVACR markets. Potential technologies are finding an entry into India through various segments be it chilling, cooling tower, cold storages or transportation. To save on electricity, using energy resources from renewable, particularly solar, has tremendous potential. Precision in technique and innovative experimentation shall only pave the way to build an energy efficient environment.

Optimum efficiency parameters are needed in cooling systems to keep the overall energy consumption under control other than a focus on cost savings. In a wider perspective, cooling bears a vast relevance with regard to the progress made on environmental issues like ozone depletion, global warming, and increasing population. It requires a strong determination to solve the issues of accelerated demand for cooling and refrigeration with pace of technology. Obviously, priorities for the course of action need be addressed with regard to the right factors and to create opportunities. ■

Gopal Krishna Anand

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Editor - Gopal Krishna Anand

SOLAR-ASSISTED COOLING

Case Study by Clique Solar

India is well-known for its power problems. According to the Central Electricity Authority (CEA), India's energy shortage was 8.5% and its peak shortfall was 9.8% in the fiscal year 2010-2011. This situation is expected to deteriorate further. With industrial & urban expansion, growth in household consumption and electrification of rural areas, power requirements are continuously rising. But new electricity generation capacity is not coming online as fast because of the delays related to permissions, acquiring land and funding, and construction.

- Prof Shireesh B Kedare

Environmental concerns have started impacting the progress of upcoming power projects. One example: bidding for the 4,000 MW power project at Surguja in Chhattisgarh has been held up for over a year. The Fukushima nuclear power plant meltdown in Japan in the aftermath of the earthquake & tsunami earlier this year has increased the concerns around the proposed 9,900 MW nuclear plant in Jaitapur in Maharashtra.

More recently, doubts over the availability of cheap coal (coal accounts for over half of India's electricity generation) are also posing as an obstacle for new power plants. Coal-exporting countries like Indonesia (India imports about 50% of its imported coal from Indonesia) have made amendments in conditions related to exports of coal from their shores, causing a spurt in imported coal prices. Many private utilities have won projects via competitive tariff-bidding route and the imported coal supply was based on bilateral agreements with fuel suppliers, mainly from Indonesia. However, contractual framework does not protect power companies from coal price changes triggered by any 'change in law' event in the coal exporting country. Hence, private power producers like Reliance and Tata have sought the government intervention to tackle this issue, which could possibly lead to an increase in power tariff for consumers. According to a study by McKinsey, the power deficit in India could be as high as 25% by 2017.

Cooling and air conditioning is one of most energy intensive processes amongst the various energy consuming applications. Some estimates suggest that HVAC (Heating, Ventilation, and Air Conditioning) networks are to blame for over 30% of a building energy usage. When you consider the potentially millions of Indian homes and businesses installing air conditioning every year, the electricity consumption is enormous. The drastic increase in electricity demand on hot summer days not only causes a large increase in the use of fossil and nuclear energy, but also threatens the stability of electricity grids. According to a study by World Bank, one-third of Indian businesses cite expensive and unreliable power as one of their main business constraints.

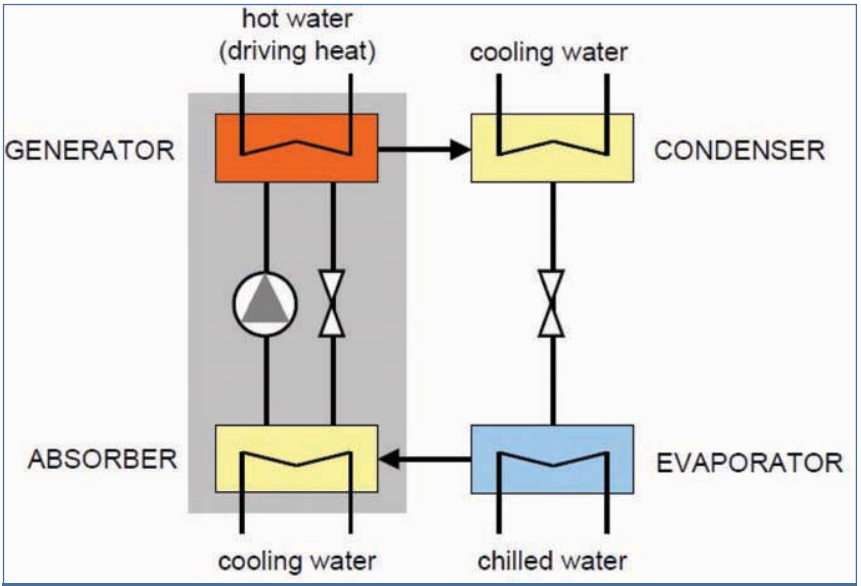
Thus, any technology that can help to save energy in the cooling and air-conditioning applications can help to reduce India's power shortage burden to a great extent.

Absorption Cooling Technology

The traditional compressor driven cooling and air-conditioning systems are known to be energy guzzlers. Absorption cooling is a promising alternative for these traditional compressor-driven systems that are widely prevalent today. The absorption cooling systems are driven by heat, unlike the traditional compressor driven systems which run on electricity. The operating principle of the absorption cooling is explained below.

A thermal compression of the refrigerant is achieved by using a liquid refrigerant/sorbent solution and a heat source, thereby replacing the electric power consumption of a mechanical compressor. For chilled water above 0°C, as is used in air conditioning, a liquid H_2O/LiBr solution is typically applied with water as a refrigerant. Most systems use an internal solution pump, but consume only little electric power. In the operation of an H_2O/LiBr absorption chiller, a crystallization of the solution has to be avoided by internal control of the heat rejection temperature in the machine. The main components of an absorption chiller are shown in the figure below. The cooling effect is based on the evaporation of the refrigerant (water) in the evaporator at very low pressure. The vaporized refrigerant is absorbed in the absorber, thereby diluting the H_2O/LiBr solution. To make the absorption process efficient, the process has to be cooled. The solution is continuously pumped into the generator, where the regeneration of the solution is achieved by applying driving heat (e.g. hot water). The refrigerant leaves the generator by this process, condenses through the application of cooling water in the condenser, and circulating by means of an expansion valve again into the evaporator.

Typical chilling capacities of absorption chillers are several hundred TR. They are generally supplied with waste heat or heat



Source: ESTIF, Key Issues for Renewable Heat in Europe, August 2006

from cogeneration. The required heat source temperature is usually above 80°C for single-effect machines and the COP is in the range of 0.6 to 0.8. Double-effect machines with two generator stages require driving temperatures of above 140°C, but the COPs may achieve values up to 1.2. A few absorption chillers with capacities below 50 TR are also now available.

The heat requirement of the absorption cooling systems is typically in the range of 80°C to 180°C, which is very much suitable for the solar thermal concentrator systems available today. The small & medium size applications (up to 100 TR) are typically very much suitable for solar assisted cooling systems.

Solar-Assited Cooling Systems

In solar assisted cooling systems, solar heat is used to drive the cooling process. Thermally driven cooling machines, such as absorption chillers have been used for decades, but have been powered mainly by industrial waste heat. In recent years, demonstration projects have shown the potential to use solar thermal energy to drive those chillers. Because most of the available thermal chillers have large cooling capacities, the focus of R&D has largely been on developing smaller cooling units as well as to improve the system design.

Solar assisted cooling systems use the thermal energy of solar radiation captured through solar concentrators to power thermally driven cooling machines. As many cooling loads, such as air conditioning, have a high coincidence with the availability of solar irradiation, the combination of solar thermal and cooling obviously has a high potential to replace conventional cooling machines based on electricity. Larger solar cooling systems have been successfully demonstrated and smaller machines, which could be used in (small) residential and office buildings, are entering the market. About 100 systems have been installed in Europe by several companies till date. The use of solar assisted cooling systems is on the rise in India too. However, solar cooling systems are not yet widely available commercially yet, mainly due to following barriers to its wide acceptance:

- Only few types of solar concentrators that can deliver the temperatures required by the vapor absorption machines
- Lack of awareness in the industry for the solar cooling systems
- Lack of chilling units with small capacities
- Higher initial investment costs for the solar cooling systems.

These issues are being addressed by the joint effort of the industry and government policies to promote the use of solar assisted cooling systems, which could have a huge impact on India's energy scenario.

Clique Solar and its innovative Arun solar dish concentrator

Clique Solar is a respected name in the Solar Thermal energy industry with its pioneering and indigenous solar concentrating technologies providing economical process heat for heating and cooling requirements in industries, hotels and residential and commercial complexes. It has successfully installed its ARUN solar concentrator dishes at various locations across India. This innovative dish has resulted from almost a decade of engineering and development efforts.

ARUN Technology

The ARUN dish is a 100% indigenously developed Fresnel Paraboloid Solar Concentrator with a point focus. The innovative dish design and the automatic two-axis tracking system helps it to deliver the highest thermal energy output per sqm of collector area compared to other solar concentrators in India. The performance superiority keeps improving with the increase in the operating temperatures at the application level. ARUN typically generates close to 1 ton of dry saturated steam per day at 150 to 180°C & 5 to 10 kg/sq cm pressure on a typical clear sunny day. The simplicity of operation coupled with the highest standards of safety ensures minimum maintenance over an extended period of time.

ARUN is the first IBR certified solar thermal boiler in India. The system can be used in 'add-on' mode and can be retrofitted to the existing boiler or heater system in the industry. Clique Solar possesses the skills needed for integration of ARUN dish with the existing system. In this mode ARUN delivers energy whenever solar radiation is available, while the boiler or heater is operational at other times. A provision can also be made to store the thermal energy generated to meet energy requirements during non-solar hours. The thermal medium can be high or low pressure process steam, hot water, hot air, or any other thermic fluid.

Key Benefits of ARUN

- **Clean Source of Energy:** One ARUN dish installation results in fossil fuel savings of about 70-80 liters/day. This is equivalent to a saving of over 5 Lac liters of fossil fuel over the life of the installation.

- **Small Footprint Area and Retrofits:** The small footprint area of ARUN dish (3m x 3m per dish) enables it to be mounted at locations which have space limitations. It can also be erected on rooftops of existing buildings.
- **Highest Efficiency:** ARUN delivers maximum thermal energy output per sqm compared to any other solar concentrator technology. Clique Solar guarantees the performance characteristics of ARUN dish.
- **Highest Temperature and Pressure Delivery:** ARUN can operate up to 400°C (oil) and 25 bar (steam) delivering Hot Water, Steam and Thermic Fluid with an accuracy of +/-1°C as per the process requirements.
- **Reduced CO_2 Emissions and Carbon Credit Gains:** Depending on type of fuel saved, CO_2 emissions in the atmosphere can be reduced to the tune of almost 60-70 tons per year.
- **Government Subsidy:** The Ministry of New and Renewable Energy (MNRE) provides support by way of capital subsidy or soft loans for every ARUN installation.
- **Automated Tracking:** ARUN automatically tracks the sun on both, E-W and N-S axes enabling it to capture maximum solar radiation.
- **Non-Solar Hours Operations:** Since ARUN can reach high temperatures, it can be augmented with a heat energy storage facility for operation in non-solar hours.
- **Augmentation with other Heat sources:** ARUN is generally used in 'add-on' mode and Clique Solar can retrofit it to the existing boiler or heater system.
- **Scalability:** The system is easily scalable for higher thermal needs by adding multiple dishes.
- **IBR Approval:** ARUN is the first IBR approved Solar Boiler in India.
- **Safety Parameters:** ARUN has built-in automatic safety control system that has been thoroughly tested under various conditions.

Technical Specifications		Performance Parameters	
Aperture area	169 sq. m	Daily energy output	5-6 Lacs kcal per day per dish
Possible operating fluids	Steam, Hot Water & Thermic Fluid	Effective saving of fuel	70-80 liters per day per dish
Delivery temperature	up to 400^{0}C & 25 bar	Effective saving of electrical energy	600-700 kWh per day per dish
Operating wind speed	up to 12 m/s	Effective saving of CO_2 emissions	50-60 tons / year per dish
Survival wind speed	45 m/s (150 km/hr)	Average steam output	90 – 100 kg/hr per dish
Foot-print required	3m x 3m	Tracking and control energy	1kWh / day per dish

Potential Applications of ARUN technology

Following are some of the processes in various industries where ARUN can be used.

Industry/Process	Application
All industries with boiler installations	Boiler feed-water heating as well as steam generation
Pharmaceutical Industry	Pasteurization, cleaning and other thermal processes
Automobile industry	Cleaning and degreasing operations, paint drying
Chemical processing plants	Effluent treatment, galvanizing, solvent extraction, drying of chemicals
Food industry	Distillation, concentration of extracts, bio-mass dehydration, honey processing, herbal processing
Residential Housing complexes	Hot water for bathing, washing, comfort cooling using VAM
Service industries like hospitals	Cooking, bathing, washing, sterilization, laundry, comfort cooling using VAM
Space cooling & Cold Storage Units	For perishable food, marine and horticultural products at remote places
Co-generation plants	Generating electrical power along with process heat

ARUN installations

Some of the companies where Clique Solar has installed ARUN dishes are as below:

Companies	Industry Type	Requirement (Application of Arun)
Mahanand Dairy at Latur	Dairy	Hot Water Generation for milk pasteurization
M/s. B.G. Chitale at Sangli	Dairy	Steam generation for Pasteurization, Milk Chilling, Cleaning in Place (CIP), Crate washing, etc.
ITC, The Maurya Hotel, New Delhi	Hotel	Steam generation steam for laundry, cooking and bathing
Mahindra at Chakan, Pune	Automobile	Hot Water generation for Degreasing
Heavy Water Project, Kota	Support function for Nuclear power plant	Steam generation for effluent treatment plant
Turbo Energy Limited, Chennai.	Automobile	Air-Conditioning purpose & delivering hot water @ 180˚C to VAM

Solar Assited Cooling using Arun Dish – Case Study

The first cooling system assisted by ARUN solar concentrator has been installed at the office building of Turbo Energy Limited (TEL), Paiyanoor, which is about an hour's drive from Chennai. TEL is a leading supplier of turbochargers to many Original Equipment Manufacturer (OEMs) operating in India. The company has undertaken various green initiatives & has been the first certified auto ancillary company under 'PLATINUM' category by LEED USGBC (United States Green Building Council). TEL has successfully installed one ARUN solar concentrator dish for fulfilling its hot water requirements for operating a Vapor Absorption Machine (VAM) for air-conditioning for administration block. It is in the process of installing another dish for increasing its air-conditioning capacity.

The process of hot water generation for operating Vapor Absorption Machine to produce air-conditioning with the help of ARUN is as explained in the figure herein:

Average expected daily thermal output of one ARUN®160 dish at Chennai	4,50,000 kcal
Number of clear sunny days in Chennai	275 days
Total energy expected to be delivered by one ARUN dish	1,23,750 Mcal
Calorific value of fuel (HSD)	9,000 cal/liter
Efficiency of hot water generation run by HSD	90%
Expected annual fuel saving by ARUN dish	15,300 liters of HSD per dish per annum

Schematic Description

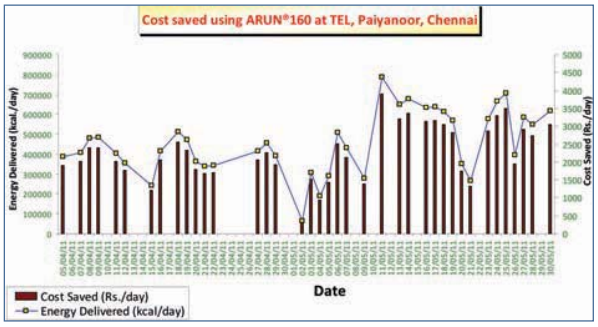
The vapor absorption machine (VAM) installed at TEL, is hot water driven. Pressurized water at 180°C is required for the machine to operate at an optimal level. The return temperature of the hot water is 160°C. The machine with 40 TR capacity requires 5 m³/hr of the pressurized hot water which can be catered to by 2 ARUN dishes. The solar circuit is kept pressurized at 15 bar using the nitrogen pressurization system. The nitrogen cylinders are connected to the expansion tank in the circuit, for this purpose. The cooling system is used for air conditioning of the administration office in the plant.

Operation Philosophy

The water is circulated, using centrifugal type circulating pump, through the ARUN dishes. The dishes are arranged in parallel configuration; therefore a single pump is sufficient for the water circulation through both dishes. The system is kept pressurized at 15 bar pressure to avoid the steam formation in the circuit. The water at 160°C, from the VAM, is taken as inlet to the ARUN®160 dishes and it is heated to 180°C. The average heat output from the two dishes is about 1,00,000 kcal/hr, which is sufficient for the heat requirement of the vapor absorption machine.

Expected fuel saving by one ARUN dish

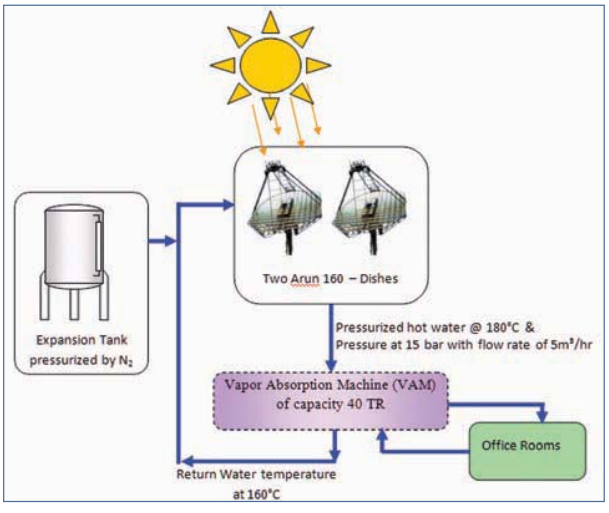
The following chart shows that the actual savings in fuel cost of TEL is Rs 88,397 for one month of operation using ARUN.



Closing Remarks

availability of solar irradiation. In a country like India where solar energy is available in most parts of the country and power shortfall is very common, the combination of solar thermal and cooling has a high potential to replace conventional cooling machines that run on electricity. Solar thermal concentrating technologies like Clique Solar's ARUN dish can be used to achieve higher temperatures, thus allowing the use of multiple effect VAMs which can reach higher COPs. The actual data of fuel savings by the ARUN dish installation at Chennai is an excellent example and an inspiration for others to follow. ■

Many cooling loads generally have a high coincidence with the



Prof S B Kedare, Adjunct Professor, DoE Science & Engineering, IIT, Mumbai; Director, Clique Developments Ltd is BTech in Mech Engineering and PhD in Renewable Energy from IIT-B. He is considered as an authority in research, design, construction & project management on various aspects of concentrating solar collectors including optics, mechanical & thermal design, system integration, commissioning and operation. His role was pivotal in research, development, design, fabrication, installation & performance testing of ARUN. He is currently a part of the team at IIT-Bombay working on development of a MW scale solar thermal power plant with focus on solar collector field design, technology selection & implementation & involved in development of 1.5 kWe Stirling engine & solar concentrator dish suitable for it.