Response to UNEP Call for Case Studies that Avoid or Replace HCFCs
Submitted to ruperto.dejesus@unep.org
July 14, 2009

Cotherm Water Heating

Eliminating Atmosphere Carbon Discharge & HCFC Refrigerants

For Heating of Water in Hotels

Puerto Vallarta, Mexico

2006 – 2008

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COTHERM
Connecting the dots for an integrated energy future

Abstract:

It is estimated that 5% of the world's daily energy consumption is expended on fuel for heating water. An electric heat pump is an alternative to burning fuel for heating water. A heat pump uses a vapor compression cycle to take heat from a low-temperature source and raise its temperature to a useful level. Heat pump water heaters using CFC and HCFC refrigerants have been a niche market dating back to the 1970's. HFC refrigerants have been introduced for heat pump water heating but mainly for space heating in cooler climates. Commercial buildings such as hotels in warm climates have a simultaneous need for heating potable water and comfort cooling. During the period of March 2006 through November 2008, a market test of a heat pump technology known as Cotherm Water Heating was conducted in the hotel resort community of Puerto Vallarta, Mexico. The concept was to install a complete heat pump system that will maintain hot water tanks at 60C temperature while providing 10 to 30% of the cooling requirement. This system enables the existing water heater fuel valves to be completely shut off, thereby saving fuel and eliminating carbon discharge for water heating. Using a totally installed or "turn-key" approach, seven hotels adopted the new technology which featured special water to water heat pumps using HFC134a refrigerant instead of HCFCs. The monthly savings in fuel ranged from US$5,000 to $20,000 depending on the degree of application and size of the hotel. The savings in fuel, fuel cost and carbon discharge were diligently recorded for 32 months. Over 1.6 Million liters of fuel were saved over the period by the seven hotels, representing a value of over US$ 800,000. Over 3000 tons of carbon was saved from discharge and since cooling was produced simultaneously with the water heating, little or no additional electricity was used. The market test proved the commercial viability of the application on a capital purchase basis or lease with service. HFC refrigerants were applied successfully in lieu of HCFCs. HFC134a, while commercially viable, has a global warming potential 1300 times greater than CO2. Perhaps one of the most important outcomes of the test was the practical experience to design an improved unit that can be applied internationally with double wall heat exchangers to make the same application practical for code compliance and the safe use of low GWP natural refrigerants.

BACKGROUND ABOUT THE COMPANY

Cotherm of America and Cotherm of Puerto Vallarta

- Opened in 2005 to innovate and qualify options for sustainable energy technology in the commercial sector with an initial focus on water heating.
- Expanded into Puerto Vallarta, Mexico to confirm the market acceptance of fuel-less water heating with concentration on the hotel market.
- Closely analyzed the sales, installation and savings for seven lead clients in preparation for international market penetration.

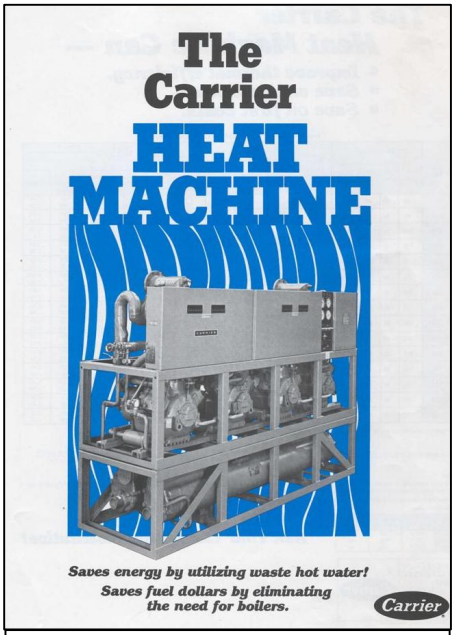
Ted Jagusztyn - Managing Director

- 36 years in the HVAC industry in sales, engineering and innovation.
- Led the marketing of the 1980's Carrier Heat Machine, a modified chiller designed to sustainably heat water.
- Innovator of one of the first sustainable water heating systems located at HSBC Hong Kong Headquarters. Implemented in 1980 and still in operation today.
- Inventor of the CoTherm Water Heating technology with intellectual property filed under the Patent Coordination Treaty in 2007.

PREVIOUS SYSTEM AND REFRIGERANT

In the 1970's and 80's there were some pioneering projects which displaced the burning of fossil fuels for heating water by employing a heat pump. A heat pump uses a vapor compression cycle to take heat from a low-temperature source and raise its temperature to a useful level. Over thirty years ago, one such project was located in Hios, Norway. A lake was polluted and a water treatment facility was erected to clean up the lake. It was proven expensive to heat the facility. Engineer Emir Chevro and the author proposed a system to modify an R-12 centrifugal chiller to capture heat from the lake water and produce 45C hot water to heat the facility instead of burning fuel.

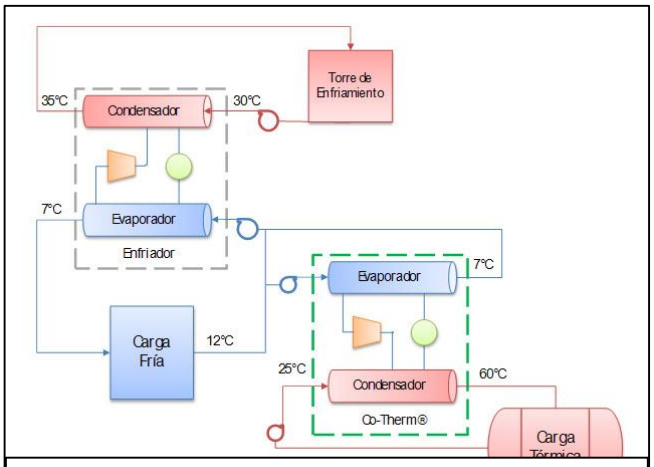
In the early 1980's, world renowned architect Norman Foster orchestrated the building of the headquarters of the HSBC bank in Hong Kong. His team challenged suppliers to develop systems for the 21st century. A system was proposed and adopted whereby the entire building is heated by a single centrifugal refrigeration machine extracting heat from the adjacent harbor at an efficiency of 500% . Pioneers further developed these water-to-water heat pumps by modifying existing water chillers to supply the heat for water heating. This opened up a niche market for what was called "heat machines" by one brand and "Templifliers" by another brand. These water-to-water heat pumps generally used HCFC22 for temperatures up to 50C, and CFC12 for hot water temperatures up to 70C. A market opened up in warm climates for these machines in hotels to provide hot water for showers instead of using boilers. This "heat machines" recovered heat from either the cooling tower or return chilled water and produced hot water at the desired temperature. The customers appreciated the fuel saved and reduced problems in dealing with the smoke flue discharge of boilers. The Regent Hotel in Bangkok Thailand, the Princess Hotel in Singapore and the Royal Mayan Hotel in Cancun, Mexico adopted the technology in the 1980's. The Montreal Protocol came to ban CFC's and discourage HCFCs and, with relatively low fuel prices, the heat pump water heating market was largely ignored by major manufacturers.



In the 1980's air conditioning manufactures such as Carrier developed vapor compression machines using HCFC22 and CFC12 that produced hot water recovering a buildings internal heat instead of burning fuel in boilers.

Swimming pool heaters using HCFC 22 were promulgated by niche firms around the world. In 1998 a small manufacturer in Mexico developed and installed a water-to-water heat pump they coined "Co-therm Chillers." These machines were modified to use either HCFC22 or HFC134a to produce up to 60C hot water. The HFC alternative started a path beyond HCFCs. Hotels were a particularly attractive application because of the constant need for cooling simultaneous with a large demand for hot water. An article appeared in a hotel magazine, *Alta Hoteleria* , publicizing the first initial installation. Starting in November of 2005, Cotherm of America Corporation based in Florida USA and TECSIR of Monterrey, Mexico teamed up to test market the heat machine concept in the concentrated hotel area of Puerto Vallarta, Mexico.

NEW SYSTEM AND REFRIGERANT



The Co-Therm Fluid Heater developed and manufactured by TECSIR of Mexico is a machine that by using either HCFC22 or HFC134a that 60C hot water could be produced instead of burning fuel in boilers. The 2006-2008 market test in Puerto Vallarta Mexico had the machines installed in eight hotels using HFC 134a only for producing hot water.

HFC134a has came to be an accepted refrigerant for heating water but the application has yet to go beyond a small niche market. An upgraded design of the "heat machine" was evolved for the test market in Puerto Vallarta, Mexico The controls were upgraded to electronic controls with dial up modems to extract two weeks of operating data and enable remote upgrade of the software. A decision was made to steer clear of HCFC's and standardize on HFC134a for hot water and HFC507 for pool water heating[1]. The author was stationed in Puerto Vallarta to sell a turnkey concept to the hotels. An entire "Co-therm" system would be engineered, manufactured, installed and serviced by one entity to assure the result. A project would start by studying the fuel consumption history of the property and isolating that fuel consumption attributed to the heating of water. This data corroborates the theoretical sizing of the capacity of the equipment. All the projects used one or more of two sizes. Model CT200 yielded a capacity of 500,000 BTUs of heating at 60C hot water with 30 tons of cooling. A Duplex model which basically doubled the capacity was also applied. These models used two or four 15 ton reciprocating R134a compressors either Carlyle or Bitzer. The first three hotels were installed free for three months to prove out the savings. After the trial period the hotel had the option to purchase the entire system or lease it. After a contract was signed, a team was assembled at the jobsite to prepare the electrical and plumbing connections to the location of the prospective machine. Once the machine and pumps arrived both were set and final plumbing connections were made. The shortest time from machine arrival to machine start-up was 11 days with three men performing the installation. Once the machine was installed and producing hot water, the fuel valves of the water heaters were turned off. Customers experienced dramatic savings of fuel and noted that there was not any appreciable increase in electricity after installation. The efficiency in electricity usage was caused by two designed in-system effects. The first is that the Co-therm units pre-cooled the return chilled water before the existing chillers. This thereby reduced the load of the air conditioning system by allowing the large chillers either reduced power in part load or turned off completely. Secondly, the incoming municipal water was pre-heated in a special sub-cooler. This Pre-heater /Subcooler heat exchanger increased the efficiency. The efficiency per unit of heat of refrigerant HCFC22 is generally better than HFC134a however the design of the cycle improvement mitigated the difference.

EXPERIENCE SO FAR

The story of this innovation is mentioned in an article in the July 2009 edition of *Innovation Magazine*. See www.innovationmagazine.com, "Innovation – The Way Through Recession." http://www.innovationmagazine.com/volumes/v9n1/preserved-docs/60_61.pdf

1 In one hotel Co-Therm pool heating system R507 refrigerant was specified and tested but R-22 was initially supplied due to an incorrect TXV head supplied. It was urgent that the machine be supplied in time to be operational for pool heating season. The customer agreed to the change with the understanding that the refrigerant can be changed in the field to R507 at his option.

The Marival Hotel in Nuevo Vallarta had four Co-Therm machines installed. This property with conventional water heating technology regularly demanded 8 propane truck deliveries per month prior to installation of the new technology. After retrofitting to Cotherm technology, the propane water heaters were completely shut off and the meters were at a standstill while the hot water tanks were still at 60C temperature and the guests enjoyed hot showers. Today the property has three or less deliveries of propane per month. The gas supplier was dismayed and offered a lower price because he thought the customer had changed suppliers. The hotel assured the gas supplier that they were just using a more advanced heating technology. This hotel is leasing the Co-Therm systems with service included and the fuel cost saved every month greatly exceeds the lease payment.

Cumulative Vallarta Area Fuel Savings with CoTherm Technology

Update 16-Dec-08

Project Location	Type of Fuel	Start-Up date	Report Date	Months of Operation	Liters Of Fuel Saved	Pesos* Saved	US Dollars* Saved	Carbon Tons Saved
Marriott PV	Diesel	18-Mar-06	30-Nov-08	32.5	594,777	$ 3,045,689	$ 298,597	1790
Marival NV	LP Gas	11-Nov-06	30-Nov-08	24.7	519,796	$ 2,435,886	$ 238,812	115
Holiday Inn PV	Diesel	21-Jan-07	30-Nov-08	22.3	186,796	$ 932,322	$ 91,404	562
Grand Mayan Laundry NV	LP Gas (Recorded since 06/2008)	7-Jun-08	30-Nov-08	5.8	49,112	$ 238,022	$ 22,039	11
Occidental NV	LP Gas (Recorded since 06/2008)	30-May-08	30-Nov-08	6.0	72,382	$ 350,785	$ 34,391	16
Sheraton PV	LP Gas	2-Sep-08	30-Nov-08	2.9	77,614	$ 383,870	$ 37,634	17
NH Krystal	LP Gas	10-Nov-08	30-Nov-08	0.7	5,886	$ 29,584	$ 2,900	2
Total				114.2	1,691,403	8,285,545	811,012	3,014

* 10.2 Pesos to One US Dollar exchange rate

The savings in fuel measured in liters, fuel cost in Pesos and converted to US dollars and carbon in tons were recorded monthly from March 2006 till November 2008. The basis for the fuel savings for the first year was the fuel used per occupied room in the base 2005 month. After this period the machines had software that calculated the amount of fuel saved based on the amount of heat they produced versus the base fuel water heater. The carbon discharge saved was calculated with software based on the amount fuel not combusted at the normal efficiency.

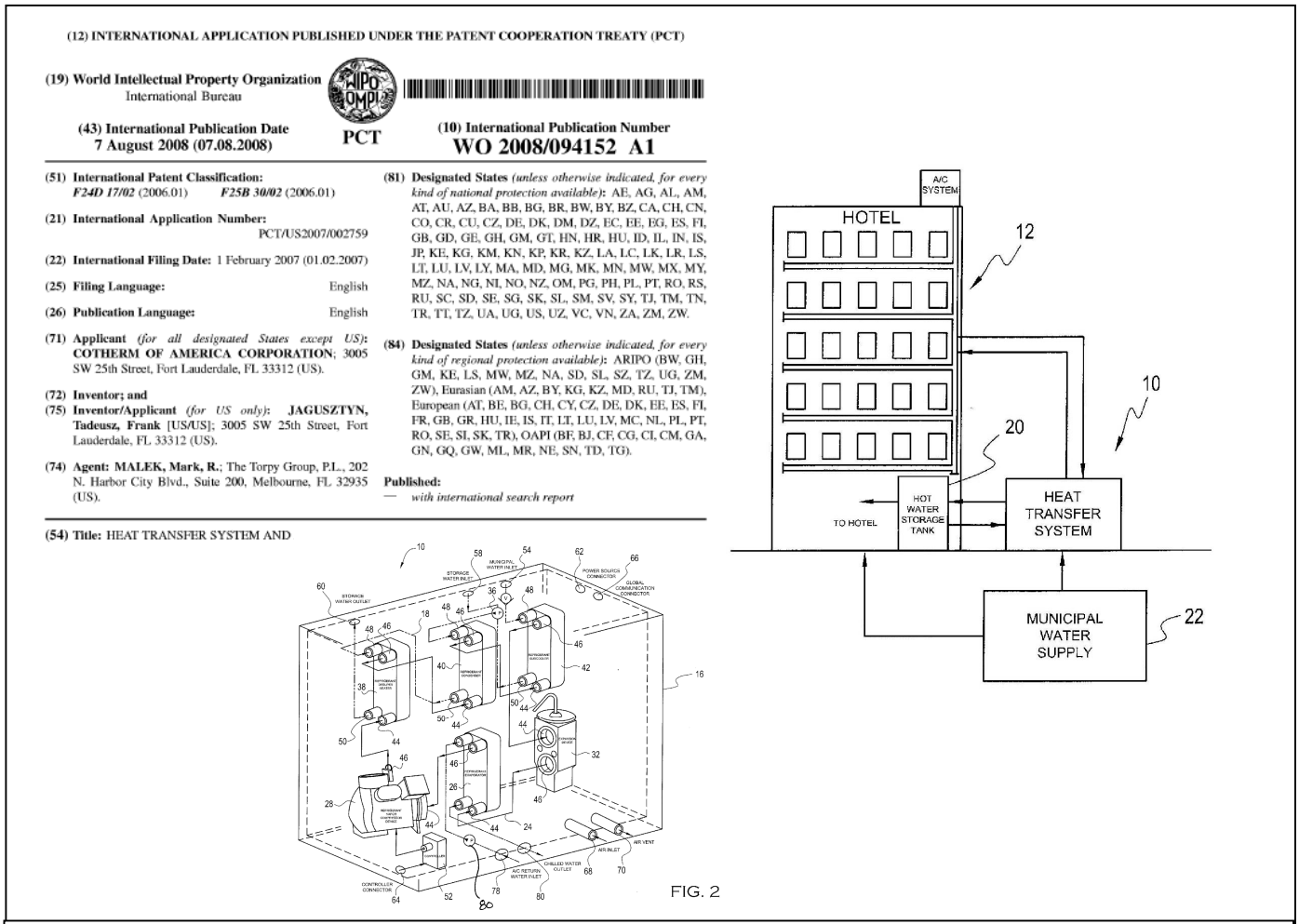
We noted that the applications that used diesel fuel and steam boilers were a bit more difficult to calculate the savings because it depended on the part load efficiency of the boilers and the effectiveness of the steam traps. In one application the steam traps were ineffective, bypassing live steam so the savings were not realized and the customer not convinced. The seven lead customers are convinced of the value of the application and some have provided testimonials. The applications saving diesel fuel such as the Marriott significantly reduced their carbon footprint as well as reducing their operating cost. The savings with applications that had gas water heaters had much faster fuel cost savings due to the relatively high cost of propane. In just the first month of operation, the Sheraton hotel clearly saw that they saved 20,000 liters of propane. Several water furnaces were completely shut off while the guest rooms and kitchens had plenty of hot water. The Marriott Hotel engineer was especially adept at saving electricity and fuel. In the winter months he heated the pool with Cotherm and scheduled to run the laundry at night, matching a hot water load with a cooling load. He was able to shut off the main chillers with the Cotherm units providing the hot water and chilled water with the same kilowatt. The Marriott Co-Therm system was oversized in capacity. The property used this free hot water to their advantage. In a later room refurbishment, the hotel decided to change out the air conditioning fan coils in all the rooms and add re-heat humidity control. This solves a long standing problem in almost all tropical hotels. Before humidity control, the rooms humidity was almost always above 75% but maintain the desired temperature. This situation sometimes leads to guest complaints particularly with the odors that the high humidity may cause. After the change, the guest comfort was tangibly improved . These practices were later documented in a Best Practice document by Marriott.

ENERGY EFFICIENCY ADVANTAGE

The Coefficient of Performance or CoP is a measure of efficiency. It is the ratio of the output energy to the input energy. An traditional electric hot water heater uses resistance rods immersed in the water tank to heat water. An

electrical input of 1000 KW generates a heat output of about 1000 KW. Therefore 1000Kw Output / 1000Kw Input is a CoP = 1. For a gas water heater of say 500,000 btuh input, the typical output would be less at about 400,000 BTUh or a CoP = 0.8 The efficiency advantage of this Cotherm technology over any existing water heating system is many times greater than either of the aforementioned conventional technologies**. Studies show that the CoTherm Water Heater is in fact more than six times greater efficiency than conventional water heating.** For every 1000 KW of input to the Cotherm Water Heater machine 3500 Kw of heat is output and 2500 Kw of cooling is output. Therefore the Cotherm CoP is 3500Kw + 2500Kw total output / 1000Kw Input, calculating a CoP = 6. That is 600% efficiency but the big energy efficiency story and the one most desired by customers is the fuel saved. A video documentary on the internet explains the technology benefit at this URL
http://www.cothermwaterheating.com/Documentary.html

While the Puerto Vallarta market test proved that the Co-Therm application was a viable application, certain deficiencies were uncovered that need to be addressed if this technology is to be in the mainstream in the near term. The proto-type units in the test market had condensers and sub-coolers heat exchangers that were "single wall". That means that on one side of the heat exchangers was a fluid mixture of HFC134a and refrigerant oil and on the other side, potable water. If a breach in the heat exchanger was to occur, say by corrosion, one side would "cross-connect" to the other. Internationally recognized plumbing codes specify "cross-connection" prevention measures that preclude the potential for non-potable fluids such as refrigerant oil to enter a potable water stream. Some international hotel chains also include cross-connection prevention in their codes of practice. To make Cotherm Water Heating more efficient and practical for international application including the safe use of natural refrigerants an international patent application was made. The WIPO reference is pictured below. This intellectual property is meant to be inclusive rather than exclusive, as wide application of this technology may bring about a paradigm shift toward ***Fuel-Less Water Heating*** and away from global warming refrigerants. This certainly is a step in the right direction to wean ourselves away from the practice of greenhouse gas discharge with synthetic refrigerants or carbon discharge in heating water by burning fuel.



(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

PCT

(43) International Publication Date
7 August 2008 (07.08.2008)

(10) International Publication Number
WO 2008/094152 A1

(51) International Patent Classification:
F24D 17/02 (2006.01) *F25B 30/02* (2006.01)

(21) International Application Number:
PCT/US2007/002759

(22) International Filing Date: 1 February 2007 (01.02.2007)

(25) Filing Language: English

(26) Publication Language: English

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(54) Title: HEAT TRANSFER SYSTEM AND

FIG. 2

Cotherm of America Corporation is a firm that develops innovations and makes them available to the public and private sector for license. This patent application is a sustainable commercial water heater featuring double wall heat exchangers, in a packaged design that is recyclable and able to apply any refrigerant but the preferred embodiment is with low GWP natural refrigerants such as hydrocarbons, ammonia or CO2. This application may be studied at the WIPO website by referencing WO 2008/094152.