

# Technical Sheet

## A DOUBLE SECTION DIRECT CONTACT WATER HEATER: AN EFFICIENT SOLUTION FOR MULTI-PURPOSES APPLICATIONS

### BACKGROUND

The boiler room at the SOREL GENERAL HOSPITAL (Quebec) must provide steam and hot water for various uses such as medical equipment sterilization, hydronic heating, domestic hot water heating and cooking equipment water heating. The significant energy consumption related to these loads justified the search for high efficiency equipment.

At the Sorel General Hospital, it was decided to replace an electrical hot water boiler and an oil boiler with a natural gas high efficiency hybrid-type direct contact water heater. This is an attractive solution when both steam and hot water are needed on the same site.



Dual temperature direct contact water heater installed at the Sorel General Hospital

The direct contact water heating technology is based on the direct contact heat transfer between hot combustion gases from a natural gas burner and the water to be heated. The heat transfer is done in a vertical packed, counter

current, heat exchanger. The "hybrid" characteristic allows the recuperation of the energy contained in the flue gases of the steam boiler as an auxiliary heat source to produce hot water, which increases the steam boiler efficiency.

### LIMITATIONS

A direct contact water heater is based on the counter current heat exchanger concept. The efficiency is based on the inlet water temperature, which will limit the temperature at which the combustion gases will be lowered before they leave the equipment.

The inlet water temperature is the coldest temperature the exhausted combustion gases can reach. A high inlet water

temperature in the water heater will yield a high combustion gases outlet temperature with a significant amount of residual energy, meaning a lower thermal efficiency.

For high temperature closed-loop applications such as space heating, where the return water is still hot, the unit thermal efficiency drops drastically. The high efficiency inherent to the direct contact

technology is then reduced. The Sorel General Hospital is an example of an application where the temperature of the return water from the hydronic heating loop is relatively high, but where other loops at lower temperature are accessible (domestic hot water and kitchen hot water) and could be used to increase the overall efficiency of the system.

"DUAL" TEMPERATURE DIRECT CONTACT WATER HEATER

## AN INNOVATIVE SOLUTION

A dual temperature direct contact water heater ("DUAL") was developed to prevent the efficiency drop problem associated with high temperature return water. The "DUAL" technology is based on the fact that many commercial, institutional or multi-family building sites require hot water for various uses such as hydronic heating, domestic hot water production, kitchen water production, make-up air heating, pool heating, etc. Some applications, like high temperature hydronic heating, will have a hot water return to the water heater while others, like domestic or kitchen water production, pool heating or make-up air heating, will have a cool or cold water return to the water heater.

These lower return water temperatures are used in a second exchanger to recover residual energy in the

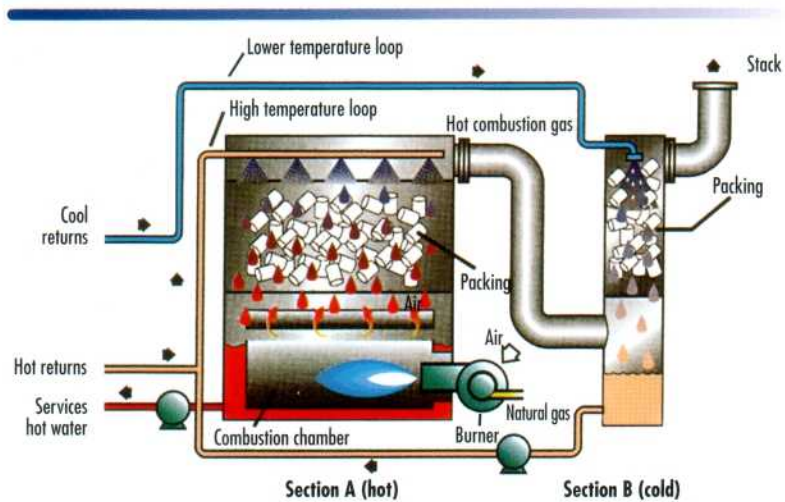


Figure 1: "DUAL" principle

flue gases, that could not be recovered by the hot water return resulting from the combination of the different loops in a standard direct contact water heater. This configuration will insure the recuperation of energy otherwise lost at the stack, leading to a constant high efficiency.

## OPERATING PRINCIPLE

The "DUAL" water heater uses two direct contact heat exchange sections instead of one. Cool and cold water returns are supplied to a secondary direct contact section (section B), where they are preheated. The preheated water is then merged with the hot water returns and the resulting mixed stream is supplied to the main direct contact section (section A). Hot water coming out of section A is then pumped to the different heat exchangers that are used to heat the different building water circuits. Water in section A is heated by the combustion gases

of a natural gas burner while water in section B is heated by the residual energy of the combustion gases going out of section A. That configuration, where hot water at two different temperatures is fed, insures the recuperation of the residual energy contained in the flues gases, otherwise lost at the stack, and a constant high efficiency operation. The flow diagram of the developed technology is showed in figure 1, where a recuperation section (section B) is added to a standard direct contact water heater (section A), forming the "DUAL" direct contact water heater.

## SOREL GENERAL HOSPITAL INSTALLATION

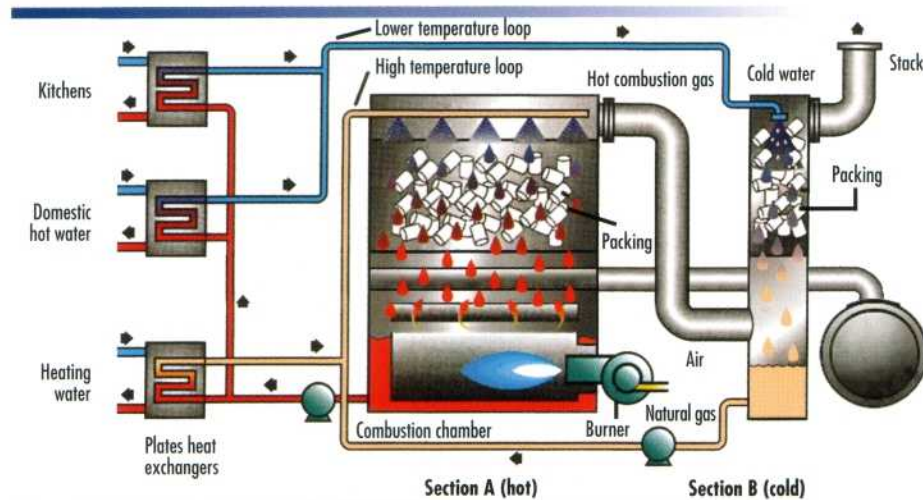
The “DUAL” direct contact water heater is well suited for the Sorel General Hospital installation, where hot water for different uses is required in the building.

### THE UNIT

A 2.0 MW “Hybrid DUAL” unit was designed and installed at the Sorel General Hospital to meet the space heating, domestic hot water and kitchens hot water needs.

Space heating return is considered as the hot water return at section A while domestic hot water and kitchens hot water returns are considered as cool or cold returns at section B. The different service loops are heated by the primary water loops through a set of three plates heat exchangers which have close to 100% heat transfer efficiency. A flow diagram of the Sorel installation is shown at figure 2.

During the heating season, 90 l/min coming from the kitchen and domestic hot water exchangers are preheated in section B from an average of 37°C to 65°C. This stream is then mixed with the space heating water return and 1,700 l/min are heated in section A to about 70°C. When the water heater control detects a domestic or kitchen hot water need, the section A outlet water temperature set point is fixed at 70°C.



**FIGURE 2:** Flow diagram of the “DUAL” installation at the Sorel General Hospital

Otherwise, the outlet water temperature set point of section A is dependant on an indoor-outdoor temperature schedule.

While similar in principle to the “DUAL” system in figure 1, the “DUAL Hybrid” unit installed at the Sorel General Hospital can circulate combustion gases from an existing steam boiler through its heat exchangers as an auxiliary energy source in the main section of the water heater (section A). The recuperation of the steam boiler flue gases increases the overall efficiency of the equipment, which is now only used at partial load since the boiler room was upgraded. For the Sorel installation, the average recovery potential is 140 kW. The “hybrid” option then insures an optimal boiler room energy utilisation and provides further energy savings for the user.

## EFFICIENCY AND ENERGY SAVINGS

For a 60 day period during heating season, the performance was monitored on the "DUAL Hybrid" installation of the Sorel General Hospital. Throughout the measuring period, the unit global efficiency was nearly constant between 87% and 89% (based on the high heating value of natural gas). Section A efficiency, that is representative of a standard

direct contact water heater efficiency, was about 75%, for a 65°C return water temperature at this section (see figure 2). These performances justify the choice of the dual temperature direct contact water heater for the Sorel General Hospital, that is designed to overcome the efficiency loss problem associated with high return water temperature. Adding

section B, that completes the "DUAL Hybrid" water heater, raises the daily unit overall thermal efficiency to an average 88%.

Higher efficiency leads to energy savings. For the Sorel General Hospital boiler room, energy savings using the "DUAL Hybrid" are shown in table 1.

**TABLE 1: Energy savings at the Sorel General Hospital using "DUAL Hybrid" water heater**

Boiler room configuration	Period	Energy consumption	Energy savings (adjusted for an equivalent heating load)
Previous system <sup>1</sup>	Jan-Feb 1998	3,585 GJ	37%
With DUAL <sup>2</sup>	Jan-Feb 2000	2,412 GJ	
Previous system <sup>1</sup>	March 1997 to February 1998	26,835 GJ	16%
With DUAL <sup>2</sup>	March 1999 to February 2000	22,015 GJ	

- 1 (electric boiler and oil boiler used in dual-energy mode) + steam gas boiler  
 2 DUAL gas water heater + steam gas boiler

## AN ADVANTAGEOUS SOLUTION

### "DUAL" direct contact water heater provides numerous benefits:

- high efficiency
- non pressurized equipment
- carbon dioxide (CO<sub>2</sub>) emission reduction
- ease of construction

## MULTIPLE APPLICATIONS

Several commercial, institutional or multi-family building applications require hot water for various purposes, resulting in water returns at different temperatures. The "DUAL" direct contact water heater is perfectly suited for these multi-use

applications, like the one experienced at the Sorel General Hospital. The "DUAL" insures highly efficient operation by the optimal management of the thermal recuperation potential associated with these various water returns.

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