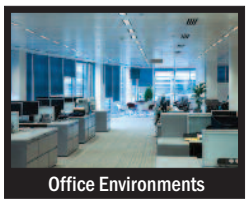
TOTALAIRE™
by Desert Aire

DEDICATED OUTDOOR AIR SYSTEMS

DOAS and HOAS Equipment for 100% Outdoor Air and Mixed Air Applications


Office Environments


Hotels and Motels


Educational Environments


Restaurants


Medical Facilities

Desert Aire's TotalAire™ Series dehumidifiers provide you the most complete solution for your dedicated outdoor air system (DOAS) and high outside air system (HOAS) applications. Our many options allow you to design the highest energy saving solution for your compliance to ASHRAE 62.1 code ventilation requirements for new construction and renovation projects. This system allows the engineer to separate the latent load of the building and deliver conditioned air to the space which will optimize the performance of the buildings convention heating and cooling systems. Rely on Desert Aire for a solution for your complete outside air needs.

OPTIMIZING SOLUTIONS THROUGH SUPERIOR DEHUMIDIFICATION TECHOLOGY

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TotalAire™ Indoor Air Quality (IAQ)

Issues of Indoor Air Quality (IAQ)

Several HVAC trade and professional organizations, including ASHRAE, have documented the need for suitable indoor air quality. A primary requirement for maintaining proper IAQ is through the introduction of varying amounts of outdoor air. The down side of adding outdoor air is that it also admits excess moisture into the facility. If this condition is not controlled, it can create an environment for mold, mildew, viruses and other potentially hazardous organisms to flourish. The key to preventing mold formation and growth is to control the relative humidity within the space. A standard air conditioner cannot achieve this since it controls only temperature. Instead, a system must be implemented that can provide full control of both temperature and relative humidity.

Figure 1 - Basic Refrigeration Circuit Diagram

Dehumidification

All TotalAire™ units are designed around a reliable, efficient dehumidification system. There are two main reasons for using the dehumidifier as a base to build a complete ventilation system:

- Significant additional energy costs will result if the latent cooling provided by a standard air handler is used for dehumidification. In contrast, dehumidifiers are the **only** efficient means to regulate moisture removal.
- TotalAire™ dehumidifiers are configured for the easy addition of optional components needed for a complete solution, options that offer effective solutions that are not otherwise available.

TotalAire™ units are engineered and manufactured for excellent performance, dependability and serviceability. Specially designed evaporator coils provide maximum moisture removal. Components are carefully selected for reliable long-term operation.

Dedicated Outdoor Air Systems (DOAS)

The most energy efficient method to remove moisture is through the use of a dedicated outdoor air system that lowers the dew point temperature of supply air to below 55° F. This also helps remove existing moisture from inside a facility. A DOAS design can also be optimized to remove maximum moisture at the lowest electrical consumption rate (Moisture Removal Efficiency, MRE) at both full and part-load conditions. Desert Aire manufactures DOAS units under our Aura™, TotalAire™ and VerticalAire™ product lines.

High Outdoor Air Systems (HOAS)

If the application requires an air handler to accept outside air volumes of 50% to 100% of the supply air volume, conventional sensible heating and cooling units cannot be used. The system must be designed to remove the outdoor air's moisture, but also incorporate a specialized sequence of operation to provide the appropriate sensible cooling and heating. A HOAS design can also be optimized to remove maximum moisture at the lowest electrical consumption rate (Moisture Removal Efficiency, MRE) during both full and part-load conditions. Desert Aire manufactures HOAS units under our Aura™, TotalAire™ and VerticalAire™ product lines..

Design Options

Desert Aire's TotalAire™ Series offers the widest range of performance options while maintaining its main focus: Meeting the target dewpoint while attaining the lowest operational cost. In addition, the many options help to reduce the operating cost of the remainder of the building's sensible cooling and heating systems. The design engineer has the ability to configure the system with the following configuration options.

- **DOAS or HOAS** - System is flexible in the amount of outside air delivered
- **Energy Recovery** - An enthalpy wheel can recover energy from the exhaust air stream
- **Control Strategy** - Multiple choices allows better energy efficiency
- **Choice of Condensers** - Air, water or geothermal (or combinations)
- **Auxiliary Heating** - Many options including:
  - Gas
  - Electric
  - Hot water or Steam Coils
  - Geothermal
- **Miscellaneous Options** - Indoor/Outdoor systems, fan discharge direction, coated coils and better filtration are just a few of the many additional configuration options available for inclusion on the TotalAire™ Series.

Condenser Design Options

Each unit includes a hot gas reheat coil that is integrated into the refrigeration circuit along with a modulating control system to maintain the discharge temperature based upon the choice of control algorithm. This coil reheats the leaving air to the precise temperature required and rejects any remaining energy to a second condenser.

A choice of secondary condenser options allows the design engineer to integrate the superior design features of the TotalAire™ system into any building type or location. The condensing system is selected to work in series with the hot gas reheat coil to implement the control option of choice. You may choose either an air-cooled condenser, that dissipates heat to the outdoors, or a water-cooled heat exchanger, which releases heat into a facility's chilled water or cooling tower loop.

Air-cooled condensers may be packaged with the dehumidifier on a single skid in an outdoor application. A split system allows the dehumidifier to be located away from the condenser, indoors or outdoors. Desert Aire only requires two refrigeration pipes (suction and liquid lines) to be run between the dehumidifier and remote condenser.

An optional water-cooled condenser can also be selected for use in loop systems, hybrid systems or in geothermal applications.

Air Separated Coils

If a hot gas reheat coil is installed too close to the evaporator coil, re-hydration can occur. Water on the surface of the evaporator coil can be blown onto the hot gas reheat coil. This will convert it back into vapor which will then be returned to the space. This completely negates all dehumidification efforts and fails to meet basic IAQ design requirements. Consequently, the system will remove less moisture at a higher electrical cost. That's the reason we design our IAQ units with adequate separation between the outlet face of the evaporator coil and the inlet face of the hot gas reheat coil to prevent re-hydration.

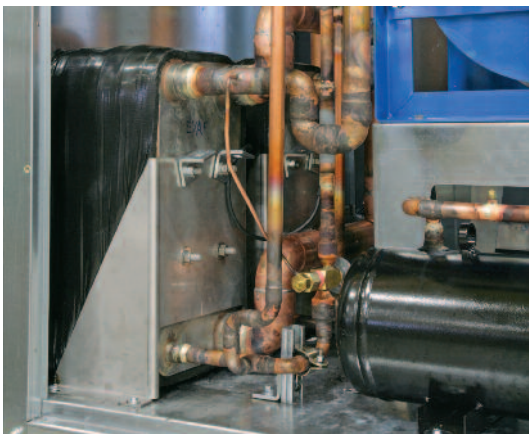

Figure 2 - Water Condenser

Figure 3 - Packaged System

Cabinet and Construction

The TotalAire™ Series features a double wall construction cabinet with a powder coated galvanneal steel outer wall and a sturdy galvanized inner panel. Hinged access doors shall allow easy access to internal components within each section. Each door shall have a minimum of two cam latches. Weatherproof compression gaskets shall seal between the door and unit casing to produce an airtight seal. The unit is designed for complete access for service and maintenance from one side only.

Outdoor cabinets include a rain hood and isolation dampers with actuator and have a fully weatherproof roof with a cross broken roof for water drainage.

Filtration

Outdoor air contains many airborne particles and pollutants. Filtration is essential to prevent dirt from accumulating on coils and contaminating indoor spaces. When 1-inch or 2-inch wide filters are used, they must be frequently replaced. Therefore, our IAQ units are equipped with a minimum of 4-inch, MERV 8, pleated filters to reduce filter maintenance. Optional prefilters and higher efficiency MERV 13 filters are available as an option.

Coil Coatings

Sea coast coil coatings are available. Desert Aire uses ElectroFin™ coil coatings to provide long life in corrosive environments.

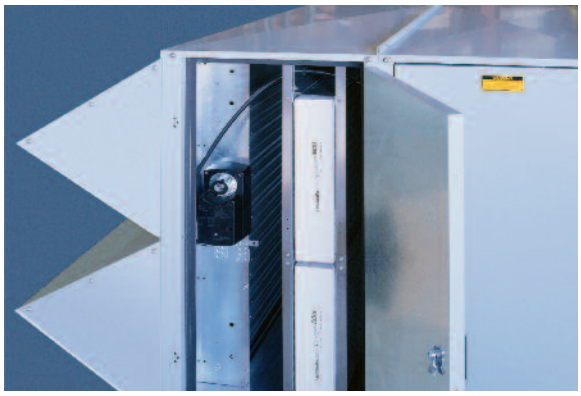

Figure 4 - TotalAire™ Filter Rack With MERV 13 Filters Installed.

Building Management Integration

The unit's controller has the following BMS choices:

- **LonWorks® compatible.**
- **BACnet™ MSTP compatible.**
- **BACnet™ Ethernet compatible.**
- **Modbus® compatible.**

Complete Solutions for 100% Outdoor Air

Solving the 100% outdoor air problem is easy with a TotalAire™ dehumidifier and the expertise of a Desert Aire representative. Complete solutions addressing moisture, cooling and heating loads while recovering and saving energy will help ensure proper indoor air quality and comfort. Contact Desert Aire for assistance when you need complete solutions for conditioning ventilation air.

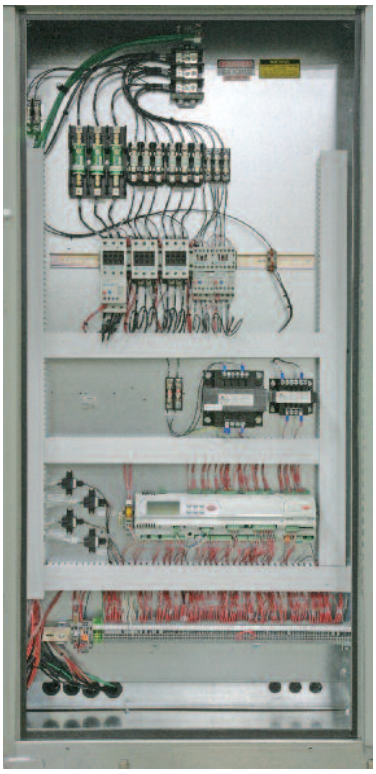

Figure 5 - TotalAire™ Electrical Panel Detail

Optimizing Solutions Through Superior Dehumidification Technology

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WARNING: Cancer and Reproductive Harm - www.P65Warnings.ca.gov

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LEAVING AIR TEMPERATURE CONTROL OPTIONS

Supply Air Control Strategy

DX-DOAS and DX-HOAS units can use three unique methods to control supply air temperature. The first and simplest strategy is referred to as Supply Air Temperature Control. This method maintains a constant supply air temperature (SAT) regardless of the season and space requirements.

However, two other strategies can achieve greater energy efficiency – Zone Reset of Supply Air Temperature Control as well as Outdoor Air Reset of Supply Air Temperature Control. Both of these methods allow the design engineer to integrate the loads of the DX-DOAS and the main air handler. Because supply air temperature can be varied by the DX-DOAS, the main air handler can be downsized to save compressor and fan energy since the latent load is minimized or eliminated for this sensible cooling system.

Supply Air Temperature Control

In this basic mode, the unit always maintains the supply air setpoint value, regardless of the outdoor or inside room temperature. This fundamental control allows the outdoor air to be conditioned to a neutral temperature (e.g. 72° F) in all seasons. The main air handler for the space controls the actual space temperature. This strategy uses a duct-mounted discharge temperature sensor to provide a feedback signal to the PID controller and maintain a precise SAT regardless of the conditions of the entering air. The SAT on the system is maintained at ±0.2° F DB when the compressor is running.

This method enables the DX-DOAS system to deliver neutral air while the main air handler must be sized for the zone's full load.

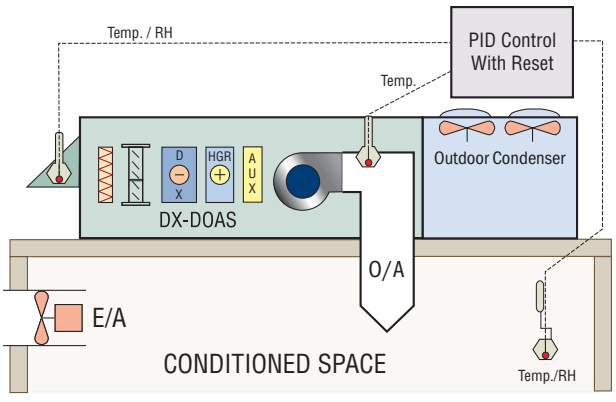

Figure 1 - Zone Reset Control Configuration

Zone Reset of Supply Air Temperature Control

This strategy combines a wall-mounted zone sensor with a duct-mounted sensor to provide supplemental sensible heating or cooling to the conditioned space (see figure 1). The zone sensor completes a feedback loop to the controller such that the supply air temperature setpoint is adjusted to maintain a targeted zone temperature due to changing conditions in the zone. When the system's compressors are energized, the controller will vary the amount of hot gas being rejected to the reheat coil. In the auxiliary heating mode it varies the auxiliary heating output. The controller varies the supply air temperature within a fixed range (e.g., 60° to 95° F) to maintain a room's setpoint (conditional upon system's capacity).

In this strategy, the DX-DOAS unit becomes the first stage cooling or heating system with the main air handler being the second stage. This is best applied if rooms have similar load characteristics. While a DX-DOAS primarily focuses on dehumidifying and reheating the air, the unit provides a secondary benefit in the cooling mode. Should the space temperature rise above the setpoint, the system can switch to the cooling mode and reject the resulting heat to the condenser. Because the DX-DOAS assumes a large portion of the cooling load, the size of the main air handler can be reduced proportionally to provide second stage cooling.

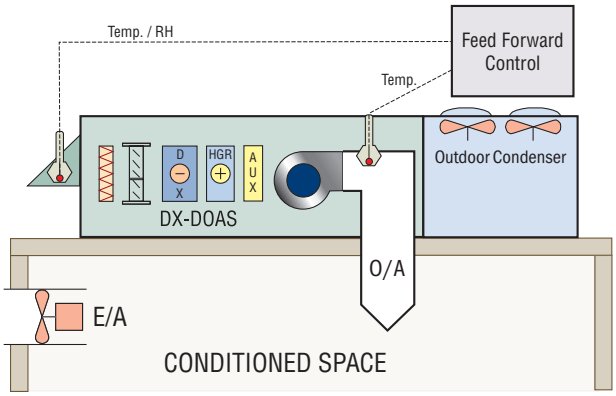

Figure 2 - Outdoor Air Reset Control Configuration

Outdoor Air Reset

This strategy uses feed-forward logic in that the controller resets SAT based on the outdoor air temperature. (See Figure 2.) As outdoor air becomes warmer and more humid, the DX-DOAS will identify that the space needs cooling and thus lower the SAT of the system. If the outdoor air turns cooler, it will reset the SAT to a warmer temperature. Four temperature ranges are established. All reset setpoints are adjustable between 60° and 95° F, but cannot overlap.

Heat Pump Auxiliary Heating Option

DEHUMIDIFICATION MODE OF OPERATION

Q-pump Provides Highest COP

Q-PUMP™- 100% OUTDOOR AIR SYSTEM

Desert Aire's Q-Pump™ system (protected by patent #6,666,040 and an additional patent applied) uses a four-element refrigeration system to overcome the typical problems of a two-element reverse cycle system, including:

1.) **Reduced efficiency and performance.**
2.) **High cost of oversized refrigeration valves.**
3.) **Potential for liquid slugging and need for accumulators.**
4.) **Refrigerant suddenly flashing into vapor, violently expanding and damaging pipes.**

Desert Aire's Q-Pump™ dehumidifier uses a unique method of heating 100% outdoor winter air without the need for a separate auxiliary heat source such as a gas furnace. The system utilizes an Electronic Expansion Valve (EXV) to insure the best performance and operation at low outside air temperatures while reducing the set-up time. At typical airflows for DOAS, our basic system is effective down to 0°F winter design temperature. With an optional enthalpy wheel, the system is effective down to minus10°F.

The key difference between Desert Aire's Q-Pump™ option and prior solutions is the use of two independent water condensers. One acts as the true condenser for the balance of the total heat of rejection (THR) of the system and the other is the evaporator in the reverse cycle heating mode.

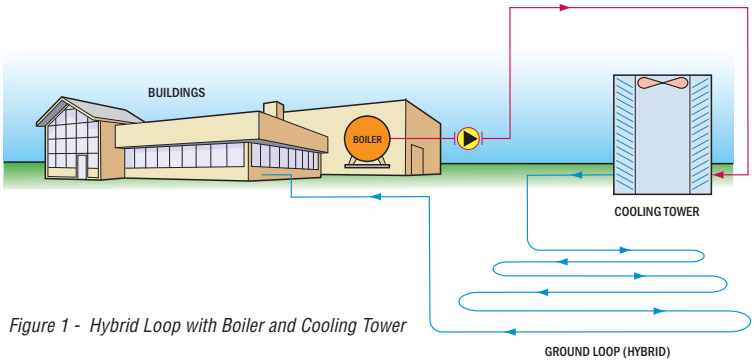

Figure 1 - Hybrid Loop with Boiler and Cooling Tower

The Q-Pump™ is easily incorporated into Desert Aire's TotalAire™ systems by adding one water exchanger. The hot gas reheat coil typically rejects 75% of the THR. The remaining energy is rejected to the water condenser which raises the ground source water loop by 2.5° - 3°F. This added energy to the water loop increases the system's efficiency. In the summer mode the water evaporator is inactive and removed from the refrigeration loop by a solenoid valve. In the winter, the air evaporator coil is inactive and the water evaporator will pull energy from the slightly heated ground water loop. The evaporator reduces the water temperature by 5°to 6°F. Figures 7 and 8 provide a detailed schematic of our Q-Pump™ system and also show how it functions in the summer and winter modes.

A second unique feature to Desert Aire's Q-Pump™ is its sophisticated control logic that automatically adjusts the systems condensing temperature to allow the system to have enough heat on cold winter days to meet the desired leaving air temperatures. Without enthalpy wheels, conventional heat pumps turn off at entering temperatures below 40°F and must utilize auxiliary heating devices to heat the air. During this operating period, these devices have COP's less than 1.0. Desert Aire's Q-Pump™ uses the following sequence to eliminate this problem:

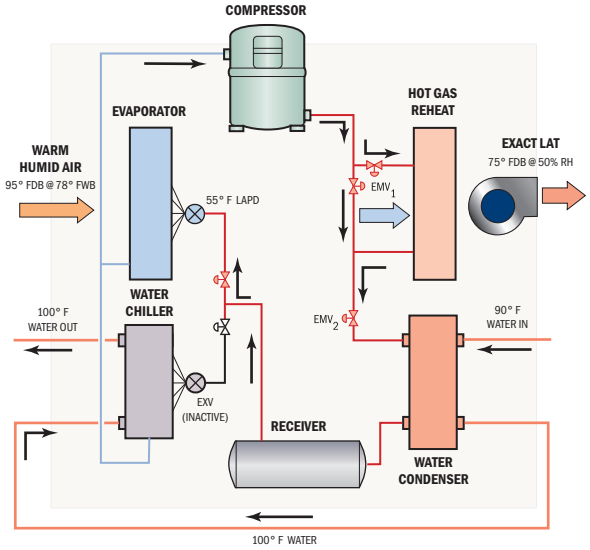

Figure 2 - Q-Pump Schematic with LAT Control: Cooling Mode

- First stage is to adjust the Electronic Modulating Valves (EMV_1) valves to regulate the amount of hot gas to the hot gas reheat coil. This controls the air temperature while keeping power consumption low. COP for this mode will generally fall between 3.5 and 4.0.
- Second stage is to adjust the EMV_2 valve that regulates the systems condensing temperature. Raising the condensing temperature increases the heating capacity of the system, but this increases the electrical energy consumed so at the coldest entering air temperature (e.g. 0°F), the COP would be reduced slightly to approximately 3.0.

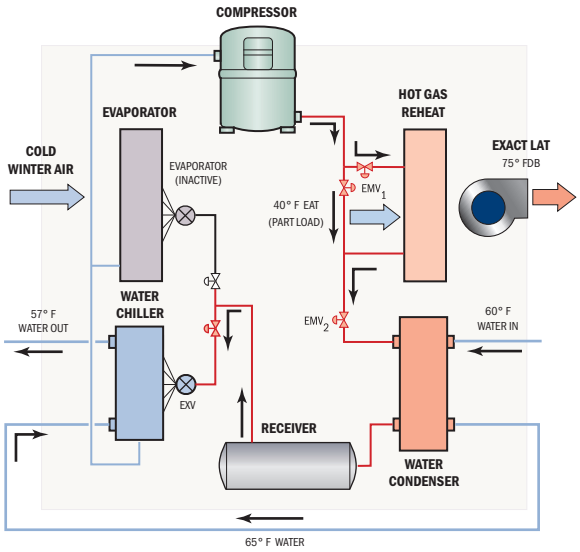

Figure 3 - Q-Pump Schematic with LAT Control: Heating Mode

CONCLUSION

If feasible, the installation of a heat pump into an HVAC application provides many advantages. First and foremost, this type of system provides such an efficient exchange of energy that a facility can expect an average of 50% savings in heating and cooling bills with respect to the 100% outside air dehumidifier.

While the concept of a heat pump is simple, the application requires precise, flawless engineering. Because Desert Aire's TotalAire™ dehumidifiers are specifically designed for energy recovery, a Q-Pump™ can be easily incorporated into the system. Desert Aire's Q-Pump™ provides these unique benefits:

- Lowest operating cost by utilizing dedicated evaporators for the dehumidification and heat extraction
- Control of heating set-points at the lowest entering air conditions
- Automatic adjustment of system set-up using electronic expansion valve

Contact your local Desert Aire representative if you would like more information or assistance about incorporating a TotalAire™ dehumidifier and heat pump into your HVAC system.

OPTIMIZING SOLUTIONS THROUGH SUPERIOR DEHUMIDIFICATION TECHNOLOGY

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TOTALAIRE™ by Desert Aire

AUXILIARY ELECTRIC HEAT

ELECTRIC HEAT

OPTIONAL AUXILIARY ELECTRIC HEATING OPTIONS

Desert Aire provides auxiliary electric heating options for the TotalAire™ Series that are sized to meet the winter heating requirements of the outside air.

These heating elements are utilized when the outside air temperature for a DOAS unit or mixed air temperature for a HOAS unit drops below the low economizer set point. The heaters are not allowed to operate when the unit is in the cooling or dehumidification mode.

Desert Aire sizes the heating elements to precisely match the load requirement of the system. The heaters are automatically controlled by the units microprocessor to maintain an exact leaving air temperature. An SCR controller is used for the electric heat option to vary the heat output.

Design Specifications

The following list highlights the noteworthy features of the TotalAire™ Series electric heaters:

- System Single Point Power to Dehumidifier
- NiCr 60 Corrosion-Resistant Element
- Welded Construction Using 20 MSG Galvanized Steel
- Automatic Reset High Temperature Limit Safety Switch
- Manual Reset High Maximum Temperature Limit Safety Switch
- Air Flow Pressure Switch
- Fusing as Required for Each 48 Amp Circuit
- Fused Circuits per N.E.C., UL, and CSA

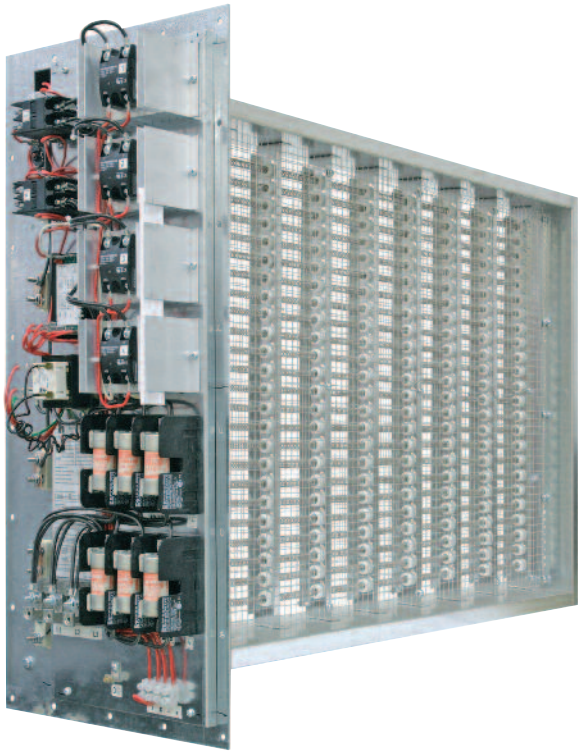

Figure 1 - Detail of Electric Heating Element for TotalAire™ Series Unit

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AUXILIARY GAS HEAT

Multiple Gas Heating Options

Desert Aire provides multiple gas heater options for its TotalAire™ Series product line that are sized to meet the winter heating requirements of the outside air. Both natural gas and LP gas burner options are available. These heating elements are utilized when the outside air temperature for a DOAS unit or mixed air temperature for a HOAS unit drops below the low economizer set point. The heaters are not allowed to operate when the unit is in the cooling or dehumidification mode.

Desert Aire combines different burner sizes to precisely match the load of the system. This may be in a single heater module or in multiple modules. A modulating gas valve is automatically controlled by the unit's microprocessor to maintain an exact leaving air temperature. If multiple burner sets are utilized, then a veneer sequence is used where the base burner is modulated and the others are staged. The system's overall turn down ratio is a function of the number of heating modules and is summarized in the table below:

Tons	Quantity Heaters	Turndown Ratio Natural Gas	Turndown Ratio LP Gas
2 to 30 tons	1	4 to 1	2 to 1
20 to 30 tons	2	8 to 1	4 to 1
40 to 60 tons	3	12 to 1	6 to 1

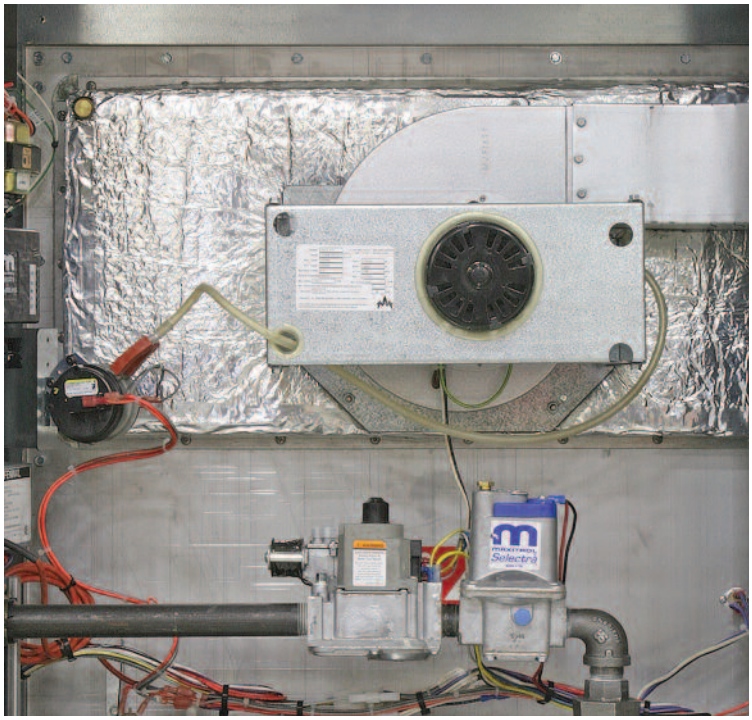


Figure 1 - Detail of Gas Heat Compartment on TotalAire™ Series Unit

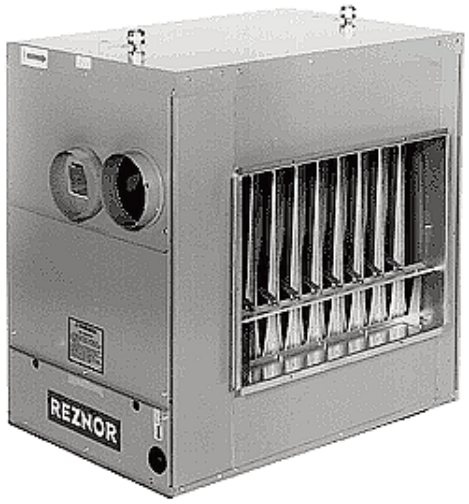


Figure 2 - Detail of Gas Heat Burner Assembly

The gas module shall provide a minimum combustion efficiency of 80%, and listed for operation downstream of refrigeration or cooling system, and provide means for removal of condensate that occurs in the heat exchanger during cooling operation. They are listed for outdoor installation without the need for additional power ventilation.

Heat exchanger shall be clamshell in design and constructed of Type 409 stainless steel and employ (integral formed dimple restrictors, formed turbulators) to provide for an unobstructed drainage path for condensate and provide a positive pitch to promote drainage.

AUXILIARY GAS HEAT

Additionally the gas module shall employ:

- Inshot gas burner, with integral carryovers, capable of operation at 4:1 turndown with modulating controls
- A combustion blower to provide for positive venting of flue gases
- Pressure switch to prove air supply for combustion
- Direct spark ignition of gas burners with remote flame sensor to prove carryover across all burners
- An automatic reset type high limit switch to limit maximum outlet air temperature to less than 250° F
- Manual reset flame rollout switch
- Listed Combination Gas Valve incorporating redundant safety shut-off valve, manual shut-off , and gas regulator which regulates gas pressure to burner supply manifold.
- Direct Spark ignition control design certified by a Recognized National Testing Laboratory and incorporating a LED diagnostic light and alarm capable contact

The completed heater assembly shall be factory fire tested prior to shipment.

Gas Utility

- 13.5” w.c. (1/2 PSI) Maximum Inlet Pressure
- Minimum Inlet Pressure
  - 5.0” w.c.– Natural Gas for 75 to 300 MBH modules
  - 6.0” w.c. - Natural Gas for 350 to 400 MBH modules
  - 11.0” w.c.– Propane Gas

TOTALAIRE™ by Desert Aire

ENERGY RECOVERY OPTION

ENERGY RECOVERY WHEEL

ENTHALPY WHEEL = ENERGY COST SAVINGS

Desert Aire's enthalpy wheel recovers a significant amount of energy from exhaust air. This wheel is a rotary counter flow air-to-air device that transfers both sensible and latent heat between air streams. Filtered outdoor air encounters the upper half of the wheel while filtered exhaust air flows through the lower half of the wheel. As the wheel constantly rotates during ventilation, it recovers valuable energy. Except for its rotation, the wheel is a passive device. Its function basically reverses between summer and winter. Figure 2 on page 2 shows the differences. For more information, read Desert Aire's Technical Bulletin 19 -Energy Recovery Wheel Technology.

Figure 1 - Enthalpy Wheel Installed in a Desert Aire Aura™ Unit

Desert Aire's wheels contain a patented molecular sieve coating that selectively adsorbs and desorbs water molecules in the air. This thin molecular sieve coating permanently adheres onto a sea water resistant aluminum alloyed that is composed of wave and flat, continuously wound layers to guarantee laminar flow and low static pressure loss. The wheel matrix, or its total mass, provides for highly effective sensible and latent energy exchange.

Most other media will have the desiccant coated, bonded or synthesized onto the matrix. The desiccant material must usually be applied as a thick coating layer that is subject to delaminate or erode off the media through the normal life expectancy of the wheel. In contrast, the desiccant on Desert Aire's media is designed to permanently adhere to the surface of the aluminum alloy.

Our design offers excellent face flatness to minimize wear of the inner seal surfaces and reduce cross leakage while offering a minimum life expectancy of 15 years. Our wheel frames are constructed of evenly spaced spokes, a galvanized steel band and an aluminum center hub. Frame component sizes and number of parts vary with wheel size.

We use a fractional horsepower AC drive motor and a durable multilink drive belt as our standard drive system.

It is not uncommon for frost to develop on the wheel under extremely cold winter conditions. The wheel can cool down to below 32°F and will then freeze moisture from the exhaust stream. Frost may reduce the airflow, but it will not damage the wheel.

Summertime Operation

In summer, ventilation air transfers its heat to the mass of the wheel. When the wheel turns into the exhaust air stream, it releases its heat. This significantly cools ventilation air even before it reaches the evaporation coil. But the wheel also assists with dehumidification. Its media is impregnated with a water-selective desiccant (4Å molecular sieve) that captures moisture from outdoor air. When the wheel turns into the flow of drier exhaust air, moisture is released. This reduces the moisture load on the dehumidification coil.

Wintertime Operation

In winter, sensible heat is transferred from warm exhaust air to cooler ventilation air. This heat transfer works in reverse to that of summer because the exhaust air is much warmer than the incoming air from outdoors.

The transfer of moisture is also reversed. The wheel recovers moisture from the exhaust air and deposits it into the dry, cold incoming air.

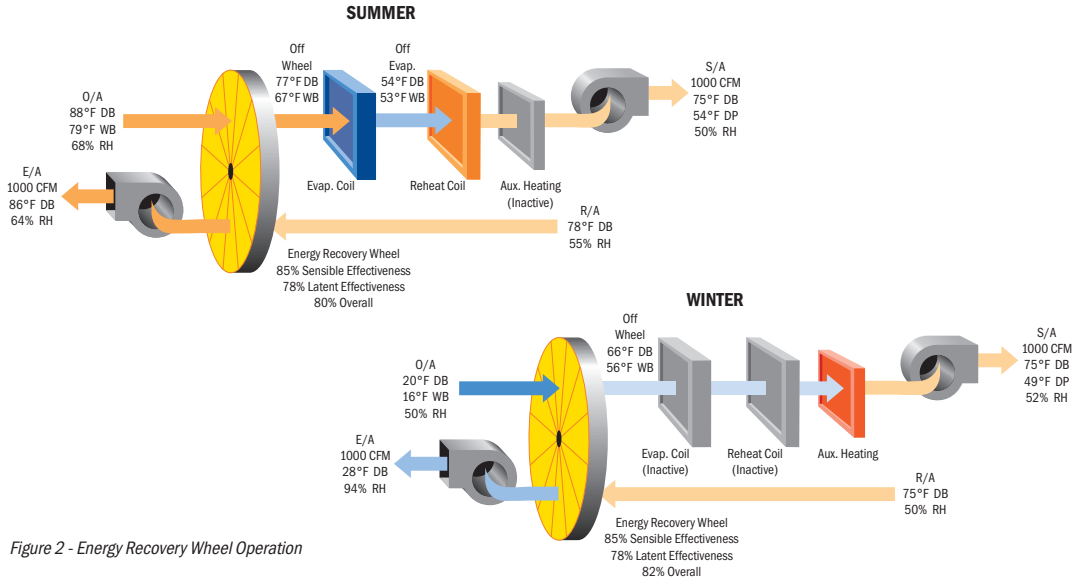


Figure 2 - Energy Recovery Wheel Operation

Reduced Loads

The energy recovered by the wheel significantly reduces sensible heating and cooling loads. Likewise, the load on the refrigerant dehumidification system is also reduced allowing you to use a smaller TotalAire™ dehumidifier.

While the wheel cannot meet the full moisture load alone, it can greatly reduce peak loads on the dehumidifier, especially when there is a large difference in moisture content between the air streams. Dehumidification through refrigeration is a standard industry approach.

However, integrating an energy recovery wheel into this type of system allows the dehumidifier to work more efficiently. The wheel significantly decreases the dehumidifier size required to ensure a complete year-round solution. Its impact is so great that it reduces the required compressor capacity by approximately half.

NIGHTTIME SETBACK

DEMAND CONTROL OPTIONS SAVE ENERGY

Night Setback Strategy

During the unoccupied mode, the night setback strategy is too close the outdoor air damper and turn off the blower to save energy. However, in some humid environments, there is still a high infiltration rate of moist outdoor air into buildings during unoccupied times creating excessive humidity levels.

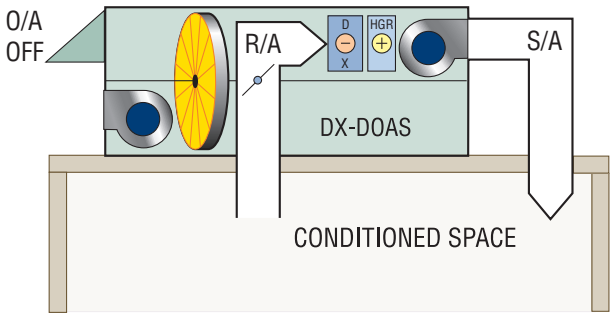


Figure 1 - Diagram of a TotalAire™ Series unit with a wheel in night setback mode.

In these instances, it is desired to add a recirculation damper to the system and turn on the blower and compressors to remove the unwanted moisture during unoccupied times. Desert Aire has two system configurations that provide night setback. This capability is available on Desert Aire's TotalAire™ series by adding our enthalpy wheel option and an internal mixing damper. The Zone Reset of Supply Air Temperature Control package must be ordered to receive the zone sensors.

CO_2 Control Strategy

As engineers continue to meet ASHRAE 62 ventilation code air flow rates, they also are trying to minimize energy costs where ASHRAE 90.1, LEED programs, GSA P100, or other codes and standards are required. Using additional sophistication in the controls can be an excellent way to minimize energy cost while maintaining proper indoor air quality and building pressurization.

The Ventilation Rate procedure of ASHRAE 62 is a prescriptive procedure that indicates the outdoor air intake flow rate based on the level and type of occupancy as well as the floor area. The Ventilation Rate procedure allows for a dynamic reset of the outdoor air intake flow as operating conditions change. Although the floor area in any building is fixed, the level and type of occupancy may change from day to day or even throughout a single day.

One of the most effective methods of dynamically changing the flow rate based on occupancy is the utilization of CO_2 sensors. Although expected concentrations of CO_2 are not considered a direct contaminant, it is an excellent measurable "tracer gas" that indicates the number of occupants present and their activity level. CO_2 sensors are also relatively inexpensive and durable devices.

Desert Aire TotalAire™ units can be ordered with a CO_2 control strategy that optimizes the energy efficiency by providing an optimized level of outdoor air at all times. The addition of two CO_2 sensors and variable frequency drives work together to maintain constant total system air flow by recirculating zone air and introducing varying outdoor air flow rates.

Since the zone floor area and the rate required for the floor area are fixed in any one application, the TotalAire™ unit can be programmed with a minimum outdoor air flow rate to account for this. When a change in CO_2 is sensed due to occupants entering or exiting the breathing zone, the outdoor air dampers account for this change in occupancy. The outdoor air flow rate will vary between the minimum flow rate programmed and 100% outdoor air as needed, always optimizing the indoor air quality and energy use.

The return air is used to maintain the supply air flow rate while the outdoor air flow rate varies. The constant supply air flow rate ensures that the duct system operates as intended. It also ensures that diffusers are able to deliver ventilation air at the correct velocity so that it reaches the breathing zone at all times as required by ASHRAE 62.1.

Desert Aire's basic CO_2 strategy incorporates one indoor CO_2 sensor and one outdoor CO_2 sensor. The controller calculates the differential CO_2 level (ppm) between the indoor and outdoor signals and then uses this value to properly adjust both the outdoor ventilation air and the bypass return air to deliver a constant volume to the space.

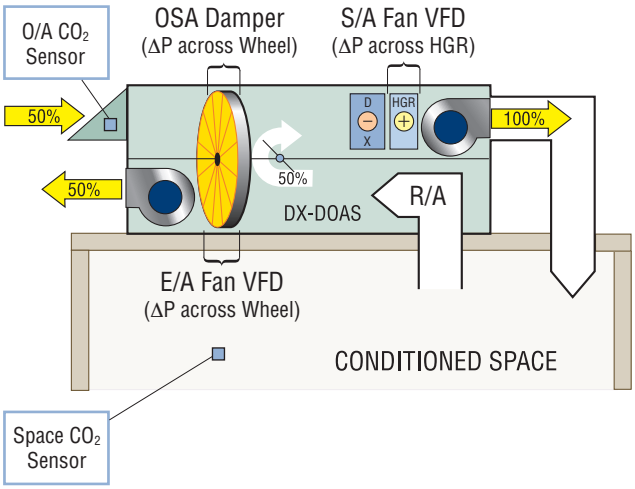


Figure 2 - VFD Control of Fans Using Pressure Sensors

For applications that require the same Desert Aire unit to monitor multiple indoor CO_2 sensors, we suggest working with the project's engineer to determine the best method to process these multiple signals into a final, single indoor CO_2 level for the unit to use in the differential calculation. This would be an average of all CO_2 sensors in the space, or using the signal from the one indoor CO_2 sensor detecting the greatest concentration of CO_2. In any event, the Desert Aire controller will only accept a single input for the indoor CO_2 level and a single input for the outdoor CO_2 level to calculate a final CO_2 differential value. The controller then uses this differential value to modulate the outside air damper and the bypass damper positions in order to provide adequate ventilation and maintain a constant supply air volume to the space.

Furthermore, using a differential calculation eliminates errors in estimating the natural background levels of CO_2 and changes in the levels in urban areas. Also, when sensor drift does occur, the sensors tend to drift in a similar fashion. Calculating a differential helps to ensure accuracy between calibrations. Desert Aire equipment includes a control loop that further optimizes the outdoor air flow rate by controlling to a specific concentration of CO_2 differential through the use of a PID (proportional/integral/derivative) control loop. In contrast to many other controls for CO_2 which have proportional only control and introduce more air than required during partial occupancy, the TotalAire™ unit further optimizes energy efficiency by closely maintaining the correct outdoor air flow rate required at any time for any given occupancy.

Since these applications must bring return air back to the unit, it is most beneficial to use an enthalpy wheel to reduce energy consumption.

CO2 MODULATION CONTROL

Zone CO_2 > Setpoint (Occupied)

The bypass damper modulates closed and the outdoor air damper modulates open. This continues until the zone CO_2 setpoint is met or 100% outdoor air is introduced. The supply air blower VFD adjusts to an established pressure differential across the hot gas reheat coil. The pressure drop corresponds to the design supply air volume. Also, the exhaust air blower VFD adjusts to an established pressure differential setpoint across the wheel's exhaust air side to maintain design exhaust air volume. Please note that the supply and exhaust air volumes can be different to maintain a design positive pressure in the space.

Zone CO_2 < Setpoint (Occupied)

The bypass damper modulates open and the outdoor air damper modulates closed. This continues until the zone CO_2 setpoint is met or the minimum outdoor air flow rate is sensed. The supply air blower VFD will adjust to maintain the same pressure differential setpoint across the hot gas reheat coil to maintain the specified supply air volume. The exhaust air blower VFD will adjust to a new pressure differential setpoint across the wheel to meet the exhaust air volume.

Unoccupied Time

During unoccupied times, the system can be turned off or enter the night setback mode where the outdoor air is off, the mixing damper opens and the unit controls the humidity within the space based on the standard sequence described in the previous section.

HOT WATER HEAT

OPTIONAL HOT WATER HEATING OPTIONS

Desert Aire provides auxiliary heating options for its TotalAire™ Series product line that are sized to meet the winter heating requirements of the outside air.

These heating elements are utilized when the outside air temperature for a DOAS unit or mixed air temperature for a HOAS unit drops below the low economizer set point. The heaters are not allowed to operate when the unit is in the cooling or dehumidification mode. Desert Aire sizes the heating elements to precisely match the load requirement of the system. The heaters are automatically controlled by the unit's microprocessor to maintain an exact leaving air temperature. A customer supplied hot water control valve is modulated from the controller with a 0 to 10 VDC direct acting signal. Please refer to figure 1 for a typical installation.

HWC Design Inputs

The coil is selected for each customer's particular application based on the following criteria:

- **Entering water temperature (EWT), typically between 140° F and 180° F**
- **Leaving water temperature (LWT), typically 20 degrees less than the EWT**
- **MBH capacity desired**
- **Entering air temperature (EAT), winter design for your area**
- **Leaving air temperature (LAT), typically neutral to a maximum of 100° F**
- **GPM flow rate desired**
- **If there are fluid pressure drop restrictions to be aware of.**
- **Type and concentration of glycol used**

For freeze protection Desert Aire uses a capillary type temperature sensor which is attached across the downstream face of the coil. Freezestat is set at 38 deg F with an auto reset switch. If engaged the unit controls would respond by closing the outdoor air damper, open the return air damper (if applicable), de-energize the fan, open the hot water coil valve 100%, and log the alarm on the controller.

To size the control valve, please provide a qualified vendor the water temperature, flow rate (gpm) and the requirement for a 0 to 10VDC signal and they will select the appropriate valve to purchase.

Optional ElectroFin coil coating for sea coast construction is available.

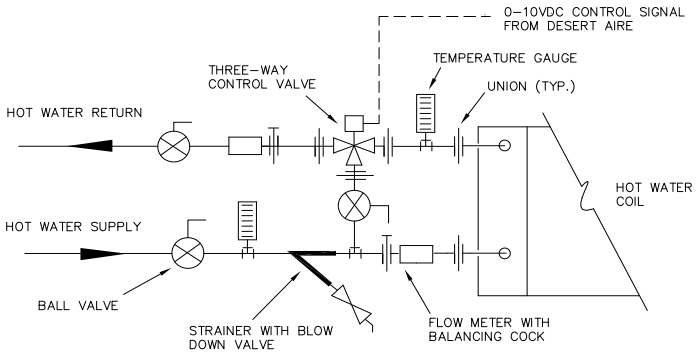
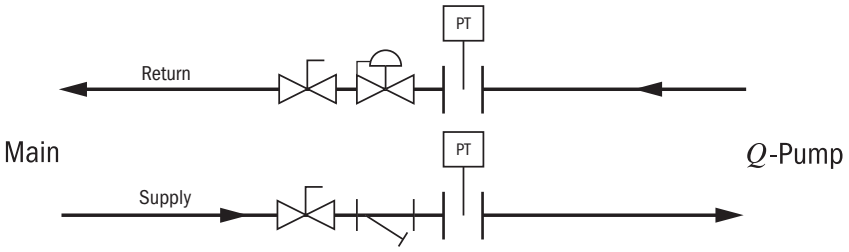


Figure 1 - Hot Water Piping Detail

TOTALAIRE™ by Desert Aire

BASIC FLOW CONTRL PACKAGE

NO CONTROL VALVE OPTION



Package Components

- **Y-Ball Strainer (20 Mesh)**
- **Automatic balancing control valve**
- **Blowdown valve**
- **PT plugs on inlet / outlet**

Maintaining proper, constant flow through water-source heat pump equipment optimizes efficiency and capacity. In today's larger, dynamic loops that include many valves, branches, and variable speed pumps, maintaining this constant flow can be challenging. A simple ball valve or circuit setter may not be sufficient to regulate the flow in these situations. The result may be lower efficiency, nuisance alarm trips, or even possible long-term equipment damage.

Desert Aire has selected Hays Fluid Controls as its partner for its flow regulation control package vendor because of the importance of maintaining precise flow through our *Q*-Pump. These flow control packages dynamically regulate water flow during changing conditions to allow the heat pumps to achieve the highest energy efficiency in both heating and cooling while eliminating the nuisance alarms so typical of unregulated loop piping systems.

The Hays Mesurflo™ flow regulation valve provides a constant flow rate over a wide range of pressure differentials (2 to 80 psid). As the pressure drop increases, the rubber diaphragm will flex into the contoured orifice plate to decrease the flow path. Both the rubber diaphragm and the contoured orifice plate are rigidly controlled to provide a constant flow rate. The "flexing" action of the rubber diaphragm against the fixed orifice plate makes the Mesurflo™ difficult to clog and resistant to cavitation damage.

The Hays Mesurflo™ is a constant flow rate device. Since it is a variable orifice that changes to govern the flow, it cannot be described with the C_V or a pressure drop at a given flow for piping systems design purposes. The designer may assume a constant flow rate over the differential pressure.

The control packages simplify the selection and installation of the piping system. Each component in the package has been predefined to work with the corresponding Desert Aire system. All of the rcommended accessories for typical loops are included in the package. The packages for models QS 02 through 15 further reduces installation time by including a flexible hose with NPT unit connections. The control package and equipping the unit with optional NPT connections allows for quick, leak-free connections, vibration isolation, and fewer issues with misalignment.

Standard Features of Package

- Operating range 32°F to 225°F
- ± 10% flow accuracy
- Valve body suitable for 400 psig
- Pipe Type
  - 15 ton and less – 24 inch Flexible Hose Kits provided by Desert Aire
  - 20 ton and larger – Hard pipe provided by others
- Extended Pressure / Temperature Ports
- Material Specifications
  - Ball – chrome plated brass
  - P/T ports – brass
  - O-rings – EPDM
  - Orifice – Polyphenylsulfone

PACKAGE SPECIFICATIONS

Package Specifications

Tons	DA Part #	GPM	Connection Size		Valve Body	Connection Type
			Main (In. FNPT)	Q-Pump (In. MNPT)		
02	DFQ02FN	7	3/4"	3/4"	Brass	Flex Hose
03	DFQ03FN	11	3/4"	3/4"	Brass	Flex Hose
05	DFQ05FN	19	1"	1"	Brass	Flex Hose
08	DFQ08FN	26	1-1/4"	1-1/4"	Gray Iron	Flex Hose
10	DFQ10FN	34	1-1/4"	1-1/4"	Gray Iron	Flex Hose
15	DFQ15FN	49	1-1/2"	1-1/2"	Gray Iron	Flex Hose

Tons	DA Part #	GPM	Connection Size		Valve Body	Connection Type
			Main (In. FNPT)	Q-Pump (In. MNPT)		
20	DFQ20PN	69	2-1/2"	2-1/2"	Ductile Iron	Hard Pipe
25	DFQ25PN	84	2-1/2"	2-1/2"	Ductile Iron	Hard Pipe
30	DFQ30PN	102	2-1/2"	2-1/2"	Ductile Iron	Hard Pipe
36	DFQ36PN	118	2-1/2"	2-1/2"	Ductile Iron	Hard Pipe
40	DFQ40PN	137	3"	3"	Ductile Iron	Hard Pipe
46	DFQ46PN	153	3"	3"	Ductile Iron	Hard Pipe
50	DFQ50PN	168	3"	3"	Ductile Iron	Hard Pipe

Tons	DA Part #	GPM	Connection Size		Valve Body	Connection Type
			Main (In. FLGT)	Q-Pump (In. FLGT)		
56	DFQ56PN	186	4"	4"	Carbon Steel	Flanged
60	DFQ60PN	203	4"	4"	Carbon Steel	Flanged

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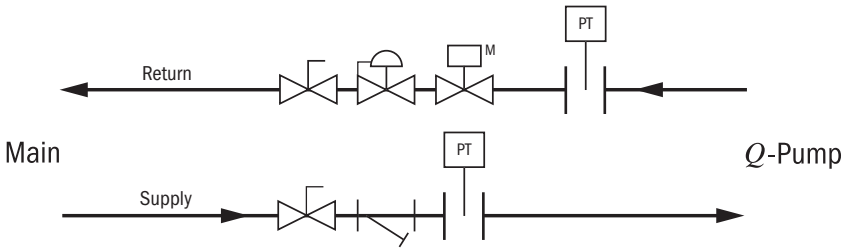
2-WAY FLOW CONTROL PACKAGE

2-WAY FLOW CONTROL PACKAGE OPTION



Package Components

- **Y-Ball Strainer (20 Mesh)**
- **Automatic balancing control valve**
- **Blowdown valve**
- **Automatic 2-way control valve w/actuator**
  - **Transformer and signal from *Q*-Pump**
- **PT plugs on inlet / outlet**

Maintaining proper, constant flow through water-source heat pump equipment optimizes efficiency and capacity. In today's larger, dynamic loops that include many valves, branches, and variable speed pumps, maintaining this constant flow can be challenging. A simple ball valve or circuit setter may not be sufficient to regulate the flow in these situations. The result may be lower efficiency, nuisance alarm trips, or even possible long-term equipment damage.

Desert Aire has selected Hays Fluid Controls as its partner for its flow regulation control package vendor because of the importance of maintaining precise flow through our *Q*-Pump. These flow control packages dynamically regulate water flow during changing conditions to allow the heat pumps to achieve the highest energy efficiency in both heating and cooling while eliminating the nuisance alarms so typical of unregulated loop piping systems.

The Hays Mesurflo™ flow regulation valve provides a constant flow rate over a wide range of pressure differentials (2 to 80 psid). As the pressure drop increases, the rubber diaphragm will flex into the contoured orifice plate to decrease the flow path. Both the rubber diaphragm and the contoured orifice plate are rigidly controlled to provide a constant flow rate. The "flexing" action of the rubber diaphragm against the fixed orifice plate makes the Mesurflo™ difficult to clog and resistant to cavitation damage.

The Hays Mesurflo™ is a constant flow rate device. Since it is a variable orifice that changes to govern the flow, it cannot be described with the C_V or a pressure drop at a given flow for piping systems design purposes. The designer may assume a constant flow rate over the differential pressure.

The two way flow package includes an integral actuator to terminate the flow to the *Q*-Pump™ when the DOAS system is commanded to the unoccupied mode for those water loops with variable speed drives on the water pumps.

The control packages simplify the selection and installation of the piping system. Each component in the package has been predefined to work with the corresponding Desert Aire system. All of the rcommended accessories for typical loops are included in the package. The packages for models QS 02 through 15 further reduces installation time by including a flexible hose with NPT unit connections. The control package and equipping the unit with optional NPT connections allows for quick, leak-free connections, vibration isolation, and fewer issues with misalignment.

Standard Features of Package

- Operating range 32°F to 225°F
- ± 10% flow accuracy
- Valve body suitable for 400 psig
- Pipe Type
  - 15 ton and less – 24 inch Flexible Hose Kits provided by Desert Aire
  - 20 ton and larger – Hard pipe provided by others
- Extended Pressure / Temperature Ports
- Material Specifications
  - Ball – chrome plated brass
  - P/T ports – brass
  - O-rings – EPDM
  - Orifice – Polyphenylsulfone
- Actuator
  - 24VAC
  - 2 position
  - Manual operating lever / position indicator
  - Location - NEMA 2. IEC IP31

PACKAGE SPECIFICATIONS

Package Specifications

Tons	DA Part #	GPM	Connection Size		Valve Body	Connection Type
			Main (In. FNPT)	*Q*-Pump (In. MNPT)		
02	DFQ02FD	7	3/4"	3/4"	Brass	Flex Hose
03	DFQ03FD	11	3/4"	3/4"	Brass	Flex Hose
05	DFQ05FD	19	1"	1"	Brass	Flex Hose
08	DFQ08FD	26	1-1/4"	1-1/4"	Gray Iron	Flex Hose
10	DFQ10FD	34	1-1/4"	1-1/4"	Gray Iron	Flex Hose
15	DFQ15FD	49	1-1/2"	1-1/2"	Gray Iron	Flex Hose

Tons	DA Part #	GPM	Connection Size		Valve Body	Connection Type
			Main (In. FNPT)	*Q*-Pump (In. MNPT)		
20	DFQ20PD	69	2-1/2"	2-1/2"	Ductile Iron	Hard Pipe
25	DFQ25PD	84	2-1/2"	2-1/2"	Ductile Iron	Hard Pipe
30	DFQ30PD	102	2-1/2"	2-1/2"	Ductile Iron	Hard Pipe
36	DFQ36PD	118	2-1/2"	2-1/2"	Ductile Iron	Hard Pipe
40	DFQ40PD	137	3"	3"	Ductile Iron	Hard Pipe
46	DFQ46PD	153	3"	3"	Ductile Iron	Hard Pipe
50	DFQ50PD	168	3"	3"	Ductile Iron	Hard Pipe

Tons	DA Part #	GPM	Connection Size		Valve Body	Connection Type
			Main (In. FLGT)	*Q*-Pump (In. FLGT)		
56	DFQ56PD	186	4"	4"	Carbon Steel	Flanged
60	DFQ60PD	203	4"	4"	Carbon Steel	Flanged

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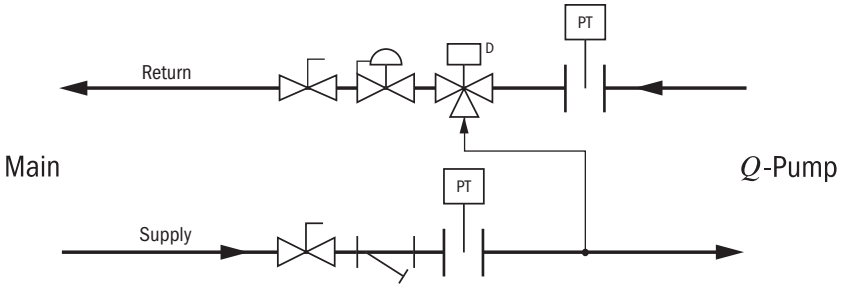
TOTALAIRE™ by Desert Aire

3-WAY FLOW CONTROL PACKAGE

3-WAY FLOW CONTROL PACKAGE OPTION



Package Components

- **Y-Ball Strainer (20 Mesh)**
- **Automatic balancing control valve**
- **Blowdown valve**
- **Automatic 3-way control valve w/actuator**
  - **Transformer and signal from *Q*-Pump**
- **PT plugs on inlet / outlet**

Maintaining proper, constant flow through water-source heat pump equipment optimizes efficiency and capacity. In today's larger, dynamic loops that include many valves, branches, and variable speed pumps, maintaining this constant flow can be challenging. A simple ball valve or circuit setter may not be sufficient to regulate the flow in these situations. The result may be lower efficiency, nuisance alarm trips, or even possible long-term equipment damage.

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The three way flow package includes an integral actuator to terminate the flow to the *Q*-Pump™ when the DOAS system is commanded to the unoccupied mode for those water loops with variable speed drives on the water pumps.

The control packages simplify the selection and installation of the piping system. Each component in the package has been predefined to work with the corresponding Desert Aire system. All of the rcommended accessories for typical loops are included in the package. The packages for models QS 02 through 15 further reduces installation time by including a flexible hose with NPT unit connections. The control package and equipping the unit with optional NPT connections allows for quick, leak-free connections, vibration isolation, and fewer issues with misalignment.

Standard Features of Package

- Operating range 32°F to 225°F
- ± 10% flow accuracy
- Valve body suitable for 400 psig
- Pipe Type
  - 15 ton and less – 24 inch Flexible Hose Kits for connection to the unit and 12 inch flexible bypass hose provided by Desert Aire
  - 20 ton and larger – Hard pipe provided by others
- Extended Pressure / Temperature Ports
- Material Specifications
  - Ball – chrome plated brass
  - P/T ports – brass
  - O-rings – EPDM
  - Orifice – Polyphenylsulfone
- Actuator
  - 24VAC
  - 2 position
  - Manual operating lever / position indicator
  - Location - NEMA 2. IEC IP31

PACKAGE SPECIFICATIONS

Package Specifications

Tons	DA Part #	GPM	Connection Size		Valve Body	Connection Type
			Main (In. FNPT)	Q-Pump (In. MNPT)		
02	DFQ02FT	7	3/4"	3/4"	Brass	Flex Hose
03	DFQ03FT	11	3/4"	3/4"	Brass	Flex Hose
05	DFQ05FT	19	1"	1"	Brass	Flex Hose
08	DFQ08FT	26	1-1/4"	1-1/4"	Gray Iron	Flex Hose
10	DFQ10FT	34	1-1/4"	1-1/4"	Gray Iron	Flex Hose
15	DFQ15FT	49	1-1/2"	1-1/2"	Gray Iron	Flex Hose

Tons	DA Part #	GPM	Connection Size		Valve Body	Connection Type
			Main (In. FLGT)	Q-Pump (In. FLGT)		
20	DFQ20PT	69	2-1/2"	2-1/2"	Carbon Steel	Flanged
25	DFQ25PT	84	2-1/2"	2-1/2"	Carbon Steel	Flanged
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