Energy savings in HVAC systems:

Heat Recovery system in Make Up Air Unit (MUAU)

Make Up Air Units, which are frequently required to remove humidity from the air, usually require large cooling and heating demands, in order to perform thermodynamic drying of the air. Advanced design of such units can result in significant energy savings and reduce of environmental impact.

This document presents an engineering solution that was characterized and designed by Precise Engineering.

The solution is successfully implemented for several customers for many years, and recently broadly adopted, inter alia, by a large international pharmaceutical company.

Background

During most of the year, removing moisture from the fresh air, requires cooling the air from it's ambient conditions, to a relatively low dew point (8-9°C), and immediately afterwards heating the air to its dry bulb temperature that is required in the conditioned areas.

Traditionally, a Make Up Air Unit (MUAU) is equipped with one or more cooling coils, which are used to cool the air to the required dew temperature and thus remove moisture. These coils are usually fed with chilled water at 6-7°C.

The air is then reheated to the required supply temperature by electric, steam or water coil(s).

Proposed Solution

The proposed solution, developed by Precise Engineering, is based on heat recovery and thermodynamic resources balancing. It utilizes two additional water coils installed inside the MUAU. The coils are interconnected with a piping system and a pump.

The thermodynamic resources balance and energy recovery are achieved by utilizing the low dew temperature for drying purposes, in order to cool the fresh air.

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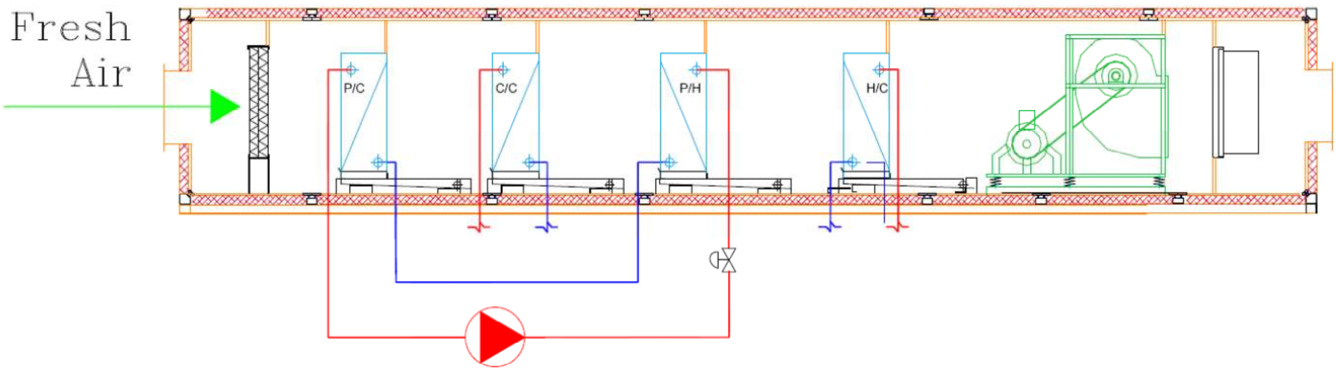
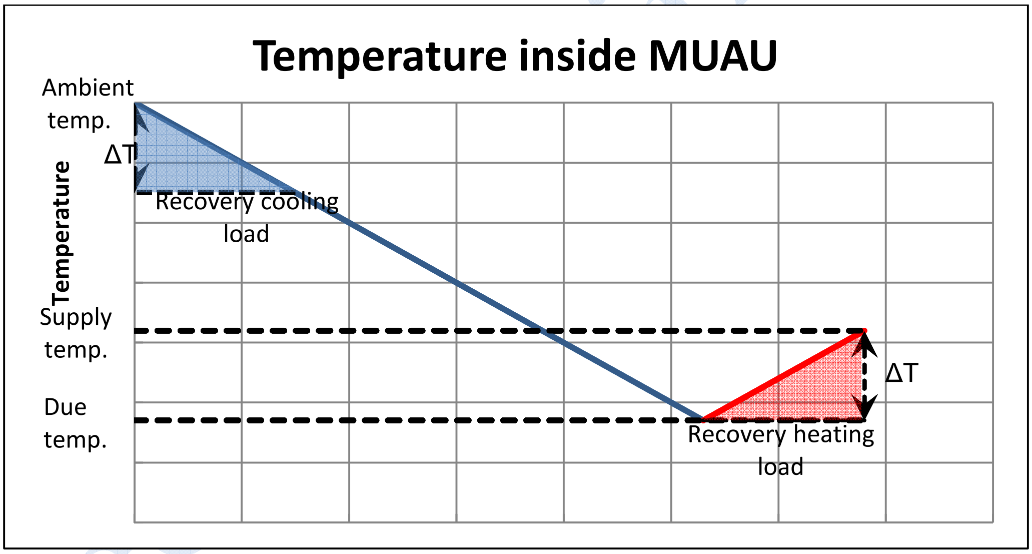
The following diagram illustrates the MUAU configuration:



Performance

The following simple temperature graph demonstrates the temperature and energy of the air as it pass inside the MUAU:



As seen in the graph, the highlighted blue and red areas represent the cooling and heating load in the preliminary cooling/heating coils. Since the two preliminary coils are interconnected, their cooling/heating load is identical.

The performance of the recovery system is highly depended on the operating conditions - mainly ambient temperature and humidity, dew temperature and supply temperature.

The maximum capacity of the recovery system (both heating and cooling) depends on the difference between the dew and supply temperature.

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The actual performance of the recovery system depends on the ambient conditions and heat transfer capacity: the higher the ambient temperature, the higher is the heat transfer from the preliminary cooling coil to the connecting heating coil. As the ambient air temperature drops, the heat transfer, and the heat recovery capacity will decrease, with the lower limit being the dew temperature.

The heat recovery system efficiency is highest at peek weather conditions, and supply temperature close to room temperature. In order to achieve good energetic efficiency across the entire operational range, the recovery system should be carefully designed to target moderate conditions, where the efficiency decreases, and the coils should be more cautiously designed.

Design Considerations

The design of a recovery system is somewhat challenging, as multiple iteration steps are required for each coil's configuration and for balancing the coils, since the coils are interconnected and energetically coupled.

Optimization of the recovery system must take into account many factors, such as: MUAU capacity changes, changing weather conditions, water flow and pressures, redundancy, control aspects and many other design considerations.

During the design and investment assessment, additional energy consumers and cost elements should be taken into account:

- Water pump
- Added fan power due to the preliminary coils air resistance.

Control

Special attention should be given for the control method chosen for the recovery system. It should handle changing weather conditions (temperature and humidity) and changing airflow. An improperly designed control system may cause the MUAU to exceed its required parameters such as supplied temperature and humidity, decrease the recovery system performance, and even to increase energy costs.

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A real life example

A heat recovery system similar to the one described in this document was designed for a pharmaceutical plant with the following key parameters:

- Location- Israel costal area.
- Required supply temperature: 16 ˚C.
- Dew temperature: 8.5˚C.

The performance analysis showed year round **saving of nearly 25% of the cooling load and nearly 74% of the heating load**, considering real wheatear data (both day and night and with year round weather conditions).

Conclusion

Precise Engineering brings practical value, with professional, efficient end economic design, and original thinking, allowing its customers to target their production requirements, and enjoy optimal resource utilization.

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