Analysis 2: Mechanical System

Background and problem

The Kennedy Krieger Institute Outpatient Medical center is a medical center for children and adolescences with developmental disabilities. It therefore requires the building to have a 100% exhaust air system. The building has three Air Handling Units that require a 40,000 cfm capacity. The air handling units are on a need basis with AHU 1 being the primary unit. When needed the AHU 2 and AHU 3 will work in conjunction to AHU 1. With the AHU's 100% exhaust air system, this creates a great loss of energy which will therefore increase the energy costs to run the building.

Proposal

The proposed solution to prevent this enormous amount of lost energy is to install a heat recovery system, which in this case is an enthalpy wheel. The enthalpy wheel is made up of aluminum coil that capture the hot/cold exhaust air. The Enthalpy wheel is installed and works in conjunction with the air handling units. The enthalpy wheels will have an exhaust duct system attached to it to prevent contamination of the supply air.

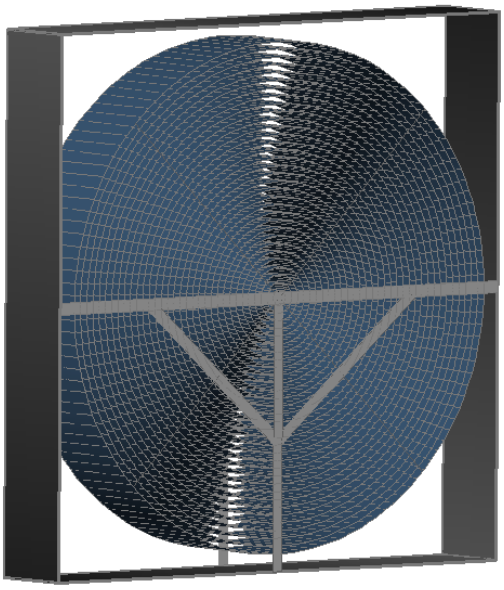

Figure 2.1 by Katie Sennett in AutoCAD.

On the left is an image of the enthalpy wheel that will be used for this analysis. It is a 10 foot diameter wheel that is housed in an 11 foot by 11 foot frame. The wheel coils are made of durable aluminum. The heat recovery system will have three of these enthalpy wheels.

Goal

The goal is to install enthalpy wheels into each air handling unit. The Enthalpy wheel will take the exhaust air and use it to pre condition the outdoor air. The purpose is to save energy from heating/cooling the supply air by using the exhaust air to preheat/pre-cool the supply air. The second goal of this system is to maintain a clean air system but removing any contaminations through an exhaust duct system that is located near the side of the spinning wheel and removes the contaminates through the exhaust air duct.

Analysis:

The enthalpy wheel for the recovery system was designed to be a 10 foot diameter wheel with an 11 foot by 11 foot framing unit. This unit has a nominal cfm of 40,000 and will be adequate to work with the mechanical system.

Step 1: Structural System Impact

The total weight of each wheel is about 3,000 lbs. This is a good bit of weight but will not change the structural system by much because the three systems are relatively spaced apart. This allows for better distribution of weight on the flooring system. However, the only major change would be a slight increase to the size of the beams and girders with a decrease in the spacing of the beams. No structural calculations where done here, because the wheels did not seem to effect the structure enough to go into deep analysis.

Step: 2 Calculating the Energy Efficiency

To determine the energy efficiency of the enthalpy wheel the following information about the building was determined. See table below, (Figure 2.1) for design conditions. For mechanical breadth analysis information, please see **Appendix F**.

	1st Floor	2nd Floor	3rd Floor	4th Floor	5th Floor	6th Floor
Occupancy Type	Exam Rm/Enterance	Offices	Treatment/Gym	Gym/Exam Rm	Offices	Pool and Penthouse
Floor area	16704 sf	16705 sf	16706 sf	16707 sf	16708 sf	16709 sf
Floor Height	16ft	18ft	13ft	13ft	14ft	18ft
Max Occ. # per floor	50	25	35	45	75	5
Linear Ftage. Of exterior walls	540ft	540ft	540ft	540ft	540ft	540ft
R-values	See Below					
% Glass walls /U-values Glass	South 20%/2.8 W/m^2k^2	North 85%/2.8 W/m^2k^2		West 70%/ 2.8 W/m^2k^2	East 2%/2.8 W/m^2k^2	
Supply Air Temp/Room Temp Seasons	Cool 67 degrees/ Heat 70 degrees					
What floor AHU service	AHU 1 runs all floors until AHU 2 and AHU 3 are needed. They work as needed.					
Utility rate nat. gas.	#0.94 /Thermo Natural Gas					
Location	Baltimore, Maryland					

R-Values			
Precast Concrete	Rigid Insulation	Batt Insulation	GWB
6"	2"	6"	(2) 5/8"
R-0.48	R- 9.1	R-8.7	R-5

Table 2.1 Design Information

Mechanical Impact:

The enthalpy wheels will be part of the air handling units. Therefore, the units will need to be modified to be able to house the wheels. The image below shows a section view of what the new system will look like once the enthalpy wheels are installed.

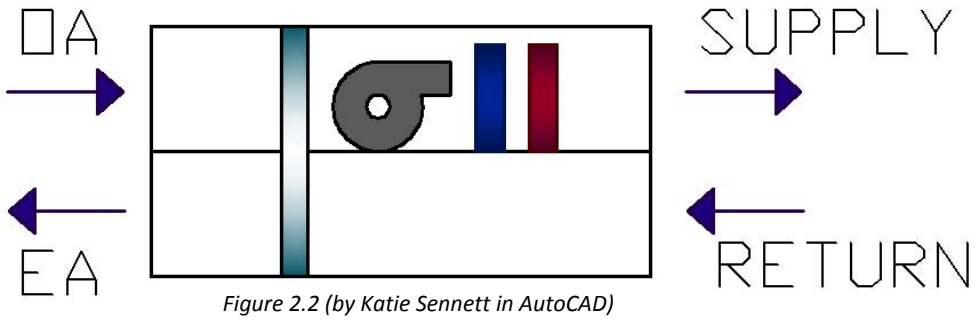

Figure 2.2 (by Katie Sennett in AutoCAD)

Figure 2.2 is a section view of the AHU with the enthalpy wheel. The enthalpy wheel works by capturing the cold air/ hot air from the exhaust air. This cold/hot energy that is captured on the spinning enthalpy wheel is then used to precondition the outdoor air. The air then travels through the fan which pushes the preconditioned air through the heating/cooling coils for the correct supply air temperature. This supply air is then distributed throughout the building.

Schedule:

The enthalpy wheel is a large piece of equipment and requires a long lead time between 3 to 6 months prior to installation. It takes approximately 6.6 days to install one enthalpy wheel. This will take a total of 20 days to install all three units into the air handling units. This installation will take place around the same time that the air handling units are installed.

Cost Savings:

The amount of energy that the enthalpy wheel saves is a total cost savings of $2,898 a year. However, initial cost of the enthalpy wheel is $39,550 for just one wheel. For three wheels, the cost would be $118,650 dollars. It would 41 years to pay off the equipment which does not include early maintenance or replacing of the entire wheel. This replacement of the wheel could increase the price greatly because the roof system would need to be removed to remove and replace a new wheel. This is an issue because architects do not design buildings to have an easily removable roof system.

	Electric	**Gas**	**Total Cost**
	$/yr	$/yr	yr
Existing System	$122,824	$3,774	$126,598
Redesign	$120,098	$3,602	$123,700
		Total Savings =	**$2,898**

Table 2.2 Cost Savings

Conclusion:

Saving money on energy costs is becoming more of a standard rather than an option in new construction. However, not every building design can be changed in a way to save money by reducing energy costs. For a building with 100% exhaust air, a heat recovery system would be a great way to reduce that energy costs. However for the outpatient medical center the initial cost of such a system outweighs the amount of savings. Therefore, the enthalpy wheel would not be a good system to use for the project.