Project Brief - Indoor Pool Climate Controller

1 Introduction

Indoor swimming pools are normally enclosed spaces, which require heating, ventilation and artificial lighting. To maintain indoor swimming pools to be safe environments for patrons, the following are constantly monitored and controlled:

1. Humidity
2. Temperature
3. Lighting
4. Bathing load

As a design team, you have been commissioned to design, simulate, test and implement an indoor swimming pool climate controller for a 24 hours indoor swimming facility. This includes all the necessary control systems required as well as the DC power supply to power the system.

2 Background Information

2.1 Humidity Control

Indoor swimming pools require special monitoring for the ever-present challenge of humidity control. To help prevent condensation, protect the building for structural damage and provide a comfortable environment for swimmers, humidity must be carefully controlled. The relative humidity is an expression of the air's actual water vapour pressure compared to the water vapour pressure when the air is saturated. It is normally stated as a percentage. The humidity levels in an indoor swimming pool can be operated with a differentiated set point, so that it is low during winter (50% RH) to avoid condensation problems on cold surfaces, and high during summer (60% RH). Going above 60 % RH will impact the comfort level negatively and increase the risk of condensation problems and fungal attacks. An RH value any lower than 50 % RH is not appropriate either, since this will increase evaporation leading to greater dehumidification requirements and increased operating costs.

2.2 Temperature control

In an indoor swimming pool, it is important that the air temperature levels of the indoor space are strictly maintained at the required levels. The water temperature for a public swimming pool is normally maintained between 26°C and 28°C. Usually the space temperature is maintained the same as the water temperature or at most a maximum of 1°C warmer. This is done to minimize evaporation causing water loss and humidity and ensure that swimmers do not become cold too quickly once they exit the pool.

2.3 Lighting Control

Lighting is used to provide adequate illumination and control reflection on the water surface. Reflection of light on the pool surface and its surroundings can cause glare which can be hazardous to the eyes. Artificial lighting is normally provided to regulate lighting in indoor swimming pools. Safety regulations require that all portions of the pool including the bottom of the pool should be readily visible without glare. Underwater lighting can reduce the effect of reflections on the pool surface and improve the general evenness of illumination below the surface of the water. For most swimming activities, the recommended levels of illuminance for swimming pools is 300 lux. For swimming competitions, 500 lux is the recommended illuminance level. Other lights are also required for safe operation of the building. These include security lights and parking lot lights.

2.4 Bathing Load Control

The bathing load is the maximum number of persons allowed in the pool at one time. Exceeding the bathing load of a swimming pool leads to increased risk of injury and drowning. It is also true that each swimmer brings a host of contaminants into the pool requiring that the pool sanitation levels be maintained at all times. Pool sanitation is maintained by matching the bathing load to the capacity of the pool treatment equipment. The bathing load also depends on the size and depth of the pool. Most facilities can accommodate non-swimming patrons who can enter the building but do not access the changing rooms, showering cubicles or the pool.

2.5 Management by Staff

5 people who have different roles manage the indoor swimming pool facility. Apart from the 5 management workers there are lifeguards work shifts of 8 hours around 24 hrs. The facility has a parking lot dedicated to patrons only.

3 Considerations for Design

Using a resistive humidity sensor; measure and control the humidity levels within the specified ranges for winter and summer season. It is expected that in wintertime when the air is dryer; the humidity levels can drop lower than specified level. If this happens then moisture is introduced in the environment. This is done by opening moisture sprinklers controlled by relays. In summer it is expected that the humidity levels might rise above the specified levels. When this is occurs, ventilation vents in the roof (driven by DC motors) are opened to allow for the moisture to escape.

Using temperature sensor(s) measure the air temperature and maintain it within the required range for all seasons. In winter the air temperature is maintained around the lower temperature range. In summer the temperature is maintained around the upper temperature range. Turning on an LED will indicate heating of the space in winter, while switching on a fan will indicate cooling in summer. A good temperature measurement is taken to be an average from at least three measurements.

The lights to be controlled are:

- Lights in the pool area,
- Security lights inside and outside the building and
- The parking lot lights.

The lights in the pool are lit in three stages depending on the light levels. As the ambient light in the pool area diminishes then the lights are progressively switched on to make sure that the pool area is lit to the recommended levels. However the second and third stage lighting comes on only if there are people in the pool area. Stage one lights are also the security lights inside the building. The outside security lights are lit whenever the ambient light outside the building is at a level that compromises the security of the patrons and the facility. The parking lights are lit when the outside ambient light falls below safe levels and only if there are cars parked indicating that there are still people inside the facility. A visible light phototransistor is to be used for the control of the inside lights, a pin photodiode is to be used for the control of the parking lot lights and a light dependent resistor is to be used for the control of the security lights. All lights are indicated by LEDs.

The number of patrons must be limited to the safe levels as determined by the bathing load. Patrons are let in and out of the pool area through dedicated automated gates. Gap sensors are used at the entrance and exit gates. At any time of the day the number of patrons in the pool must be displayed on seven-segment light emitting diodes. Once the maximum number is reached, then entrance is allowed only if a patron exits the pool area. There are always two lifeguards in the pool area responsible for the safety of the patrons. Lifeguards use the same automated doors used by patrons to enter and exit the pool area. Whilst the facility maximum number is not reached a green light outside the entrance gate is lit and once the safety limit is reached a red light is switched on to indicate that the facility is full. Note that each project team will be assigned a unique safety limit for patrons in the swimming pool. These will be posted on the course webpage.

4 Project Requirements

1. Determine the subsystems that make up the system.
2. Represent the system in a block diagram.
3. Subdivide the design tasks as equitably as possible amongst the project team members.
4. Design, simulate, build test and fully document the design in your engineering notebook as stipulated in CB.
5. As a team attend to the three mandatory consultations during the execution period as per the CBO.
6. Interface the subsystems and present a functional system for final testing.
7. Write a team technical report. The details of the report will be provided in due course in a separate document.

5 Project Equipment

- A 1 Amp multiple voltage output transformer is provided for the power supply
- All required sensors i.e. humidity, temperature, and light sensors will be provided
- NPN transistors and MOSFETS will be provided for switching and current amplification.

- All the loads to be driven i.e. DC motor; DC fan; LED's; relay and seven segment LED's will be provided.
- A component-issuing file is placed at the electronics workshop. Students must complete and sign their team's component-issuing card to keep track of issued components.
- The implementation of the design should be carried out using electronic components available in the school electronic workshop. Only the course coordinator can authorize the use of alternative components.
- All other required electronic components, except breadboards will be provided