

Title of Invention: Optimization of the dehumidification process in real time based on changing weather conditions

DEHUMIDIFICATION OPTIMIZATION PROCESS

BACKGROUND

The present invention relates to system and method for optimizing the dehumidification process in real time based on changing weather conditions.

Conventional dehumidification systems operate with fixed process parameters —such as compressor speed, and refrigeration flow controls—which often result in process and energy inefficiencies under changing weather conditions. For instance, in a high-temperature and/or high-humidity environment, conventional dehumidification systems consume excessive energy by cooling the refrigerant more than necessary, when similar levels of moisture removal could be achieved at lower energy input. Conversely, in a less favourable weather condition where temperature and/or humidity is low, conventional dehumidification systems result in disproportionate dehumidification relative to the energy consumed.

This excessive energy consumed in the long run results in negative implications—technical, economical, and environmental. Technical implications include accelerated wear and tear of mechanical components. For instance, running a compressor at full load constantly despite sufficiency at partial load accelerates its mechanical wear. Economic implications include overall higher operating costs. Every unnecessary watt consumed translates directly into higher electricity bills. Lastly, environmental implications include increased carbon emissions. The carbon emissions in turn accelerate global warming by trapping heat in the atmosphere, leading to more extreme weather, rising sea levels, and disruptions to ecosystems and food supplies.

As excessive energy consumed results in numerous negative implications, there are therefore technical, economical, and environmental needs for a system and method which optimizes the dehumidification process in real time based on changing weather conditions.

SUMMARY

In one embodiment, the present invention provides a method for optimizing dehumidification process in real time using sensor-acquired environmental data and algorithm-driven control of system parameters. In another embodiment, the invention provides an apparatus comprising sensors, a control system, and a dehumidification system configured to dynamically adjust operations and optimize the dehumidification process.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a system diagram, a visual representation of optimizing the dehumidification process in real time based on changing weather conditions.

DETAILED DESCRIPTIONS

Fig. 1 is a system diagram of one embodiment of the present invention as an optimization process for dehumidification in real time, containing a data acquisition system, dehumidification system, and a data processing and analysis system.

The data acquisition system which is configured to measure and collect real time weather data through sensors include, but are not limited to, a temperature sensor 1, a dew point sensor 2, and a humidity sensor 3, which are all connected to the microprocessor 16 in the control box 15.

The dehumidification system configured to remove moisture from the air with real time system data collection through sensors including, but not limited to, a condenser 4, an evaporator 5, a compressor 6, an expansion valve 7, a fan 8, a temperature sensor 9 before the evaporator 5, a temperature sensor 10 after the evaporator 5, a pressure sensor 11 before the compressor 6, a pressure sensor 12 after the compressor 6, a water collection tank 13, and a hydrostatic pressure sensor 14.

The data processing and analysis system which holds and executes one or more algorithms consists of, but is not limited to a control box 15 which may include, but are not limited to a microprocessor 16 and an energy meter 17. The algorithm is configured to process the acquired parameters, including but not limited to weather conditions such as humidity and temperature, energy consumption and water generation and evaluate the dehumidification conditions to predict optimal output parameters for optimized dehumidification process.

The processed data is then programmed into the compressor 6 and expansion valve 7 which are adjusted by closing or opening the expansion valve 7, and increasing or decreasing the compressor 6 speed, to optimize the dehumidification process.

In certain embodiments, the optimization process illustrated in Fig. 1 operates in a closed-loop configuration, wherein feedback from the data acquisition system and dehumidification system are continuously analyzed by the algorithm in the data processing and analysis system, to predict adjustments to be made to the process parameters— compressor 6

and expansion valve 7 to optimize dehumidification in real time based on changing weather conditions

Although the present invention has been described with reference to preferred embodiments, those skilled in the art will recognize that various modifications, substitutions, and changes in form and detail may be made without departing from the spirit and scope of the invention as defined by the appended claims.

THE INVENTION CLAIMED

1. A system for optimization of a dehumidification process in real time based on changing weather conditions, the system comprising:
 - a. a data acquisition system to receive real-time environmental data including but not limited to temperature, dew point, and humidity;
 - b. a dehumidification system functioning as moisture remover and water collector;
 - c. a data acquisition system for the dehumidification process to receive real-time system data including but not limited to temperature, pressure, energy, and hydrostatic pressure;
 - d. a data processing and analysis system comprising one or more algorithms configured to analyze and calculate process parameters, including but not limited to expansion valve opening and compressor speed, based on data from the data acquisition system and data from the dehumidification system.
2. The system of claim 1, wherein the data acquisition system is configured to collect data continuously or at predefined intervals.
3. The system of claim 1, wherein the algorithm is a self-learning algorithm that refines process parameters based on historical performance.
4. The system of any preceding claim, wherein the data acquisition system communicates with the data processing and analysis system via a wired or wireless connection.
5. The system of any preceding claim, wherein the dehumidification system communicates with the data processing and analysis system via a wired or wireless connection.
6. The system of any preceding claim, wherein the data-processing and analysis system predicts optimal process parameters to pre-emptively adjust process parameters.
7. The system of any preceding claim, wherein the data-processing and analysis system adjusts process parameters to maintain superheat condition at the compressor suction line.
8. The system of any preceding claim, wherein the dehumidification system is configured to suspend operation when ambient humidity falls below a predefined threshold and to resume when conditions return to suitable levels.
9. A method for optimization of a dehumidification process in real time based on changing weather conditions, the method comprising:

- a. collecting, via one or more sensors, real-time weather data comprising at least one of temperature, dew point, humidity, and additional environmental parameters;
 - b. collecting, via one or more sensors, real-time system data comprising at least one of temperature, pressure, energy, hydrostatic pressure, and additional operational parameters;
 - c. inputting the collected data into one or more customized algorithms configured to operate in a real-time environment;
 - d. calculating process parameters, including but not limited to, expansion valve opening position and compressor speed using one or more customized algorithms;
 - e. adjusting said process parameters in the compressor and expansion valve to optimize dehumidification efficiency;
 - f. adjusting said process parameters in the compressor and expansion valve to maintain superheat condition at compressor suction line;
 - g. determining when weather conditions are unsuitable for dehumidification, through one or more customized algorithms analyzing including but not limited to low humidity or freezing temperatures, and suspending the process accordingly; and
 - h. automatically restarting the dehumidification process when weather conditions meet predefined operational parameters.
10. The method of claim 9, wherein the weather and system data are collected continuously or at predefined intervals.
 11. The method of claim 9, further comprising monitoring energy consumption and water generation to refine the algorithm over time.
 12. The method of any preceding claim, wherein the algorithm utilises predictive modelling based on weather data, system data, and historical performance data.
 13. An apparatus for optimization of a dehumidification process in real time based on changing weather conditions, the apparatus comprising:
 - a. a data acquisition system comprising one or more sensors configured to collect environmental data, including but not limited to temperature, humidity, and dew point;
 - b. a dehumidification system comprising one or more condenser, evaporator, compressor, expansion valve, and fan;

- c. a data acquisition system for the dehumidification system comprising one or more sensors configured to collect system data, including but not limited to temperature, pressure, energy, and hydrostatic pressure;
- d. a data processing and analysis system comprising one or more control box with compressor and energy meter, one or more microprocessors incorporating one or more algorithms configured to:
 - i. receive weather data from sensors in real time;
 - ii. receive system data from sensor in real time;
 - iii. calculate optimal process parameters.