INTEGRATED FAN DRIVE SYSTEM FOR COOLING TOWER

CROSS-REFERENCE TO RELATED APPLICATIONS:

This application claims the benefit of U.S. Provisional Application No. 60/978,916, filed October 10, 2007. The entire disclosure of the aforesaid application no. 60/978,916 is hereby incorporated by reference.

TECHNICAL FIELD:

The present invention generally relates to a fan drive system for a wet cooling tower.

BACKGROUND ART:

Wet cooling towers are well known in the art and are used in a variety of industries for cooling fluids such as water. The primary use of large, industrial cooling tower systems is to remove the heat absorbed in circulating cooling water systems used in power plants, petroleum refineries, petrochemical and chemical plants, natural gas processing plants and other industrial facilities. The absorbed heat is rejected to the atmosphere by the evaporation of some of the cooling water in mechanical forced-draft or induced draft towers.

Cooling towers are widely used in the petroleum refining industry. Refining of petroleum cannot take place without cooling towers. Refineries process hydrocarbons at high temperatures and pressures. Cooling water is used to control operating temperatures and pressures. The loss of cooling water circulation within a refinery can

Claims:

1. A wet cooling tower for cooling fluids used in an industrial process, wherein the wet-cooling tower has a fan (27) that causes an airflow that cools the fluids, a fan-drive system for causing rotation of the fan (27) and a basin for collecting cooled fluids, characterised in that the fan-drive system is a direct-drive system comprising:

a high-torque, low variable speed permanent magnet motor (52) having a rotatable shaft (56) connected to the fan (27) and a plurality of sealed bearings (90, 92), wherein the high torque, low variable speed permanent magnet motor (50) is configured to have a speed range of 0-250 RPM and maximum power of about 133HP/100KW;

a variable frequency drive device (50) to generate electrical signals that effect rotation of the rotatable shaft (56) of the motor (52) in order to rotate the fan (27), wherein the variable frequency drive device (50) is configured to receive control signals that represent a desired motor rotational speed, and in response, generate electrical signals for input into the motor (52) to cause the motor (52) to operate at a rotational speed that is substantially the same as the desired rotational speed; and

vibration sensors (200, 202) in proximity to the bearings for measuring vibrations of the bearings and outputting signals representing the measured vibrations;

temperature sensors (200, 202, 204) for measuring heat of the stator (94) and bearings (90, 92) and outputting signals representing the measured heat;

at least one temperature sensor (208) located in the basin for outputting a signal representing the temperature of the fluid in the basin;

at least one airflow sensor (206) positioned downstream of the cooling tower fan to measure airflow and output signals representing the airflow; and

a computer (300) in electronic signal communication with the variable frequency drive device (50), wherein the computer (300) processes the signals representing (i) the measured heat of the motor stator and bearings, (ii) the measured vibrations of the motor bearings, (iii) the measured temperature of the fluid in the basin and (iv) the measured airflow, wherein the computer, the variable frequency drive device and all of the sensors form a feedback loop, wherein the computer generates the control signals for input into the variable frequency drive device in order to adjust the speed of the high-torque, low variable speed permanent magnet motor (52) in response to the processed signals.

2. The wet cooling tower according to claim 1 wherein the efficiency of the high torque, low variable speed permanent magnet motor (52) is between 85% and 95% when the motor speed is between about 60 RPM and 200 RPM.

3. The wet cooling tower according to claim 1 wherein the fan (27) comprises a fan hub (28) and a plurality of fan blades (30) and the rotatable shaft (56) of the high torque, low variable speed permanent magnet motor (52) is connected to the fan hub (28).

4. The wet cooling tower according to claim 1 wherein the computer (300) is configured to output control signals to the variable frequency drive device (50) to cause reverse rotation of the high-torque, low variable speed permanent magnet motor (52).

5. The wet cooling tower according to claim 1 wherein the computer (300) further comprises a display screen device (302) that enables a user or operator to visually monitor the signals outputted by the heat, temperature, vibration and air-flow sensors.

6. The wet cooling tower according to claim 1 wherein the computer (300) is programmed to generate control signals that reduce the rotational speed of the high torque, low variable speed permanent magnet motor (52) if the computer (300) determines, as a result of processing the measured vibrations, a pending fan blade-out situation exists.

7. The wet cooling tower according to claim 1 wherein the computer (300) is programmed to perform a reliability algorithm on the signals outputted by the heat, temperature, vibration and air-flow sensors.

8. A method of operating a wet cooling tower for cooling fluids used in an industrial process, wherein the wet cooling tower has a fan (27) for causing an airflow that cools the fluid, a basin for collecting cooled fluid, and a fan-drive system for causing rotation of the fan, characterized in that the fan-drive system is a direct-drive system comprising a high-torque, low variable speed permanent magnet motor (52) comprising a rotatable shaft (56) connected to the fan (27) wherein the high torque, low variable speed permanent magnet motor (50) is configured to have a speed range of 0-250 RPM and maximum power of about 133HP/100KW, a stator (94) and bearings (90, 92), and a variable frequency drive device (50) to generate electrical signals that effect rotation of the rotatable shaft (56) of the motor (52) in order to rotate the fan (27), wherein the variable frequency drive device (50) is

configured to receive control signals that represent a desired motor rotational speed, and in response, generate electrical signals for input into motor (52) to cause the motor (52) to operate at a rotational speed that is substantially the same as the desired rotational speed, wherein the method of operating the wet cooling tower comprises the steps of:

measuring vibrations of the bearings (90, 92) and providing signals representing the measured vibrations;

measuring heat of the stator (94) and the bearings (90, 92) and providing signals representing the measured heat;

measuring airflow produced by the fan (27) and providing signals representing the measured airflow;

measuring the temperature of the fluids in the basin;

utilizing a computer (300) to process the signals representing (i) the measured heat of the motor stator (94) and bearings (90, 92), (ii) the measured vibrations of the motor bearings (90, 92), (iii) the measured airflow, and (iv) the measured temperature of the fluids in the basin; and

generating control signals for input into the variable frequency drive device (50) in order to adjust the speed of the motor (52) in response to the processed signals.

9. The method according to claim 8 further comprising the step of generating control signals for input into the variable frequency drive device (50) to cause reverse rotation of the motor (52).

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CLAIMS:

What is claimed is:

1. A drive apparatus, comprising:

a high-torque, low speed permanent magnet motor; and

a variable frequency drive device in electrical signal communication with the permanent magnet motor to control the rotational speed of the permanent magnet motor.

2. A fan drive system, comprising:

a high-torque, low speed permanent magnet motor having a rotatable shaft;

a fan comprising a hub that is directly connected to the rotatable shaft and a plurality of fan blades that are attached to the hub; and

a variable frequency drive device in electrical signal communication with the permanent magnet motor to control the rotational speed of the permanent magnet motor.

3. The fan drive system according to claim 2 wherein the high-torque, permanent magnet motor comprises no more than two bearings in operative association with the shaft.

4. The fan drive system according to claim 2 wherein the variable frequency drive device comprises:

a variable frequency controller that has an input for receiving AC power and an output for providing electrical signals that control the operational speed of the high-torque, permanent magnet motor; and

a user interface in electronic data signal communication with the variable frequency controller to allow a user to input data representing a desired motor speed.

5. The fan drive system according to claim 4 further comprising a plurality of sensors in electronic data signal communication with the user interface so as to provide sensor output data signals representing vibration and heat at the bearings of the motor, heat at the motor stator, and air flow created by rotation of the fan.

6. The fan drive system according to claim 5 further comprising a data signal processing resource in electronic data signal communication with the user interface to receive the sensor output data signals.

7. The fan drive system according to claim 6 wherein in response to the sensor output data signals, the data signal processing resource generates feedback signals that are inputted into the user interface to allow adjustment of the motor speed.

8. The fan drive system according to claim 7 wherein the data signal processing resource comprises a computer and a display device.

9. In combination:

a wet cooling tower having a fan deck;

a fan cylinder positioned upon the fan deck;

a fan that is located within the fan cylinder and which comprises a hub to which are connected a plurality of fan blades;

a high-torque, low speed permanent magnet motor having a rotatable shaft that is connected to the hub, the permanent magnet motor having a rotational speed between 0 RPM and about 250 RPM; and

a variable frequency drive device in electrical signal communication with the permanent magnet motor to control the rotational speed of the permanent magnet motor, the variable frequency drive device

comprising:

a variable frequency controller that has an input for receiving AC power and an output for providing electrical signals that control the operational speed of high-torque, permanent magnet motor, and

a user interface in electronic data signal communication with the variable frequency controller to allow a user to input motor speed control data.

10. The combination according to claim 9 further comprising a plurality of sensors in electronic data signal communication with the user interface so as to provide sensor data output signals representing vibration and heat at the bearings of the high-torque, permanent magnet motor, heat at the motor stator, and air flow created by operation of the fan.

11. The combination according to claim 10 further comprising a data signal processing resource in electronic data signal communication with the user interface to receive the sensor output data signals.

12. The combination according to claim 11 wherein the data signal processing resource comprises a computer.