CLAIMS

1. A method of controlling a thermal system of an industrial process, the thermal system including a heater system and a process control system configured to generate an output control for the heater system based on intermediate data generated by the process control system, the method comprising:

monitoring the intermediate data, wherein the intermediate data comprises proportional gain data, integral gain data, derivative gain data, controller gain data, loop data of a cascade control system, or a combination thereof;

associating the intermediate data with correlation data, wherein the correlation data includes an internal process control input, an external heater control input, the output control, or a combination thereof;

generating a model that defines a relationship between the intermediate data and the correlation data;

identifying a state of the heater system based on the model; and

selectively performing a corrective action based on the identified state of the heater system.

2. The method of Claim 1, wherein the output control is based on a sum of the proportional gain data, the integral gain data, and the derivative gain data.

3. The method of Claim 1, wherein the process control system includes the cascade control system having a primary controller and a secondary controller, and wherein the intermediate data includes the loop data of the cascade control system.

4. The method of Claim 3, wherein the output control is based on a sum of proportional gain data of the secondary controller, integral gain data of the secondary controller, and derivative gain data of the secondary controller.

5. The method of Claim 1, wherein the intermediate data includes the controller gain of the process control system.

6. The method of Claim 1, wherein the model is a mathematical model, a machine learning model, or a combination thereof.

7. The method of Claim 6, wherein the machine learning model is a supervised learning model configured to predict the state of the heater system based on the intermediate data and the correlation data.

8. The method of Claim 1 further comprising:

comparing the model with a nominal model defining a nominal relationship between the intermediate data and the correlation data; and

determining a deviation between the nominal model and the model, wherein the identified state of the heater system is further based on the deviation.

9. The method of Claim 8, wherein the deviation includes a proportional gain deviation, an integral gain deviation, a derivative gain deviation, or a combination thereof.

10. The method of Claim 1, wherein the internal process control input comprises a desired setpoint of a performance characteristic of the heater system, a setpoint for controlling the heater system, a process variable, a measured value of the process variable, an alert associated with the thermal system, or a combination thereof.

11. The method of Claim 1, wherein the corrective action includes controlling power to the heater system based on the identified state of the heater system.

12. The method of Claim 1, wherein the corrective action includes broadcasting an alert based on the identified state of the heater system, wherein the alert indicates a material accumulation within a conduit communicatively coupled to the process control

system, a nominal thermal deviation of a resistive heating element communicatively coupled to the process control system, or a combination thereof.

13. The method of Claim 1, wherein the external heater control input is an output generated by an external device of the process control system.

14. The method of Claim 1, wherein the internal process control input comprises pressure data, mass flow rate data, vibration data, strain data, temperature data, or a combination thereof.

15. A process control system for controlling a heater system, the process control system configured to generate an output control for the heater system based on intermediate data generated by the process control system, the process control system comprising:

a processor; and

a nontransitory computer-readable medium comprising instructions that are executable by the processor, wherein the instructions comprise:

monitoring the intermediate data, wherein the intermediate data comprises proportional gain data, integral gain data, derivative gain data, controller gain data, loop data of a cascade control system, or a combination thereof;

associating the intermediate data with correlation data, wherein the correlation data includes an internal process control input, an external heater control input, the output control, or a combination thereof;

generating a model that defines a relationship between the intermediate data and the correlation data;

identifying a state of the heater system based on the model; and

selectively performing a corrective action based on the identified state of the heater system.

16. The process control system of Claim 15, wherein the process control system includes the cascade control system having a primary controller and a secondary controller, and wherein the intermediate data includes the loop data of the cascade control system.

17. The process control system of Claim 15, wherein:

the model is configured to predict the state of the heater system based on the intermediate data and the correlation data; and

the instructions further comprise:

comparing the model with a nominal model defining a nominal relationship between the intermediate data and the correlation data; and

determining a deviation between the nominal model and the model, wherein the identified state of the heater system is further based on the deviation.

18. The process control system of Claim 15, wherein the internal process control input comprises a desired setpoint of a performance characteristic of the heater system, a setpoint for controlling the heater system, a process variable, a measured value of the process variable, an alert associated with the thermal system, or a combination thereof.

19. A method of controlling a thermal system of an industrial process, the thermal system including a heater system and a process control system configured to generate an output control for the heater system based on intermediate data generated by the process control system, the method comprising:

associating the intermediate data with correlation data, wherein the correlation data includes an internal process control input, an external heater control input, the output control, or a combination thereof, and wherein the intermediate data comprises proportional gain data, integral gain data, derivative gain data, controller gain data, loop data of a cascade control system, or a combination thereof;

generating a model that defines a relationship between the intermediate data and the correlation data;

comparing the model with a nominal model defining a nominal relationship between the intermediate data and the correlation data;

identifying a state of the heater system based on the comparison between the nominal model and the model; and

selectively performing a corrective action based on the identified state of the heater system.

20. The method of Claim 19, wherein the process control system includes the cascade control system having a primary controller and a secondary controller, and wherein the intermediate data includes the loop data of the cascade control system.

21. The method of Claim 19, wherein the identified state of the heater system is further based on a deviation between the nominal model and the model, and wherein the deviation includes a proportional gain deviation, an integral gain deviation, a derivative gain deviation, or a combination thereof.

22. The method of Claim 19, wherein the internal process control input comprises a desired setpoint of a performance characteristic of the heater system, a setpoint for controlling the heater system, a process variable, a measured value of the process variable, an alert associated with the thermal system, or a combination thereof.

23. The method of Claim 19, wherein the external heater control input is an output generated by an external input controller of the process control system.

24. The method of Claim 19, wherein the internal process control input comprises pressure data, mass flow rate data, vibration data, strain data, temperature data, or a combination thereof.