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(54) SYSTEMS AND METHODS FOR OIL HEATER CONTROLS FOR AN INTERNAL COMBUSTION ENGINE SYSTEM

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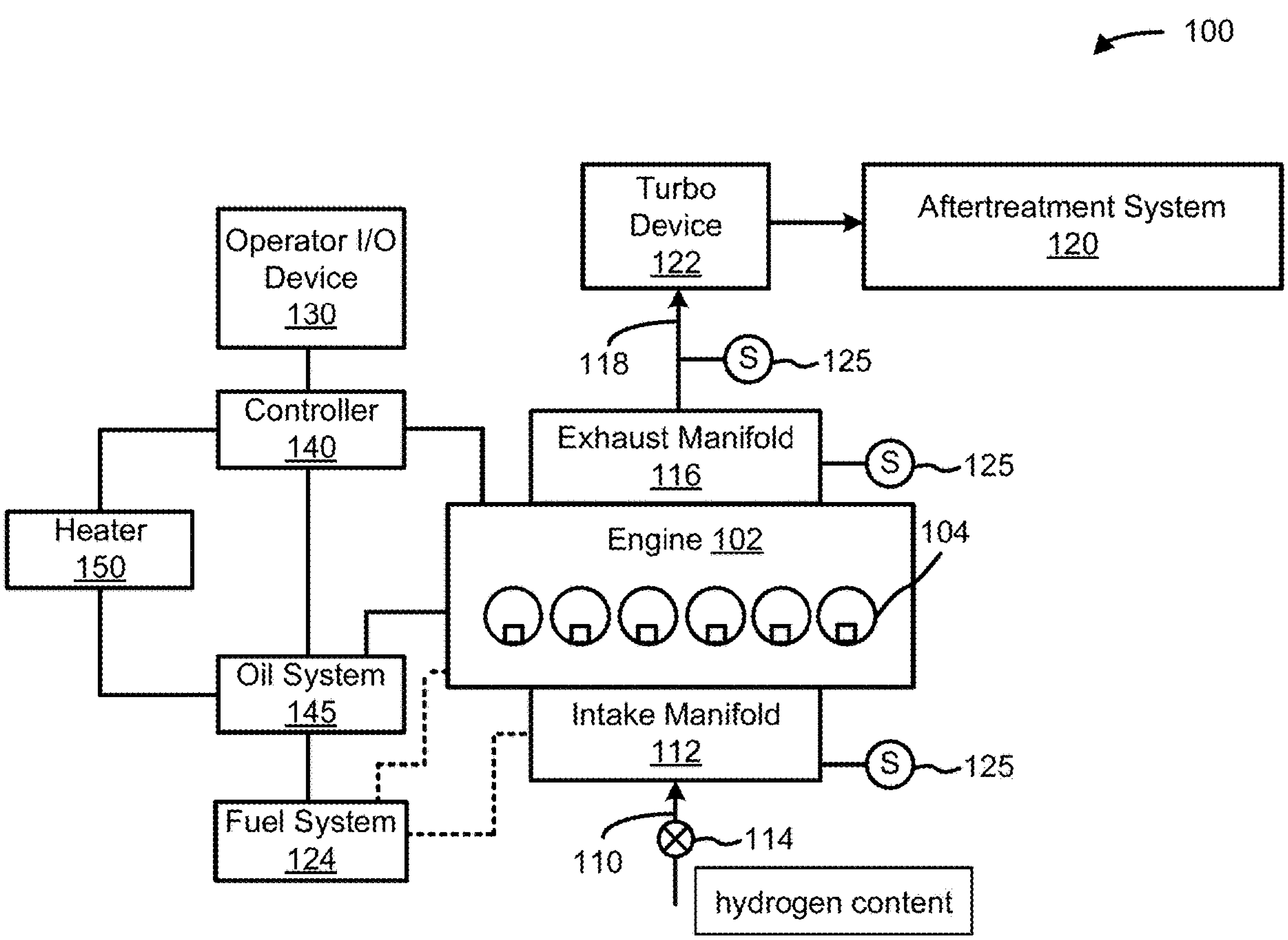
(57) **ABSTRACT**

A system includes a heater configured to heat a fluid of a lubricant system, a controller coupled to the heater, the controller including at least one processor coupled to at least one memory device storing instructions that, when executed by the at least one processor, cause the controller to perform operations including: receiving information regarding an engine operating parameter of an engine, receiving information regarding an operating parameter of the lubricant system, and activating the heater responsive to determining that at least one of the engine operating parameter or the operating parameter of the lubricant system is at or below a predefined threshold.



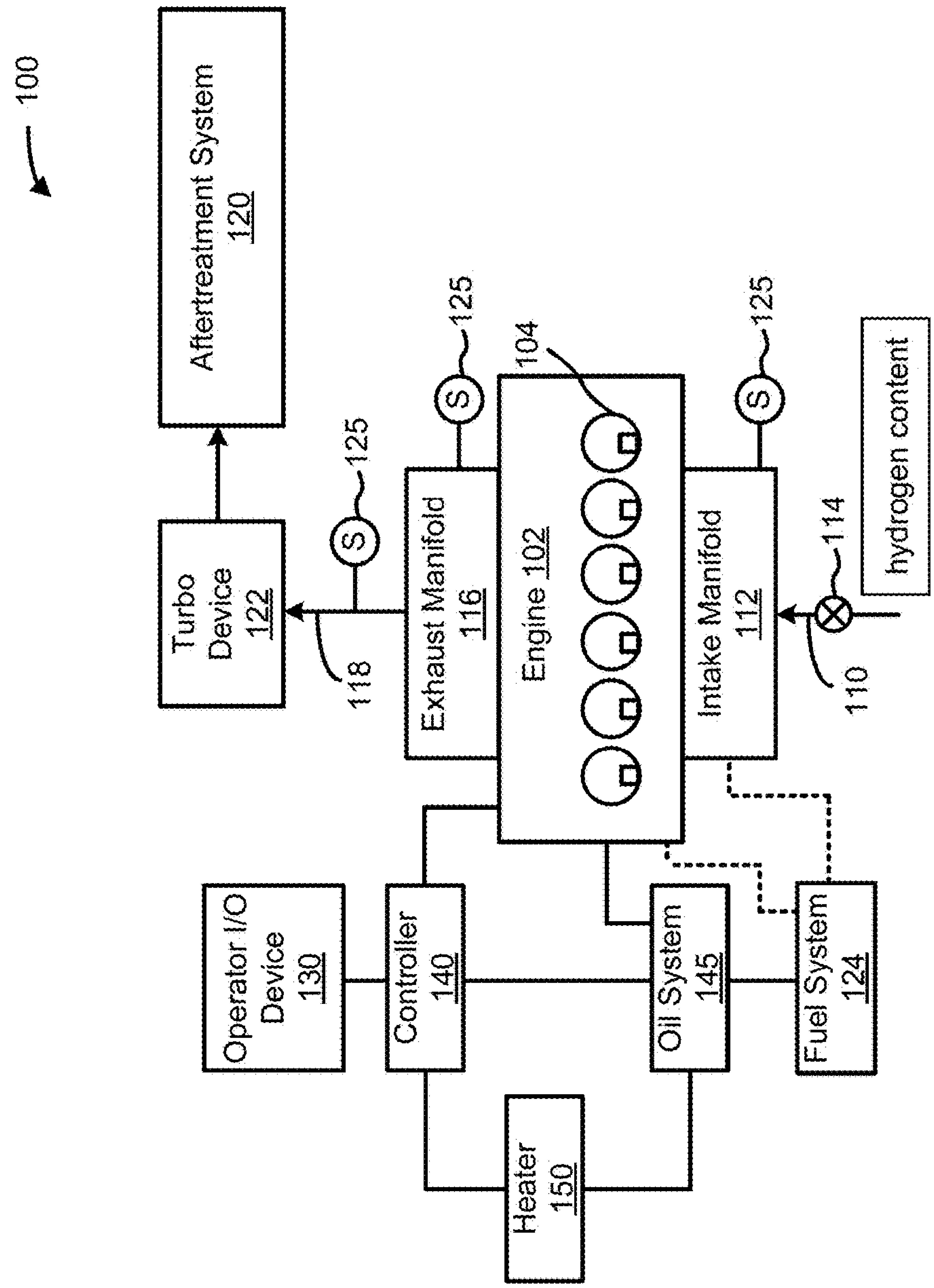

100
Aftertreatment System 120
Turbo Device 122
118
125
Exhaust Manifold 116
125
104
Engine 102
125
Intake Manifold 112
114
110
hydrogen content
Operator I/O Device 130
Controller 140
Oil System 145
Fuel System 124
Heater 150

FIG. 1

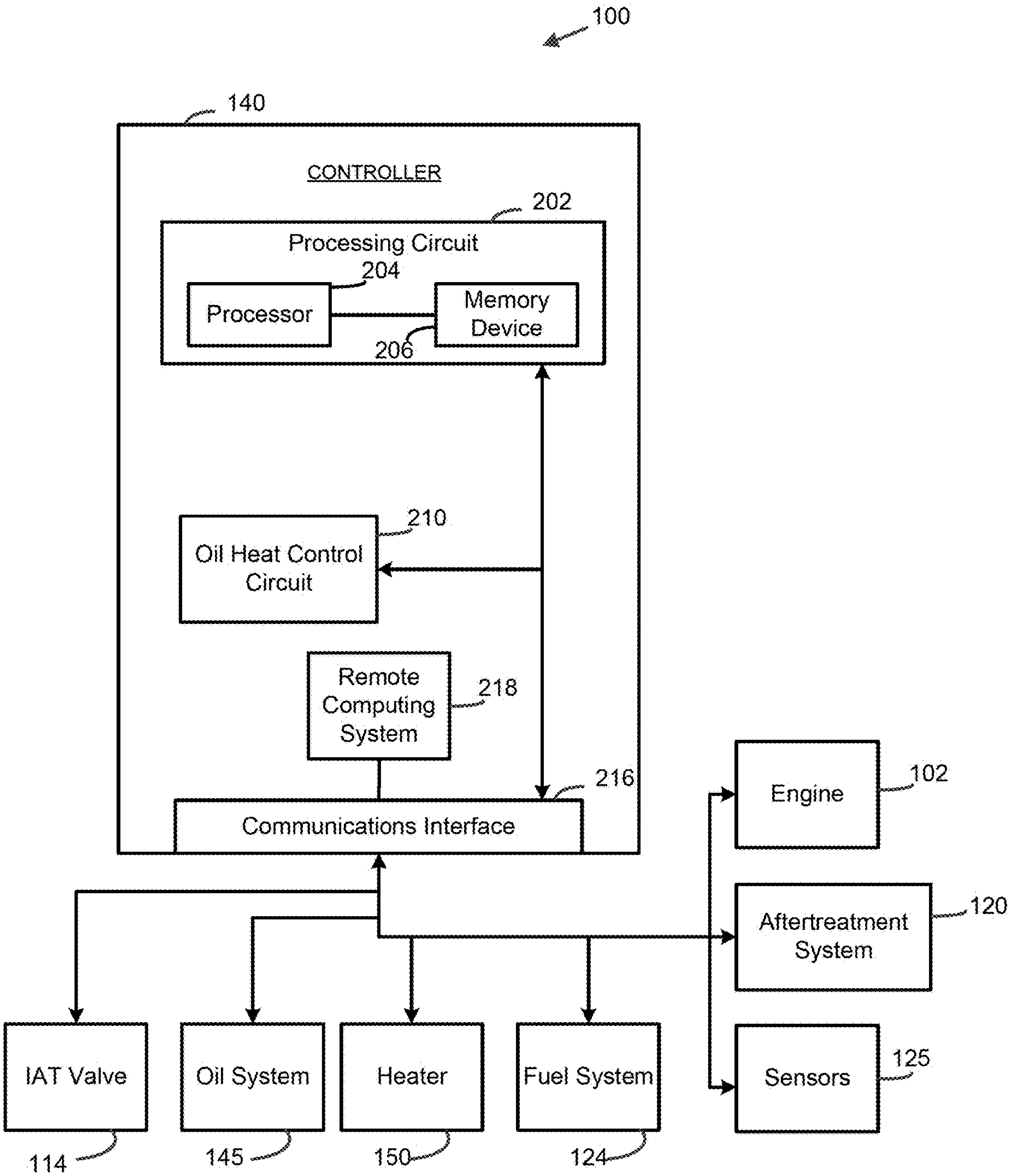

100
140
CONTROLLER
202
Processing Circuit
204
Processor
Memory Device
206
210
Oil Heat Control Circuit
Remote Computing System
218
216
Communications Interface
Engine
102
Aftertreatment System
120
Sensors
125
IAT Valve
114
Oil System
145
Heater
150
Fuel System
124

FIG. 2

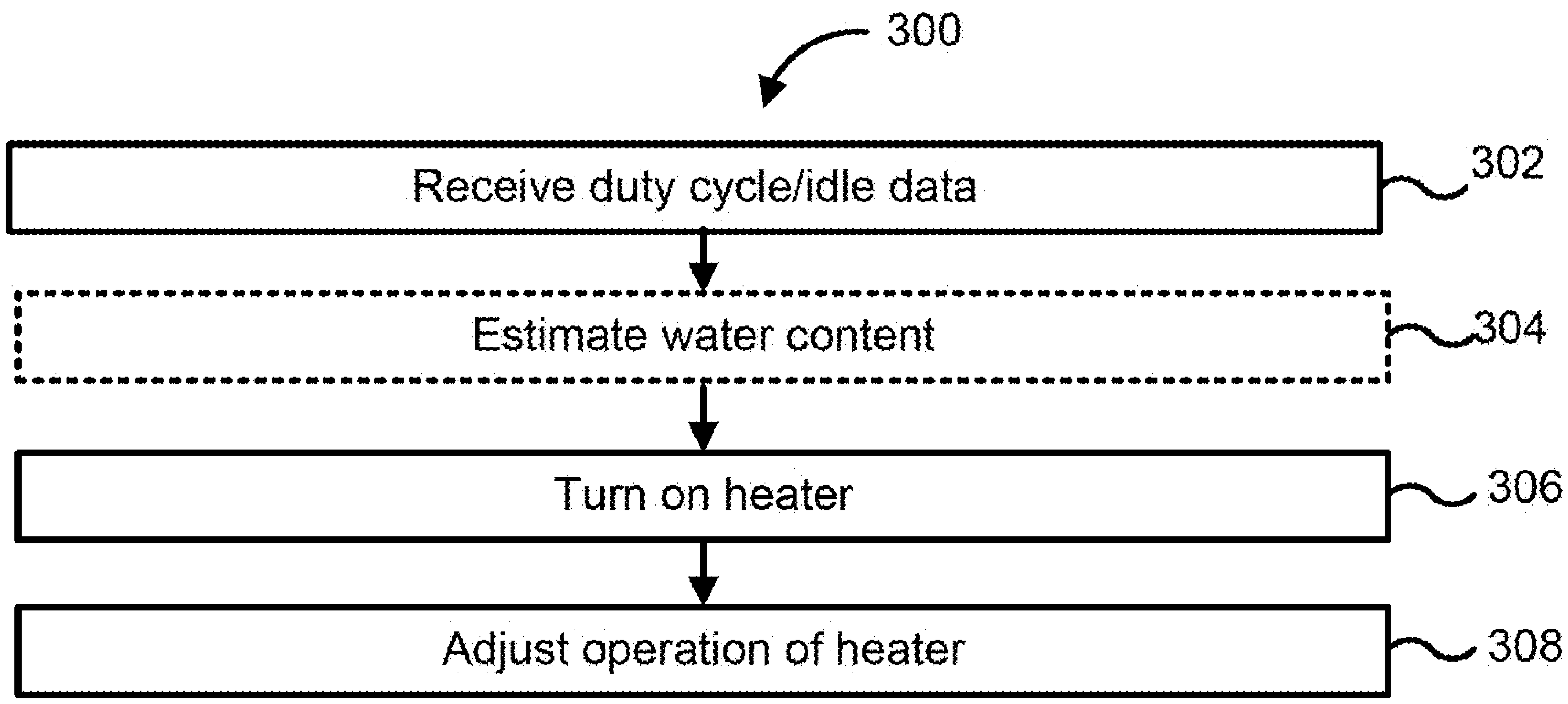

300
Receive duty cycle/idle data
302
Estimate water content
304
Turn on heater
306
Adjust operation of heater
308

FIG. 3

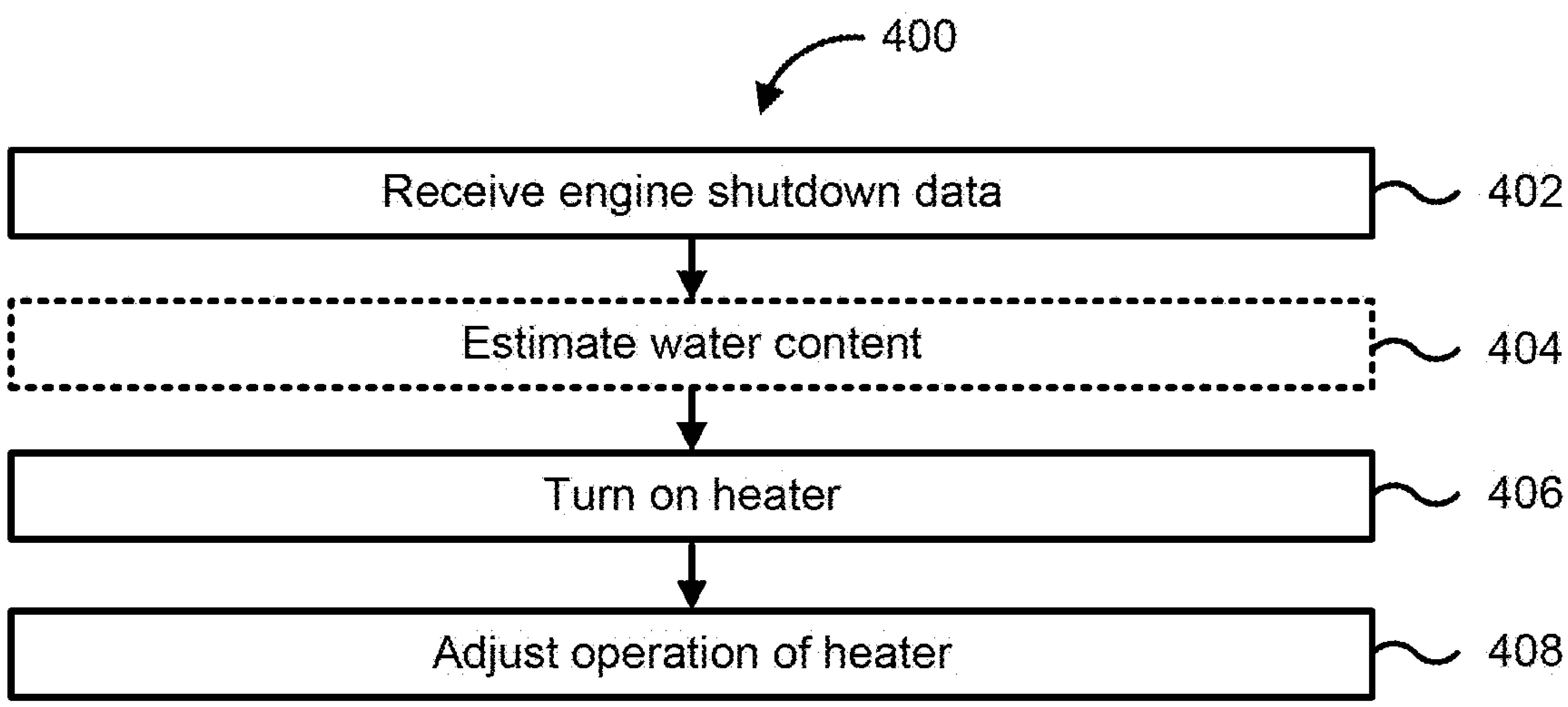

400
Receive engine shutdown data
402
Estimate water content
404
Turn on heater
406
Adjust operation of heater
408

FIG. 4

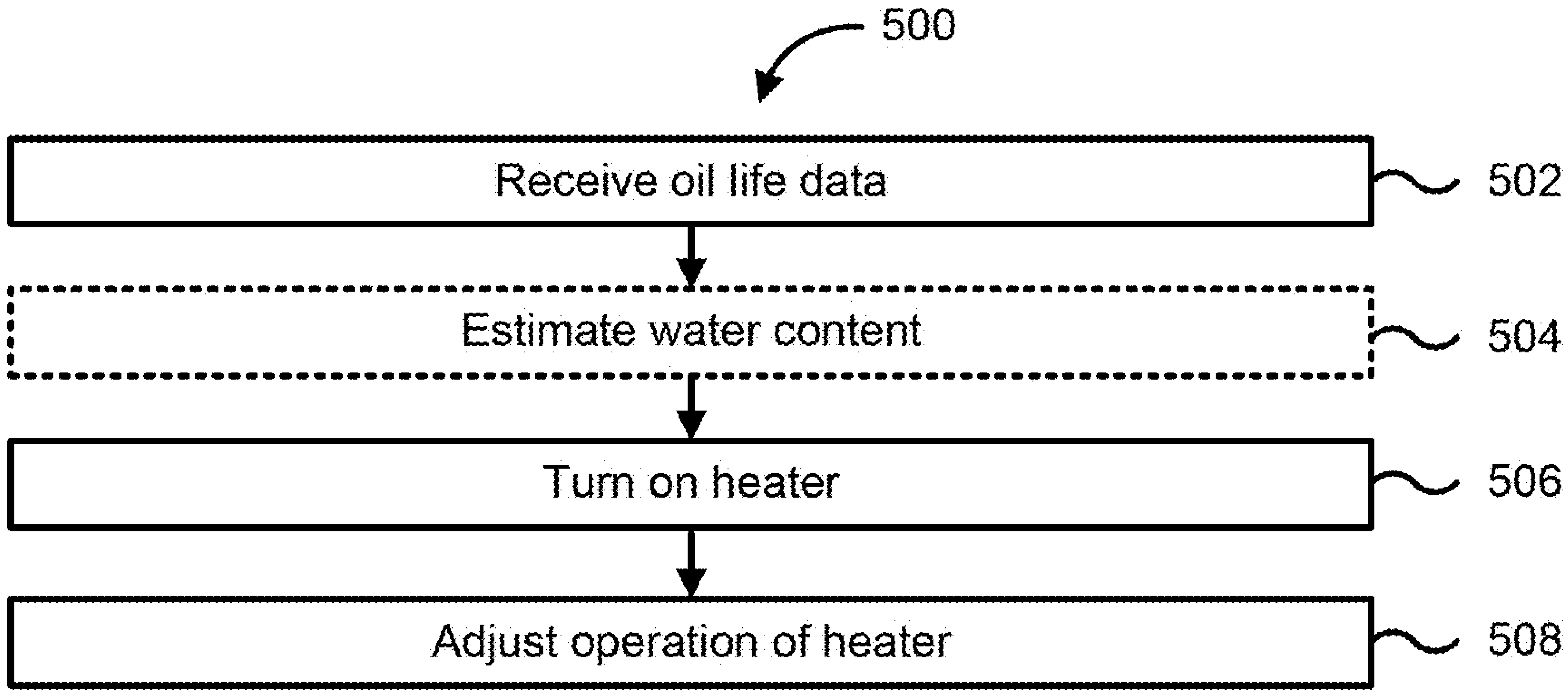

500
Receive oil life data
502
Estimate water content
504
Turn on heater
506
Adjust operation of heater
508

FIG. 5

SYSTEMS AND METHODS FOR OIL HEATER CONTROLS FOR AN INTERNAL COMBUSTION ENGINE SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The application claims the benefit and priority to U.S. Provisional Application No. 63/550,546, filed Feb. 6, 2024, which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates generally to systems, methods, and computer readable media for an oil heater controls for a hydrogen-fueled internal combustion engine system.

BACKGROUND

[0003] A hydrogen-fueled internal combustion engine (H2-ICE) consumes hydrogen gas (H_2) as fuel. In particular, the H2-ICE may combust a mixture of hydrogen fuel and ambient air. The combustion of hydrogen fuel in the presence of air yields water (H_2O) as a byproduct. Typically, the water is route out of the H2-ICE via an exhaust system, such as an exhaust aftertreatment system. However, in some situations, a portion of the water may leak into an oil system of the engine (e.g., an oil lubricant system, an oil cooling system, etc.), which may adversely affect operation of the oil system.

SUMMARY

[0004] One embodiment relates to a system including a heater configured to heat a fluid of a lubricant system and a controller coupled to the heater. The controller includes at least one processor coupled to at least one memory device storing instructions that, when executed by the at least one processor, cause the controller to perform operations including: receiving information regarding an engine operating parameter of an engine; receiving information regarding an operating parameter of the lubricant system; and activating the heater responsive to determining that at least one of the engine operating parameter or the operating parameter of the lubricant system is at or below a predefined threshold.

[0005] Another embodiment relates to a method. The method includes receiving a first operating parameter of an engine; receiving a second operating parameter of a lubricant system associated with the engine; and activating a heater associated with the lubricant system responsive at least one of the first operating parameter being at or below a first predefined threshold or the second operating parameter being at or below a second predefined threshold.

[0006] Yet another embodiment relates to a non-transitory computer-readable media storing instructions that, when executed by one or more processors, cause the one or more processors to perform operations. The operations include receiving a first operating parameter of an engine; receiving a second operating parameter of an oil system associated with the engine; and activating a heater associated with the oil system responsive at least one of the first operating parameter being at or below a first predefined threshold or the second operating parameter being at or below a second predefined threshold.

[0007] Numerous specific details are provided to impart a thorough understanding of embodiments of the subject matter of the present disclosure. The described features of the subject matter of the present disclosure may be combined in any suitable manner in one or more embodiments and/or implementations. In this regard, one or more features of an aspect of the invention may be combined with one or more features of a different aspect of the invention. Moreover, additional features may be recognized in certain embodiments and/or implementations that may not be present in all embodiments or implementations.

BRIEF DESCRIPTION OF THE FIGURES

[0008] FIG. **1** is a block diagram of an engine system, according to an example embodiment.

[0009] FIG. **2** is a block diagram of a controller of the system of FIG. **1**, according to an exemplary embodiment.

[0010] FIG. **3** is a flow diagram of a method of purging water from the lubricant system of the engine system of FIG. **1**, according to an exemplary embodiment.

[0011] FIG. **4** is a flow diagram of another method of purging water from the lubricant system of the engine system of FIG. **1**, according to an exemplary embodiment.

[0012] FIG. **5** is a flow diagram of another method of purging water from the lubricant system of the engine system of FIG. **1**, according to an exemplary embodiment.

DETAILED DESCRIPTION

[0013] Following below are more detailed descriptions of various concepts related to, and implementations of, methods, apparatuses, and systems for controlling a heater, and particularly a lubricant or oil heater, for a hydrogen-fueled internal combustion engine system. Before turning to the Figures, which illustrate certain exemplary embodiments in detail, it should be understood that the present disclosure is not limited to the details or methodology set forth in the description or illustrated in the Figures. It should also be understood that the terminology used herein is for the purpose of description only and should not be regarded as limiting.

[0014] As utilized herein, the term "content" and like terms are used to refer to an amount of a substance within a mixture. The amount may be expressed as a value, such as a mass value (e.g., measured in grams, kilograms, etc.), a weight value (e.g., measured in ounces, pounds, etc.), or another suitable value, such as a molar value. In some embodiments, the amount may be expressed as a concentration (e.g., an amount of a substance divided by the total amount of a mixture), such as parts per million, percent weight, percent mass, molar concentration, volumetric concentration, and so on. For example, a water content in an oil system may be a mass of the water, a concentration of water relative to the oil, a percentage of water by weight relative to the weight of the oil, etc. In another example, a water content in a gas stream may be a mass of the water, a concentration of water relative to the gas stream, a percentage of water by weight relative to the gas stream, etc.

[0015] As utilized herein, the term "estimating" is used to refer to determining a value that is not a measured value, such as measurements from a real sensor (e.g., a temperature measured by a temperature sensor, etc.). In other words, estimation refers to an approximation of a value(s) that may differ from an actual or measured value. Estimating a value may be based on information from a real sensor (e.g., sensor data, historical sensor data, real-time sensor data, etc.) or information from another source. In some embodiments, estimating the value can be performed using one or more models (e.g., statistical models, artificial intelligence models, machine learning models, etc.). For example, estimating a temperature value can include using data, such as sensor data, with a model to determine the temperature value. As utilized herein, the term "measuring" and like terms are used to refer to determining an approximate value based on detecting or receiving information regarding the desired parameter (e.g., using a sensor). The measured value may be close but not necessarily exactly the actual value of the measured value, yet still a closer or more accurate approximation relative to an "estimated" value.

[0016] As utilized herein, the term "operational data" and like terms are used to refer to data regarding the operation of a system, such as an engine system. In some embodiments, operational data may include settings, values, or other information regarding the operation of a system. For example, operational data of an engine system may include a ratio of an amount of air relative to an amount of fuel provided to the engine for combustion (referred to herein as an "air to fuel ratio"). In some embodiments, the operational data may be measured (e.g., by one or more real sensors) or estimated (e.g., by one or more virtual sensors or by a computer device or processing circuit).

[0017] As used herein, the term "duty cycle" refer to one or more characteristics regarding the operation of a system, such as an engine system, over a predefined period of time or other unit of operation of the system. A duty cycle of an engine system may include a set of values or characteristics including an engine speed value, an engine load value, an engine fueling characteristic (e.g., fuel consumption), a system temperature value (e.g., an engine temperature value, an aftertreatment system temperature value, an oil system temperature value, etc.), and/or other suitable characteristic, measured or determined over a predefined period of time. In some embodiments, the set of values or characteristics may be repeatable for corresponding periods of time. The duty cycles of the system may be grouped by similarity, such as an engine speed values relative to engine load values. For example, a "low" duty cycle may refer to relatively lower engine speeds, engine loads, fueling characteristics, and/or temperature values. More specifically, a low duty cycle may refer to one or more of the operating characteristics being at or below respective predetermined "low" thresholds. For example, a low duty cycle may refer to a low engine load or a period of engine idling. Similarly, a "high" duty cycle may refer to relatively greater engine speeds, engine loads, fueling characteristics, and/or temperature values. More specifically, a high duty cycle may refer to one or more of the operating characteristics being at or above a predetermined respective "high" thresholds. In any of the above-described embodiments, the predefined period of time may be a specific time value (e.g., 1 hour, 8 hours, 12 hours, etc.), or a dynamic time value based on a mission of the system, such as a time to complete a mission of the system, a time remaining for a mission of the system, and so on.

[0018] As described herein, an engine system may include an engine (e.g., a hydrogen-fueled engine), an oil system coupled to the engine, and at least one heater coupled to the oil system. A control system or controller may be coupled to the engine and/or the heater. The control system may monitor one or more parameters of the components of the engine system using one or more sensors (e.g., actual sensors and/or virtual sensors) to collect and/or determine sensor data. In particular, the sensor data may include a water content within an oil system. The water content may be a measured water content (e.g., measured by one or more actual sensors) and/or an estimated water content (e.g., estimated by the control system and/or one or more virtual sensors). In some embodiments, the control system may use the sensor data with one or more models, lookup tables, etc. to determine various data, such as an estimated water content.

[0019] Technically and beneficially, the systems, methods, and apparatuses described herein provide intelligent heater controls for heating an oil system coupled to a hydrogen internal combustion engine. In various embodiments, the systems and methods described herein may be applied to other low carbon gaseous fuels for an internal combustion engine (e.g., natural gas, propane, butane, dual or multi fuels, etc.). Water entering the oil system of an engine can pose mechanical problems to the engine system. For example, the oil can age prematurely or damage to the engine may arise. It may be desirable to purge (e.g., remove or substantially remove) water that has entered an oil system. Removing water content from an oil system may be beneficial to prolong the life of the engine system. Various systems, processes, and methods are disclosed herein that relate to removing water from an oil system. A water content may be estimated to determine when to enable a water purging process from the oil system. The controller or control system may estimate the water content based on data received from one or more sensors and/or one or more models (e.g., machine learning models, statistical models, etc.). For example, the control system may estimate the water content based on a known air to fuel ratio (e.g., an amount of air relative to an amount of fuel provided to the combustion cylinders of the engine, also referred to herein as "AFR"). The systems, computer-readable media, and methods described herein advantageously remove water from an oil system. The systems, computer-readable media, and methods described herein provide a relatively accurate, low-cost, reliable, and durable process of removing water from an oil system. That is, the systems, computer-readable media, and methods described herein provide a technical solution to the technical problem of removing or substantially removing water that has entered into an oil system of an engine system.

[0020] In an example embodiment, an engine system includes a hydrogen fueled internal combustion engine. The system includes an oil system coupled to the engine and a heater coupled to the oil system. The system includes a controller configured to control the heater. For example, the controller may activate the heater responsive to determining that water is present in the oil system. Advantageously, when the controller activates the heater, a fluid in the oil system (e.g., an oil-water mixture), is heated such that the water is removed from the oil system (e.g., via evaporation of the water). In this way, the controller may remove water from the oil system using one or more methods. In an example scenario, a control system (e.g., a controller, a vehicle controller, etc.) utilizes one or more methods to acquire data regarding a water content in an oil system. The control system may estimate a water content in the oil system. The water content may be estimated based on an amount (e.g., a mass and/or volume) of the water in the oil system (which may be a measured value or an estimated value) and a total amount (e.g., a mass and/or volume) of oil in the oil system (which may be a known value, a measured value, and/or an estimated value) and dividing the amount of water by the amount of oil. The water content in the oil system may be expressed as a percentage or a ratio (e.g., parts per million). In various embodiments, a sensor may estimate the water content in the oil system. The water content may be estimated by measuring an ambient humidity within and/or surrounding the oil system and correlating the value to a water content (e.g., via one or more look-up tables, algorithms, etc.). In some embodiments, the control system may estimate the water content based on data received from one or more sensors and one or more models (e.g., machine learning models, statistical models, etc.). In some embodiments, the control system may estimate the water content based on a known air to fuel ratio (e.g., an amount of air relative to an amount of fuel provided to the combustion cylinders of the engine, also referred to herein as "AFR"). In some embodiments, the controller may not acquire data relating to a water content. In an example embodiment, a method of removing water from the oil system includes receiving data related to a duty cycle and/or an idle state of the engine system and removing water from the oil system based on a point in the duty cycle or idle state. In another example embodiment, a method of removing water from the oil system includes receiving data related to a shutdown event of the engine system and removing water from the oil system before, during, or after the shutdown event. In another example embodiment, a method of removing water from the oil system includes receiving data related to the lifespan of the oil in the oil system and removing water from the oil system based on the oil life. These and other features and benefits are described herein below.

[0021] Referring now to FIG. **1**, a schematic view of a block diagram of an engine system **100** is shown, according to an example embodiment. The engine system **100** includes an engine **102** and an aftertreatment system **120** in exhaust gas receiving communication with the engine **102**. The system **100** may also include a controller **140** (as shown in FIG. **2**) and an operator input/output (I/O) device **130**, where the controller **140** is communicably coupled to each of the aforementioned components. In some embodiments, the system **100** also includes an oil system **145** coupled to the engine **102**. The system **100** also includes a heater **150** coupled to an oil system **145**. The controller **140** may be communicably coupled to the heater **150**. In some embodiments, the engine system **100** also includes a turbo device **122** disposed between the engine **102** and the aftertreatment system **120**, such that the turbo device **122** is in exhaust gas receiving communication with the engine **102** and exhaust gas providing communication with the aftertreatment system **120**. In these embodiments, the aftertreatment system **120** is in exhaust gas receiving communication with the engine **102** (e.g., via the turbo device **122**).

[0022] In the configuration of FIG. **1**, the engine system **100** is included in a vehicle. The vehicle may be any type of on-road or off-road vehicle including, but not limited to, wheel-loaders, fork-lift trucks, line-haul trucks, mid-range trucks (e.g., pick-up truck, etc.), sedans, coupes, and any other type of vehicle. In another embodiment, the engine system **100** may be embodied in a stationary piece of equipment, such as a power generator or genset. All such variations are intended to fall within the scope of the present disclosure.

[0023] In the configuration shown in FIG. **1**, the engine **102** is a hydrogen internal combustion engine (ICE). The hydrogen ICE may consume hydrogen fuel to generate power. In other embodiments, the engine **102** may be part of a hybrid engine system having a combination of an internal combustion engine and at least one electric motor coupled to at least one battery. In some embodiments, the hybrid engine system may be configured as a mild-hybrid powertrain, a parallel hybrid powertrain, a series hybrid powertrain, or a series-parallel powertrain.

[0024] The engine **102** includes one or more cylinders **104** (e.g., combustion cylinder). As shown in FIG. **1**, the engine **102** includes six cylinders **104**. However, it should be understood that the engine **102** may include more or fewer cylinders **104** (e.g., at least one) than as shown in FIG. **1**. Furthermore, the cylinders **104** may be provided in varying arrangements, (e.g., in-line, horizontal, V, or other suitable cylinder arrangement).

[0025] The engine system **100** includes an intake conduit **110** and an intake manifold **112**. The intake conduit **110** is configured to route an intake gas stream, including air (e.g., ambient air), to the intake manifold **112**. The intake manifold **112** is configured to route the intake gas stream from an intake conduit **110** into the engine **102**. More specifically, the intake manifold **112** is configured to route air from the intake conduit **110** into each of the cylinders **104**.

[0026] The engine system **100** includes an intake air throttle (IAT) valve **114**. The IAT valve **114** is disposed at the intake conduit **110** and upstream of the intake manifold **112**. The IAT valve **114** is structured to control an amount of air supplied to the engine **102**. The IAT valve **114** may be actuated (e.g., by an actuator controlled by the controller **140**) between an open position and a closed position. In the open position, the IAT valve **114** allows a maximum amount of air to flow from the air intake to the engine **102**. In the closed position, the IAT valve **114** allows a minimum amount of air to flow from the air intake to the engine **102**. The controller **140** may selectively actuate the IAT valve **114** (e.g., by controlling the actuator) in a plurality of positions between and/or including the open position and the closed position to adjust the amount of air received by the engine **102**. In some embodiments, the IAT valve **114** is operable to control an amount and/or timing of air provided to the engine **102** to achieve a target air to fuel ratio (AFR). For example, the controller **140** may control the IAT valve **114** to adjust an amount of air provided to the engine **102** relative to an amount of fuel provided to the engine **102**.

[0027] The engine system **100** includes an exhaust manifold **116** and an exhaust conduit **118**. The exhaust manifold **116** is configured to route an exhaust gas stream from the engine **102** to the exhaust conduit **118**. More specifically, the exhaust manifold **116** is configured to route an exhaust gas stream from each of the cylinders **104** to the exhaust conduit **118**. The exhaust conduit **118** is configured to route the exhaust gas stream from the exhaust manifold **116** to a downstream component, such as the aftertreatment system **120** and/or the turbo device **122**. In some embodiments, a first portion of the exhaust conduit **118** is disposed between the exhaust manifold **116** and turbo device **122**. The first portion of the exhaust conduit **118** is configured to route the exhaust gas stream from the exhaust manifold **116** to turbo device **122**. In some embodiments, a second portion of the exhaust conduit **118** is disposed between the turbo device **122**. The second portion of the exhaust conduit **118** is configured to route the exhaust gas stream from the turbo device **122** to the aftertreatment system **120**.

[0028] The aftertreatment system **120** is in exhaust gas receiving communication with the engine **102**. The aftertreatment system **120** includes components used to reduce exhaust emissions, such as a selective catalytic reduction (SCR) catalyst, an oxidation catalyst, an ammonia slip catalyst (ASC), a particulate filter configured to remove particulate matter, such as soot, from exhaust gas flowing in the exhaust gas conduit system, an exhaust fluid dosing module (e.g., a doser) supply a dosing fluid, such as hydrogen (H_2), to the exhaust gas flowing in the aftertreatment system, a plurality of sensors for monitoring the aftertreatment system (e.g., a nitrogen oxide (NOx) sensor, a sulfur oxide (SOx) sensor, temperature sensors, etc.), and/or still other components. One or more catalyst devices (i.e., the SCR catalyst, the oxidation catalyst, a three-way catalyst, etc.) may be configured to facilitate conversion of the exhaust gas constituents (e.g., nitrogen oxides, NOx, sulfur oxides, SO_x, etc.) to less harmful elements (e.g., water, nitrogen, N_2, etc.). In various embodiments, a fluid may enter the aftertreatment system **120**. The fluid may be water or NOx produced by the combustion of hydrogen with ambient air. In some embodiments, the fluid may be hydrogen that has not been combusted by the engine **102**. In various embodiments, a reductant may be introduced into the exhaust. The reductant may reduce an emission of undesirable components in the exhaust.

[0029] The turbo device **122** may be any type of turbo machinery, such as a turbocharger, a supercharger, a variable geometry turbocharger, a power turbine, etc. The turbo device **122** may be operatively coupled to the engine **102** and/or another component of the engine system **100**, such as a drivetrain, a battery, an electric machine, or other suitable component.

[0030] The engine system **100** also includes a fuel system **124**. The fuel system **124** is configured to provide fuel (e.g., hydrogen) to the engine **102**. More specifically, the fuel system **124** is configured to provide fuel to each of the one or more cylinders **104**. The fuel system **124** may include one or more components for providing the fuel to the engine **102**, such as a storage tank for storing the fuel, one or more regulators (e.g., valves, solenoids, etc.) for controlling an amount or a timing of fuel provided to the engine **102**, and/or a fuel injector. In some embodiments, the fuel injector is provided at the intake manifold **112**. In other embodiments, the fuel system **124** includes a separate fuel injector for each cylinder **104** such that the fuel system **124** directly injects the fuel into each of the cylinders **104**.

[0031] In some embodiments, the controller **140** is operatively coupled to the fuel system **124** such that the controller **140** may control the operation of the fuel system **124**. More specifically, the controller **140** may control the fuel system **124** to control an amount and/or a timing of fuel provided to the engine **102**. In some embodiments, the fuel system **124** is operable to control an amount and/or timing of fuel provided to the engine **102** to achieve a target AFR. For example, the controller **140** may control the fuel system **124** to adjust an amount of fuel provided to the engine **102** relative to an amount of air provided to the engine **102**.

[0032] As shown, a plurality of sensors **125** are included in the engine system **100**. The number, placement, and type of sensors included in the engine system **100** is shown for example purposes only. That is, in other configurations, the number, placement, and type of sensors may differ. The sensors **125** may be constituent sensors (e.g., NOx sensors, oxygen sensors, H_2O/humidity sensors, etc.), temperature sensors, particulate matter (PM) sensors, flow rate sensors (e.g., mass flow rate sensors, volumetric flow rate sensors, etc.), other exhaust gas emissions constituent sensors, pressure sensors, some combination thereof, and so on. The constituent sensors may include an H_2O/humidity sensor that is structured to acquire data indicative of the presence of water in an oil system (e.g., a water content). The data from the H_2O/humidity sensor may be used to estimate a water content in the oil system. The sensors **125** may be condensation sensors that measure condensation and relate the sensor value to a water content. The sensors **125** used to determine a water content in the oil system may be located within the oil system **145**. For example, a sensor **125** may be located in, on, or proximate to an oil pan of the oil system **145** and/or an oil pump of the oil system **145**. The sensors **125** may be positioned directly upstream of the oil system **145** to detect water that is entering the oil system **145**. In various embodiments, the sensors **125** determine water content in terms of water activity in the oil system **145** (i.e., an indication of free water formation). In various embodiments, the sensors **125** may monitor a dissolved water content in the oil. In various embodiments, the sensors **125** may be positioned in an oil pan and may indicate when water has collected in the oil pan.

[0033] As shown in FIG. **1**, the sensors **125** may be located at or proximate the intake conduit **110**, the intake manifold **112**, the exhaust manifold **116**, and the exhaust conduit **118**. It should be understood that the location of the sensors may vary, and the engine system **100** may include more or fewer sensors than as shown in FIG. **1**. In one embodiment, the engine system **100** may include sensors **125** located both before and after the aftertreatment system **120**. In various embodiments, the engine system **100** may include sensors **125** located proximate the oil system **145**.

[0034] Additional sensors may be also included with the system **100**. The sensors may include engine-related sensors (e.g., torque sensors, speed sensors, pressure sensors, flowrate sensors, temperature sensors, etc.). The sensors may further include sensors associated with other components of the vehicle, such as the aftertreatment system **120**, the turbo device **122**, the fuel system **124**, and/or the oil system **145**. For example, the sensor may include a water sensor configured to acquire data regarding a water content proximate the sensor.

[0035] The sensors **125** may be real or virtual (i.e., a non-physical sensor that is structured as program logic in the controller **140** that makes various estimations or determinations). For example, an engine speed sensor may be a real or virtual sensor arranged to measure or otherwise acquire data, values, or information indicative of a speed of the engine **102** (typically expressed in revolutions-per-minute). The sensor is coupled to the engine (when structured as a real sensor) and is structured to send a signal to the controller **140** indicative of the speed of the engine **102**. When structured as a virtual sensor, at least one input may be used by the controller **140** in an algorithm, model, lookup table, etc. to determine or estimate a parameter of the engine (e.g., power output, etc.). Any of the sensors **125** described herein may be real or virtual.

[0036] The controller **140** is coupled, and particularly communicably coupled, to the sensors **125**. Accordingly, the controller **140** is structured to receive data from one more of the sensors **125** and provide instructions/information to the one or more sensors **125**. The received data may be used by the controller **140** to control one more components in the system **100** and/or for monitoring and thermal management purposes.

[0037] The operator input/output (I/O) device **130** may be coupled to the controller **140**, such that information may be exchanged between the controller **140** and the I/O device **130**, where the information may relate to one or more components of FIG. **1** or determinations (described below) of the controller **140**. The operator I/O device **130** enables an operator of the system **100** to communicate with the controller **140** and one or more components of the system **100** of FIG. **1**. For example, the operator input/output device **130** may include, but is not limited to, an interactive display, a touchscreen device, one or more buttons and switches, voice command receivers, etc. In this way, the operator input/output device **130** may provide one or more indications or notifications to an operator, such as a malfunction indicator lamp (MIL), etc. Additionally, the vehicle may include a port that enables the controller **140** to connect or couple to a scan tool so that fault codes and other information regarding the vehicle may be obtained.

[0038] The oil system **145** may include an oil sump, a pump, and an oil filter. The oil system **145** may circulate a lubricant throughout the engine system to remove heat from certain areas of the system and/or reduce friction for various components. For example, the oil system may provide oil to the engine **102** for lubrication and/or cooling purposes. While the lubricant is described as an "oil" herein, it should be understood that other types of lubricant may be used with the system. For example, a lubricant may be motor oil, grease, a penetrating lubricant, a synthetic lubricant, a mineral lubricant, a biosynthetic lubricant, and/or a petroleum lubricant. In some situations, water, from ambient air or from combusting hydrogen in the presence of air, may enter the oil system. When a temperature of the oil in the oil system is low (e.g., at or below a first oil temperature threshold), the water may become trapped in the oil system (e.g., in the oil sump and/or in the oil filter). When the temperature of the oil in the oil system is high (e.g., at or above a second oil temperature threshold), the water may evaporate and flow out of the oil system (e.g., to ambient or to the aftertreatment system **120**).

[0039] The at least one heater **150** may be any sort of external heat source that can be structured or configured to increase the temperature of oil in the oil system **145** relative to a current temperature of the oil. As such, the heater **150** may be an electric heater, an induction heater, a microwave, or a fuel-burning (e.g., HC fuel) heater. It should be understood that the heater used for the systems and methods described herein may utilizing existing heater technologies. For instance, the systems and methods described herein may use a block heater intended for cold start aid as part of the processes described herein. Thus, the systems and methods described herein may enable and provide a non-conventional and non-routine usage of the existing heater or heating source. In other embodiments, the heater or heat source may be dedicated to the functions and operations as described herein of the present disclosure. The heater may be powered from a battery of a vehicle housing the system **100** when a state of charge of the battery is sufficient to power the heater (e.g., the state of charge is at or above a predefined threshold for powering the at least one heater **150**). In some instances, if the state of charge of the battery is below the predefined threshold, the systems and methods that use the at least one heater **150** may be disabled (not executed/run) or have the operation adjusted (i.e., run at a lower power).

[0040] The at least one heater may be of a convection type, where heat is transferred to the oil, or of a conduction type, where the heater heats a component which transfers heat to the oil. The heater may be configured to increase the temperature of at least one component of the oil system **145** and/or of the oil flowing through the oil system **145** relative to a current temperature. The heater **150** may be activated when a thermal management mode is enabled to increase the temperature of at least one component of the oil system **145** and/or of the oil flowing through the oil system **145**. In various embodiments, the heater **150** may be positioned within the oil system **145**. For example, the heater **150** may be positioned at or below an oil pan of the oil system **145** to heat the oil collected in the pan. In various embodiments, the heater **150** may be a heater coupled to a portion of the engine **102**, for example an engine block. The heater **150** may heat the oil as it moves through the engine **102**. In various embodiments, the heater **150** may be positioned upstream of the oil system **145**. For example, the heater **150** may be positioned such that the oil is heated and water is removed prior to reentering the oil system **145** and subsequently exiting the oil system to the rest of the system **100**.

[0041] In various embodiments, the systems and methods described herein may be applicable to systems that heat oil without a using cooling system of the vehicle or systems that lack a cooling system. In various embodiments, an oil cooler may be or include a heat exchanger that is configured to cool (e.g., reduce the temperature of) the oil in the oil system **145** passing through the oil cooler. The oil system **145** may include a first valve and a second valve, an oil cooler, the heater **150**, an oil conduit system, and an oil passage. The oil system **145** may be configured to route oil from the oil system **145** to the engine **102**, the heater **150**, and/or the oil cooler. One or more conduits, pipes, etc. of the oil conduit system may transport the oil to various components of the system **100** through one or more oil passages. The first valve may be positioned at or proximate the engine **102** and selectively route the oil to the engine **102**. A second valve may be positioned downstream of the engine **102** and selectively route oil from the engine **102**. The first and second valves may be operable between a plurality of positions and may route oil to and from one or more components of the system **100**. The system **100** may include additional valves for routing oil to various components. For example, the second valve may be positioned such that a first portion of the oil of the oil system **145** is routed from the engine **102** to an oil pan and a second portion of the oil of the oil system **145** is routed to the heater **150**. In various embodiments, one or more components may be bypassed. For example, the valves may be configured such that the oil cooler is bypassed and the oil is routed to the heater **150**, thus heating the oil without the oil passing through the cooling system. In some embodiments, the system **100** may lack a cooling system. The valves may be configured to route oil to and from various components of the system, such as the heater **150** and the engine **102**.

[0042] The controller **140** is structured to control, at least partly, the operation of the system **100** and associated sub-systems, such as the engine **102**, the operator I/O device **130**, and the heater **150**. Communication between and among the components may be via any number of wired or wireless connections. For example, a wired connection may include a serial cable, a fiber optic cable, a CAT5 cable, or any other form of wired connection. In comparison, a wireless connection may include the Internet, Wi-Fi, cellular, radio, etc. In one embodiment, a controller area network (CAN) bus provides the exchange of signals, information, and/or data. The CAN bus includes any number of wired and wireless connections. Because the controller **140** is communicably coupled to the systems and components of FIG. **1**, the controller **140** is structured to receive data from one or more of the components shown in FIG. **1**. The structure and function of the controller **140** is further described in regard to FIG. **2**.

[0043] As the components of FIG. **1** are shown to be embodied in the system **100**, the controller **140** may be structured as one or more electronic control units (ECUs), such as one or more microcontrollers. The controller **140** may be separate from or included with at least one of a transmission control unit, an exhaust aftertreatment control unit, a powertrain control module, an engine control unit, an engine control module, etc.

[0044] Now referring to FIG. **2**, a schematic diagram of the controller **140** of the system **100** of FIG. **1** is shown, according to an example embodiment. As shown, the controller **140** includes at least one processing circuit **202** having at least one processor **204** and at least one memory device **206**, an oil heat control circuit **210**, and a communications interface **216**. The controller **140** is structured to control the heater **150** to remove or substantially remove an unwanted fluid (e.g., water) from the oil system **145** in response to determining or detecting the presence of water in the oil system **145**. As described herein, the estimated water content may be based on an air to fuel/oil ratio, a water content of an intake gas stream, a water content of the exhaust gas stream, an ambient humidity level, and/or a humidity/condensation level determined by a sensor. Specific processes for removing water from the oil system are described herein below.

[0045] In one configuration, the oil heat control circuit **210** is embodied as instructions (e.g., stored by the memory device **206**) that are executable by a processor, such as processor **204**. As described herein and amongst other uses, the instructions facilitate performance of certain operations to enable reception and transmission of data. For example, the machine-readable media may provide an instruction (e.g., command, etc.) to, e.g., acquire data. In this regard, the machine-readable media may include programmable logic that defines the frequency of acquisition of the data (or, transmission of the data). The computer readable media instructions may include code, which may be written in any programming language including, but not limited to, Java or the like and any conventional procedural programming languages, such as the "C" programming language or similar programming languages. The computer readable program code may be executed on one processor or multiple remote processors. In the latter scenario, the remote processors may be connected to each other through any type of network (e.g., CAN bus, etc.).

[0046] In another configuration, the oil heat control circuit **210** is embodied as a hardware unit, such as one or more electronic control units. As such, the oil heat control circuit **210** may be embodied as one or more circuitry components including, but not limited to, processing circuitry, network interfaces, peripheral devices, input devices, output devices, etc. In some embodiments, the oil heat control circuit **210** may take the form of one or more analog circuits, electronic circuits (e.g., integrated circuits (IC), discrete circuits, system on a chip (SOCs) circuit, microcontrollers, etc.), telecommunication circuits, hybrid circuits, and any other type of "circuit." In this regard, the oil heat control circuit **210** may include any type of component for accomplishing or facilitating achievement of the operations described herein. For example, a circuit as described herein may include one or more transistors, logic gates (e.g., NAND, AND, NOR, OR, XOR, NOT, XNOR, etc.), resistors, multiplexers, registers, capacitors, inductors, diodes, wiring, and so on. The oil heat control circuit **210** may also include or be programmable hardware devices such as field programmable gate arrays, programmable array logic, programmable logic devices or the like. The oil heat control circuit **210** may include one or more memory devices for storing instructions that are executable by the processor(s) of the oil heat control circuit **210**. The one or more memory devices and processor (s) may have the same definition as provided below with respect to the memory device **206** and processor **204**. In some hardware unit configurations, the oil heat control circuit **210** may be geographically dispersed throughout separate locations in the vehicle. Alternatively, and as shown, oil heat control circuit **210** may be embodied in or within a single unit/housing, which is shown as the controller **140**.

[0047] In the example shown, the controller **140** includes the processing circuit **202** having the processor **204** and the memory device **206**. The processing circuit **202** may be structured or configured to execute or implement the instructions, commands, and/or control processes described herein with respect to the oil heat control circuit **210**. The depicted configuration represents the oil heat control circuit **210** as being embodied as machine or computer-readable media. In some embodiments, the instructions may be included with the memory device **206**. However, as mentioned above, this illustration is not meant to be limiting as the present disclosure contemplates other embodiments where the oil heat control circuit **210**, is configured as a hardware unit. All such combinations and variations are intended to fall within the scope of the present disclosure.

[0048] The processor **204** may be implemented as one or more single- or multi-chip processors, digital signal processors (DSPs), application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), and/or suitable processors (e.g., other programmable logic devices, discrete hardware components, etc. to perform the functions described herein). A processor may be a microprocessor, a group of processors, etc. A processor also may be implemented as a combination of computing devices, such as a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration. In some embodiments, the one or more processors may be shared by multiple circuits (e.g., the oil heat control circuit **210** may comprise or otherwise share the same processor which, in some example embodiments, may execute instructions stored, or otherwise accessed, via different areas of memory). Alternatively or additionally, the one or more processors may be structured to perform or otherwise execute certain operations independent of one or more co-processors. In other example embodiments, two or more processors may be coupled via a bus to enable independent, parallel, pipelined, or multi-threaded instruction execution. All such variations are intended to fall within the scope of the present disclosure.

[0049] The memory device **206** (e.g., memory, memory unit, storage device) may include one or more devices (e.g., RAM, ROM, Flash memory, hard disk storage) for storing data and/or computer code for completing or facilitating the various processes, layers and modules described in the present disclosure. For example, the memory device **206** may include dynamic random-access memory (DRAM). The memory device **206** may be communicably connected to the processor **204** to provide computer code or instructions to the processor **204** for executing at least some of the processes described herein. Moreover, the memory device **206** may be or include tangible, non-transient volatile memory or non-volatile memory. Accordingly, the memory device **206** may include database components, object code components, script components, or any other type of information structure for supporting the various activities and information structures described herein.

[0050] The communications interface **216** may include any combination of wired and/or wireless interfaces (e.g., jacks, antennas, transmitters, receivers, transceivers, wire terminals) for conducting data communications with various systems, devices, or networks structured to enable in-vehicle communications (e.g., between and among the components of the vehicle) and out-of-vehicle communications (e.g., with a remote server). For example, and regarding out-of-vehicle/system communications, the communications interface **216** may include an Ethernet card and port for sending and receiving data via an Ethernet-based communications network and/or a Wi-Fi transceiver for communicating via a wireless communications network.

[0051] The communications interface **216** may be structured to communicate via local area networks or wide area networks (e.g., the Internet) and may use a variety of communications protocols (e.g., IP, LON, Bluetooth, ZigBee, radio, cellular, near field communication).

[0052] As shown in FIG. **2**, the communications interface **216** may enable communication with the engine **102**, the aftertreatment system **120** (and/or a component thereof), the one or more sensors **125**, the IAT valve **114**, the oil system **145**, the heater **150**, and/or the fuel system **124**.

[0053] The oil heat control circuit **210** is structured to determine a water content in the oil system **145**. In some embodiments, the oil heat control circuit **210** is structured to receive sensor data (e.g., from the sensors **125**) regarding the water content in the oil system **145**. In some embodiments, the oil heat control circuit **210** is structured to estimate the water content in the oil system **145** based on the received sensor data and/or other information described herein.

[0054] The sensor data may include a water content in an oil system **145**. In some embodiments, the water content in the oil system may be measured by a sensor (e.g., a water sensor, a humidity sensor, etc.) positioned at an intake of the oil system **145**, or another location upstream of the engine **102**. In some embodiments, the water content in the oil system **145** may be estimated (e.g., by the controller **140** and/or by a virtual humidity sensor **125**). For example, the water content in the oil system **145** may be equivalent to and/or estimated based on an ambient humidity (e.g., via a lookup table that correlates ambient humidity to water content in particular locations, which may be based on experimental data for various ambient humidities at various operating conditions of the engine, such as temperature zones). For example, a "high" humidity level (e.g., 70 percent ambient humidity or higher (or another threshold may be used)) may correlate to a "high" water content (e.g., 0.02 percent water in the oil system). A look-up table may be used to maintain various correlations, such that water content can be readily determined based on, for example, ambient humidity values. In some embodiments, the ambient humidity may be measured by an ambient humidity sensor. In other embodiments, the ambient humidity may be received (e.g., by the controller **140**, via the communications interface **216**) from an external computing system (e.g., from a weather reporting service, etc.). In some embodiments, the water content may be estimated based on an oil life of the oil in the oil system **145**. In various embodiments, as the oil life decreases, the water content may increase. For example, if an oil life is determined to be 50 percent remaining, a water content may be estimated to be 0.015 percent. If an oil life is determined to be 100 percent remaining, a water content may be estimated to be 0 percent. This may be based on a look-up table or other formula, algorithm, etc. that correlates oil life to water content that the controller may access when determining the water content. In other embodiments, a combination of parameters (e.g., remaining oil life, ambient humidity, duty cycles, an air-to-fuel ratio (AFR), sensor data, etc.) may be used to determine a water content in the system (e.g., based on one or more models, algorithms, processes, look-up tables, etc.).

[0055] In some embodiments, the oil heat control circuit **210** is structured to receive information regarding the ambient humidity proximate the system **100** from a remote computing system (e.g., a computing system that is located remotely from the system **100**). The information regarding the ambient humidity may include a water content value, a relative humidity value, an ambient temperature value, a condensation value, and/or other information regarding the ambient humidity proximate the system **100**. In this way, the water content in the oil system **145** may include or be based on the information regarding the ambient humidity. The correlation may be based on a model (e.g., physics models, machine learning (ML) models, mathematical models, statistical models, etc.) and/or a lookup table. The correlation may be based on a lookup table that correlates ambient humidity to water content in particular locations, which may be based on experimental data for various ambient humidities at various operating conditions of the engine, such as temperature zones. In various embodiments, the water content in an intake gas stream and/or exhaust gas stream may be correlated and/or otherwise indicative of a water content in the oil system **145**. In various embodiments, the water content in the fuel system **124** may be correlated and/or otherwise indicative of a water content in the oil system **145**. The correlation may be based on a model (e.g., physics models, machine learning (ML) models, mathematical models, statistical models, etc.) or a lookup table.

[0056] In some embodiments, the oil heat control circuit **210** is structured to receive system operational data. The system operational data may include information regarding the operation of the system **100**. For example, the system operational data may include an air to fuel ratio. In some embodiments, the AFR is a target AFR (e.g., an AFR commanded by the controller **140**). In other embodiments, the AFR is a measured AFR (e.g., an AFR measured and/or estimated by one or more sensors **125**, such as a lambda sensor). For example, one or more sensors **125**, such as an oxygen sensor, may be disposed at or in the intake manifold **112** and/or the exhaust manifold **116**. The oxygen sensor may acquire data regarding an oxygen content in the oil system, intake gas stream, and/or in the exhaust gas stream. In some embodiments, the oil heat control circuit **210** may use one or more of a lookup table or one or more models (e.g., mathematical models, statistical models, machine learning models, etc.) that correlate the AFR with a water content in the oil system. More specifically, the lookup table and/or model(s) may correlate an AFR with a water content in the oil system based on one or more additional operational parameters, such as a time since a last water purge, known combustion characteristics of the engine **102** (e.g., relative amounts of fuel, water, and other exhaust gas constituents expected to be present in exhaust gases based on the AFR), and/or other operational parameters.

[0057] In various embodiments, a water content of the oil system can be estimated based on the fueling parameters of the engine system **100**. For example, at a constant humidity value (e.g., a humidity value that remains for a predefined amount of time), a leaner AFR (i.e., the AFR is relatively higher), corresponds to a relatively lower water content in the exhaust gas stream of the engine system, and therefore the expected water content of water in the oil system may be lower. Similarly, a richer AFR corresponds to a relatively higher water content in the exhaust gas stream of the engine system, and therefore the expected water content of water in the oil system may be higher.

[0058] In various embodiments, ambient humidity may impact the water content of the oil system **145**. For example, if the ambient humidity is high and the engine is operating at a low duty cycle, the water content in the oil system **145** may be greater. In various embodiments, a telematics device may be able to be utilized to estimate water content in the oil system. For example, a telematics device can communicate weather data for the location of the vehicle. The oil heat control circuit **210** may estimate the water content of the oil system based on the weather (e.g., outside temperature, humidity, dew point, etc.).

[0059] In various embodiments, the water content of one or more of the intake gas stream, exhaust gas stream, and/or fuel system may be correlated to the water content of the oil system **145**. The correlation may be based on a model (e.g., physics models, machine learning (ML) models, mathematical models, statistical models, etc.) or a lookup table.

[0060] In various embodiments, the system **100** may be embodied in one vehicle of a fleet of vehicles. When the system **100** is embodied as one vehicle in a fleet of vehicles, a correction factor or adjustment factor may be utilized to perform maintenance on one or more vehicles in the fleet of vehicles, responsive to determining that there is a problem with one or more of the vehicles in the fleet. In these embodiments a remote computing system **218** (shown in FIG. **2**) may receive data from each vehicle, or a predefined subset of vehicles, in the fleet of vehicles. The remote computing system **218** is a computing system such as a remote server, a cloud computing system, and the like. Accordingly, as used herein, "remote computing system" is used to mean a computing or data processing system that has terminals distant from the central processing from which users and/or other computing systems communicate with the central processing unit. In some embodiments, the remote computing system **218** is part of a larger computing system such as a multi-purpose server, or other multi-purpose computing system. In other embodiments, the remote computing system **218** is implemented on a third-party computing device operated by a third-party service provider (e.g., AWS, Azure, GCP, and/or other third-party computing services). The remote computing system **218** may be operated by a product and/or service provider. Accordingly, in some embodiments, the remote computing system **218** is a service and/or system/component provider computing system and in turn controlled by, managed by, or otherwise associated with service and/or system/component provider (e.g., an engine manufacturer, a vehicle manufacturer, an exhaust aftertreatment system manufacturer, etc.).

[0061] The data received by the remote computing system **220** may include operational data regarding the operation of each vehicle, or the predefined subset of vehicles, in the fleet of vehicles. The operational data may include an AFR value (as described above), an ambient humidity value, engine duty cycle information, and/or other suitable information. The remote computing system **218** may determine that one or more vehicles of the fleet of vehicles has high water content in fuel or oil systems based on the received data (e.g., water content above a predefined high content threshold value). The remote computing system **220** may determine that the fleet of vehicles is experiencing issues based on a predefined number or quantity of the vehicles in the fleet having high water content in fuel or oil systems that exceeds the predetermined threshold. In other words, the remote computing system **220** may extrapolate the determination regarding the subset of vehicles to the fleet. Responsive to determining that the fleet of vehicles is experiences issues (e.g., when at least a predetermined number of vehicles in the fleet are determined to have high water content in fuel or oil systems), the remote computing system **220** may perform one or more operations to correct the issue. For example, the manner in which maintenance on the system **100** is performed may be adjusted, or the manner in which equipment is operated may be adjusted. In various embodiments, a layout of the system **100** may be corrected (e.g., by an independent manufacturer or original equipment manufacturer) to resolve the issue. For example, a type or formulation of oil used in the oil system **145**, and/or additives to the oil, may be adjusted.

[0062] In various embodiments, the controller **140** is structured to initiate or otherwise enable a purge operation or process to remove, substantially remove, or otherwise attempt to remove or substantially remove water, or at least an amount thereof, in the oil system **145** (or, in some embodiments, another component of the system **100**), based on the water content in the oil system **145**. The controller **140** may purge the water content of the oil system **145** via the oil heat control circuit **210**. The water content of the oil system **145** may be adjusted via operation of the heater **150**. The heater **150** may be activated such that one or more components of the oil system **145** are heated to a temperature such that the water in the oil system **145** evaporates and/or is otherwise purged from the system, while the oil and/or other components of the oil system **145** are not affected.

[0063] The heater **150** may be activated and operated in various ways. For example, the controller **140** may activate the heater **150** and adjust its operation such that the heater **150** is operated to provide a relatively a higher temperature power output and/or operated to provide a relatively lower or decreased power output (e.g., to provide lower temperatures). The operation run time of the heater **150** may be adjusted (e.g., run time is increased for a higher concentration of water in the oil system relative to a run time for a lower concentration of water in the oil system). The heater **150** may also be turned on and/or off at a high duty cycle duty cycle so that the heater is active and operating during a low duty cycle (i.e., when water is likely to accumulate in the oil system **145**). The heater **150** may also be turned off or deactivated at a lower concentration of water in the oil system **145** and/or fuel system **124**. For example, the heater **150** may be configured to operate within a threshold corresponding to an upper-end water content and a lower-end water content. If the water content falls below the predefined lower-end water content, the heater **150** may automatically or manually be turned off. The heater **150** may also be activated at an earlier time period depending on the impending operating conditions of the system **100**. For example, if the system **100** and/or engine **102** will be shut off, the heater **150** can be activated earlier so that the water content is completely purged from the oil system **145** before the shutdown occurs. In various embodiments, the heater may be controlled more aggressively (i.e., higher temperature, longer time) when the ambient humidity is greater (i.e., above a certain threshold). The heater **150** may be activated, deactivated, and/or controlled using various additional methods or under various different parameters or conditions not described herein.

[0064] In various embodiments, the water content in the oil system **145** may be controlled by activating and controlling the heater **150** in response to the duty cycle. In various embodiments, there may be a greater accumulation of water in an oil system during a low duty cycle of a vehicle. The system **100** or a component thereof may receive data indicating a concentration of water in the oil system **145**. The data could be received from, for example, one or more sensors **125**. The sensors **125** may be humidity and/or condensation sensors that measure humidity and/or condensation and relate the sensor value to a water content. In various embodiments, there may be a greater accumulation of water at a low or extended idle of a vehicle. The controller **140** of the system **100** may receive data relating to a duty cycle of the vehicle. The controller **140** may also receive data relating to an idle of the vehicle. If the data relating to the duty cycle and/or the idle indicate that a concentration of water may be too high in the oil system **145** (e.g., at or above a predefined high content threshold), the controller **140** may activate the heater **150**. The heater **150** may be activated via the oil heat control circuit **210**. In various embodiments, the controller **140** may adjust the operation of the heater **150** depending on the concentration of water in the oil system **145**. For example, if the controller **140** and/or other component of the system **100** anticipates activating and controlling the heater **150** at a low duty cycle and/or during extended idle conditions, the controller **140** activate the heater **150** at a relatively lower duty cycle (i.e., when one or more operating characteristics of the system **100**, such as an engine speed, an engine load, an engine temperature, an oil system temperature, etc., are at or below a predetermined threshold) so that the heater is activated and functioning at when a low duty cycle occurs and can remove the water from the oil system **145** completely and efficiently. In various embodiments, the heater may be turned off at a relatively higher duty cycle (e.g., a higher duty cycle relative to a lower duty cycle) so that the heater is active or primarily active during the low duty cycle. In various embodiments, the controller **140** may not receive data from sensors **125** or any other component of the system indicating a water content of the oil system **145**. The controller **140** may operate the heater **150** regardless of a sensor indication of a water content. For example, if the controller **140** receives data indicating that the system **100** has been operating at a low or extended idle for a long period of time, the controller **140** may activate and control the heater **150** to purge water from the oil system **145**, without receiving an indication of water content, since a low or extended idle for a long period of time generally may lead to the engine **102** operating in a condition such that the engine **102** is creating water that may be in the oil system **145**.

[0065] In various embodiments, the water content in the oil system **145** may be controlled by activating and controlling the heater **150** before, during, or after a shutdown of the engine **102**. The controller **140** may receive information that the engine **102** of the system **100** is going to be shut down for a period of time. For example, the engine **102** may be shut down when the system **100** has reached an end of a route or trip, when a driver of the system **100** and/or the system **100** has reached an end of a shift, when a driver of the system **100** is taking a rest break from a route, etc. After the controller **140** has received information about an impending shutdown of the engine **102**, the controller **140** can activate the heater **150** prior to the engine shutdown. The operation of the heater **150** can reduce an amount of water left to sit in the oil system **145** during the engine shutdown. In various embodiments, the controller **140** may determine the water content in the oil system **145**. The water content may be, but is not limited to, a ratio of water to oil, a volume of water, and/or a concentration of water. The water content of the oil system **145** may be determined by one or more sensors **125**. The operation of the heater **150** may be modulated depending on a level or amount of water detected in the oil system **145**. For example, if the water content is at or above a predetermined threshold (concentration, ratio, etc.), the operation of the heater **150** may be more aggressive to remove a greater amount of water and/or more quickly remove the water from the oil system **145**.

[0066] In various embodiments, the heater **150** may be activated and controlled after a shutdown of the engine **102**. In various embodiments, the heater **150** is run after a shutdown (e.g., based on the controller **140** receiving an indication of or detecting water in the oil system **145**). In various embodiments, the heater **150** may be run after a shutdown even if there is not an indication or detection of water in the oil system **145**. In various embodiments, the heater **150** may be run during the engine shutdown. In various embodiments, the heater **150** may be operated at any time periods, alone or in combination, before, during, and/or after the engine shutdown.

[0067] In various embodiments, the water content in the oil system **145** may be controlled by activating and controlling the heater **150** based on an oil life of the oil in the oil system **145**. In various embodiments, the oil life of the oil may be related to the quality of the oil (i.e., a number of contaminants or particles present in the oil). In various embodiments, oil life may be determined based on an oil drain interval (i.e., how often the oil is drained and replaced with fresh oil). In various embodiments, an oil life monitor or sensor may estimate an oil life by tracking mileage and/or other parameters of the vehicle and comparing the value against a predetermined mileage interval that indicates when the oil needs (or is recommended) to be replaced. For example, a predetermined mileage interval may be 5,000 miles The current mileage may be 2500 miles, which may indicate a 50% oil life remaining. As an engine operates, the quality of the oil may decrease. In various embodiments, oil at 100% oil life may be oil newly added to the oil system **145** and/or other components of the system **100** that does not contain contaminants or particles associated with the operation of the system **100**. Oil at 100% oil life may hold less water than degraded oil (i.e., oil at an oil life less than 100%, e.g., 50%).

[0068] The controller **140** of the system **100** may receive information related to the oil life of the oil in the oil system **145**. The oil life may be estimated using various methods. For example, the oil life may be estimated based on a drain interval of the oil system **145**. The oil life may additionally or alternatively be estimated via an oil change monitor, a calculation based on time, a calculation based on mileage, and/or a calculation based on engine run hours since last oil change. The controller **140** may modify control of the heater **150** based on the oil life of the oil in the oil system **145**. In various embodiments, as the life of the oil degrades, the controller **140** may more aggressively control operation of the heater **150**. For example, as the oil life degrades from 100% to 50%, the controller **140** may adjust operation of the heater **150** such that the heater operates for ten minutes to purge water from the oil system **145** when the oil life is at 100% and operates for twenty minutes to purge water from the oil system **145** when the oil life is at 50%. In various embodiments, one or more methods of controlling the heater **150** may be used simultaneously. For example, the heater **150** may be active for both a longer period of time and operate at a higher temperature when the oil life is at 50% compared to when the oil life is at 100%. In various embodiments, controlling the heater **150** based on the oil life of the oil may be used either alone or in combination with another method of purging water from an oil system described herein. For example, the heater **150** may be activated and controlled before a shutdown of the engine **102**. In this example, the heater **150** may be operated for a longer period of time (relative to the period of time the heater **150** would be run if the oil life were 100%) prior to the engine shutdown if the oil life of the oil is at a lower oil life percentage. In various embodiments, the controller **140** may automatically adjust activation and control of the heater **150** to operate according to the oil life. For example, the controller **140** may configure the oil heat control circuit **210** to extend the duration of time it runs the heater **150** gradually as oil life degrades. In various embodiments, after the oil in the oil system **145** is changed and oil life increases (e.g., goes from 10% to 100%), heater controls may reset to be less aggressive and/or be reset to standard operating conditions correlating to when oil life is 100%.

[0069] In various embodiments, the controller **140** and/or various components thereof may include an oil regeneration and/or purge cycle timer feature. The feature may be configured to be part of oil heat control circuit **210** or another component of the controller **140**. In various embodiments, the oil regeneration/purge cycle timer feature may monitor the number of hours of engine operation since the last oil regeneration (i.e., oil change) for the system **100**. The oil regeneration/purge cycle timer feature may also monitor the number of hours of engine operation under certain engine operating parameters (e.g., low idle, low load, etc.) since the last oil regeneration for the system **100**. The oil regeneration and/or purge cycle timer data may be used by the controller **140** to adjust operation of the heater **150** under various operating conditions. The oil regeneration and/or purge cycle timer may also use humidity and/or condensation sensors, such as the sensors **125** described herein, to determine water content in the oil system **145**. In various embodiments, the oil regeneration and/or purge cycle timer may monitor the oil degradation rate. For example, the oil regeneration and/or purge cycle timer may detect that the oil life is degrading at a rate that is faster than expected given a time since a last oil regeneration/This data may be communicated to the controller **140** and the operating parameters of the heater **150** may be modified. For example, if the oil life is degrading faster than expected the controller **140** may increase the time the heater **150** runs relative to if the oil life is degrading as expected to purge water from the oil system **145**.

[0070] In various embodiments, the heater **150** may be activated and controlled based on various other operating parameters of the system **100**. For example, the heater **150** may be activated based on an oil temperature of the oil in the oil system **145**. For example, if the oil is already at or above a predefined temperature (e.g., at or above 100 degrees Celsius), the heater **150** may operate at a lower temperature or a shorter period of time since, since water is being purged from the heat of the oil itself.

[0071] The heater **150** may also be activated in response to condensation in the engine **102** or other component of the system **100**. Sensors **125** may detect condensation has formed in a component of the system **100**. In various embodiments, the sensors **125** may determine that condensation is likely to form in a component of the system **100**. The sensor data can be communicated to the controller **140**, and the controller **140** can operate the heater **150** accordingly.

[0072] In various embodiments, the heater **150** may be activated during or in response to a cold start of the engine **102**. If an ambient air temperature and/or coolant temperature is less than a first predefined threshold value, the controller **140** may activate the heater **150** until the oil temperature is above a second predefined threshold value. For example, if the ambient air temperature is at or below a predefined temperature (e.g., 0 degrees Celsius), the heater **150** may be activated to heat the oil until it reaches a temperature of 110 degrees Celsius or greater.

[0073] In various embodiments, the system **100** may include an oil pan coupled to or included with the oil system **145**. The oil pan may be located in a compartment separate from the oil system **145**. The oil pan may be configured such that water is permitted to leave the oil system **145** and separate out from the oil and accumulate in the oil pan. The heater **150** may then be applied to the oil pan to evaporate or purge the water from the oil system **145**.

[0074] Referring now to FIG. **3**, a flow diagram for a method **300** of purging water from the oil system **145** is shown, according to an example embodiment. In particular, the controller **140** and/or one or more components thereof, such as the oil heater control circuit **212**, is configured to perform the method **300**. It should be understood that the order of the method **300** is shown as an example only. That is, one or more processes may be performed concurrently, partially concurrently, sequentially, and/or in a different order than as shown in FIG. **3**. Further, some processes of the method **300** may be omitted while other processes may be added to the method **300**. The method **300** may be performed periodically and/or dynamically responsive to changes in, for example, information received from the sensors **125**.

[0075] At process **302**, the controller **140** receives one or more operational parameters relating to the engine **102** (e.g., an engine operating parameter). For example, at step **302**, the controller may receive duty cycle data.

[0076] In some embodiments, at process **302**, the controller may receive a first operating parameter (e.g., the engine operating parameter) of the engine **102**. For example, the controller **140** may receive duty cycle data and/or idle data. The duty cycle data may include one or more operational parameters relating to the engine **102** (e.g., an engine operating parameter). The duty cycle data may include one or more operational parameters relating to a lubricant system, such as the oil system **145** (e.g., a lubricant system operating parameter). Accordingly, at process **302**, the controller may receive a second operating parameter (e.g., the lubricant system operating parameter) of the oil system **145**.

[0077] In some embodiments, the duty cycle data may include information about if and when the system **100** operates at a high duty cycle and/or a low duty cycle. The controller **140** may additionally and/or alternatively receive operational parameters of the engine **102** relating to idle data. The idle data may include if and when the system **100** is operating at a low and/or extended idle. The idle data may also include the duration of a low and/or extended idle. The idle data may include data about past, present, and/or future idle conditions of the system **100**.

[0078] At process **304**, a water content of the oil system **145** is determined or estimated. The controller **140** receives or estimates a water content of the oil system **145**. In various embodiments, process **304** is optional and may not be implemented. At process **304**, the water content may be estimated via one or more sensors **125**. The controller **140** may estimate the content via one or more sensors **125** (e.g., real sensors or virtual sensors). The estimated water content may be communicated to the controller **140**. For example, the controller **140** may receive the estimated water content from a real sensor or estimate the water content via a virtual sensor.

[0079] In some embodiments, the water content may be estimated based on an amount (e.g., a mass or volume) of the water in the oil system **145** (which may be a measured value or an estimated value) and a total amount (e.g., a mass or volume) of oil in the oil system (which may be a known value, a measured value, or an estimated value). By way of example, the controller **140** may receive (from one or more sensors **125**), the amount of water in the oil system **145**. The controller **140** may also receive (from one or more sensors **125**) the amount of oil in the oil system **145**. Then, the controller **140** may determine the water content based on the amount of water relative to the amount of oil.

[0080] At process **306**, the controller **140** selectively turns on or activates the heater **150**. The controller **140** may activate the heater **150** responsive to determining that the operational parameter of the engine is at or below a predetermined threshold. For example, the controller **140** may activate the heater responsive to determining that the system **100** is operating at a low duty cycle and/or extended idle. In various embodiments, at process **306** is the controller **140** may activate the heater **150** responsive to determining that the system **100** was previously operating at a low duty cycle and/or will operate at a low duty cycle in the near future (e.g., within a predetermined period of time). In some embodiments, process **306** may be delayed. For example, responsive to determining that the system **100** is currently operating at a high duty cycle, the controller may delay process **306** until the controller **140** determines that the system **100** is operating at a low duty cycle.

[0081] At process **308**, the controller **140** may selectively adjust operation of the heater **150**. The heater **150** may be adjusted based on one or more operating parameters of the system **100** described above. The controller **140** may selectively adjust operation of the heater **150** based on, for example, one or more operating parameters of the system **100** described above. For example, the temperature of the heater **150** may be increased relative to a current temperature of the heater **150** responsive to determining that the water content is at or above a predetermined threshold. The controller **140** may increase a heat output by the heater **150** relative to a current heat output by the heater **150** responsive to determining that the water content is at or above a predetermined threshold.

[0082] In some embodiments, process **308** may include turning off the heater **150**. The controller **140** may selectively turn off the heater **150** at process **308**. The heater **150** may be turned off responsive to determining that the water content of the oil system **145** is at or below a predetermined threshold and has been purged or substantially purged from the oil system **145**. By way of example, the controller **140** may turn off the heater **150** responsive to the water content of the oil system **145** being at or below a predetermined threshold and/or responsive to the water content in the oil system **145** being purged or substantially purged from the oil system **145**. For example, the controller **140** may receive data from the sensors **125** indicating that the water content is at or below the threshold. In various embodiments, the heater **150** may be turned off without determining the water content in the oil system **145**. The controller **140** may turn off the heater **150** without determining the water content in the oil system **145**. For example, the controller **140** may be configured to turn off the heater **150** after a predetermined period of time, regardless of the amount of water remaining in the oil system **145**, at the end of the predetermined period of time.

[0083] In some embodiments, the controller **140** may adjust operation of the heater **150** by adjusting a control parameter of the heater **150**. The control parameter is a parameter value of a control signal that the controller **140** provides to the heater **150**, such as a power value, a heat value, a temperature value, etc. Thus, the control parameter may be one or more of a temperature of the heater **150**, a duration of activation of the heater **150**, and/or a point in time at which the heater **150** is activated. By way of example, the controller **140** may increase the control parameter of the heater **150**, which, in turn, increases a heat output by the heater **150** in response to a fluid level of the fluid in the oil system **145** (e.g., a water content of the oil system **145**) being at or above a first predefined water content threshold. In an example implementation, increasing, by the controller **140**, the control parameter of the heater **150** includes at least one of increasing a temperature output from the heater **150** relative to a current temperature output from the heater, increasing a duration of an operation of the heater relative to a current duration of operation of the heater (or continuing a duration of activation despite the heater being typically commanded off), or activating the heater during a high duty cycle. In another example implementation, increasing, by the controller **140**, the control parameter of the heater **150** includes deactivating the heater during a high duty cycle.

[0084] In some embodiments, the controller **140** may adjust (e.g., increase) the control parameter of the heater **150** before, during, or after shutdown of the engine **102**. By way of example, the controller **140** may increase the control parameter of the heater **150** during a first time period before shutdown of the engine **102** responsive to the water content value being at or below a second predefined water content threshold (indicative of the water being purged or substantially purged from the oil system **145**) before shutdown of the engine **102**. By way of another example, the controller **140** may increase the control parameter of the heater **150** during shutdown of the engine **102** responsive to the water content value being at or below the second predefined water content threshold (indicative of the water being purged or substantially purged from the oil system **145**) during the shutdown of the engine **102**. By way of yet another example, the controller **140** may increase the control parameter of the heater **150** during a second period of time after shutdown of the engine responsive to the water content value being at or below the second predefined water content threshold (indicative of the water being purged or substantially purged from the oil system **145**) after shutdown of the engine.

[0085] Referring now to FIG. **4**, a flow diagram of a method **400** of purging water from the oil system **145** is shown, according to an example embodiment. In particular, the controller **140** and/or one or more components thereof, such as the oil heater control circuit **212**, is configured to perform the method **400**. It should be understood that the order of the method **400** is shown as an example only. That is, one or more processes may be performed concurrently, partially concurrently, sequentially, and/or in a different order than as shown in FIG. **4**. Further, some processes of the method **400** may be omitted while other processes may be added to the method **400**. The method **400** may be performed periodically and/or dynamically responsive to changes in, for example, information received from one or more of the sensors **125**.

[0086] At process **402**, the controller **140** receives operational parameters of the engine **102** (e.g., an engine operating parameter or a first operating parameter of the engine **102**). For example, the controller **140** receives engine shutdown data. Engine shutdown data may include information about when the system **100** and/or engine **102** will shut down. The shut down data may be for a next shut down or a shut down further in the future. The method **400** may halt or terminate responsive to determining that an engine shut down is not coming in a predetermined amount of time from a current time. For example, the method **400** may halt in response to determining that an engine shutdown will not occur for 12 hours. The method **400** may resume in response to determining that an engine shutdown will occur in a predetermined amount of time (e.g., 12 hours or less).

[0087] At process **404**, a water content of the oil system **145** is estimated or determined. The controller **140** receives or estimates a water content of the oil system **145**. In various embodiments, process **404** is optional and may not be implemented. At process **404**, the water content may be estimated via one or more sensors **125**. The controller **140** may receive or estimate the water content via one or more sensors **125** (e.g., real or virtual sensors). The estimated water content may be communicated to the controller **140**. For example, the controller **140** may receive the water content from a real sensor or estimate water content via a virtual sensor

[0088] In some embodiments, the water content may be estimated based on an amount (e.g., a mass or volume) of the water in the oil system **145** (which may be a measured value or an estimated value) and a total amount (e.g., a mass or volume) of oil in the oil system (which may be a known value, a measured value, or an estimated value). By way of example, the controller **140** may receive (from one or more sensors **125**), the amount of water in the oil system **145**. The controller **140** may also receive (from one or more sensors **125**) the amount of oil in the oil system **145**. Then, the controller **140** may determine the water content based on the amount of water relative to the amount of oil.

[0089] At process **406**, the controller **140** can selectively turn on or activate the heater **150**. The controller **140** may selectively activate the heater **150** responsive to determining that the operational parameter of the engine is occurring at or below a predetermined threshold of time. For example, the heater **150** may be activated in response to the controller **140** determining that an engine shutdown will occur within fifteen minutes. The controller **140** may activate the heater **150** in response to an engine shutdown occurring within the predetermined time threshold. In various embodiments, process **406** may be delayed responsive to the controller **140** determining that the operational parameter of the engine will occur above of a predetermined threshold of time. For example, process **406** may be delayed in response to determining that the engine **102** will not be shut down in an upcoming, predetermined amount of time, for example, one hour. In various embodiments, process **406** may be delayed until the engine shutdown is near. In various embodiments, process **406** may occur at any point before, during, or after an engine shutdown occurs.

[0090] At process **408**, the controller **140** may adjust operation of the heater **150**. The heater **150** may be adjusted based on one or more operating parameters of the system **100** described above. For example, the temperature of the heater **150** may be increased relative to a current temperature of the heater **150** responsive to determining that the water content is at or above a predetermined threshold and an engine shutdown is occurring at or below a predetermined threshold of time (e.g., within 5 minutes). The controller **140** may increase the heat output by the heater **150** relative to the current heat output by the heater **150** responsive to the water content being at or above the predetermined threshold and the engine shutdown occurring within a predetermined threshold of time. In various embodiments, process **408** may include turning off the heater **150**. The heater **150** may be turned off responsive to determining that that the water content is at or below a predetermined threshold and has been purged or substantially purged from the oil system **145**. The controller **140** may turn off the heater **150** responsive to the water content being at or below a predetermined threshold and responsive to the water content being purged or substantially purged from the oil system **145**. Sensors **125** may be used to determine if the water content has fallen below the threshold. The controller **140** may receive the water content from one or more sensors **125**, and the received water content may be used to determine if the water content has fallen below the threshold.

[0091] In various embodiments, the heater **150** may be turned off without knowing the water content in the oil system **145**. For example, the heater **150** may be configured to turn off after a predetermined period of time, regardless of the amount of water remaining in the oil system **145** at the end of the predetermined period of time. The controller **140** may be configured to turn off the heater **150** after a predetermined period of time, regardless of the amount of water remaining in the oil system **145** at the end of the predetermined period of time. In various embodiments, the heater **150** may be turned off responsive to determining that the operational parameters of the engine **102** has occurred. For example, the heater **150** may be turned off responsive to determining that the engine **102** has shut down. The controller **140** may turn off the heater **150** based on the operational parameters of the engine **102**. For example, the controller **140** may turn off the heater **150** responsive to the engine **102** being shut down.

[0092] In some embodiments, the controller **140** may adjust operation of the heater **150** by adjusting a control parameter of the heater **150**. By way of example, the controller **140** may increase the control parameter of the heater **150**, which, in turn, increases a heat output by the heater **150** in response to a fluid level of the fluid in the oil system **145** (e.g., a water content of the oil system **145**) being at or above a first predefined water content threshold. In an example implementation, increasing, by the controller **140**, the control parameter of the heater **150** includes at least one of increasing a temperature output from the heater **150** relative to a current temperature output from the heater, increasing a duration of an operation of the heater relative to a current duration of operation of the heater (e.g., a previously scheduled duration of activation), or activating the heater during a high duty cycle. In another example implementation, increasing, by the controller **140**, the control parameter of the heater **150** includes deactivating the heater during a high duty cycle.

[0093] In some embodiments, the controller **140** may adjust (e.g., increase) the control parameter of the heater **150** before, during, or after shutdown of the engine **102**. By way of example, the controller **140** may increase the control parameter of the heater **150** during a first time period before shutdown of the engine **102** responsive to the water content value being at or below the second predefined water content threshold (indicative of the water being purged or substantially purged from the oil system **145**) before shutdown of the engine **102**. By way of another example, the controller **140** may increase the control parameter of the heater **150** during shutdown of the engine **102** responsive to the water content value being at or below the second predefined water content threshold (indicative of the water being purged or substantially purged from the oil system **145**) during the shutdown of the engine **102**. By way of yet another example, the controller **140** may increase the control parameter of the heater **150** during a second period of time after shutdown of the engine responsive to the water content value being at or below the second predefined water content threshold (indicative of the water being purged or substantially purged from the oil system **145**) after shutdown of the engine.

[0094] Referring now to FIG. **5**, a flow diagram for a method **500** of purging water from the oil system **145** is shown, according to an example embodiment. In particular, the controller **140** and/or one or more components thereof, such as the oil heater control circuit **212**, is configured to perform the method **500**. It should be understood that the order of the method **500** is shown as an example only. That is, one or more processes may be performed concurrently, partially concurrently, sequentially, and/or in a different order than as shown in FIG. **5**. Further, some processes of the method **500** may be omitted while other processes may be added to the method **500**. The method **500** may be performed periodically and/or dynamically responsive to changes in, for example, information received from one or more of the sensors **125**.

[0095] At process **502**, the controller **140** may receive an operating parameter of the oil system **145** (e.g., an oil system operating parameter). In various embodiments, the operating parameter of the oil system **145** may include oil life data. Oil life data may include information about the lifespan or remaining life of the oil in the oil system **145**. The lifespan or remaining life of the oil may be represented as a single value, referred to as an "oil life value," which may be expressed as a percentage. For example, the oil life value may be an amount of life of the oil remaining relative to a predetermined life of the oil (e.g., 100% oil life indicates fresh oil, 50% oil life indicates partially degraded oil, and) % indicates fully degraded oil).

[0096] At process **504**, a water content of the oil system **145** is estimated or determined. The controller **140** estimates, determines, or receives the water content of the oil system **145**. In various embodiments, process **504** is optional and may not be implemented. At process **504**, the water content may be estimated via one or more sensors **125**. The estimated water content may be communicated to the controller **140**. For example, the controller **140** may receive the estimated water content from one or more real sensors. In another example, the controller **140** may estimate the water content via one or more virtual sensors.

[0097] In some embodiments, the water content may be estimated based on an amount (e.g., a mass or volume) of the water in the oil system **145** (which may be a measured value or an estimated value) and a total amount (e.g., a mass or volume) of oil in the oil system (which may be a known value, a measured value, or an estimated value). By way of example, the controller **140** may receive (from one or more sensors **125**), the amount of water in the oil system **145**. The controller **140** may also receive (from one or more sensors **125**) the amount of oil in the oil system **145**. Then, the controller **140** may determine the water content based on the amount of water relative to the amount of oil.

[0098] At process **506**, the controller **140** can selectively turn on or activate the heater **150**. The heater **150** may be activated responsive to determining that an operating parameter of the oil system **145** is at or below a predetermined threshold. The controller **140** may activate heater **150** responsive to an operating parameter of the oil system **145** being at or below a predetermined threshold. For example, the heater **150** may be activated responsive to determining that the oil life of the oil system **145** is at or below a predetermined percentage (e.g., 50%). In another example, the controller **140** may activate the heater **150** responsive to the oil life value of the oil system **145** being at or below a predetermined oil life threshold or percentage (e.g., 50%). In various embodiments, the controller **140** may activate the heater **150** regardless of the operating parameter of the oil system **145**. That is, the controller **140** may activate the heater **150** even if the operating parameter of the oil system **145** is not at or below a predetermined threshold.

[0099] At process **508**, the controller **140** may selectively adjust operation of the heater **150**. The heater **150** may be adjusted based on the oil life data received at process **502**. The controller **140** adjusts operation of the heater **150** based on the oil life data received at process **502**. The adjustment of the heater **150** may be correlated to an amount below the predetermined threshold that the operating parameter of the oil system is at. The controller **140** may adjust the operation of the heater **150** based on the predetermined oil life threshold relative to the operating parameter of the oil system (e.g., the oil life value), such as a difference between the predetermined oil life threshold and the oil life value. For example, the operation of the heater **150** may be correlated to the oil life of the oil. In various embodiments, the aggressiveness of the operation of the heater **150** increases relative to a current state of operation of the heater **150** as oil life degrades. For example, the temperature of the heater **150** may be increased relative to a current temperature of the heater **150** responsive to determining that the oil life is at 50% relative to determining that the oil life is at 100%.

[0100] In various embodiments, process **508** may include turning off the heater **150**. The heater **150** may be turned off responsive to determining that the water content of the oil system **145** is at or below a predetermined threshold. Sensors **125** may be used to determine that the water content has fallen below the threshold and has been purged or substantially purged from the oil system **145**. In various embodiments, the controller **140** may turn off the heater **150** without knowing the water content in the oil system **145**. For example, the controller **140** may turn off the heater **150** after a predetermined period of time, regardless of the amount of water remaining in the oil system **145**, at the end of the predetermined period of time.

[0101] In some embodiments, the controller **140** may adjust operation of the heater **150** by adjusting a control parameter of the heater **150**. By way of example, the controller **140** may increase the control parameter of the heater **150**, which, in turn, increases a heat output by the heater **150** in response to a fluid level of the fluid in the oil system **145** (e.g., a water content of the oil system **145**) being at or above a first predefined water content threshold. In an example implementation, increasing, by the controller **140**, the control parameter of the heater **150** includes at least one of increasing a temperature output from the heater **150** relative to a current temperature output from the heater, increasing a duration of an operation of the heater relative to a current duration of operation of the heater (e.g., increasing a duration of operation relative to a previously defined or scheduled duration of operation), or activating the heater during a high duty cycle. In another example implementation, increasing, by the controller **140**, the control parameter of the heater **150** includes deactivating the heater during a high duty cycle.

[0102] In some embodiments, the controller **140** may adjust (e.g., increase) the control parameter of the heater **150** before, during, and/or after shutdown of the engine **102**. By way of example, the controller **140** may increase the control parameter of the heater **150** during a first time period before shutdown of the engine **102** responsive to the water content value being at or below the second predefined water content threshold (indicative of the water being purged or substantially purged from the oil system **145**) before shutdown of the engine **102**. By way of another example, the controller **140** may increase the control parameter of the heater **150** during shutdown of the engine **102** responsive to the water content value being at or below the second predefined water content threshold (indicative of the water being purged or substantially purged from the oil system **145**) during the shutdown of the engine **102**. By way of yet another example, the controller **140** may increase the control parameter of the heater **150** during a second period of time after shutdown of the engine responsive to the water content value being at or below the second predefined water content threshold (indicative of the water being purged or substantially purged from the oil system **145**) after shutdown of the engine.

[0103] Referring to the method **300**, the method **400**, and the method **500**, generally, the methods **300**, **400**, and **500** described in FIGS. **3**, **4**, and **5**, respectively, may be implemented alone or in combination with one another. By way of example, the controller **140** may perform the method **300** concurrently or partially concurrently with the method **400** and/or the method **500**. Similarly, the controller **140** may perform the method **400** concurrently or partially concurrently with the method **300** and/or the method **500**. Finally, the controller **140** may perform the method **500** concurrently or partially concurrently with the method **300** and/or the method **400**. Of course, the method **300**, the method **400**, and the method **500** may also be performed sequentially (e.g., in any order) or independently of each other.

[0104] By way of example, when one or more of the method **300**, the method **400**, or the method **500** are performed concurrently or partially concurrently, process **302**, process **402**, and process **502** may be performed concurrently or partially concurrently. Similarly, process **304**, process **404**, and process **504** may be performed concurrently or partially concurrently. Additionally, process **306**, process **406**, and process **506** may be performed concurrently or partially concurrently. Finally, process **308**, process **408**, and process **508** may be performed concurrently or partially concurrently.

[0105] By way of another example, when the method **300** and the method **500** are preformed concurrently or partially concurrently, the controller **140** may receive a first operating parameter regarding the engine **102** (e.g., as in process **302**). The controller **140** may also receive a second operating parameter regarding the oil system **145** (e.g., as in process **502**). Then, the controller **140** may activate the heater **150** responsive at least one of the first operating parameter being at or below a first predefined threshold (e.g., as in process **306**) or the second operating parameter being at or below a second predefined threshold (e.g., as in process **506**).

[0106] By way of yet another example, when one or more of the method **300**, the method **400**, or the method **500** are performed concurrently or partially concurrently, the controller **140** may receive, from one or more sensors **125** (e.g., one or more virtual sensors or one or more real sensors), a water content regarding the oil system (e.g., as in process **304**, process **404**, and/or process **504**).

[0107] In additional and/or alternative embodiments, when one or more of the method **300**, the method **400**, or the method **500** are performed concurrently, partially concurrently, or sequentially, at process **306**, process **406**, and/or process **506**, the controller **140** may activate the heater **150** responsive to determining that the operational parameter of the oil system **145** is at or above a predetermined threshold. For example, the controller **140** may activate the heater **150** responsive to determining that water content in the oil system **145** at or above the second predetermined threshold.

[0108] As utilized herein, the terms "approximately," "about," "substantially," and similar terms are intended to have a broad meaning in harmony with the common and accepted usage by those of ordinary skill in the art to which the subject matter of this disclosure pertains. It should be understood by those of skill in the art who review this disclosure that these terms are intended to allow a description of certain features described and claimed without restricting the scope of these features to the precise numerical ranges provided. Accordingly, these terms should be interpreted as indicating that insubstantial or inconsequential modifications or alterations of the subject matter described and claimed are considered to be within the scope of the disclosure as recited in the appended claims.

[0109] It should be noted that the term "exemplary" and variations thereof, as used herein to describe various embodiments, are intended to indicate that such embodiments are possible examples, representations, or illustrations of possible embodiments (and such terms are not intended to connote that such embodiments are necessarily extraordinary or superlative examples).

[0110] The term "coupled" and variations thereof, as used herein, means the joining of two members directly or indirectly to one another. Such joining may be stationary (e.g., permanent or fixed) or moveable (e.g., removable or releasable). Such joining may be achieved with the two members coupled directly to each other, with the two members coupled to each other using one or more separate intervening members, or with the two members coupled to each other using an intervening member that is integrally formed as a single unitary body with one of the two members. If "coupled" or variations thereof are modified by an additional term (e.g., directly coupled), the generic definition of "coupled" provided above is modified by the plain language meaning of the additional term (e.g., "directly coupled" means the joining of two members without any separate intervening member), resulting in a narrower definition than the generic definition of "coupled" provided above. Such coupling may be mechanical, electrical, or fluidic. For example, circuit A communicably "coupled" to circuit B may signify that the circuit A communicates directly with circuit B (i.e., no intermediary) or communicates indirectly with circuit B (e.g., through one or more intermediaries).

[0111] References herein to the positions of elements (e.g., "top," "bottom," "above," "below") are merely used to describe the orientation of various elements in the FIGURES. It should be noted that the orientation of various elements may differ according to other exemplary embodiments, and that such variations are intended to be encompassed by the present disclosure.

[0112] While various circuits with particular functionality are shown in FIG. **2**, it should be understood that the controller **140** may include any number of circuits for completing the functions described herein. For example, the activities and functionalities of the oil heat control circuit **210** may be combined in multiple circuits or as a single circuit. Additional circuits with additional functionality may also be included. Further, the controller **140** may further control other activity beyond the scope of the present disclosure.

[0113] As mentioned above and in one configuration, the "circuits" may be implemented in machine-readable medium for execution by various types of processors, such as the processor **204** of FIG. **2**. Executable code may, for instance, comprise one or more physical or logical blocks of computer instructions, which may, for instance, be organized as an object, procedure, or function. Nevertheless, the executables need not be physically located together, but may comprise disparate instructions stored in different locations which, when joined logically together, comprise the circuit and achieve the stated purpose for the circuit. Indeed, a circuit of computer readable program code may be a single instruction, or many instructions, and may even be distributed over several different code segments, among different programs, and across several memory devices. Similarly, operational data may be identified and illustrated herein within circuits, and may be embodied in any suitable form and organized within any suitable type of data structure. The operational data may be collected as a single data set, or may be distributed over different locations including over different storage devices, and may exist, at least partially, merely as electronic signals on a system or network.

[0114] While the term "processor" is briefly defined above, the term "processor" and "processing circuit" are meant to be broadly interpreted. In this regard and as mentioned above, the "processor" may be implemented as one or more processors, application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), digital signal processors (DSPs), or other suitable electronic data processing components structured to execute instructions provided by memory. The one or more processors may take the form of a single core processor, multi-core processor (e.g., a dual core processor, triple core processor, quad core processor, etc.), microprocessor, etc. In some embodiments, the one or more processors may be external to the apparatus, for example the one or more processors may be a remote processor (e.g., a cloud-based processor). Alternatively or additionally, the one or more processors may be internal and/or local to the apparatus. In this regard, a given circuit or components thereof may be disposed locally (e.g., as part of a local server, a local computing system, etc.) or remotely (e.g., as part of a remote server such as a cloud-based server). To that end, a "circuit" as described herein may include components that are distributed across one or more locations.

[0115] Embodiments within the scope of the present disclosure include program products comprising computer or machine-readable media for carrying or having computer or machine-executable instructions or data structures stored thereon. Such machine-readable media can be any available media that can be accessed by a computer. The computer readable medium may be a tangible computer readable storage medium storing the computer readable program code. The computer readable storage medium may be, for example, but not limited to, an electronic, magnetic, optical, electromagnetic, infrared, holographic, micromechanical, or semiconductor system, apparatus, or device, or any suitable combination of the foregoing. More specific examples of the computer readable medium may include but are not limited to a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), a portable compact disc read-only memory (CD-ROM), a digital versatile disc (DVD), an optical storage device, a magnetic storage device, a holographic storage medium, a micromechanical storage device, or any suitable combination of the foregoing. In the context of this document, a computer readable storage medium may be any tangible medium that can contain, and/or store computer readable program code for use by and/or in connection with an instruction execution system, apparatus, or device. Machine-executable instructions include, for example, instructions and data which cause a computer or processing machine to perform a certain function or group of functions.

[0116] The computer readable medium may also be a computer readable signal medium. A computer readable signal medium may include a propagated data signal with computer readable program code embodied therein, for example, in baseband or as part of a carrier wave. Such a propagated signal may take any of a variety of forms, including, but not limited to, electrical, electro-magnetic, magnetic, optical, or any suitable combination thereof. A computer readable signal medium may be any computer readable medium that is not a computer readable storage medium and that can communicate, propagate, or transport computer readable program code for use by or in connection with an instruction execution system, apparatus, or device. Computer readable program code embodied on a computer readable signal medium may be transmitted using any appropriate medium, including but not limited to wireless, wireline, optical fiber cable, Radio Frequency (RF), or the like, or any suitable combination of the foregoing.

[0117] In one embodiment, the computer readable medium may comprise a combination of one or more computer readable storage mediums and one or more computer readable signal mediums. For example, computer readable program code may be both propagated as an electro-magnetic signal through a fiber optic cable for execution by a processor and stored on RAM storage device for execution by the processor.

[0118] Computer readable program code for carrying out operations for aspects of the present disclosure may be written in any combination of one or more other programming languages, including an object-oriented programming language such as Java, Smalltalk, C++ or the like and conventional procedural programming languages, such as the "C" programming language or similar programming languages. The computer readable program code may execute entirely on the user's computer, partly on the user's computer, as a stand-alone computer-readable package, partly on the user's computer and partly on a remote computer or entirely on the remote computer or server. In the latter scenario, the remote computer may be connected to the user's computer through any type of network, including a local area network (LAN) or a wide area network (WAN), or the connection may be made to an external computer (for example, through the Internet using an Internet Service Provider).

[0119] The program code may also be stored in a computer readable medium that can direct a computer, other programmable data processing apparatus, or other devices to function in a particular manner, such that the instructions stored in the computer readable medium produce an article of manufacture including instructions which implement the function/act specified in the schematic flowchart diagrams and/or schematic block diagrams block or blocks.

[0120] Although the figures and description may illustrate a specific order of method steps, the order of such steps may differ from what is depicted and described, unless specified differently above. Also, two or more steps may be performed concurrently or with partial concurrence, unless specified differently above. Such variation may depend, for example, on the software and hardware systems chosen and on designer choice. All such variations are within the scope of the disclosure. Likewise, software implementations of the described methods could be accomplished with standard programming techniques with rule-based logic and other logic to accomplish the various connection steps, processing steps, comparison steps, and decision steps.

[0121] It is important to note that the construction and arrangement of the apparatus and system as shown in the various exemplary embodiments is illustrative only. Additionally, any element disclosed in one embodiment may be incorporated or utilized with any other embodiment disclosed herein.

What is claimed is:

1. A system comprising:

a heater configured to heat a fluid of a lubricant system; and

a controller coupled to the heater, the controller comprising at least one processor coupled to at least one memory device storing instructions that, when executed by the at least one processor, cause the controller to perform operations comprising:

receiving information regarding an engine operating parameter of an engine;

receiving information regarding an operating parameter of the lubricant system; and

activating the heater responsive to determining that at least one of the engine operating parameter or the operating parameter of the lubricant system is at or below a predefined threshold.

2. The system of claim **1**, wherein the instructions, when executed by the at least one processor, cause the controller to perform further operations comprising:

receiving, from one or more sensors, data relating to an amount of water in the lubricant system; and

determining a water content regarding the fluid in the lubricant system based on the amount of water in the lubricant system relative to an amount of lubricant in the lubricant system.

3. The system of claim **2**, wherein the instructions, when executed by the at least one processor, cause the controller to perform further operations comprising:

increasing, based on at least one of the engine operating parameter or the operating parameter of the lubricant system, a control parameter of the heater responsive to determining that a fluid level of the fluid in the lubricant system is at or above the predefined threshold, wherein the control parameter of the heater is one or more of a temperature of the heater, a duration of operation of the heater, and a point in time at which the heater is activated.

4. The system of claim **3**, wherein:

the engine operating parameter is at least one of a duty cycle of the engine or a shutdown parameter of the engine; and

the operating parameter of the lubricant system is a predefined lifespan value of the lubricant of the lubricant system.

5. The system of claim **3**, wherein increasing the control parameter of the heater further includes:

increasing the control parameter relative to a current control parameter of the heater when the fluid level of the lubricant system is above a first predefined threshold value.

6. The system of claim **5**, wherein increasing the control parameter of the heater comprises at least one of: increasing a temperature output from the heater relative to a current temperature output from the heater, increasing the duration of the operation of the heater relative to a current duration of the operation of the heater, activating the heater during a high duty cycle, or deactivating the heater during the high duty cycle.

7. The system of claim **4**, wherein increasing the control parameter of the heater occurs at least one of a time period before, during, or after shutdown of the engine.

8. The system of claim **4**, wherein the increasing the control parameter of the heater occurs at a time period before shutdown of the engine responsive to determining that the fluid is purged or substantially purged from the lubricant system before an engine shutdown;

wherein the increasing the control parameter of the heater occurs during the engine shutdown responsive to determining that fluid is purged or substantially purged from the lubricant system during the engine shutdown; and

wherein the increasing the control parameter of the heater occurs during a period of time after the engine shutdown responsive to determining that the fluid is purged or substantially purged from the lubricant system after the engine shutdown.

9. A method comprising:

receiving a first operating parameter of an engine;

receiving a second operating parameter of a lubricant system associated with the engine; and

activating a heater associated with the lubricant system responsive at least one of the first operating parameter being at or below a first predefined threshold or the second operating parameter being at or below a second predefined threshold.

10. The method of claim **9**, further comprising:

receiving, from one or more sensors, a first amount of water in the lubricant system; and

determining a water content regarding the lubricant system based on the first amount of water in the lubricant system relative to a second amount of lubricant in the lubricant system.

11. The method of claim **10**, further comprising increasing a control parameter of the heater responsive to the water content being above a predetermined threshold.

12. The method of claim **11**, wherein increasing the control parameter of the heater comprises at least one of:

increasing a temperature output from the heater relative to a current temperature output from the heater;

increasing a duration of operation of the heater relative to a current duration of activation of the heater; or

activating the heater during a high duty cycle.

13. The method of claim **11**, wherein at least one of:

increasing the control parameter of the heater occurs at a first time period before shutdown of the engine responsive to the water content being at or below a second predefined water content threshold before shutdown of the engine;

increasing the control parameter of the heater occurs during shutdown of the engine responsive to the water content being at or below the second predefined water content threshold during shutdown of the engine; or

increasing the control parameter of the heater occurs during a second period of time after shutdown of the engine responsive to the water content being at or below the second predefined water content threshold after shutdown of the engine.

14. The method of claim **9**, further comprising:

receiving an life value regarding lubricant in the lubricant system;

responsive to the life value being at or below a predetermined lubricant life threshold, activating the heater; and

adjusting operation of the heater based on the predetermined life value threshold relative to the life value.

15. A non-transitory computer-readable media storing instructions that, when executed by one or more processors, cause the one or more processors to perform operations comprising:

receiving a first operating parameter of an engine;

receiving a second operating parameter of an oil system associated with the engine; and

activating a heater associated with the oil system responsive at least one of the first operating parameter being at or below a first predefined threshold or the second operating parameter being at or below a second predefined threshold.

16. The non-transitory computer-readable media of claim **15**, wherein the instructions, when executed by the one or more processors, cause the one or more processors to perform further operations comprising:

receiving, from one or more sensors, a first amount of water in the oil system; and

determining a water content regarding the oil system based on the first amount of water in the oil system relative to an amount of oil in the oil system.

17. The non-transitory computer-readable media of claim **16**, wherein the instructions, when executed by the one or more processors, cause the one or more processors to perform further operations comprising increasing a control parameter of the heater responsive to the water content being above a predetermined threshold.

18. The non-transitory computer-readable media of claim **17**, wherein increasing the control parameter of the heater comprises at least one of:

increasing a temperature output from the heater relative to a current temperature output from the heater;

increasing a duration of operation of the heater relative to a current duration of activation of the heater; or

activating the heater during a high duty cycle.

19. The non-transitory computer-readable media of claim **17**, wherein the instructions, when executed by the one or more processors, cause the one or more processors to perform further operations comprising at least one of:

increasing the control parameter of the heater occurs at a first time period before shutdown of the engine responsive to the water content being at or below a second predefined water content threshold before shutdown of the engine;

increasing the control parameter of the heater occurs during shutdown of the engine responsive to the water content being at or below the second predefined water content threshold during shutdown of the engine; or

increasing the control parameter of the heater occurs during a second period of time after shutdown of the engine responsive to the water content being at or below the second predefined water content threshold after shutdown of the engine.

20. The non-transitory computer-readable media of claim **15**, wherein:

the first operating parameter is at least one of a duty cycle of the engine or a shutdown parameter of the engine; and

the second operating parameter is a life value of an oil of the oil system.

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