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(54) **SYSTEMS AND METHODS FOR REMOVING FUEL FROM ENGINE OIL**

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F01M 5/00 (2006.01)

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See application file for complete search history.

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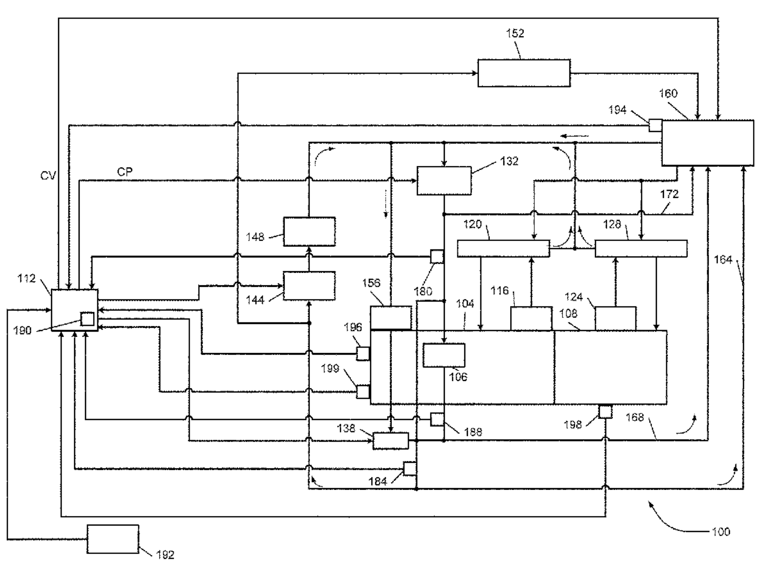
(57) **ABSTRACT**

A coolant control system of a vehicle includes a fraction module, and a coolant valve control module. The fraction module determines an oil fuel fraction based on an amount of fuel in an amount of engine oil. The coolant valve control module, based on the oil fuel fraction, selectively actuates a coolant valve to enable coolant flow from an integrated exhaust manifold (IEM) of an engine to an engine oil heat exchanger.

20 Claims, 4 Drawing Sheets



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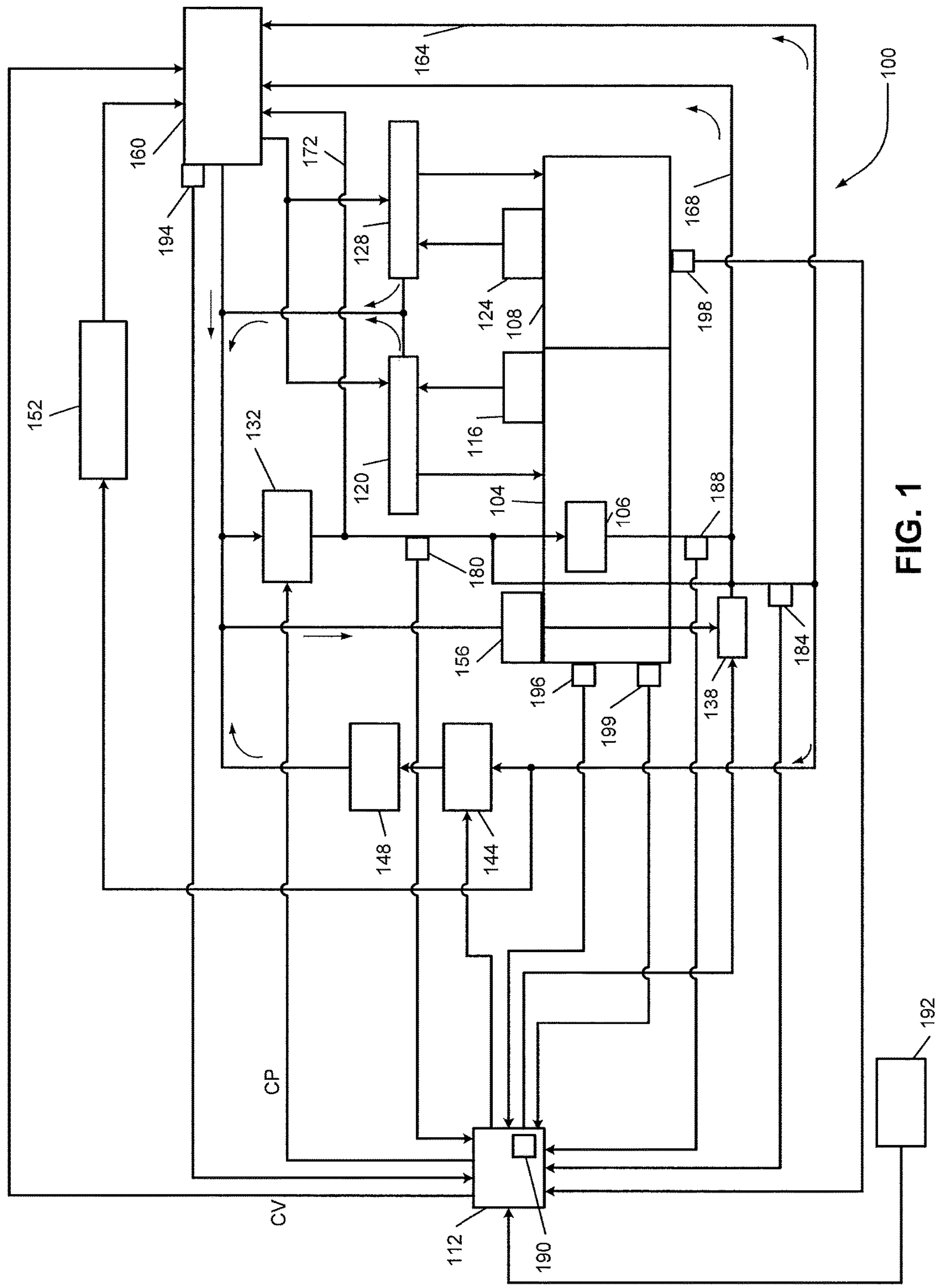

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FIG. 1

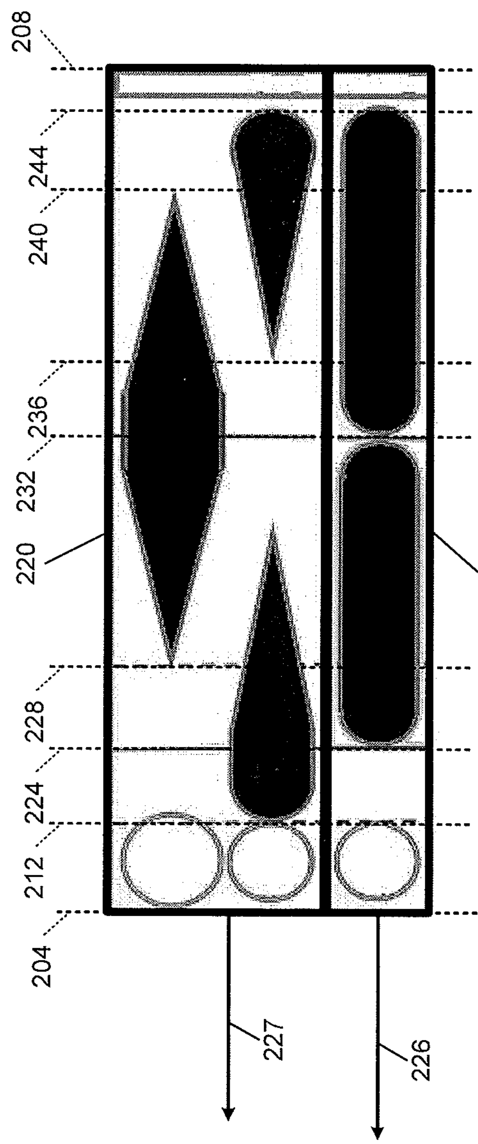

FIG. 2

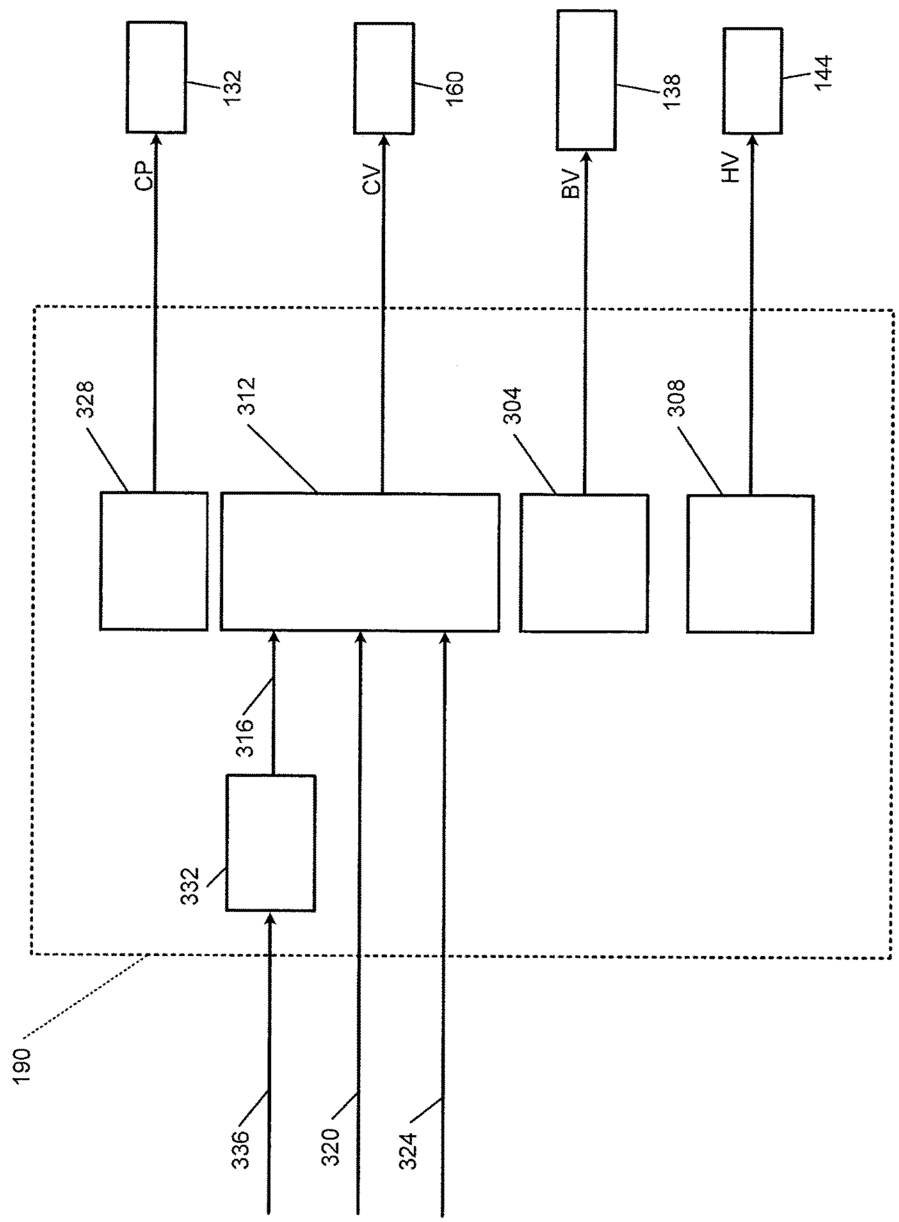
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FIG. 3

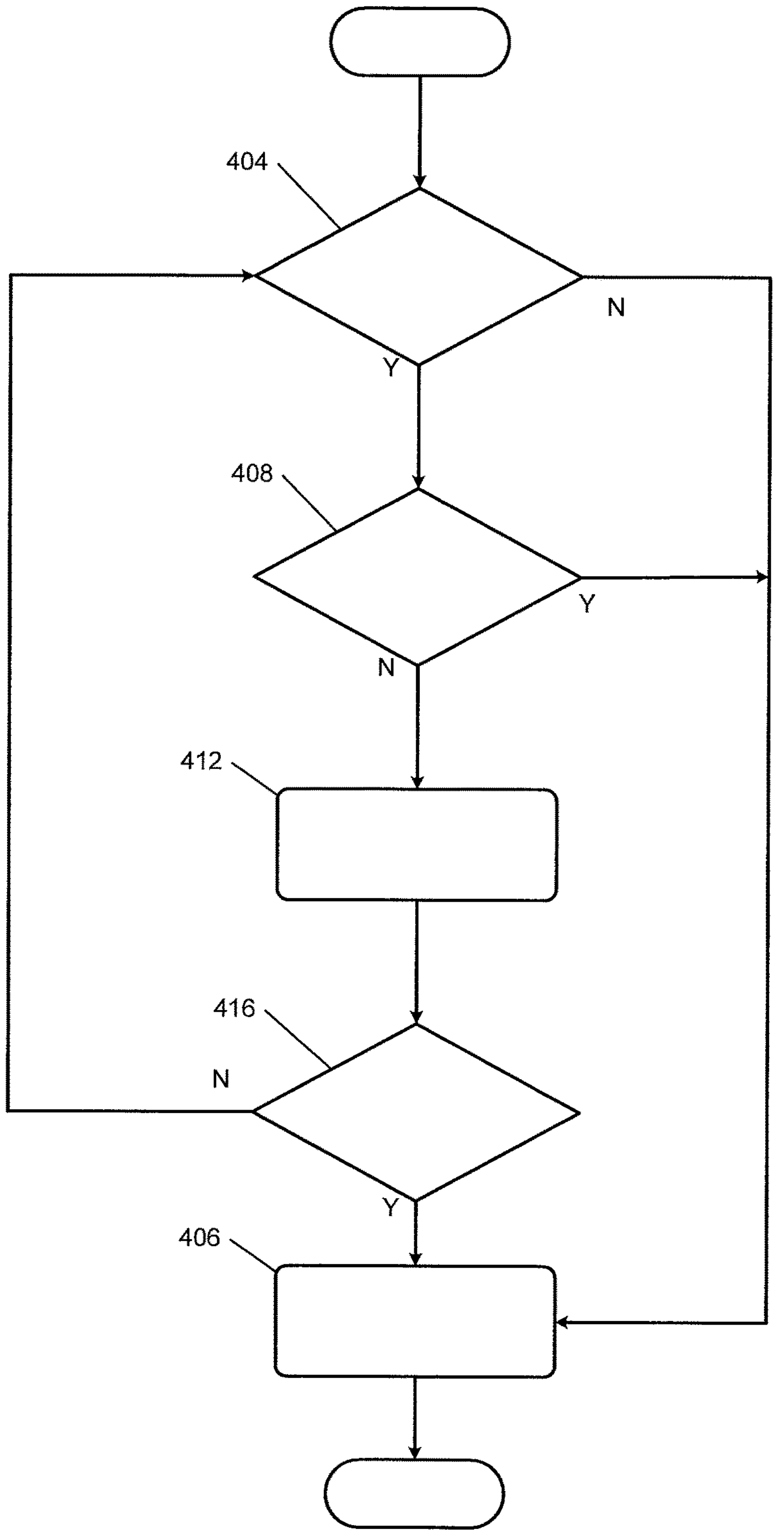

FIG. 4

SYSTEMS AND METHODS FOR REMOVING FUEL FROM ENGINE OIL

FIELD

The present disclosure relates to vehicles with internal combustion engines and more particularly to systems and methods for controlling engine coolant flow.

BACKGROUND

The background description provided here is for the purpose of generally presenting the context of the disclosure. Work of the presently named inventors, to the extent it is described in this background section, as well as aspects of the description that may not otherwise qualify as prior art at the time of filing, are neither expressly nor impliedly admitted as prior art against the present disclosure.

An internal combustion engine combusts air and fuel within cylinders to generate drive torque. Combustion of air and fuel also generates heat and exhaust. Exhaust produced by an engine flows through an exhaust system before being expelled to atmosphere.

Vehicles that include an internal combustion engine typically include a radiator that is connected to coolant channels within the engine. Engine coolant circulates through the coolant channels and the radiator. The engine coolant absorbs heat from the engine and carries the heat to the radiator. The radiator transfers heat from the engine coolant to air passing the radiator. The cooled engine coolant exiting the radiator is circulated back to the engine.

Internal combustion engines also typically include a lubricant reservoir or sump that supplies lubricant, such as engine oil, to the engine. The engine oil lubricates various moving components throughout engine. As internal combustion engines operate, the fuel may mix with, and contaminate, the engine oil. Engine oil contaminated with fuel may have reduced lubricity, which can shorten the lifetime of the engine, engine components, and/or other components of the vehicle.

SUMMARY

A coolant control system of a vehicle includes a fraction module, and a coolant valve control module. The fraction module determines an oil fuel fraction based on an amount of fuel in an amount of engine oil. The coolant valve control module, based on the oil fuel fraction, selectively actuates a coolant valve to enable coolant flow from an integrated exhaust manifold (IEM) of an engine to an engine oil heat exchanger.

In further features, the coolant valve control module actuates the coolant valve to enable coolant flow from the IEM to the engine oil heat exchanger when the oil fuel fraction is greater than a predetermined value.

In further features, the coolant valve control module actuates the coolant valve to prevent coolant flow from the IEM to the engine oil heat exchanger when the oil fuel fraction is less than the predetermined value.

In further features, the coolant valve control module selectively actuates the coolant valve to control coolant flow from the IEM to the engine oil heat exchanger further based on at least one of a transmission temperature and an engine oil temperature.

In further features, the coolant valve control module actuates the coolant valve to enable coolant flow from the IEM to the engine oil heat exchanger when: (i) the transmission temperature is less than a predetermined temperature; and (ii) the oil fuel fraction is greater than a predetermined value.

In further features, the coolant valve control module selectively actuates the coolant valve to prevent coolant flow of from the IEM to the engine oil heat exchanger when the transmission temperature is greater than the predetermined temperature.

In further features, the coolant valve control module actuates the coolant valve to prevent coolant flow from the IEM to the engine oil heat exchanger when the oil fuel fraction is greater than the predetermined value.

In further features, the coolant valve control module actuates the coolant valve to enable coolant flow from the IEM to the engine oil heat exchanger when: (i) the engine oil temperature is less than a predetermined temperature; and (ii) the oil fuel fraction is greater than a predetermined value.

In further features, the coolant valve control module selectively actuates the coolant valve to prevent coolant flow of from the IEM to the engine oil heat exchanger when the engine oil temperature is greater than the predetermined temperature.

In further features, the coolant valve control module actuates the coolant valve to prevent coolant flow from the IEM to the engine oil heat exchanger when the oil fuel fraction is greater than the predetermined value.

A coolant control method includes: determining an oil fuel fraction based on an amount of fuel in an amount of engine oil; and, based on the oil fuel fraction, selectively actuating a coolant valve to enable coolant flow from an integrated exhaust manifold (IEM) of an engine to an engine oil heat exchanger.

In further features, selectively actuating the coolant valve includes actuating the coolant valve to enable coolant flow from the IEM to the engine oil heat exchanger when the oil fuel fraction is greater than a predetermined value.

In further features, selectively actuating the coolant valve includes actuating the coolant valve to prevent coolant flow from the IEM to the engine oil heat exchanger when the oil fuel fraction is less than the predetermined value.

In further features, selectively actuating the coolant valve to control coolant flow from the IEM to the engine oil heat exchanger further based on at least one of a transmission temperature and an engine oil temperature.

In further features, selectively actuating the coolant valve includes actuating the coolant valve to enable coolant flow from the IEM to the engine oil heat exchanger when: (i) the transmission temperature is less than a predetermined temperature; and (ii) the oil fuel fraction is greater than a predetermined value.

In further features, selectively actuating the coolant valve includes actuating the coolant valve to prevent coolant flow of from the IEM to the engine oil heat exchanger when the transmission temperature is greater than the predetermined temperature.

In further features, selectively actuating the coolant valve includes actuating the coolant valve to prevent coolant flow from the IEM to the engine oil heat exchanger when the oil fuel fraction is greater than the predetermined value.

In further features, selectively actuating the coolant valve includes actuating the coolant valve to enable coolant flow from the IEM to the engine oil heat exchanger when: (i) the engine oil temperature is less than a predetermined temperature; and (ii) the oil fuel fraction is greater than a predetermined value.

In further features, selectively actuating the coolant valve includes actuating the coolant valve to prevent coolant flow of from the IEM to the engine oil heat exchanger when the engine oil temperature is greater than the predetermined temperature.

In further features, selectively actuating the coolant valve includes actuating the coolant valve to prevent coolant flow from the IEM to the engine oil heat exchanger when the oil fuel fraction is greater than the predetermined value.

Further areas of applicability of the present disclosure will become apparent from the detailed description, the claims and the drawings. The detailed description and specific examples are intended for purposes of illustration only and are not intended to limit the scope of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The present disclosure will become more fully understood from the detailed description and the accompanying drawings, wherein:

FIG. **1** is a functional block diagram of an example vehicle system according to the present disclosure;

FIG. **2** is an example diagram illustrating coolant flow to and from a coolant valve for various positions of the coolant valve;

FIG. **3** is a functional block diagram of an example coolant control module according to the present disclosure; and

FIG. **4** is a flowchart depicting an example method of controlling coolant flow according to the present disclosure.

In the drawings, reference numbers may be reused to identify similar and/or identical elements.

DETAILED DESCRIPTION

An engine combusts air and fuel in a combustion chamber of a cylinder to generate drive torque. For example, during combustion, a piston may reciprocate within the cylinder to generate the drive torque. Engine oil may be used to lubricate the moving piston and other moving parts in the engine. Piston rings can be used to sealingly separate fuel in the combustion chamber from engine oil used to lubricate the piston.

The engine also includes an integrated exhaust manifold (IEM) that receives exhaust resulting from combustion within cylinders of the engine. The exhaust flows through the IEM and one or more components of an exhaust system before the exhaust is expelled to the atmosphere.

A coolant system circulates coolant through various portions of the engine, such as a cylinder head, an engine block, and the IEM. Traditionally, the coolant system is used to absorb heat from the engine, engine oil, transmission fluid, and other components and to transfer heat to air. For example, coolant may circulate through an engine oil heat exchanger and/or a transmission heat exchanger to absorb heat from the engine oil and/or the transmission fluid, respectively.

Under some circumstances, fuel may enter, and mix with, the engine oil. For example, as the pistons reciprocate within the cylinder during combustion, fuel may enter the engine oil from around the piston rings. Accordingly, the engine oil may include a mixture of engine oil and fuel, defining an oil fuel fraction (i.e., a ratio of a quantity of fuel within a quantity of engine oil). Lubricity of the engine oil is inversely related to the oil fuel fraction. Thus, as the oil fuel fraction increases, the lubricity of the engine oil decreases. The lubricity of the engine oil impacts the amount of energy lost to friction within the engine, and therefore impacts the design and durability of various components within the engine.

Under some circumstances, the engine oil may be cold, such as when a vehicle is started. When the engine oil is heated, the fuel within the engine oil evaporates and is purged, thus reducing the oil fuel fraction and increasing the lubricity of the engine oil.

When the oil fuel fraction is greater than a predetermined value, a coolant control module according to the present disclosure may actuate a coolant valve to control a flow of coolant from the IEM to the engine oil heat exchanger and/or to the transmission heat exchanger. The coolant warmed by the IEM warms the engine oil flowing through the engine oil heat exchanger and/or the transmission fluid flowing through the transmission heat exchanger. Warming the engine oil using coolant that is warmed by the IEM may more quickly purge fuel from the engine oil, and therefore more quickly decrease the oil fuel fraction and increase the lubricity of the engine oil.

When the transmission is greater than a predetermined transmission temperature and/or the engine oil is greater than a predetermined engine oil temperature, the coolant control module may actuate the coolant valve to prevent the flow of coolant from the IEM to the engine oil heat exchanger and/or to the transmission heat exchanger.

Referring now to FIG. **1**, a functional block diagram of an example vehicle system is presented. An engine **104** combusts a mixture of air and fuel within cylinders to generate drive torque. An integrated exhaust manifold (IEM) **106** receives exhaust output from the cylinders and is integrated with a portion of the engine **104**, such as a head portion of the engine **104**.

The engine **104** outputs torque to a transmission **108**. The transmission **108** transfers torque to one or more wheels of a vehicle via a driveline (not shown). An engine control module (ECM) **112** may control one or more engine actuators to regulate the torque output of the engine **104**.

An engine oil pump **116** circulates engine oil through the engine **104** and a first heat exchanger **120**. The first heat exchanger **120** may be referred to as an (engine) oil cooler or an oil heat exchanger (HEX). When the engine oil is cold, the first heat exchanger **120** may transfer heat to engine oil within the first heat exchanger **120** from coolant flowing through the first heat exchanger **120**. The first heat exchanger **120** may transfer heat from the engine oil to coolant flowing through the first heat exchanger **120** and/or to air passing the first heat exchanger **120** when the engine oil is warm.

Viscosity of the engine oil is inversely related to temperature of the engine oil. That is, viscosity of the engine oil decreases as the temperature increases and vice versa. Frictional losses (e.g., torque losses) of the engine **104** associated with the engine oil may decrease as viscosity of the engine oil decreases and vice versa.

A transmission fluid pump **124** circulates transmission fluid through the transmission **108** and a second heat exchanger **128**. The second heat exchanger **128** may be referred to as a transmission cooler or as a transmission heat exchanger. When the transmission fluid is cold, the second heat exchanger **128** may transfer heat to transmission fluid within the second heat exchanger **128** from coolant flowing through the second heat exchanger **128**. The second heat exchanger **128** may transfer heat from the transmission fluid to coolant flowing through the second heat exchanger **128** and/or to air passing the second heat exchanger **128** when the transmission fluid is warm.

Viscosity of the transmission fluid is inversely related to temperature of the transmission fluid. That is, viscosity of the transmission fluid decreases as the temperature of the transmission fluid increases and vice versa. Losses (e.g., torque losses) associated with the transmission **108** and the transmission fluid may decrease as viscosity of the transmission fluid decreases and vice versa.

The engine **104** includes a plurality of channels through which engine coolant ("coolant") can flow. For example, the engine **104** may include one or more channels through the head portion of the engine **104**, one or more channels through a block portion of the engine **104**, and/or one or more channels through the IEM **106**. The engine **104** may also include one or more other suitable coolant channels.

When a coolant pump **132** is on, the coolant pump **132** pumps coolant to the channels of the engine **104**. While the coolant pump **132** is shown and will be discussed as an electric coolant pump, the coolant pump **132** may alternatively be mechanically driven (e.g., by the engine **104**) or another suitable type of coolant pump.

A block valve (BV) **138** may regulate coolant flow out of (and therefore through) the block portion of the engine **104**. A heater valve **144** may regulate coolant flow to (and therefore through) a third heat exchanger **148**. The third heat exchanger **148** may also be referred to as a heater core. Air may be circulated past the third heat exchanger **148**, for example, to warm a passenger cabin of the vehicle.

Coolant output from the engine **104** also flows to a fourth heat exchanger **152**. The fourth heat exchanger **152** may be referred to as a radiator. The fourth heat exchanger **152** transfers heat to air passing the fourth heat exchanger **152**. A cooling fan (not shown) may be implemented to increase airflow passing the fourth heat exchanger **152**.

Various types of engines may include one or more turbochargers, such as turbocharger **156**. Coolant may be circulated through a portion of the turbocharger **156**, for example, to cool the turbocharger **156**.

A coolant valve **160** may include a multiple input, multiple output valve or one or more other suitable valves. In various implementations, the coolant valve **160** may be partitioned and have two or more separate chambers. An example diagram illustrating coolant flow to and from an example where the coolant valve **160** includes 2 coolant chambers is provided in FIG. **2**. The ECM **112** controls actuation of the coolant valve **160**.

Referring now to FIGS. **1** and **2**, the coolant valve **160** can be actuated between two end positions **204** and **208**. When the coolant valve **160** is positioned between the end position **204** and a first position **212**, coolant flow into a first one of the chambers **216** is blocked, and coolant flow into a second one of the chambers **220** is blocked. The coolant valve **160** outputs coolant from the first one of the chambers **216** to the first heat exchanger **120** and/or the second heat exchanger **128** as indicated by **226**. In this regard, while the coolant valve **160** is generally shown and described herein as outputting coolant to the both the first and second heat exchangers **120**, **128** at **226**, the coolant valve **160** may output coolant to only the first heat exchanger **120** at **226**. The coolant valve **160** outputs coolant from the second one of the chambers **220** to the coolant pump **132** as indicated by **227**.

When the coolant valve **160** is positioned between the first position **212** and a second position **224**, coolant flow into the first one of the chambers **216** is blocked and coolant output by the engine **104** flows into the second one of the chambers **220** via a first coolant path **164**. Coolant flow into the second one of the chambers **220** from the fourth heat exchanger **152**, however, is blocked.

When the coolant valve **160** is positioned between the second position **224** and a third position **228**, coolant output by the IEM **106** via a second coolant path **168** flows into the first one of the chambers **216**, coolant output by the engine **104** flows into the second one of the chambers **220** via the first coolant path **164**, and coolant flow into the second one of the chambers **220** from the fourth heat exchanger **152** is blocked. The ECM **112** may actuate the coolant valve **160** to between the second and third positions **224** and **228**, for example, to warm the engine oil and the transmission fluid.

When the coolant valve **160** is positioned between the third position **228** and a fourth position **232**, coolant output by the IEM **106** via the second coolant path **168** flows into the first one of the chambers **216**, coolant output by the engine **104** flows into the second one of the chambers **220** via the first coolant path **164**, and coolant output by the fourth heat exchanger **152** flows into the second one of the chambers **220**. Coolant flow into the first one of the chambers **216** from the coolant pump **132** via a third coolant path **172** is blocked when the coolant valve **160** is between the end position **204** and the fourth position **232**. The ECM **112** may actuate the coolant valve **160** to be between the third and fourth positions **228** and **232**, for example, to warm the engine oil and the transmission fluid.

When the coolant valve **160** is positioned between the fourth position **232** and a fifth position **236**, coolant output by the coolant pump **132** flows into the first one of the chambers **216** via the third coolant path **172**, coolant flow into the second one of the chambers **220** via the first coolant path **164** is blocked, and coolant output by the fourth heat exchanger **152** flows into the second one of the chambers **220**. When the coolant valve **160** is positioned between the fifth position **236** and a sixth position **240**, coolant output by the coolant pump **132** flows into the first one of the chambers **216** via the third coolant path **172**, coolant output by the engine **104** flows into the second one of the chambers **220** via the first coolant path **164**, and coolant output by the fourth heat exchanger **152** flows into the second one of the chambers **220**.

When the coolant valve **160** is positioned between the sixth position **240** and a seventh position **244**, coolant output by the coolant pump **132** flows into the first one of the chambers **216** via the third coolant path **172**, coolant output by the engine **104** flows into the second one of the chambers **220** via the first coolant path **164**, and coolant flow from the fourth heat exchanger **152** into the second one of the chambers **220** is blocked.

Coolant flow into the first one of the chambers **216** from the IEM **106** via the second coolant path **168** is blocked when the coolant valve **160** is between the fourth position **232** and the seventh position **244**. The ECM **112** may actuate the coolant valve **160** to between the fourth and seventh positions **232** and **244**, for example, to cool the engine oil and the transmission fluid. Coolant flow into the first and second chambers **216** and **220** is blocked when the coolant valve **160** is positioned between the seventh position **244** and the end position **208**. The ECM **112** may actuate the coolant valve **160** to between the seventh position **244** and the end position **208**, for example, for performance of one or more diagnostics.

Referring back to FIG. **1**, a coolant input temperature sensor **180** measures a temperature of coolant input to the engine **104**. A coolant output temperature sensor **184** measures a temperature of coolant output from the engine **104**.

An IEM coolant temperature sensor **188** measures a temperature of coolant output from the IEM **106**. A coolant valve position sensor **194** measures a position of the coolant valve **160**. An oil temperature sensor **196** measures a temperature of engine oil, such as within the engine **104**. A transmission fluid temperature sensor **198** measures a temperature of transmission fluid, such as within the transmission **108**. An oil fuel fraction sensor **199** measures an amount of fuel in the engine oil (i.e., the oil fuel fraction), such as within the engine **104**. One or more other sensors **192** may be implemented, such as one or more engine (e.g., block and/or head) temperature sensors, a radiator output temperature sensor, a crankshaft position sensor, a mass air flowrate (MAF) sensor, a manifold absolute pressure (MAP) sensor, and/or one or more other suitable vehicle sensors. One or more other heat exchangers may also be implemented to aid in cooling and/or warming of vehicle fluid(s) and/or components.

Output of the coolant pump **132** varies as the pressure of coolant input to the coolant pump **132** varies. For example, at a given speed of the coolant pump **132**, the output of the coolant pump **132** increases as the pressure of coolant input to the coolant pump **132** increases, and vice versa. The position of the coolant valve **160** varies the pressure of coolant input to the coolant pump **132**.

A coolant control module **190** (see also FIG. **2**) controls coolant flow to warm the engine oil and the transmission fluid using coolant output from the IEM **106**. Warming the transmission fluid using coolant output from the IEM **106** quickly warms the transmission fluid and therefore decreases torque losses associated with the transmission fluid temperature. Warming the engine oil using coolant output from the IEM **106** quickly warms the engine oil and therefore reduces the amount of fuel in the engine oil (i.e., the oil fuel fraction) such that the lubricity of the engine oil increases. While the coolant control module **190** is shown as being implemented within the ECM **112**, the coolant control module **190** or one or more portions of the coolant control module **190** may be implemented within another module or independently.

Referring now to FIG. **3**, a functional block diagram of an example implementation of the coolant control module **190** is presented. A block valve control module **304** controls the block valve **138**. For example, the block valve control module **304** controls whether the block valve **138** is open (to allow coolant flow through the block portion of the engine **104**) or closed (to prevent coolant flow through the block portion of the engine **104**).

A heater valve control module **308** controls the heater valve **144**. For example, the heater valve control module **308** controls whether the heater valve **144** is open (to allow coolant flow through the third heat exchanger **148**) or closed (to prevent coolant flow through the third heat exchanger **148**).

A pump control module **328** controls the speed of the coolant pump **132** according to a desired engine coolant output temperature and a corresponding coolant flow rate. In other words, the pump control module **328** controls the speed of the coolant pump **132** to generate a coolant flow rate to achieve the desired engine coolant output temperature. The speed of the coolant pump **132** required to achieve the desired engine coolant output temperature at a given position of the coolant valve **160** may be calibrated based on, for example, an initial vehicle condition. For example, the pump control module **328** may disable the coolant pump **132** when an oil fuel fraction is less than a predetermined oil fuel fraction, or when a transmission temperature is greater than a predetermined transmission temperature, or when an oil temperature is greater than a predetermined oil temperature. Conversely, the pump control module **328** may activate the coolant pump **132** when the oil fuel fraction is less than the predetermined oil fuel fraction, and when the transmission temperature is greater than the predetermined transmission temperature, and when the oil temperature is greater than the predetermined oil temperature. If the coolant pump **132** is a mechanically driven coolant pump, the pump control module **204** may be omitted.

A coolant valve control module **312** controls the coolant valve **160**. The coolant valve control module **312** may provide a signal to the pump control module **328** indicating the selected position of the coolant valve **160**. In this manner, the pump control module **328** controls the speed of the coolant pump **132** for the selected position of the coolant valve **160**.

As described above, the position of the coolant valve **160** controls coolant flow into the chambers of the coolant valve **160** and also controls coolant flow out of the coolant valve **160**. More specifically, the coolant valve control module **312** controls whether the coolant valve **160** outputs coolant to the first heat exchanger **120**, the second heat exchanger **128**, both the first and second heat exchangers **120** and **128**, or neither of the first and second heat exchangers **120** and **128**. For example, as described above, when the coolant valve **160** is between the second and fourth positions **224** and **232** (FIG. **2**), the coolant valve **160** may output coolant to the first and second heat exchangers **120** and **128**.

The coolant valve control module **312** may control the coolant valve **160**, for example, based on an oil fuel fraction **316**, a transmission temperature **320**, and an engine oil temperature **324**. The transmission temperature **320** and the engine oil temperature **324** may be, for example, measured using the transmission temperature sensor **198** and the oil temperature sensor **196**, respectively.

A fraction module **332** may determine the oil fuel fraction **316**. In some configurations, the fraction module **332** may receive a signal **336** from the oil fuel fraction sensor **199** defining the oil fuel fraction **316**. In other configurations, the fraction module **332** may calculate the oil fuel fraction **316** based on the signal **336**. When the oil fuel fraction **316** is greater than a predetermined oil fuel fraction, and when the transmission temperature **320** is less than a predetermined transmission temperature, the coolant valve control module **312** controls the coolant valve **160** to direct the flow of coolant from the IEM **106**, through the coolant valve **160**, and to the first and second heat exchangers **120** and **128**, in the manner described above.

The predetermined oil fuel fraction may be calibratable and may be set based on an oil fuel fraction above which the lubricity of the engine oil, and/or the performance of the engine **104**, may be adversely impacted. The predetermined oil fuel fraction may be between 1% and 5%. For example only, the predetermined oil fuel fraction may be approximately 3%-4%. The predetermined transmission temperature may, likewise, be calibratable and may be set based on a temperature above which coolant flowing through the IEM **106** may increase the transmission temperature to a value that could hinder the performance of the transmission **108**. For example only, the predetermined transmission temperature may be approximately 125° Celsius or another suitable temperature.

The coolant valve control module **312** controls the flow of coolant from the higher temperature IEM **106** to the lower temperature first and second heat exchangers **120** and **128**, in order to increase the engine oil temperature **324** and the transmission temperature **320**, respectively. Coolant within the channels through the IEM **106** may absorb heat from the IEM **106**. The IEM **106** receives heat from exhaust resulting from combustion within the engine **104**.

Coolant flowing from the IEM **106** to the first and second heat exchangers **120** and **128** (through the coolant valve **160**) warms the engine oil within the first heat exchanger **120** and warms the transmission fluid within the second heat exchanger **128**. The warming of the transmission fluid and the transmission **108** decreases losses associated with the transmission **108** and the transmission fluid. The decrease in the losses may decrease fuel consumption. The warming of the engine oil evaporates the fuel within the engine oil, and thereby increases the lubricity of the engine oil and decreases losses associated with the engine **104** and the engine oil.

When (i) the engine oil temperature **324** exceeds a predetermined engine oil temperature (e.g., 140° Celsius or another suitable temperature), (ii) the transmission temperature **320** exceeds the predetermined transmission temperature, and/or (iii) the oil fuel fraction **316** exceeds the predetermined oil fuel fraction, the coolant valve control module **312** controls the coolant valve **160** to prevent the flow of coolant from the IEM **106** to the first and/or second heat exchangers **120** and **128**, in the manner described above. In this manner, the coolant valve control module **312** ensures that the coolant flowing through the higher temperature IEM **106** does not overheat the transmission fluid and/or the engine oil. While the coolant valve control module **312** is generally shown and described herein as providing coolant flow to both the first and second heat exchangers **120**, **128**, in other configurations, the transmission temperature may be ignored and coolant flow may not be provided to the second heat exchanger **128** when the oil fuel fraction **316** is less than the predetermined oil fuel fraction.

Referring now to FIG. **4**, a flowchart is presented depicting an example method of controlling coolant flow to dilute an amount of fuel present in the engine oil (i.e., a method of reducing an oil fuel fraction). Control may begin at **404** where the coolant valve control module **312** determines whether the oil fuel fraction is greater than a predetermined oil fuel fraction. As discussed above, the predetermined oil fuel fraction may be 3%-4%, or another suitable value above which the amount of fuel in the engine oil may be considered high enough to adversely affect the lubricity of the engine oil, and/or adversely affect the performance of the engine **104**.

If **404** is false, control continues to **406** where the coolant valve control module **312** controls the coolant valve **160** to prevent the flow of coolant from the IEM **106** to the first and/or second heat exchangers **120** and **128**. If **404** is true, control continues to **408**, where the coolant valve control module **312** determines whether the transmission temperature is greater than the predetermined transmission temperature. If **408** is true, control continues to **406**. If **408** is false, control continues to **412**.

At **412**, the coolant valve control module **312** controls the flow of coolant from the IEM **106** to the first heat exchanger **120** and to the second heat exchanger **128**. In particular, the coolant valve control module **312** may actuate the coolant valve **160** to enable coolant flow from the IEM **106** through the coolant valve **160** to the first and second heat exchangers **120**, **128** at **412**. For example, the coolant valve control module **312** may actuate the coolant valve **160** for a predetermined amount of time at **412**.

As discussed above, enabling the flow of coolant from the IEM **106** to the first and second heat exchangers **120**, **128** allows the coolant to heat the engine oil and the transmission fluid flowing through the first and second heat exchangers **120**, **128**, respectively. Heating the engine oil with the coolant in the first heat exchanger **120** enables the evaporation of fuel from the engine oil.

At **416**, the coolant valve control module **312** determines whether the engine oil temperature is greater than the predetermined engine oil temperature. If **416** is true, control continues to **406**. In particular, if the oil temperature is greater than the predetermined engine oil temperature, control may determine that controlling coolant flow to dilute an amount of fuel present in the engine oil is no longer necessary (e.g., the evaporation of fuel from the engine oil is complete), and may prevent the flow of coolant from the IEM **106** to the first and/or second heat exchangers **120** and **128** prior to exiting the control. If **416** is false, control returns to **404**.

The foregoing description is merely illustrative in nature and is in no way intended to limit the disclosure, its application, or uses. The broad teachings of the disclosure can be implemented in a variety of forms. Therefore, while this disclosure includes particular examples, the true scope of the disclosure should not be so limited since other modifications will become apparent upon a study of the drawings, the specification, and the following claims. As used herein, the phrase at least one of A, B, and C should be construed to mean a logical (A or B or C), using a non-exclusive logical OR. It should be understood that one or more steps within a method may be executed in different order (or concurrently) without altering the principles of the present disclosure.

In this application, including the definitions below, the term module may be replaced with the term circuit. The term module may refer to, be part of, or include an Application Specific Integrated Circuit (ASIC); a digital, analog, or mixed analog/digital discrete circuit; a digital, analog, or mixed analog/digital integrated circuit; a combinational logic circuit; a field programmable gate array (FPGA); a processor (shared, dedicated, or group) that executes code; memory (shared, dedicated, or group) that stores code executed by a processor; other suitable hardware components that provide the described functionality; or a combination of some or all of the above, such as in a system-on-chip.

The term code, as used above, may include software, firmware, and/or microcode, and may refer to programs, routines, functions, classes, and/or objects. The term shared processor encompasses a single processor that executes some or all code from multiple modules. The term group processor encompasses a processor that, in combination with additional processors, executes some or all code from one or more modules. The term shared memory encompasses a single memory that stores some or all code from multiple modules. The term group memory encompasses a memory that, in combination with additional memories, stores some or all code from one or more modules. The term memory may be a subset of the term computer-readable medium. The term computer-readable medium does not encompass transitory electrical and electromagnetic signals propagating through a medium, and may therefore be considered tangible and non-transitory. Non-limiting examples of a non-transitory tangible computer readable medium include nonvolatile memory, volatile memory, magnetic storage, and optical storage.

The apparatuses and methods described in this application may be partially or fully implemented by one or more computer programs executed by one or more processors.

The computer programs include processor-executable instructions that are stored on at least one non-transitory tangible computer readable medium. The computer programs may also include and/or rely on stored data.

What is claimed is:

1. A coolant control system of a vehicle, comprising:
- a fraction module that determines an oil fuel fraction based on an amount of fuel in an amount of engine oil; and
- a coolant valve control module that, based on the oil fuel fraction, selectively actuates a coolant valve to enable coolant flow from an integrated exhaust manifold (IEM) of an engine to an engine oil heat exchanger.

2. The system of claim **1**, wherein the coolant valve control module actuates the coolant valve to enable coolant flow from the IEM to the engine oil heat exchanger when the oil fuel fraction is greater than a predetermined value.

3. The system of claim **2**, wherein the coolant valve control module actuates the coolant valve to prevent coolant flow from the IEM to the engine oil heat exchanger when the oil fuel fraction is less than the predetermined value.

4. The system of claim **1**, wherein the coolant valve control module selectively actuates the coolant valve to control coolant flow from the IEM to the engine oil heat exchanger further based on at least one of a transmission temperature and an engine oil temperature.

5. The system of claim **4**, wherein the coolant valve control module actuates the coolant valve to enable coolant flow from the IEM to the engine oil heat exchanger when:
- (i) the transmission temperature is less than a predetermined temperature; and
- (ii) the oil fuel fraction is greater than a predetermined value.

6. The system of claim **5**, wherein the coolant valve control module selectively actuates the coolant valve to prevent coolant flow of from the IEM to the engine oil heat exchanger when the transmission temperature is greater than the predetermined temperature.

7. The system of claim **5**, wherein the coolant valve control module actuates the coolant valve to prevent coolant flow from the IEM to the engine oil heat exchanger when the oil fuel fraction is greater than the predetermined value.

8. The system of claim **4**, wherein the coolant valve control module actuates the coolant valve to enable coolant flow from the IEM to the engine oil heat exchanger when:
- (i) the engine oil temperature is less than a predetermined temperature; and
- (ii) the oil fuel fraction is greater than a predetermined value.

9. The system of claim **8**, wherein the coolant valve control module selectively actuates the coolant valve to prevent coolant flow of from the IEM to the engine oil heat exchanger when the engine oil temperature is greater than the predetermined temperature.

10. The system of claim **9**, wherein the coolant valve control module actuates the coolant valve to prevent coolant flow from the IEM to the engine oil heat exchanger when the oil fuel fraction is greater than the predetermined value.

11. A coolant control method for a vehicle, comprising:
- determining an oil fuel fraction based on an amount of fuel in an amount of engine oil; and
- based on the oil fuel fraction, selectively actuating a coolant valve to enable coolant flow from an integrated exhaust manifold (IEM) of an engine to an engine oil heat exchanger.

12. The method of claim **11** wherein selectively actuating the coolant valve includes actuating the coolant valve to enable coolant flow from the IEM to the engine oil heat exchanger when the oil fuel fraction is greater than a predetermined value.

13. The method of claim **12** wherein selectively actuating the coolant valve includes actuating the coolant valve to prevent coolant flow from the IEM to the engine oil heat exchanger when the oil fuel fraction is less than the predetermined value.

14. The method of claim **11** further comprising selectively actuating the coolant valve to control coolant flow from the IEM to the engine oil heat exchanger further based on at least one of a transmission temperature and an engine oil temperature.

15. The method of claim **14** wherein selectively actuating the coolant valve includes actuating the coolant valve to enable coolant flow from the IEM to the engine oil heat exchanger when:
- (i) the transmission temperature is less than a predetermined temperature; and
- (ii) the oil fuel fraction is greater than a predetermined value.

16. The method of claim **15** wherein selectively actuating the coolant valve includes actuating the coolant valve to prevent coolant flow of from the IEM to the engine oil heat exchanger when the transmission temperature is greater than the predetermined temperature.

17. The method of claim **15** wherein selectively actuating the coolant valve includes actuating the coolant valve to prevent coolant flow from the IEM to the engine oil heat exchanger when the oil fuel fraction is greater than the predetermined value.

18. The method of claim **14** wherein selectively actuating the coolant valve includes actuating the coolant valve to enable coolant flow from the IEM to the engine oil heat exchanger when:
- (i) the engine oil temperature is less than a predetermined temperature; and
- (ii) the oil fuel fraction is greater than a predetermined value.

19. The method of claim **18** wherein selectively actuating the coolant valve includes actuating the coolant valve to prevent coolant flow of from the IEM to the engine oil heat exchanger when the engine oil temperature is greater than the predetermined temperature.

20. The method of claim **19** wherein selectively actuating the coolant valve includes actuating the coolant valve to prevent coolant flow from the IEM to the engine oil heat exchanger when the oil fuel fraction is greater than the predetermined value.

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