SUMMARY

[0008] A first aspect of the present invention provides a power controller for controlling power to be supplied to at least one reefer container on a container vessel, the power controller configured to:

obtain a set temperature for the at least one reefer container to be transported by the container vessel;

obtain data that indicates an amount of energy available to the container vessel from one or more power sources on board the container vessel, wherein the amount of energy available to the container vessel comprises surplus energy that exceeds energy demands of the container vessel; and

determine, based on the surplus energy, whether to cool the at least one reefer container below the set temperature.

[0009] This can allow less energy to be supplied to the at least one reefer container for a period, without affecting goods contained in the at least one reefer container. This in turn may reduce the load on the power supply systems of the container vessel meaning less fuel may be consumed by the vessel during the period. Further, the present invention allows for surplus energy available to the vessel, e.g. generated by an onboard power source, to be converted into thermal energy stored in the sub-cooled reefers. This can help avoid the surplus energy generated onboard the vessel from otherwise being wasted, e.g. while the vessel is sailing between ports.

[0010] Optionally, the amount of energy available to the container vessel comprises energy available from:

one or more power sources onboard the container vessel; and/or

one or more power sources remote from the container vessel, such as shore power.

[0011] Optionally, the one or more power sources onboard the container vessel comprise one or more of:

a heat recovery system located to receive exhaust gases emitted from one or more engines of the container vessel;

a shaft generator coupled to a propeller shaft of the container vessel; and

an energy recovery turbine generator located to receive wastewater from an exhaust gas treatment unit onboard the container vessel.

[0024] A fourth aspect of the present invention provides a method for controlling power to be supplied to at least one reefer container on a container vessel, the method comprising:

obtaining a set temperature for the at least one reefer container to be transported by the container vessel;

obtaining data that indicates an amount of energy available to the container vessel from one or more power sources on board the container vessel, wherein the amount of energy available to the container vessel comprises surplus energy that exceeds energy demands of the container vessel; and

determining, based on the surplus energy, whether to cool the at least one reefer container below the set temperature.

[0025] Optionally, the method comprises:

obtaining load data representative of a load on at least one generator of the container vessel;

obtaining target load data representative of a target load range for the at least one generator,

wherein the amount of energy available to the container vessel comprises surplus energy corresponding to a difference between the load on the at least one generator and a lower bound of the target load range for the generator; and

cooling the at least one reefer container below the set temperature by an amount determined so as to cause the load to increase to a load within the target load range.

[0026] Optionally, the method comprises determining whether to cool the at least one reefer container based on the amount of energy available to the container vessel and at least one other criterion.

[0027] Optionally, the at least one other criterion comprises at least one of:

a location on the container vessel of the at least one reefer container;

a model type of the at least one reefer container;

an amount of energy being supplied to the at least one reefer container;

a type of product contained within the at least one reefer container;

a current internal temperature of the at least one reefer container;

a coefficient of performance of the at least one reefer container; and

CLAIMS:

1. A power controller for controlling power to be supplied to at least one reefer container on a container vessel, the power controller configured to:

obtain a set temperature for the at least one reefer container to be transported by the container vessel;

obtain data that indicates an amount of energy available to the container vessel from one or more power sources on board the container vessel, wherein the amount of energy available to the container vessel comprises surplus energy that exceeds energy demands of the container vessel; and

determine, based on the surplus energy, whether to cool the at least one reefer container below the set temperature.

2. The power controller according to claim 1, wherein the amount of energy available to the container vessel comprises energy available from

one or more power sources remote from the container vessel.

3. The power controller according to claim 2, wherein the one or more power sources onboard the container vessel comprise one or more of:

a heat recovery system located to receive exhaust gases emitted from one or more engines of the container vessel;

a shaft generator coupled to a propeller shaft of the container vessel; and

an energy recovery turbine generator located to receive wastewater from an exhaust gas treatment unit onboard the container vessel.

4. The power controller according to any preceding claim, wherein the power controller is configured to obtain:

load data representative of a load on at least one generator of the container vessel; and

target load data representative of a target load range for the at least one generator;

wherein the surplus energy corresponds to a difference between the load on the at least one generator and a lower bound of the target load range for the generator,

wherein the power controller is configured to cool the at least one reefer container below the set temperature by an amount determined so as to cause the load to increase to a load within the target load range.

5. The power controller according to any preceding claim, wherein the power controller is configured to determine whether to cool the at least one reefer container based on the amount of energy available to the container vessel and at least one other criterion, wherein the at least one other criterion comprises at least one of:

a location on the container vessel of the at least one reefer container;

a model type of the at least one reefer container;

an amount of energy being supplied to the at least one reefer container;

a type of product contained within the at least one reefer container;

a current internal temperature of the at least one reefer container;

a coefficient of performance of the at least one reefer container; and

an external air temperature at the location on the container vessel of the at least one reefer container.

6. The power controller according to any preceding claim, wherein the at least one reefer container comprises plural reefer containers, and wherein the power controller is configured to determine whether to cool at least one of the reefer containers, below a respective set temperature, based on at least one of:

relative internal temperatures of the reefer containers;

relative external air temperatures, at respective locations on the container vessel, of the reefer containers;

relative locations on the container vessel of the reefer containers;

relative coefficients of performance of the reefer containers; and

relative amounts of energy being supplied to the reefer containers.

7. The power controller according to any preceding claim, wherein the power controller being configured to determine whether to cool the at least one reefer container

below the set temperature comprises the power controller being configured to determine whether to reduce the set temperature for the at least one reefer container,

wherein the set temperature comprises a set temperature range, and

wherein the power controller is configured to determine, based on the amount of energy available to the container vessel, whether to reduce a lower bound of the set temperature range.

8. The power controller according to claim 7, wherein the power controller is configured to determine whether to reduce the set temperature from a first set temperature to a second set temperature, wherein the second set temperature is determined based on the amount of energy available to the container vessel.

9. The power controller according to any preceding claim, wherein the power controller is located:

on the container vessel; or

remote from the container vessel

10. A power control system for a container vessel, the power control system comprising:

the power controller according to any preceding claim; and

at least one power interface for supplying energy to the at least one reefer container.

11. A container vessel comprising the power control system according to claim 10.

12. A method for controlling power to be supplied to at least one reefer container on a container vessel, the method comprising:

obtaining a set temperature for the at least one reefer container to be transported by the container vessel;

obtaining data that indicates an amount of energy available to the container vessel from one or more power sources on board the container vessel, wherein the amount of

energy available to the container vessel comprises surplus energy that exceeds energy demands of the container vessel; and

determining, based on the surplus energy, whether to cool the at least one reefer container below the set temperature.

13. The method according to claim 12, comprising:

obtaining load data representative of a load on at least one generator of the container vessel;

obtaining target load data representative of a target load range for the at least one generator, wherein the surplus energy corresponds to a difference between the load on the at least one generator and a lower bound of the target load range for the generator; and

cooling the at least one reefer container below the set temperature by an amount determined so as to cause the load to increase to a load within the target load range.

14. The method according to claim 12 or 13, the method comprising:

determining whether to cool the at least one reefer container based on the amount of energy available to the container vessel and at least one other criterion, wherein the at least one other criterion comprises at least one of:

a location on the container vessel of the at least one reefer container;

a model type of the at least one reefer container;

an amount of energy being supplied to the at least one reefer container;

a type of product contained within the at least one reefer container;

a current internal temperature of the at least one reefer container;

a coefficient of performance of the at least one reefer container; and

an external air temperature at the location on the container vessel of the at least one reefer container.

15. The method according to claim 14, wherein the at least one reefer container comprises plural reefer containers, and wherein the method comprises determining whether to cool at least one of the reefer containers, below a respective set temperature, based on at least one of:

relative internal temperatures of the reefer containers;

relative external air temperatures, at respective locations on the container vessel, of the reefer containers;

relative locations on the container vessel of the reefer containers;

relative coefficients of performance of the reefer containers; and

relative amounts of energy being supplied to the reefer containers.

16. The method according to any one of claims 12 to 15, wherein the determining whether to cool the at least one reefer container comprises determining whether to reduce the set temperature for the at least one reefer container,

wherein the set temperature comprises a set temperature range, and

wherein the method comprises determining, based on the amount of energy available to the container vessel, whether to reduce a lower bound of the set temperature range.

17. The method according to claim 16, comprising:

determining whether to reduce the set temperature from a first set temperature to a second set temperature, wherein the second set temperature is determined based on the amount of energy available to the container vessel.

18. The method according to any one of claims 12 to 17, wherein the obtaining data that indicates the amount of energy available to the container vessel comprises at least one of:

obtaining data that indicates a current amount of energy available to the container vessel; and

estimating an amount of energy that will be available to the container vessel at a future time.

19. A non-transitory machine-readable storage medium storing instructions that, when executed by a controller, cause the controller to carry out the method according to any one of claims 12 to 18.