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United States Patent	12385437
Kind Code	B2
Date of Patent	August 12, 2025
Inventor(s)	Smith; Raub Warfield

Combined cycle power plants with exhaust gas recirculation intercooling

Abstract

A method of operating a combined cycle power plant to facilitate increasing an output of the power plant. The method includes discharging a first exhaust gas stream from a gas turbine engine and extracting heat from the first exhaust gas stream via a heat recovery steam generator. The method also includes discharging a second exhaust gas stream from the heat recovery steam generator, pressurizing a first portion of the second exhaust gas stream using a recirculation compressor, and cooling the first portion of the second exhaust gas stream using a first cooler. The method further includes discharging a cooled exhaust gas stream from the first cooler to the gas turbine engine and modulating, via a controller, a flow and a temperature of the first portion of the second exhaust gas stream recirculated towards the gas turbine engine.

Inventors:	Smith; Raub Warfield (Ballston Lake, NY)
Applicant:	GE Infrastructure Technology LLC (Greenville, SC)
Family ID:	1000008749678
Assignee:	General Electric Company (Schenectady, NY)
Appl. No.:	18/509536
Filed:	November 15, 2023

Prior Publication Data

Document Identifier	Publication Date
US 20240301831 A1	Sep. 12, 2024

Related U.S. Application Data

continuation parent-doc US 17863011 20220712 US 11852074 child-doc US 18509536

Publication Classification

Int. Cl.: F02C7/18 (20060101); F01K23/10 (20060101); F02C3/34 (20060101); F02C7/143 (20060101)

U.S. Cl.:

CPC F02C7/185 (20130101); F01K23/101 (20130101); F02C3/34 (20130101); F02C7/143 (20130101); F05D2220/31 (20130101); F05D2220/32 (20130101); F05D2220/62 (20130101); F05D2220/72 (20130101); F05D2260/213 (20130101)

Field of Classification Search

CPC: F02C (3/34); F02C (3/305); F02C (1/08); F02C (9/16); F02C (9/20); F02C (7/185); F01K (23/10); F01K (23/101); F23C (2202/00); F23C (2202/30)

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Primary Examiner: Chau; Alain

Attorney, Agent or Firm: Armstrong Teasdale LLP

Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS

(1) This application claims the benefit of priority to U.S. patent application Ser. No. 17/863,011, filed Jul. 12, 2022, and entitled “COMBINED CYCLE POWER PLANTS WITH EXHAUST GAS RECIRCULATION INTERCOOLING”, the contents and disclosure of which are hereby incorporated in their entirety.

BACKGROUND

(2) The present disclosure relates generally to power generation systems and, more specifically, to systems that use cooled air or recirculated exhaust gas for compressor intercooling.

(3) Gas turbine systems are used to generate power, and typically include a compressor, a combustor, and a turbine. Operation of the gas turbine system at higher operating temperature generally results in increased performance, efficiency, and power output. As such, during operation various gas path components in the system may be subjected to high temperature flows. Over time, continued exposure to high temperature flows may unduly strain the components and/or reduce their service life. Thus, at least some known gas turbine components that are subjected to high temperature flows are cooled to enable the gas turbine system to continue to operate at the increased temperatures. For example, some components may be provided with compressor bleed air, and the like, for cooling purposes. However, any air compressed in the compressor and not used

to generate combustion gases generally reduces the overall efficiency of the gas turbine system.

BRIEF DESCRIPTION

(4) In one aspect, a method of operating a combined cycle power plant to facilitate increasing an output of the power plant is provided. The method includes discharging a first exhaust gas stream from a gas turbine engine and extracting heat from the first exhaust gas stream via a heat recovery steam generator. The method also includes discharging a second exhaust gas stream from the heat recovery steam generator and pressurizing a first portion of the second exhaust gas stream using a recirculation compressor. The method further includes cooling the first portion of the second exhaust gas stream using a first cooler, discharging a cooled exhaust gas stream from the first cooler to the gas turbine engine, and modulating, via a controller, a flow and a temperature of the first portion of the second exhaust gas stream recirculated towards the gas turbine engine.

(5) In another aspect, a method of increasing an output of a gas turbine engine is provided. The gas turbine engine includes a compressor and a turbine. The method includes discharging a first exhaust gas stream from the turbine of the gas turbine engine, pressurizing a portion of the first exhaust gas stream to discharge a pressurized stream using an admission compressor, and cooling the pressurized stream to discharge a cooled stream using a first cooler. The method also includes receiving the cooled stream at the compressor of the gas turbine engine, monitoring, by a controller, a temperature of the pressurized stream discharged from the admission compressor, and modulating, via the controller, a flow and a temperature of the cooled stream received by the compressor of the gas turbine engine to facilitate maintaining the temperature of the pressurized stream discharged from the admission compressor within a predefined temperature range.

(6) In a further aspect, a method of operating a combined cycle power plant to facilitate increasing an output of the power plant is provided. The method includes discharging a first exhaust gas stream from a gas turbine engine, extracting heat from the first exhaust gas stream via a heat recovery steam generator, and pressurizing an airflow stream channeled towards a compressor of the gas turbine engine using an admission compressor. The method also includes cooling at least one of the airflow stream and the second exhaust gas stream using a first cooler, discharging a cooled exhaust gas stream by the first cooler to the gas turbine engine, and modulating, via a controller, a flow and a temperature of the second exhaust gas stream recirculated towards the gas turbine engine.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. 1 is a schematic illustration of an exemplary combined cycle power plant including an exemplary gas turbine assembly.

(2) FIG. 2 is a schematic illustration of an alternative gas turbine assembly that may be used with the combined cycle power plant shown in FIG. 1.

(3) FIG. 3 is a schematic illustration of another alternative gas turbine assembly that may be used with the combined cycle power plant shown in FIG. 1.

(4) FIG. 4 is a schematic illustration of an alternative combined cycle power plant including a gas turbine assembly.

(5) FIG. 5 is a schematic illustration of another alternative combined cycle power plant including a gas turbine assembly.

(6) FIG. 6 is a schematic illustration of a further alternative combined cycle power plant including a gas turbine assembly.

DETAILED DESCRIPTION

(7) The embodiments described herein relate to power generation systems that use injected cooled air or recirculated exhaust gases for compressor intercooling. While exhaust gas recirculation is

traditionally provided to the inlet of a gas turbine, the systems described herein compress the recirculated exhaust gases to enable it to be channeled into an interstage compressor admission after the gases have been cooled. This effectively turns a simple Brayton cycle engine into an intercooled one. Alternatively, boosted and cooled ambient air may be provided to the compressor interstage admission.

(8) Benefits of derived compressor interstage admission of cooled ambient air or recirculated exhaust gas admission to a gas turbine include: a) power augmentation from the reduction in working fluid temperature from the admission of the cooled stream, as well as a reduction in compressor exit temperature, the combination of which enables more fuel to be burned; b) a reduction in the physical size of exhaust recirculation piping/duct-work versus recirculation to the compressor inlet, thus reducing costs and facilitating an ease of exhaust line routing; c) a reduced gas temperature within, and at the discharge of, the compressor, thereby reducing rotor temperatures and extending a useful life of gas turbine rotor and hot gas path components; and d) usefulness in conventional gas turbine combined cycle systems without exhaust gas recirculation by channeling aftercooled ambient air rather than exhaust gases into the boost compressor, particularly useful for any engine with compressor discharge limits and/or any turbines operating in environments where hot day output is valuable.

(9) Unless otherwise indicated, approximating language, such as “generally,” “substantially,” and “about,” as used herein indicates that the term so modified may apply to only an approximate degree, as would be recognized by one of ordinary skill in the art, rather than to an absolute or perfect degree. Accordingly, a value modified by a term or terms such as “about,” “approximately,” and “substantially” is not to be limited to the precise value specified. In at least some instances, the approximating language may correspond to the precision of an instrument for measuring the value. Additionally, unless otherwise indicated, the terms “first,” “second,” etc. are used herein merely as labels, and are not intended to impose ordinal, positional, or hierarchical requirements on the items to which these terms refer. Moreover, reference to, for example, a “second” item does not require or preclude the existence of, for example, a “first” or lower-numbered item or a “third” or higher-numbered item.

(10) FIG. 1 is a schematic illustration of an exemplary combined cycle power plant **100**. In the exemplary embodiment, power plant **100** includes a gas turbine assembly **102** and a steam turbine **104**. Gas turbine assembly **102** includes a compressor **106**, a combustor **108**, and a turbine **110** coupled together in a serial flow relationship. In operation, combustor **108** receives air from compressor section **106** and fuel from a fuel supply and mixes the fuel and air to create a fuel-air mixture that is combusted to generate combustion gases. Combustion gases are channeled through turbine **110** and discharged from turbine **110** as a first exhaust gas stream **112**. In the exemplary embodiment, power plant **100** also includes a steam cycle arrangement including a heat recovery steam generator (HRSG) **114** and steam turbine **104**. In some embodiments, the steam cycle arrangement may also include other components, including a condenser **116** and at least one circulation pump **117**. Moreover, in other embodiments, the steam cycle arrangement may also include at least one additional HRSG **114**.

(11) In the exemplary embodiment, HRSG **114** includes an inlet **118** that receives first exhaust gas stream **112** from gas turbine assembly **102**. Heat is extracted from first exhaust gas stream **112**, and a second exhaust gas stream **120** is discharged from a first outlet **122**. Second exhaust gas stream **120** is at a lower temperature than a temperature of first exhaust gas stream **112** entering inlet **118**. HRSG **114** also includes a second outlet **124** that discharges a first steam stream **126**. Steam turbine **104** receives first steam stream **126** and subsequently discharges an interstage extraction flow **128** therefrom. Any steam not extracted with flow **128** continues expansion to condensation within condenser **116**. In some embodiments, steam turbine **104** may include additional steam admissions from HRSG **114**. In the exemplary embodiment, gas turbine assembly **102** and steam turbine **104** are both coupled to a generator **132** that produces power using working fluids flowing through

each. Alternatively, turbine assembly **102** and steam turbine **104** may be on separate shafts, with each coupled to a separate generator.

(12) In the exemplary embodiment, power plant **100** also includes a carbon capture system **134**. During operation, carbon capture system **134** produces a carbon dioxide stream **138**. Carbon capture system **134** may include one or more separators, either used alone, or in combination with other separation processes, such as carbon dioxide selective membrane technologies, absorption processes, diaphragms, and the like. An exhaust stream or carbon depleted exhaust stream **140** may be discharged from carbon capture system **134** to the ambient environment. Exhaust stream **140** may also be further processed prior to discharge to the environment or elsewhere. At least a portion of carbon dioxide stream **138** may be increased to supercritical pressure for transport and/or storage, for example.

(13) Carbon capture system **134** generally includes an absorber **142**, a stripper **144**, and a stripper reboiler **146**. In operation, second exhaust gas stream **120** discharged from HRSG **114** is channeled towards absorber **142**. The exhaust gas may be pretreated for removal of particulates and impurities such as SO_x and NO_x before entry into absorber **142**. In addition, in the exemplary embodiment, a first cooler **148** is coupled between HRSG **114** and carbon capture system **134**. Alternatively, carbon capture system **134** may include at least one booster blower (not shown) to pressurize flow channeled towards carbon capture system **134**. First cooler **148** may be, but is not limited to only being, a quench tower. First cooler **148** cools a portion of second exhaust gas stream **120** to be channeled towards carbon capture system **134**. A solvent **152**, rich in carbon dioxide, is discharged from absorber **142** and is then channeled, via a pump **154**, to stripper **144**. A solvent **156**, lean in carbon dioxide, is discharged from stripper **144** and is channeled back to an upper portion of absorber **142** via reboiler **146**, a pump **166**, and heat exchanger **158**. Absorber **142** may be of any construction typical for providing gas-liquid contact and absorption. Absorber **142** and stripper **144** may incorporate a variety of internal components, such as trays, packings, and/or supports, for example. In one embodiment, absorber **142** absorbs carbon dioxide via a countercurrent flow from the entering exhaust gas. Stripper **144** removes carbon dioxide from solvent **152**. Absorber **142** and stripper **144** may be variably sized based on an amount of carbon dioxide to be removed, and may be sized according to various engineering design equations. Furthermore, a single stripper **144** may serve and be coupled to multiple absorbers **142**.

(14) The solvent may be a solution or dispersion, typically in water, of one or more absorbent compounds. More specifically, the solvent may be any compound which when mixed with water creates an absorbent fluid that, as compared to water alone, increases the ability of the fluid to preferentially remove carbon dioxide from exhaust gas. For example, the solvent may be, but is not limited to only being, monethanolamine (MEA). Inhibitors may be included in the solvent to inhibit degradation of the solvent.

(15) In the exemplary embodiment, solvent **152** is preheated in a countercurrent heat exchanger **158** against solvent **156**, and is subsequently channeled to stripper **144**. Stripper **144** is a pressurized unit in which carbon dioxide is recovered from solvent **152**. Stripper **144** generally incorporates reboiler **146** which receives a portion of solvent **156** exiting stripper **144**. Reboiler **146** vaporizes solvent **156** and channels solvent vapor **160** back to stripper **144** to facilitate increased carbon dioxide separation. A single stripper may be coupled to more than one reboiler **146**. Reboiler **146** receives steam, such as from steam turbine **104** via stream **128** to provide heating duty in reboiler **146**.

(16) Vapor **162** exiting stripper **144** is partially condensed in a condenser **136**. The condensed portion of vapor **162** is returned to stripper **144** as reflux **164**. Reflux **164** may be transferred through an accumulator (not shown) and a pump (not shown) before entry into stripper **144**. Carbon dioxide stream **138** is removed from condenser **136** for transport and/or storage after compression.

(17) In the exemplary embodiment, compressor **106** includes an inlet **168**, an outlet **170**, and an

interstage inlet **172** defined therebetween. Power plant **100** includes an admission compressor **174** and a controller **176**. Depending on its use in plant **100**, admission compressor **174** may be configured for use as a recirculation compressor. In the exemplary embodiment, a cooler **178**, also known as an aftercooler, is coupled between admission compressor **174** and interstage inlet **172**. Cooler **178** cools the pressurized air discharged from compressor **174** to define a cooled admission stream **180**. More specifically, cooler **178** discharges cooled stream **180** towards interstage inlet **172** to facilitate improving the performance of plant **100**, as described herein.

(18) However, power consumption from the operation of any booster blowers and/or compressor **174** will reduce plant output. The interstage cooling provided to compressor **106** by compressor **174** and its aftercooler **178**, facilitates improving the output of power plant **100** by reducing compression work in compressor **106** and by enabling more fuel to be combusted in combustor **108**.

(19) For example, controller **176** may monitor the power consumption of any booster blower and/or compressor **174**, (and any large auxiliaries in a particular plant) and may also determine steam cycle losses resulting from discharging steam stream **128** towards carbon capture system **134**, for example. Controller **176** may also dynamically determine the power consumption and steam cycle losses, and adjust operation of power plant **100** accordingly. Accordingly, in one embodiment, operation of any booster blower, and/or compressor **174** (and/or any other large auxiliary loads) is adjusted by controller **176** to facilitate improving plant output to a level that overcomes power consumption and steam cycle losses. That is, controller **176** may selectively modulate the flow of any stream channeled into compressor **106** as described herein, to provide an improvement to the output of power plant. In one exemplary embodiment, plant output boost should be increased by at least about 5% to about 10% using the cooled injection versus the providing about the same exhaust gas flow recirculation to the gas turbine inlet. Moreover, because the temperature of compressor exhaust discharge can be more easily controlled, bigger performance gains are possible on hot days where the temperature of compressor exhaust discharge can typically be limiting in at least some known power generation systems.

(20) One exemplary gas turbine parameter that may be monitored to determine improvements in gas turbine output is compressor discharge temperature. In the exemplary embodiment, power plant **100** includes a sensor (not shown) coupled at outlet **170** for use in monitoring the temperature of the compressed gas discharged therefrom. Controller **176** may then modulate cooled stream **180** provided to interstage inlet **172** to maintain the compressor discharge temperature within a predefined temperature range. Controller **176** facilitates extending the useful life of components within power plant **100**. Thus, the flow modulation provides an option for operators of power plant **100** to use when determining how to optimize performance of power plant **100**.

(21) It should be noted that gas turbine assembly **102** may be used independently of HRSG **114** and carbon capture system **134**. In other words, turbine assembly **102** may be operated as a simple gas turbine assembly **102** that uses cooled interstage air admission provided via admission compressor **174** and cooler **178**. More specifically, in the exemplary embodiment, when turbine assembly **102** is used as a stand-alone, simple cycle gas turbine, assembly **102** operates with cooled interstage air admission, and without inlet boost (shown on FIG. 2 and FIG. 3).

(22) The operation of gas turbine assembly **102** as a simple gas turbine facilitates eliminating a need for higher-cost rotor alloys or additional cooling air, and rather enables the use of steel compressor wheels, especially in operating conditions, such as hot days, where compressor exit air temperatures tend to be highest. In addition, the physical size and cost of cooler **178** is relatively modest in comparison to known power plant systems used to chill air flow to gas turbine inlets because the airflow is lower and the operating temperature of flow entering cooler **178** is higher in relation to the heat sink (ambient). Moreover, admission air facilitates power augmentation because the admission air facilitates reducing work required of compressor **106** while still reducing compressor exhaust discharge temperature.

(23) FIG. 2 is a schematic illustration of an alternative gas turbine assembly **102** that may be used with combined cycle power plant **100** (shown in FIG. 1.) Unlike the embodiment of FIG. 1, which illustrates an un-boosted gas turbine assembly **102**, in FIG. 2, in the exemplary embodiment of FIG. 2, gas turbine assembly **102** utilizes an external inlet boost blower **182**. More specifically, in the exemplary embodiment, external air boost blower **182** pressurizes an airflow stream **188** channeled into inlet **168** of compressor **106**. Boost blower **182** can be used to supercharge gas turbine assembly **102** such that enhanced or improved gas turbine output is facilitated. In addition, the combination of boost blower **182** and cooled admission stream **180** supplied to compressor **106** enables controller **176** (shown in FIG. 1) to provide enhanced control of the discharge temperature of compressor **106**, thus increasing power augmentation potential from turbine assembly **102**.

(24) FIG. 3 is a schematic illustration of a another alternative gas turbine assembly **102** that may be used with combined cycle power plant **100** (shown in FIG. 1). Unlike the embodiment of FIG. 1, which illustrates an un-boosted gas turbine assembly **102**, and the embodiment in FIG. 2, which illustrates an external boost blower, in the exemplary embodiment of FIG. 3, gas turbine assembly utilizes a shaft-driven boost compressor **190**. More specifically, in the exemplary embodiment, turbine assembly includes a shaft-driven, inlet boost compressor **190** that pressurizes an ambient airflow stream **194** channeled towards interstage inlet **172** of compressor **106**. Similar to boost blower **182** (shown in FIG. 2), compressor **190** may be used to supercharge gas turbine assembly **102**. However, compressor **190** is capable of providing an increased supercharged flow to gas turbine assembly **102** as compared to boost blower **182**. The increased supercharge facilitates enhancing the gas turbine output over even that of boost blower **182**. The combination of compressor **190** and cooled admission stream **180** supplied to compressor **106** enables controller **176** (shown in FIG. 1) to provide enhanced control of the discharge temperature of compressor **106**, thus increasing power augmentation potential from turbine assembly **102**.

(25) It should be noted that any of the gas turbine assemblies shown in FIGS. 1-3 may be used with or without carbon capture system **134**. Moreover, in some embodiments, any of the gas turbine assemblies **102** described herein may be used with recirculated exhaust gas admission, i.e., compressed aftercooled exhaust flow, rather than compressed aftercooled admission stream **180**. In such embodiments, the recirculated exhaust gas may be routed from downstream or upstream of first cooler.

(26) FIG. 4 is a schematic illustration of an alternative combined cycle power plant **100** (shown in FIG. 1) including gas turbine assembly **102**. The embodiment illustrated in FIG. 4 is similar to the embodiment illustrated in FIG. 1, with the differences noted herein, below, and as such, the same reference numbers are used in FIG. 4 as were used in FIG. 1. In FIG. 4, plant **100** utilizes exhaust gas recirculation **402** with post combustion carbon capture system **134**. An exhaust gas recirculation stream **402** is drawn downstream from first cooler **148** and is channeled towards an exhaust gas recirculation compressor **404**.

(27) A cooler **406** is coupled between recirculation compressor **404** and interstage inlet **172**. Cooler **406** cools the pressurized air discharged from compressor **404** to define a cooled admission stream **180**. More specifically, cooler **406** discharges cooled stream **180** towards interstage inlet **172** to facilitate improving the performance of plant **100**, as described herein. In the exemplary embodiment, because stream **402** is drawn from downstream from cooler **148**, the exhaust stream has been scrubbed and cooled and as such compression power for the recirculation compressor **404** is facilitated to be reduced, as well as after cooling needed to facilitate control of compressor discharge temperature.

(28) In the exemplary embodiment, wherein compressed aftercooled air is supplied to interstage inlet **172**, the pressurized air stream **180** is clean and as such, cooler **406** and admission compressor **404** may be physically located relatively close to cooler **148** such that piping diameter for steam **180** and plant costs are facilitated to be reduced. In embodiments wherein an existing plant is retrofitted, compressor **106** may be configured to use exhaust gas discharged from compressor **404**.

In such embodiments, assembly **102** not only gains the benefits described above, but also gains those performance benefits typically associated with exhaust gas recirculation including, but not limited to, vitiated combustion, higher exhaust carbon dioxide emissions, and lower nitrous oxide emissions, for example. Moreover, in the exemplary embodiment, the combination of the operation and pressurization of gas turbine assembly **102** and HRSG system **114** facilitates overcoming the draft losses through the cooler, i.e., quench tower **148**, and carbon capture system **134**. In other alternative embodiments, a booster fan may be used within carbon capture system **134** depending on equipment and plant design constraints, and economic considerations.

(29) FIG. **5** is a schematic illustration of another alternative combined cycle power plant **100** including a gas turbine assembly **102**. FIG. **6** is a schematic illustration of yet a further alternative combined cycle power plant **100** including a gas turbine assembly **102**. Each alternative embodiment is similar to the embodiment illustrated in FIG. **1**, with the differences noted below, and as such, the same reference numbers are used in FIGS. **5** and **6** as were used in FIG. **1**.

(30) In FIG. **5**, plant **100** utilizes exhaust gas recirculation **402** with post carbon capture system **134**. Moreover, in the exemplary embodiment illustrated in FIG. **5**, generally plant **100** uses an aftercooled compressed exhaust gas recirculation admission channeled to the main gas turbine, combined with exhaust gas recirculation to the gas turbine inlet. More specifically, an exhaust gas recirculation stream **402** is drawn downstream from first cooler **148** and a portion **502** is channeled towards an exhaust gas recirculation compressor **404**. A cooler **406** is coupled between recirculation compressor **404** and interstage inlet **172**. Cooler **406** cools the pressurized air discharged from compressor **404** to define a cooled admission stream **180**. More specifically, cooler **406** discharges cooled stream **180** towards interstage inlet **172** to facilitate improving the performance of plant **100**, as described herein.

(31) The remaining portion **504** of exhaust gas recirculation stream **402** drawn downstream from cooler **148** is channeled towards an exhaust gas boost blower **506**. Boost blower **506** discharges a pressurized and cooled flow **510** towards compressor inlet **168**. In the exemplary embodiment, because stream **402** is drawn from downstream from cooler **148**, the exhaust stream has been scrubbed and cooled. The combination of exhaust gas recirculation compressor **404** and exhaust gas blower **506** facilitates maximizing the total exhaust gas recirculation flow with the use of existing gas turbines within plant **100**. More specifically, in the exemplary embodiment of FIG. **5**, because the exhaust gas boost blower **506** is combined or paired with the inlet air boost blower **182**, gas turbine compressor **106** can operate with an inlet pressure that is greater than ambient or atmospheric pressure such that plant power output is facilitated to be optimized.

(32) Moreover, the embodiment shown in FIG. **5** also enables any losses associated with stream extraction to the carbon capture system **134** to be overcome. More specifically, within the plant embodiment illustrated in FIG. **5**, plant **100** is sufficiently pressurized such that any plant output losses associated with operating the carbon capture system **134** are overcome.

(33) The embodiment illustrated in FIG. **6** is similar to the embodiment illustrated in FIG. **5**, however the exhaust gas recirculation compressor draws exhaust gas recirculation **502** from downstream of exhaust gas boost blower **506** rather than before stream **402** enters blower **506** as is shown in FIG. **5**. Such an embodiment may facilitate simplifying exhaust gas recirculation flow control and thus facilitate reducing overall plant costs since compressor **404** and its associated piping may be located physically closer to turbine assembly **102**.

(34) The embodiments described herein relate to providing cooled ambient air or recirculated exhaust gas admission to a gas turbine compressor admission. Conventional exhaust gas recirculation heats the gas turbine inlet, thus reducing the density of working fluid flow entering the compressor and thus, gas turbine and plant output. Compressor exit temperature can also be limited and/or controlled using the cooled interstage admission and control scheme described herein. Accordingly, the embodiments described herein facilitate power augmentation, a reduction in the physical size of exhaust recirculation piping/duct, and a reduced gas temperature within, and at the

discharge of, the compressor.

(35) Further aspects of the present disclosure are provided by the subject matter of the following clauses:

(36) A method of operating a combined cycle power plant to facilitate increasing an output of the power plant, the method comprising: discharging a first exhaust gas stream from a gas turbine engine; extracting heat from the first exhaust gas stream via a heat recovery steam generator; discharging a second exhaust gas stream from the heat recovery steam generator; pressurizing a first portion of the second exhaust gas stream using a recirculation compressor; cooling the first portion of the second exhaust gas stream using a first cooler; discharging a cooled exhaust gas stream from the first cooler to the gas turbine engine; and modulating, via a controller, a flow and a temperature of the first portion of the second exhaust gas stream recirculated towards the gas turbine engine.

(37) The method in accordance with any of the preceding clauses, further comprising: discharging a steam stream from a steam turbine; receiving the steam stream at a carbon capture system; monitoring, by the controller, power consumption of the recirculation compressor; and modulating, via the controller, a flow of the steam stream to the carbon capture system based on power consumption of the recirculation compressor.

(38) The method in accordance with any of the preceding clauses, wherein the first exhaust gas stream discharged from the gas turbine engine is a stream discharged from a compressor within the gas turbine engine.

(39) The method in accordance with any of the preceding clauses, further comprising: monitoring, by the controller, a temperature of the compressor discharge stream; and modulating, via the controller, a flow of the cooled exhaust gas stream to the gas turbine engine to facilitate maintaining the temperature of the compressor discharge stream within a predefined temperature range.

(40) The method in accordance with any of the preceding clauses, wherein discharging the cooled exhaust gas stream from the first cooler comprises discharging the cooled exhaust gas stream to an interstage inlet of a compressor of the gas turbine engine.

(41) The method in accordance with any of the preceding clauses, further comprising receiving a second portion of the second exhaust gas stream via an exhaust gas recirculation line.

(42) The method in accordance with any of the preceding clauses, further comprising receiving, via a splitter, the second exhaust gas stream, wherein the splitter separates the second exhaust gas stream into the first portion, the second portion, and a third portion, and wherein the splitter is sized to define the first portion to be between about 5% to about 10% of the second exhaust gas stream, the second portion to be less than about 40% of the second exhaust gas stream, and the third portion to be a remainder by mass of the second exhaust gas stream.

(43) The method in accordance with any of the preceding clauses, further comprising receiving the third portion of the second exhaust gas stream at a carbon capture system.

(44) The method in accordance with any of the preceding clauses, further comprising cooling the third portion of the second exhaust gas stream channeled towards the carbon capture system using a second cooler between the heat recover steam generator and the carbon capture system.

(45) The method in accordance with any of the preceding clauses, further comprising receiving, by an exhaust gas boost blower, the second exhaust gas stream to be channeled towards the recirculation compressor.

(46) A method of increasing an output of a gas turbine engine, the gas turbine engine comprising a compressor and a turbine, the method comprising: discharging a first exhaust gas stream from the turbine of the gas turbine engine; pressurizing a portion of the first exhaust gas stream to discharge a pressurized stream using an admission compressor; cooling the pressurized stream to discharge a cooled stream using a first cooler; receiving the cooled stream at the compressor of the gas turbine engine; monitoring, by a controller, a temperature of the pressurized stream discharged from the

admission compressor; and modulating, via the controller, a flow and a temperature of the cooled stream received by the compressor of the gas turbine engine to facilitate maintaining the temperature of the pressurized stream discharged from the admission compressor within a predefined temperature range.

(47) The method in accordance with any of the preceding clauses, further comprising pressurizing an airflow stream prior to the airflow stream being received by the turbine of the gas turbine engine and discharged as the first exhaust gas stream using an external inlet boost blower.

(48) The method in accordance with any of the preceding clauses, further comprising pressurizing an airflow stream prior to the airflow stream being received by the turbine of the gas turbine engine and discharged as the first exhaust gas stream using an inlet boost compressor rotatably coupled to the compressor of the gas turbine engine.

(49) The method in accordance with any of the preceding clauses, further comprising monitoring, by the controller, a temperature of a compressor discharge stream discharged from the compressor of the gas turbine engine.

(50) The method in accordance with any of the preceding clauses, further comprising supercharging the gas turbine engine using an external inlet boost blower.

(51) The method in accordance with any of the preceding clauses, further comprising supercharging the gas turbine engine using a shaft-driven inlet boost compressor.

(52) A method of operating a combined cycle power plant to facilitate increasing an output of the power plant, the method comprising: discharging a first exhaust gas stream from a gas turbine engine; extracting heat from the first exhaust gas stream via a heat recovery steam generator; discharging a second exhaust gas stream from the heat recovery steam generator; pressurizing an airflow stream channeled towards a compressor of the gas turbine engine using an admission compressor; cooling at least one of the airflow stream and the second exhaust gas stream using a first cooler; discharging a cooled exhaust gas stream by the first cooler to the gas turbine engine; and modulating, via a controller, a flow and a temperature of the second exhaust gas stream recirculated towards the gas turbine engine.

(53) The method in accordance with any of the preceding clauses, wherein discharging the cooled exhaust gas stream to the gas turbine engine by the first cooler comprises discharging the cooled exhaust gas stream to an interstage inlet of a compressor of the gas turbine engine.

(54) The method in accordance with any of the preceding clauses, further comprising: discharging a steam stream from a steam turbine; receiving the steam stream at a carbon capture system; monitoring, by the controller, power consumption of the admission compressor; and modulating, via the controller, a flow of the steam stream to the carbon capture system based on power consumption of the admission compressor.

(55) The method in accordance with any of the preceding clauses, further comprising: discharging a compressor discharge stream from a compressor of the gas turbine engine; monitoring, by the controller, a temperature of the compressor discharge stream; and modulating, via the controller, at least one of a flow of the cooled exhaust gas stream and a temperature of the cooled exhaust gas stream to facilitate maintaining the temperature of the compressor discharge stream within a predefined temperature range.

(56) The above description is meant to be exemplary only, and one skilled in the art will recognize that changes may be made to the embodiments described without departing from the scope of the invention disclosed. Modifications, which fall within the scope of the present invention, will be apparent to those skilled in the art, in light of a review of this disclosure, and such modifications are intended to fall within the appended claims. The systems and methods described herein are not limited to the specific embodiments described herein, but rather components of the various systems may be utilized independently and separately from other systems and components described herein. For example, the cooled interstage admission can be implemented and utilized in connection with any application where enhanced output is desired.

(57) Although specific features of various embodiments of the invention may be shown in some drawings and not in others, this is for convenience only. Moreover, references to “one embodiment” in the above description are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the recited features. In accordance with the principles of the invention, any feature of a drawing may be referenced and/or claimed in combination with any feature of any other drawing.

(58) While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.

Claims

1. A method of operating a combined cycle power plant to facilitate increasing an output of the power plant, the method comprising: discharging a first exhaust gas stream from a gas turbine engine, the gas turbine engine including a compressor; extracting heat from the first exhaust gas stream via a heat recovery steam generator; discharging a second exhaust gas stream from the heat recovery steam generator; pressurizing a first portion of the second exhaust gas stream using a recirculation compressor; cooling the first portion of the second exhaust gas stream using a first cooler; discharging a cooled exhaust gas stream from the first cooler to the gas turbine engine; discharging a steam stream from a steam turbine; modulating, via a controller, a flow and a temperature of the first portion of the second exhaust gas stream recirculated towards an interstage inlet of the compressor for the gas turbine engine to facilitate increasing the output of the power plant; monitoring, by the controller, power consumption within at least a portion of the combined cycle power plant; and modulating, via the controller, a flow of the steam stream discharged from the steam turbine based on the monitored power consumption.
2. The method in accordance with claim 1, further comprising: receiving the steam stream at a carbon capture system; and modulating, via the controller, the flow of the steam stream to the carbon capture system based on power consumption of the recirculation compressor.
3. The method in accordance with claim 1, wherein the first exhaust gas stream discharged from the gas turbine engine is formed at least partially from a compressor discharge stream discharged from a compressor of the gas turbine engine.
4. The method in accordance with claim 3, further comprising: monitoring, by the controller, a temperature of the compressor discharge stream; and modulating, via the controller, a flow of the cooled exhaust gas stream to the gas turbine engine to facilitate maintaining the temperature of the compressor discharge stream within a predefined temperature range.
5. The method in accordance with claim 1, wherein discharging the cooled exhaust gas stream from the first cooler comprises discharging the cooled exhaust gas stream to the interstage inlet of the compressor of the gas turbine engine.
6. The method in accordance with claim 1, further comprising receiving a second portion of the second exhaust gas stream via an exhaust gas recirculation line.
7. The method in accordance with claim 6, further comprising receiving, via a splitter, the second exhaust gas stream, wherein the splitter separates the second exhaust gas stream into the first portion, the second portion, and a third portion, and wherein the splitter is sized to define the first portion to be between about 5% to about 10% of the second exhaust gas stream, the second portion to be less than about 40% of the second exhaust gas stream, and the third portion to be a remainder by mass of the second exhaust gas stream.
8. The method in accordance with claim 7, further comprising receiving the third portion of the second exhaust gas stream at a carbon capture system.
9. The method in accordance with claim 8, further comprising cooling the third portion of the second exhaust gas stream channeled towards the carbon capture system using a second cooler

between the heat recover steam generator and the carbon capture system.

10. The method in accordance with claim 1, further comprising receiving, by an exhaust gas boost blower, the second exhaust gas stream to be channeled towards the recirculation compressor.

11. A method of increasing an output of a gas turbine engine, the gas turbine engine including a compressor and a turbine, the method comprising: coupling an external inlet boost blower to the gas turbine engine to pressurize an airflow stream received by the turbine; discharging a first exhaust gas stream from the turbine of the gas turbine engine; pressurizing a portion of the first exhaust gas stream to discharge a pressurized stream using an admission compressor; cooling the pressurized stream to discharge a cooled stream using a first cooler; receiving the cooled stream at the compressor of the gas turbine engine; monitoring, by a controller, a temperature of the pressurized stream discharged from the admission compressor; and modulating, via the controller, a flow and a temperature of the cooled stream provided to an interstage inlet of the compressor of the gas turbine engine using the admission compressor and the first cooler, and based on operating parameters monitored by the controller, to facilitate maintaining the temperature of the pressurized stream discharged from the admission compressor within a predefined temperature range and increasing the output of the gas turbine engine.

12. The method in accordance with claim 11, further comprising monitoring, by the controller, a temperature of a compressor discharge stream discharged from the compressor of the gas turbine engine.

13. The method in accordance with claim 11, further comprising supercharging the gas turbine engine using the external inlet boost blower.

14. The method in accordance with claim 11, further comprising supercharging the gas turbine engine using a shaft-driven inlet boost compressor.

15. The method in accordance with claim 14, wherein discharging a stream cooled by the first cooler comprises discharging the cooled stream to an interstage inlet of a compressor of the gas turbine engine.

16. A method of operating a combined cycle power plant to facilitate increasing an output of the power plant, the method comprising: discharging a first exhaust gas stream from a gas turbine engine; extracting heat from the first exhaust gas stream via a heat recovery steam generator; discharging a second exhaust gas stream from the heat recovery steam generator; pressurizing an airflow stream channeled towards a compressor of the gas turbine engine using an admission compressor; cooling at least one of the airflow stream and the second exhaust gas stream using a first cooler; discharging a stream cooled by the first cooler to the gas turbine engine; discharging a steam stream from a steam turbine; modulating, via a controller, a flow and a temperature of the second exhaust gas stream recirculated towards the gas turbine engine monitoring, by the controller, power consumption within at least a portion of the combined cycle power plant; modulating, via the controller, a flow of the steam stream discharged from the steam turbine based on the monitored power consumption; receiving the steam stream at a carbon capture system; monitoring, by the controller, power consumption of the admission compressor; and modulating, via the controller, a flow of the steam stream to the carbon capture system based on power consumption of the admission compressor.

17. The method in accordance with claim 16, further comprising: discharging a compressor discharge stream from a compressor of the gas turbine engine; monitoring, by the controller, a temperature of the compressor discharge stream; and modulating, via the controller, at least one of a flow of the cooled stream and a temperature of the cooled stream to facilitate maintaining the temperature of the compressor discharge stream within a predefined temperature range.
