E-101/16165/2013.

ABSTRACT

The invention relates to A Heat recovery heat exchanger to recover heat from pressurized hot gas heated by solar dish. The said heat exchanger comprises a first pass cylindrical shell and second passes cylindrical shell. The said first pass shell provided with an outer shell having half pipe limpet jacket. The heating areas namely, HP Super heater, HP Evaporator and LP Super heater provided inside the said first shell forming unfired boiler. An inlet for hot gas provided to the one end of the said cylindrical first pass shell with first convergent end cover. An outlet for hot gas provided to the other end to the said first pass shell with second convergent cover. The heat recovery heating areas namely HP first Economizer, LP Evaporator and HP second Economizer, liquid Preheater of unfired boiler enclosed in the said second pass outer shell. An inlet for hot gas provided to the one end of the said cylindrical second pass shell with third convergent end cover. An outlet for hot gas provided to the other end to the said second pass shell with forth convergent cover. The said out let of first pass shell connected to the inlet of the second pass shell. An inlet and an outlet provided for liquid to be heated in the said heating areas.

WE CLAIM:- E-101/1618/2013.

1. A Heat recovery heat exchanger to recover heat from pressurized hot gas heated by solar dish comprises a first pass cylindrical shell and second pass cylindrical shell; the said first pass shell provided with an outer shell having half pipe limpet jacket ; the heating areas namely, HP Super heater , HP Evaporator and LP Super heater provided inside the said first shell forming unfired boiler; an inlet for hot gas provided to the one end of the said cylindrical first pass shell with first convergent end cover; an outlet for hot gas provided to the other end to the said first pass shell with second convergent cover; the heat recovery heating areas namely HP first Economizer , LP Evaporator and HP second Economizer ,liquid Preheater of unfired boiler enclosed in the said second pass outer shell; an inlet for hot gas provided to the one end of the said cylindrical second pass shell with third convergent end cover; an outlet for hot gas provided to the other end to the said second pass shell with forth convergent cover; the said out let of first pass shell connected to the inlet of the second pass shell; an inlet and an outlet provided for liquid to be heated in the said heating areas.
2. A heat recovery heat exchanger as claimed in claim 1 wherein the said first pass shell provided with the said HP super heater at hot gas inlet side, the said LP super heater at hot gas out let side, and said HP evaporator in the middle portion; the said second pass shell provided with first HP economizer at hot gas inlet side, adjacent to said first HP economizer a LP evaporator, adjacent to said LP evaporator a second HP economizer, and adjacent to said second HP economizer a water pre heater at hot gas out let side.
3. A Heat recovery heat exchanger as claimed in claim1 wherein the said heating areas having fluid tubes of heat recovery heat exchanger provided to generate high pressure steam, or thermal oil or pressurized hot water.
4. A Heat recovery heat exchanger as claimed in claims 1 and 2 wherein The heat recovery heat exchanger to have maximum heat recovery provided with means through various configurations, numbers and arrangements of convection banks (Like super heater, evaporator, economizer, condensate Preheater), depending of various factors such as flow, pressure, temperature of gas and the end application of the heat recovered.

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5. A Heat recovery heat exchanger as claimed in claims 1 to 3 4 wherein the solar heated hot gas at inlet of the said first pass is at 600^0 C temperature and The air pressure is maintained at 4 Kg/cm2, and the hot air coming from first pass outer shell at 317 °C (Max. 318 °C) is supplied to the inlet of Heat Recovery second pass outer shell.
6. A Heat recovery heat exchanger as claimed in claims 1 to 4 5 wherein the first pass outer shell material is SA-516 Gr. 70, and normally has thickness of 16 mm Thick and thickness and material of shell may vary as per the applicable pressure vessel code.

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FIELD OF THE INVENTION:-

E-101/16167/2013.

Present invention relates to a heat recovery heat exchanger to recover heat from pressurized hot gas. More particularly the present invention relates to recovering heat from pressurized hot air to generate superheated steam in a water tube type unfired steam boiler. Further, the present invention relates to a heat recovery steam generator working under fluctuating supply of heat from the source such as solar dish etc.

PRIOR ART:-

There are no such heat recovery heat exchanger to recover heat from pressurized hot gas available in the prior art. It is the first of its kind heat recovery heat exchanger to recover heat from pressurized hot gas.

OBJECT OF THE INVENTION:-

Object of the present invention is to develop a "Heat recovery heat exchanger to recover heat from pressurized hot gas" for generating steam in a water tube type unfired steam boiler.

It is also the object of the present invention to develop a heat recovery steam generator working under fluctuating supply of heat from the source such as solar dish

STATEMENT OF INVENTION:-

Accordingly, present invention provides a heat recovery heat exchanger to recover heat from pressurized hot gas heated by solar dish comprises a first pass cylindrical shell and second pass cylindrical shell; the said first pass shell provided with an outer shell having half pipe limpet jacket ; the heating areas namely, HP Super heater , HP Evaporator and LP Super heater provided inside the said first shell forming unfired boiler; an inlet for hot gas provided to the one end of the said cylindrical first pass shell with first convergent end cover; an outlet for hot gas provided to the other end to the said first pass shell with second convergent

cover; the heat recovery heating areas namely HP first Economizer , LP Evaporator and HP second Economizer ,liquid Preheater of unfired boiler enclosed in the said second pass outer shell; an inlet for hot gas provided to the one end of the said cylindrical second pass shell with third convergent end cover; an outlet for hot gas provided to the other end to the said second pass shell with forth convergent cover; the said out let of first pass shell connected to the inlet of the second pass shell; an inlet and an outlet provided for liquid to be heated in the said heating areas.

BRIEF DESCRIPTION OF THE SCHEMATIC DRAWING:-

The invention is described with reference to the accompanying drawing wherein,
Figure.1 describes simplified flow diagram of the heat recovery heat exchanger in accordance with the present invention.

DETAILED DESCRIPTION OF THE PRESENT INVENTION:-

Now referring to fig. 1 is a heat recovery heat exchanger recovering heat from pressurized hot gas for generating steam in a two pass water tube type unfired steam boiler according to the present invention. For example, the present invention finds an application on recovering heat from pressurized hot air generated by a Solar Concentrator dish. The heat recovery steam generator in the present invention is an unfired steam boiler / steam generator having two-pass water tube type construction.

The hot air is coming from a Solar Dish at 600 °C (Max. 650 °C) is supplied to the inlet (1) of Heat Recovery Steam Generator's first pass outer shell (4) which is having half limpet jacket (2). Water flows through half limpet jacket protecting the shell metal from getting overheated. Due to this construction feature according to the present invention, allows use of ordinary boiler quality carbon lii steel material for construction of shell. Due to this, exotic materials need not be used for construction of shell. The heating areas namely, HP Superheater (3), HP Evaporator (5) and LP Superheater (6) of unfired steam boiler are enclosed in this first pass outer shell. When air enters the first pass outer shell, it is passed over a tube bank of HP

superheater, HP evaporator and LP Superheater to generate superheated steam. The heat is transferred from hot gas to the steam flowing in HP and LP superheater and water flowing through evaporator. As a result of this heat exchange, the temperature of gas drops to about 317 ^{0}C as it exits the first pass (7). The first pass outer shell material is SA-516 Gr. 70, and has thickness of 16 mm Thick. The thickness and material of shell could vary as per the applicable pressure vessel code. The air pressure is maintained at 4 Kg/cm2 (a) in the outer shell.

The heat recovery steam generator in the present invention operates under fluctuating supply of heat from source such as Solar Dish wherein the inlet air temperature starts raising everyday at 6:00 am and in 20 minutes it reaches upto 600 °C. The inlet air (1) is maintained at this temperature from 6:00am to 4:00pm. After recovery of heat in the boiler, air comes out at 317 °C from LP superheater outlet (7) and it is sent to the second pass outer shell (11) through an interconnecting conveying duct (8).

The hot air coming from first pass outer shell at 317 °C (Max. 318 °C) is supplied to the inlet (9) of Heat Recovery Steam Generator's second pass outer shell (11). The heating areas namely, HP Economizer 1 (10), LP Evaporator (12) and HP Economizer 2 (13), Water Preheater (14) of unfired steam boiler are enclosed in this second pass outer shell. When air enters the second pass outer shell, it is passed over a tube bank of HP Economizer 1, LP Evaporator and HP Economizer 2, Water Preheater to generate superheated steam.

The first pass outer shell material is SA-516 Gr. 70, and has thickness of 16 mm Thick. The thickness and material of shell could vary as per the applicable pressure vessel code. The air pressure is maintained at 4 Kg/cm2 (a) in the outer shell. The air from exit of first pass is supplied to second pass outer shell at 318 ^{0}C temperature from 6:00am to 4:00pm. After recovery of heat in the boiler, air comes out at 102 °C from Water Preheater Heater (WPH) outlet (15) and it is sent to the atmosphere.

The first pass shell and second pass shell having end closures converging type provided with opening to form out let for hot gases.

An inlet and an outlet provided for liquid to be heated in the heat exchanger.

ADVANTAGES AND FEATURES OF THE PRESENT INVENTION:-

1. The present invention relates to a heat recovery heat exchanger which can attract renewable energy fiscal benefits as it finds application in recovering solar energy for generating high pressure steam or hot thermal oil or pressurized hot water.
2. Solar heat recovery from the pressurized gas / Hot air medium in close loop system with zero hot air leakage.
3. Steam generator operating for solar heat recovery independently for power generation with superheated steam temperature such as 620 Deg ^{0}C at 82 bar (g).
4. Daily on - off type heat exchanger operating under Fatigue load conditions.
5. Hot air entrance portion of the outer shell with half pipe jacketing controls the metal temperature and allows use of the regular carbon steel material for heat exchanger application. This helps keep the cost of heat exchanger affordable.
6. All convection banks (Like super heater, evaporator, economizer, condensate Preheater) are designed for External positive hot air pressure of 15 bar (g) and internal water / steam pressure of 100bar (g) etc.
7. First pass of the pressurized gas / Hot air guide shell designed with internal hot air pressure of 15 bar(g) and external water / steam pressure of 100 bar (g) in half pipe jacket area.
8. Designed with minimum hot air pressure loss on hot air side. (200mmwc).
9. Designed with hot air guide to convection bank (Like super heater, evaporator, economizer, condensate Preheater) to minimize the hot air contact with outer shell.
10. Designed with all boiler accessories like economizer, condensate Preheater for maximum heat recovery.
11. Natural circulation type steam generator.

VARIATIONS POSSIBLE TO BE COVERED AND PROVIDED WITHIN THE INVENTION OF HEAT RECOVERY HEAT EXCHANGER TO RECOVER HEAT FROM PRESSURIZED HOT GAS:-

1. The heat recovery heat exchanger can be designed to generate high pressure steam, or thermal oil or pressurized hot water
2. The heat recovery heat exchanger can be designed such as to have maximum heat recovery through various configurations, numbers and arrangements of convection banks (Like super heater, evaporator, economizer, condensate Preheater). These shall vary depending of various factors such as flow, pressure, temperature of gas and the end application of the heat recovered.

TYPICAL APPLICATION AREAS:-

1. Heat recovery for converting solar energy to other useful forms of energy such as heat energy, mechanical energy and, electricity.
2. The heat recovered in form of high pressure steam can be used for process application or to drive Steam Rankine cycle based power plant for electricity generation
3. The heat recovered in form of hot thermal oil or pressurized hot water can be used for process use or to drive Organic Rankine cycle based power plant for electricity
   generation

WE CLAIM:- E-101/1618/2013.

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2. A heat recovery heat exchanger as claimed in claim 1 wherein the said first pass shell provided with the said HP super heater at hot gas inlet side, the said LP super heater at hot gas out let side, and said HP evaporator in the middle portion; the said second pass shell provided with first HP economizer at hot gas inlet side, adjacent to said first HP economizer a LP evaporator, adjacent to said LP evaporator a second HP economizer, and adjacent to said second HP economizer a water pre heater at hot gas out let side.
3. A Heat recovery heat exchanger as claimed in claim1 wherein the said heating areas having fluid tubes of heat recovery heat exchanger provided to generate high pressure steam, or thermal oil or pressurized hot water.
4. A Heat recovery heat exchanger as claimed in claims 1 and 2 wherein The heat recovery heat exchanger to have maximum heat recovery provided with means through various configurations, numbers and arrangements of convection banks (Like super heater, evaporator, economizer, condensate Preheater), depending of various factors such as flow, pressure, temperature of gas and the end application of the heat recovered.

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5. A Heat recovery heat exchanger as claimed in claims 1 to 3 4 wherein the solar heated hot gas at inlet of the said first pass is at 600^0 C temperature and The air pressure is maintained at 4 Kg/cm2, and the hot air coming from first pass outer shell at 317 °C (Max. 318 °C) is supplied to the inlet of Heat Recovery second pass outer shell.
6. A Heat recovery heat exchanger as claimed in claims 1 to 4 5 wherein the first pass outer shell material is SA-516 Gr. 70, and normally has thickness of 16 mm Thick and thickness and material of shell may vary as per the applicable pressure vessel code.

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