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2,781,635

**PROCESS AND HEATING SYSTEM FOR PROVIDING HOT WATER AND POWER FOR SULFUR MINING**

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This invention relates to a process and apparatus especially useful for heating large quantities of sea water, fresh water, or similar water to temperatures well above 212° F., and is especially concerned with a system using a gas turbine.

Industrial processes frequently require large volumes of hot water in addition to power in the form of electricity. Fresh water suitable for heating in conventional indirect heat exchangers, or in direct contact steam heaters, is often not available, or if available requires costly water treating equipment and involves chemical costs. Equipment required to heat the large volumes of water by conventional means is elaborate, complicated, takes much space and due to its weight requires costly foundations. To operate the conventional plant, several operators are required and/or a large amount of costly automatic instruments must be supplied. Thermal efficiencies of the conventional plant are usually low, and in order to raise these efficiencies costly equipment must be supplied and the operation fixed to narrow limits of output, reducing the flexibility of the operation.

Heated process water in large quantities and power is needed for many purposes. Merely by way of example, large quantities of heated process water are required in the Frasch process of sulphur mining.

One of the main objects of the present invention is to provide a process and apparatus which can be used to heat fresh, sea or similar water to a temperature above that usually causing scale deposition when the water is heated in the conventional indirect heat exchanger.

A further object of the invention is to provide a process and apparatus wherein large quantities of fresh, sea or similar water can be heated to the desired elevated temperature at high efficiency and without the use of indirect heat exchanger surface in contact with the water and without the use of special metals in the heat exchangers.

A still further object of the invention is to provide a simple process and apparatus for heating water and generating power so that combustion air for a direct contact pressure combustion heater can be supplied at no premium in cost, size of equipment, or power output by the use of the gas turbine generator and a modification of the flow of compressed air from the compressor to the combustion chamber of the turbine.

In one embodiment of the invention, fresh, sea or saline water can be supplied under pressure to a direct contact pressure combustion heater, one example of a suitable heater being shown in detail in copending application of Clifford M. Cockrell, Serial No. 280,082, filed April 2, 1952, now Patent No. 2,759,328, issued August 21, 1956. Where the term "water" is used, it includes other liquid where appropriate. The water to be heated in such a direct contact pressure combustion heater passes through a heat transfer zone or zones to the combustion chamber and is collected in the hot liquid reservoir at the bottom thereof, the water being heated by direct contact with the combustion gases and vapor. The heater may have fuel

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and combustion air supplied under pressure. There may be two steps involved in the heating of the water. One step can take place just above or adjacent the combustion chamber where water is transformed to vapor. The second step can take place thereafter at which time the vapor gives up its latent heat to the incoming water. The heated process water can be withdrawn from the bottom of the pressure combustion heater.

The gas from the top or gas exit portion of the tower is fed to the combustion chamber inlet of a gas turbine with a negligible loss in pressure. A gas turbine and the direct contact pressure combustion heater of the invention both require large quantities of air. The gas turbine has an axial flow compressor connected to its shaft, part of the air from the compressor being fed to the pressure combustion heater, and the remainder of the air being fed to the gas turbine. Fuel can be added at the inlet of the gas turbine for operation thereof.

In a further aspect, exhaust gases from the turbine can be passed through a suitable heat reclaimer to preheat the raw water before it is fed to the pressure combustion heater. The gas turbine also may have a connected electric generator for supplying power to the various pumps or auxiliaries of the system.

The pressure in the pressure combustion heater can be chosen so as to be sufficiently high to maintain a partial pressure of vapor equivalent to the temperature of process liquid desired. If water is heated at atmospheric pressure in a direct contact heater, it is impossible to heat the same to more than about 190° F., even when natural gas under ideal conditions and theoretical temperatures is considered. This is due to the fact that the heat in the fuel burned is utilized in vaporizing water, this water vapor produced being a maximum of about 70 percent by volume when mixed with the combustion gases resulting in a water vapor partial pressure of about 10.6 pounds absolute, or a maximum vapor temperature of 196° F. with the tower operating at atmospheric pressure. When heating is accomplished in a pressure combustion heater of the type described herein, the increased pressure increases the partial pressure of the water vapor, consequently increasing the temperature of the water.

The system is especially adapted for the use of automatic controls for controlling temperature, pressure, water level, etc. so that from the operating viewpoint it is particularly advantageous.

These and other objects, features, and advantages of the invention will become apparent from the following descriptions and drawings which are to be considered merely exemplary.

In the drawings:

Fig. 1 is a schematic illustration of one form of the system.

Fig. 2 is a schematic illustration of a further form of the invention.

For purposes of illustration, the invention will be described in conjunction with a process water requirement of 1200 gallons per minute with the water at 325° F. for use in connection with Frasch process sulphur mining. The pressure in the heater is about 135 pounds per square inch absolute (p. s. i. a.). It is to be understood, however, that the invention can be used for other purposes and that other quantities and temperatures can be supplied by using its principles.

In a first form of the invention, the raw water can be supplied by pump 20 (Fig. 1) to a conventional direct contact heat reclaimer 21, the heat being furnished thereto in a manner which will be described hereafter. Preheated raw water is fed through line 22 by pump 53 to the water distributing means 23 of the direct contact pressure combustion heater indicated generally at 24.

As previously mentioned, details of the direct contact