Document DE 10 2011 009 280 also describes a liquid – vapor separator connected to a pipe returning to the evaporator.

Document WO 2007/104970 describes, in conjunction with figure 1 thereof, a known Rankine cycle comprising a liquid – vapor separator between the evaporator and the turbine. A pipe is provided to recirculate liquid from the separator to the evaporator. Furthermore, the liquid level in the separator is measured and determined to control the circuit pump, according to the demand for electrical energy. If the liquid level in the separator increases, the delivery rate of the pump decreases, and vice versa. The document then proposes to distinguish itself from this known system by allowing a fraction of liquid to enter the expansion member and by controlling this fraction using a complex control system.

Document WO 2012/130421 describes a facility adapted to recover heat from several distinct sources. The facility comprises a common liquid – vapor separator and a common turbine, and several evaporators and pumps corresponding to the various sources. The liquid – vapor separator acts as a liquid reservoir for the facility, since it is also supplied with liquid coming from the condenser.

Document FR 2976136 teaches a facility based on a Rankine cycle, provided with bypass valves in order to bypass the turbine.

There is therefore a true need to supply an electricity production system relying on a Rankine cycle capable of operating with an organic heat-transfer fluid, in which the expansion member is protected from any damage in a way that is simple and economical.

SUMMARY OF THE INVENTION

A first aspect of the present invention provides a system for producing electricity, comprising a closed heat-transfer-fluid circuit which comprises an evaporator, an expansion member, a condenser and a circulation pump, a generator being coupled to the expansion member, in which a liquid – vapor separator provided with a liquid reservoir is placed between the evaporator and the expansion member, the system being further provided with a control device configured to empty the reservoir if the liquid level in the reservoir reaches a maximum threshold.

According to one embodiment, the heat-transfer fluid is organic.

According to one embodiment, the emptying of the reservoir is performed by a liquid recirculation line feeding into the evaporator.

According to one embodiment, the control device is configured to reduce the delivery rate of the circulation pump if the liquid level in the reservoir reaches the maximum threshold.

According to one embodiment, the liquid level in the reservoir is kept between a minimum threshold and the maximum threshold.

According to one embodiment, the control device is configured to put a stop to the emptying of the reservoir if the liquid level in the reservoir reaches the minimum threshold.

According to one embodiment, the control device is configured to increase the delivery rate of the circulation pump if the liquid level in the reservoir reaches the minimum threshold.

A second aspect of the present invention provides a method for producing electricity, comprising the following concurrent steps:

- heating and evaporating a heat-transfer fluid using a heat source;
- separating the heat-transfer fluid that has undergone evaporation into a liquid phase and a vapor phase, the liquid phase being stored in a liquid reservoir;
- expanding the vapor phase to allow the generation of an electrical current;
- condensing the expanded vapor phase; and
- pumping the condensed phase;

and further comprising the following steps:

- monitoring the liquid level in the liquid reservoir; and
- emptying the liquid reservoir when the liquid level in this reservoir reaches a maximum threshold.

According to one embodiment, the heat-transfer fluid is organic.

According to one embodiment, the emptied liquid is recirculated to the heating and evaporation step.

According to one embodiment, the delivery rate at which the condensed phase is pumped is reduced when the liquid level in this reservoir reaches the maximum threshold.

According to one embodiment, the liquid level in the reservoir is constantly kept between a minimum threshold and the maximum threshold.

According to one embodiment, the step of emptying the reservoir is interrupted if the liquid level in the reservoir reaches the minimum threshold.

According to one embodiment, the delivery rate at which the condensed phase is pumped is increased if the liquid level in the reservoir reaches the minimum threshold.

Embodiments of the present invention make it possible to overcome the disadvantages of the prior art. More particularly the embodiments of the present invention provide an electricity production system relying on a Rankine cycle that is capable of operating with an organic heat-transfer fluid, in which the expansion member may be protected from any damage in a way that is simple and economic.

This is achieved by virtue of the use of a liquid – vapor separator provided with a liquid reservoir, at the outlet of the evaporator, which is coupled to a control device capable of controlling the level of liquid in the reservoir.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 schematically depicts a Rankine cycle that can be used to implement the invention.

Figures 2 to **5** schematically depict part of a system according to one embodiment of the invention, in various phases of operation.

DESCRIPTION OF EMBODIMENTS OF THE INVENTION

The invention is now described in greater detail and nonlimitingly in the description which follows.

Referring to **figure 1**, an electricity production system according to the invention relies on a Rankine cycle comprising an evaporator 1, an expansion member 2, a condenser 3 and a circulation pump 4.

The Rankine cycle contains a heat-transfer fluid which is preferably an organic compound, for example a hydrocarbon, or a hydrofluorocarbon, or a hydrofluoroolefin, or a mixture of several such compounds.

Preferred compounds are HFC-134a (1,1,1,2-tetrafluoroethane), HFC-32 (difluoromethane), HFC-125 (pentafluoroethane), HFC-152a (1,1-difluoroethane), HFC-134 (1,1,2,2-tetrafluoroethane), HFC-161 (fluoroethane), HFO-1234yf (2,3,3,3-tetrafluoropropene), HFO-1234ze (1,3,3,3-tetrafluoropropene), HFO-1233zd (1-chloro-3,3,3-trifluoropropene), HFO-1336mzz (1,1,1,4,4,4-hexafluorobutene) in E or Z form, HC-600 (butane), HC-600a (2-methylpropane) and HC-290 (propane).

The evaporator 1 is coupled to a heat source.

A generator 5 is coupled to the expansion member 2. It provides electrical current as an output from the system.

CLAIMS

1. A system for producing electricity, comprising a closed heat-transfer-fluid circuit which comprises an evaporator, an expansion member, a condenser and a circulation pump, a generator being coupled to the expansion member, in which a liquid – vapor separator provided with a liquid reservoir is placed between the evaporator and the expansion member, the system being further provided with a control device configured to empty the reservoir if the liquid level in the reservoir reaches a maximum threshold.

2. The system as claimed in claim 1, in which the heat-transfer fluid is organic.

3. The system as claimed in claim 1 or 2, in which the emptying of the reservoir is performed by a liquid recirculation line feeding into the evaporator.

4. The system as claimed in one of claims 1 to 3, in which the control device is configured to reduce the delivery rate of the circulation pump if the liquid level in the reservoir reaches the maximum threshold.

5. The system as claimed in one of claims 1 to 4, in which the liquid level in the reservoir is kept between a minimum threshold and the maximum threshold.

6. The system as claimed in claim 5, in which the control device is configured to put a stop to the emptying of the reservoir if the liquid level in the reservoir reaches the minimum threshold.

7. The system as claimed in claim 5 or 6, in which the control device is configured to increase the delivery rate of the circulation pump if the liquid level in the reservoir reaches the minimum threshold.