The present invention relates to an energy conservation apparatus to recover the waste energy in various industrial processes. The general assembly of the single stage 'Economizer' heat transfer unit (1) is provided with tube (4) and twisted baffle (4c) tube (5) and twisted baffle (6), tube plates (2 and 2a) which are welded to heat transfer tubes (4) and (5). The exhaust flue gas is passed through the tubes to heat the water or chemicals to 85°-90°C, the pre-heated or cold water is directed to solenoid valve (17), check valve (16) and pipe (8). When the water is heated to set up temperature control by thermostat device (9), solenoid valve (10) with check valve (11) discharges the hot water into the storage tank (55). Pressure vessel (1) is provided with safety valve (13) which relieves the excess pressure which is discharged through the storage tank (55). To control flue gas temperature into heat transfer unit (1), thermocouples (15) and (15a) are fitted. Variable speed fan (14) with impeller (14a) intakes the exhaust heat (flue gas) from the boiler which increases or decreases the excess air and provides high efficiency heat transfer which maintains the pressure drops into boiler combustion chamber.

* See back of page
DESIGNATIONS OF “DE”

Until further notice, any designation of “DE” in any international application whose international filing date is prior to October 3, 1990, shall have effect in the territory of the Federal Republic of Germany with the exception of the territory of the former German Democratic Republic.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

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"UNIVERSAL LIQUIDS HEAT TRANSFER ECONOMIZER"

The present invention relates to an energy conservation apparatus to recover the waste energy in various industrial processes.

Conventionally, large amounts of heat energy are wasted in industrial processes by being eliminated into the atmosphere in the form of heated (flue gas between 200\(^\circ\)C - 400\(^\circ\)C).

The heated exhaust flue gas can for example, be produced through the operation of a superheated steam boiler from a electricity power station and a saturated steam boiler used by large industrial processes such as in Petro-Chemical, Hospital, Paper pulp making, Brewery and Laundry.

Commonly, boilers make effective use of only about 50\% and 55\% of the input energy. Fuel with most of the remaining percentage being transferred into heated exhaust flue gas, through the chimney which produces high velocity draft to balance the pressure drops into the boilers combustion chamber.

With the use of "Economizer" (heat transfer unit) positioned in any hot duct, it is possible to capture 90\% of waste heat energy of the exhaust flue gas converted to heat water or chemicals, from 20\(^\circ\)C-90\(^\circ\)C, liquids and heat transfer oil from 100\(^\circ\)C-312\(^\circ\)C used for dryer.

The prior water heater economizer with low efficiency is common in many types of industrial applications which is found to have a deficiency, namely the waste of energy (flue gas) via exhaust pipe of dryers and steam boiler chimneys.

Existing energy saving devices in this field have
been found to achieve on average only about 5% saving in energy cost. The installation of such devices is high to the minimal saving in energy cost.

The "Universal liqids heat transfer economizer can saving of up to 90% of wasted energy from the exhaust ducts of dryers, incinerator, steam boilers, electricity power stations superheated steam boilers, gas turbine and other suitable plant and equipment for only a small capital outlay.

With the new "Economizer" installed, the new discharge temperature would be reduced to a maximum of 60⁰ - 80⁰C into the atmosphere.

The present inventor has determined that one means by which this may be achieved in an industrial process employing a boiler is by feeding heated water produced by the "Economizer" heat transfer unit back into the feed water tank to 85⁰C temperature and the excess of the hot water can be discharged through to the underground tank to redirect into the industrial process, therefore a reduction in consumption of fuel at approximately 50% to bring the water into the boiler to reach boiling point of 100⁰C.

Furthermore the present inventor has found that the "Economizer" heat transfer unit inlet water when increased in temperature by absorption of 40⁰C, solar energy prior to its entry into the "Economizer" heat transfer unit, will lead to a substantial increase in volume of hot water from 40⁰-85⁰C temperature, and less fuel need to be burned for the same volume of inlet water to reach the desired temperature in the "Economizer" heat transfer system.
According to another aspect of the "Economizer" heat transfer system, it can pre-heat the water or chemicals by the two stage heat transfer units, when the solar energy is not available, the first stage heat transfer unit will pre-heat the water or chemicals, to 40°-45°C and second stage heat transfer unit will increase the temperature from 85°-90°C of hot water or chemicals at approximately 50% of the time.

The two stage "Economizer" heat transfer units can be heated with two different liquids at the same time at different degree of temperature (°C). At this time discharged flue gas temperature through the atmosphere will be 60°C maximum.

The "Economizer" heat transfer system is provided with an electronic variable speed fan inverter to balance the pressure drops into the boiler combustion chamber e.g. when the boiler stack temperature is being increased the inverter speed up the fan and passing more flue gas through the high efficiency heat transfer system. If the stack temperature decreased the inverter reducing the speed of the fan and the remaining heat will be conserved into the boiler to save the energy cost.

The prior natural exhaust chimney required long lengths and large diameter to balance the pressure drops into the boiler, the difficulty to control the discharge flue gas through the chimney, conducted to maximum 50% cost.

With the use of the "Economizer" heat transfer units the lengths will be reduced by 75% compared with prior exhaust chimneys. The "Economizer" controls the
the discharge flue gas by the electronic speed inverter and fan to 90% minimum of saving the energy.

According to one aspect of the present invention, there is apparatus provided for reducing energy consumption in an industrial process where hot gases are exhausted through a duct.

(i) The "Economizer" heat transfer units are adapted to transfer the energy into hot gases exhausted through duct to feed water, water passing through to increase the temperature thereof.

(ii) Means, for controlling the heated water of the heat transfer unit to an energy consumption thereof, and

(iii) Means, for pre-heating the said feed water. According to another aspect of the present invention, there is provided a process where hot gases are exhausted through a duct, the said process comprising:

(i) Employing heat transfer units to transfer energy into hot gases exhaust through ducts to pre-heated feed water passing through so to increase the temperature thereof, and

(ii) Controlling the supply of heated water from the heat transfer units to an energy utilizing function of the process so as to reduce the energy consumption thereof.

In a preferred form of the invention, the control of the supply of heated water or chemicals from the heat transfer units to energy utilizing function of the process is provided by an insulated below ground pre-heated 40°-45°C
tank, and hot water 85°C tank is adapted to store the heated water at a pre-determined temperature until required by the said energy utilization function.

Where the energy utilization function is a boiler, heated water from the tank may be pumped into a boiler feed water tank to 85°C from where it is fed the boiler so that less energy is consumed to bring already heated boiler water to saturated steam at 100°C. A similar result may be achieved where heated water from heat transfer units is fed directly to the boiler feed water tank.

Further feature and advantages of the invention will become evident from the following detailed description when read in conjunction with the accompanying drawings in which:

Fig. 1 is a schematic diagram representing the single stage "Economizer" with operational installations, storage underground tanks, and electronic controller.

Fig. 2 is a schematic diagram representing the two stage "Economizer" with operational installations, storage tanks, and electronic controller.

Fig. 3 is a cross cut section A - A of the fan impeller and case.

Fig. 4 is a cross cut section C - C of the heat transfers tubes, tubes plate, vessel and external insulation, of the first stage pre-heating unit.

Fig. 5 is a cross cut section B - B of the heat transfer tubes, tube plates, vessel and external insulation of the second stage 85°C - 90°C liquids heating unit.

Fig. 6 is a cross cut section E - E of the heat transfer tubes, tubes plates, vessel and external insulation
of the single stage 85°C - 90°C liquids heating unit.

Fig. 7 is a cross cut section D - D of the fan impeller and case.

Fig. 8 is a sectional integrated representation of the two stage "Economizer" heat transfer units and variable speed axial fan.

Fig. 9 is a sectional integrated representation of a single stage "economizer heat transfer unit and the variable speed axial fan.

In the operational installation shown in Fig. 1 the single stage "Economizer" intake the exhaust flue gas from boiler 54 which generates steam to drive an industrial process supply by line 94, exhaust heat energy (flue gas) from boiler 54 is used to heat water circulation into economizer heat transfer 1. The hot water produced is passed to storage tank 55, through solenoid valve 10, non return valve 11 and pipe 92, pressure valve 13, with non return valve 13a, discharges the excessive water pressure from "Economizer" 1 into line 92. Line 96 to top up the water level of storage tank 55a, through gate valve 90, solenoid valve 100 and check 101.

Multi-stage pump 86 under control direct of solar water pump controller 82 is connected to suction pipe 88a having a check valve 88 and filter 87, multy-stage pump 86, pumps the water into line 97 through to non return valve 102, gate valve 103, non return valve 70 from solar panel 71, check valve 73, solenoid valve 72 and line 93 straight to solenoid valve 17 and check valve 16 into "Economizer" heat transfer unit 1. Solenoid valve 17 is under direct control of solar temperature controller 75,
including solenoid valve 72, thermostatic sensor 74, solenoid 67. When solar energy is available solenoid valve 72 and 17 are open and solenoid valve 67 remains closed, if solar energy is not available.

Water level sensing device 84 is controlled by controller 83, solar water pump 86 which supply the water through line 97 is controlled by controller 82, and controller 75; The storage hot water tank 55 is provided with pump 56 filter 58 and non return valve 57 which is installed on the suction pipe 57a.

Pump 56 delivery the hot water through line 95, non return valve 69, solenoid valve 68 and feed water tank 65, when the feed water tank 65 is full the water level float control 66 gives a signal to controller 77 to cutoff the water supply by solenoid valve 68. Hot water line 95 provides the processing plant with water also.

When pressure in line 95 reaches a pre-determined high level by pressure gauge 80 which has setup pressure switch 78 under control direct of water pump controller 79 to shut off pump 56. A further alternative means of relieving an excessive water pressure in the line 95, but without shutting off pump 56 is provided by pressure relief valve 85. The main cold water line 89, tops up the level into hot water tank 55 through line 99 via non return valve 98 and solenoid valve 81 which is controlled by water level sensor 64 and controller 115.

Feed water tank 65 supplies boiler 54 with 85°C hot water which is passed through line 91; To maintain the temperature constant inside hot water tank 55 is provided with steam injector 63 temperature sensor 60 and self acting steam valve 59. Steam line 94 supplies through to
valve 61 and non return valve 62 with saturated steam and self acting steam valve 59.

That temperature range of water is maintained by termostatic sensor 9 when it detects the desired range of water temperature it sends a signal to the "Economizer" controller 76 to open solenoid valve 10. Thus discharging water heated of setup range of temperature into line 92, from where it may be discharged into underground storage tank 55.

In order to maintain a high efficient heat transfer into unit 1, thermocouple 15 ad 15a sends a signal to economizer controller 76 to increase or decrease the excess air produced by variable speed fan 14, which maintain the balance of pressure drops into the boiler exhaust flue gas.

In the operational installations shown in Fig. 2, the two stage economizer 29 and 29a, intakes exhaust flue gas from boiler 54 which generates steam to drive in industrial process supply by line 94. Exhaust heat energy (flue gas) from boiler 54 is used to heat water circulating into "Economizer" heat transfer heat transfer 29 and 29a. This water produced is passed to storage tank 55 through solenoid valve 36, non return valve 37, and line 92. The pressure relief valve means of relieving an excess water pressure in line 92. Second stage "Economizer" 29 pre-heats the cold water supply from tank 55a. Pump 86 delivery through line 111 to inlet solenoid valve 34 and check valve 35 into "Economizer heat transfer 29.

Multi-stage pump 86 under direct control of pre-heated water pump controller 113 is connected to suction pipe 88a having check valve 88 and filter 87. Main cold
water line supplies the line 113a with water to tops up the level storage tank 55a. Water level sensor 84 sends a signal to water level controller 113 to open or close solenoid 109 which is provided with non return valve 110.

Main cold water line 89 feeds water into "Economizer" 29 through solenoid valve 33 and check valve 32 under control of heat transfer controller 76.

Hot water storage tank 55 operates by multi-stage water pump 56 under direct control of controller 79 is connected to suction pipe 57a having a check valve 57 and filter 58 acting on the submerged part of suction pipe 57a. Water pumped from tank 55 through check valve 69, gate valve 105, solenoid valve 68 into feed water tank 65 which supplies boiler 54 from line 91. Feed water tank float level control 66 under direct control of controller 77 opens or closed solenoid valve 68 connected to line 95, gate valve 106 and 107 supplies the hot water to the processing plant.

A further alternative means of relieving excessive water pressure in line 95 without shutting off pump 56 is provided by pressure relief valve 85 which discharges excess pressure through tank 55. In order to maintain the constant level into hot water tank 55, cold water line 99 supplies water through solenoid valve 81 and valve 98 under control of multi-level sensor 64 an controller 104.

To maintain the constant temperature of hot water tank 55, internal steam injector 63 is placed in the bottom of tank. The steam passes from line 94, gate 61, check valve 62 and supplies self acting steam valve 59.
through injector 63. "Economizer" heat transfer unit 29 is provided with pressure relief valve 18 to relieve the excessive pressure through line 114.

In order to maintain a high efficient heat transfer into units 29 and 29a, thermocouple 19 and 23 send a signal to "Economizer" controller 76a to increase or decrease the excess air produced by variable speed fan 25, which maintains the balance of pressure drops into the boiler combustion chamber.

The temperature range of water is maintained by thermostatic sensor 51 and 21, when it detects the desired range of water temperature, sends a signal to economizer controller 76a to open the solenoid valve 30 and 36. Thus discharging water heated of setup range temperature into line 92 and 114, from where it may be discharged into underground storage tanks 55 and 55a.

In Fig. 3 is shown a cross cut section A - A with impeller 24 and fan case section 25.

In Fig. 4 is represent by cross cut section C - C of the heat transfer tubes 44, 44a, 44b with baffles 43, 43b and 43a, tube 47 with baffles 48 are welded into tubes plates 46 and vessel 29, outside insulation which provides thermal insulation 28.

In Fig. 5 the cross cut section B - B shown are the large heat transfer tubes 38, 38a and 38b with baffles 39, 39a and 39 b which improves the pressure drops on the heat transfer system. The small diameter heat transfer tubes 40 with twisted baffles 41 provides the high efficiency heat transfer. Tube plate 53 is welded with tubes 40, 38, 38a, 38b and vessel 46b, outside insulation 28a provides the thermal insulation.
In Fig. 6 the cross section E-E of heat transfer
tubes 4a, 4b & 4c with baffles 4, 4d and 4e, improves
the pressure drops on the heat transfer system. The small
diametre heat transfer tube 5 with twisted baffles 6, pro-
vides the high efficiency heat transfer. Tube plate 2
is welded with tubes 5, 4a, 4b, 4c and vessel 1, outside
insulation 3 provides thermal insulation.

In Fig. 7 is shown a cross cut section D-D with im-
peller 14a and fan case section 14.

In Fig. 8 represents the integrated assembly of a
two stage "Economizer" heat transfer unit 26 is provided
with tube 38 and twisted baffles 39 tube 40 and twisted
baffles 47, tube plates 52 which are welded to heat tras-
fer tubes 38 and 40, the exhaust flue gas passed through
the tubes to heat the water or chemicals to 85° - 90°C.

The pre-heated or cold water is directed to inlet
solenoid valve 34 and check valve 35. When the water is
heated to setup temperature control by thermostatic device
21, the solenoid valve 36 with check valve 37, dischar-
ges the hot water into the storage tank. Pressure vessel
26 is provided with safety relief valve 22 and check
valve 22a, excess pressure, which is discharged through
the storage tank 55a.

To control flue gas temperature into heat trans-
fer unit 26a, thermocouple 21 and 23 are fitted, gate
valve 42 is provided for service, flange 49 is connected
to the boiler exhaust flange. Heat transfer unit 29 pro-
vides the pre-heated water or chemicals to unit 26 to a
setup temperature 45° - 50°C the excess of the flue gas
from heat transfer unit 26 is passed through the vari-
able speed axial fan 25, with impeller 24 and case 25a
which directs the flue gas into unit 29,
heat transfer tubes 44 and 47 with twisted baffles 43 and 48. The tube plates 45 and 46 are welded to heat transfer tubes 44 and 47. Inlet cold water or chemicals is directed to inlet solenoid valve 33, and check valve 32 into vessel 29. When the water is heated to setup temperature control by thermostatic device 51 solenoid valve 30 with check valve 31, discharges the pre-heated water into storage tank 55a, ready to supply unit 26.

To control flue gas temperature into heat transfer unit 29 and 29a, thermocouple 19 & 23 are fitted, heat transfer unit 29 is provided with safety pressure relief valve 18 and check valve 18a to relieve excess pressure which is discharged through the storage tank 55a. Flange 50 is connected to the exit chimney.

In Fig.9 represent the general assembly of the single stage "Economizer" heat transfer unit 1 is provided with tube 4 and twisted baffle 4c, tube 5 and twisted baffle 6, tube plates 2 & 2a which are weld to heat transfer tubes 4 and 5. The exhaust flue gas is passed through the tubes to heat the water or chemicals to 85°-90°C, the pre-heated or cold water is directed to inlet solenoid valve 17, check valve 16 and pipe 8. When the water is heated to setup temperature control by thermostatic device 9, solenoid valve 10 with check valve 11, discharges the hot water into the storage tank 55.

Pressure vessel 1 is provided with safety valve 13 which relieves the excess pressure which is discharged through the storage tank 55. To control flue gas temperature into heat transfer unit 1, thermocouple 15 and 15a are fitted. Variable speed fan 14 with impeller 14a intakes the exhaust heat (flue gas) from the boiler which increases or decreases the excess air and provides high efficiency heat transfer which maintains the pressure drops into boiler combustion chamber.
The "Economizer" is provided with thermal insulation 3 and cladding to prevent the loss of temperature. Flange 12 is connected to boiler exhaust stack flange, and flange 12a which is connected to the exit chimney of unit 1.

Various modifications may be made with details of the scope and ambit of the invention.
THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. The "Universal liquids heat transfer economizer", has a variety of multi-operation such it may be used for heating liquids or chemicals.

   A system which recover the waste energy (flue gas) through the chimney of steam boiler, superheated steam boilers, gas turbines, hot ducts used in industrial pro-
   and converts it into large volume of hot water or chemi-
   cals at 85°-90°C of temperature.

2. The components are described briefly on claim 1 following below.

3. The Universal liquids heat transfer economizer, according to claim 1 or 2 comprises of a single stage liquids heat transfer economizer and operational installa-
   tions.

4. The liquids heat transfer economizer on claims 1 or 3, is adapted with two stages of heat transfer units and operational installations, uses the same principle to increase the volume and capture the maximum waste energy.

5. According to claims 3 or 4 the heat transfer system, vessel, tubes and baffles are made by superior grade of stainless steel to resist higher temperature and provides longer life.

6. The variable speed axial fan (or centrifugal fan) provides the constant excess air into heat transfer units, and balances the pressure of flue gas.

7. The Universal liquids heat transfer economizer on claims 4 or 6 is provides operational storage tanks and solar energy to preheated water or chemicals, which increases efficiency and save the energy.

8. The operational control system of claims 3 or 7 provides electronic controls, included fan variable speed inverter, thermostatic sensing device controller, thermo-
   couple and electronic controller, solenoid valve contro-
   ller, and pressure relief valves.
9. All novel and from Universal liquids heat transfer economizer and operational installations is disclosed in the specification and drawings described in Figure 1-9.
INTERNATIONAL SEARCH REPORT

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) 6

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl. 5 F22D 1/04

II. FIELDS SEARCHED

Minimum Documentation Searched 7

Classification System | Classification Symbols

| IPC | F22D 1/04; F22D 7/16, F28F 1/40 |

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in the Fields Searched 8

AU: IPC as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT 9

Category* | Citation of Document, 11 with indication, where appropriate, of the relevant passages 12 | Relevant to Claim No 13

Y | Patents Abstracts of Japan M-738, page 155, JP,A, 63-96487 (TOSHIBA CORP) 27 April 1988 (27.04.88) 1-9


Y | US, A, 2950740 (BOCK) 30 August 1960 (30.08.60). Column 2 lines 11-25 1-9

Y | US,A, 4505326 (NORTHWEST ALASKAN PIPELINE) 19 March 1985 (19.03.85). Column 1 lines 56-68 and column 2 lines 1-17 1-9

* Special categories of cited documents: 10

“A” document defining the general state of the art which is not considered to be of particular relevance

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“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

“B” document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search 27 August 1990 (27.08.90)

Date of Mailing of this International Search Report 30 August 1990

International Searching Authority

Signature of Authorized Officer

Australian Patent Office

Form PCT/ISA/210 (second sheet) (January 1985)
This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [...] Claim numbers ..., because they relate to subject matter not required to be searched by this Authority, namely:

2. [...] Claim numbers ..., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. [...] Claim numbers ..., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4 (a):

This International Searching Authority found multiple inventions in this international application as follows:

1. [...] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. [...] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. [...] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. [...] As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

[ ] The additional search fees were accompanied by applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (supplemental sheet (2)) (January 1985)
ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 90/00216

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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END OF ANNEX