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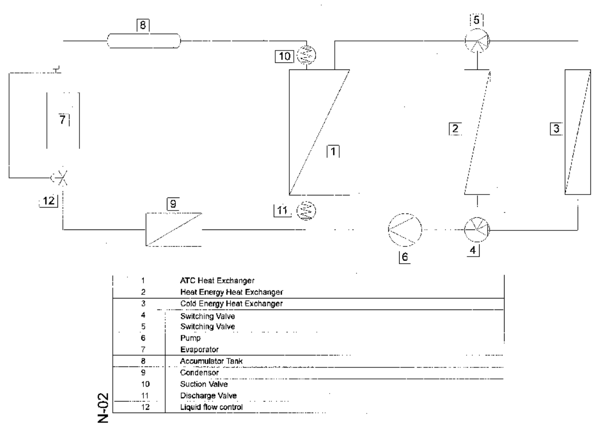
(54) **Title**: ADSORPTION THERMAL COMPRESSOR TECHNOLOGY AND APPARATUSES



(57) **Abstract**: The subject of this patent is an adsorption technology, which operates with the omission of water and water mixtures as adsorbate refrigerant, and the apparatuses called adsorption thermal compressor, which are designed and produced to operate based upon this technology. These apparatuses are described in the patent description. This technology creates cold output energy/power from the input heat energy without any additional energy. The main difference between this technology and the currently known regular adsorption technology is that the new technology does not use water or water mixtures as adsorbate refrigerant for the process and does not operate under vacuum. The proving calculations of a general case of the technology are detailed in the description, the process function drawings are detailed in Drawing 3. These apparatuses are described in the patent description.

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Adsorption Thermal Compressor Technology and Apparatuses

The subject of this patent an adsorption technology, which operates with the omission of water and water mixtures as adsorbate-refrigerant, and the apparatuses called Adsorption Thermal Compressor, which are designed and produced to operate based upon this technology. This is a technology, which produces cold output energy/power from the input heat energy without any additional energy. The main difference between this technology and the currently known regular adsorption technology is that the new technology does not use water or water mixtures as adsorbate-refrigerant for the process and does not operate under high vacuum. Furthermore, subjects of the patent are the apparatuses, which are designed and produced to operate based upon this technology.

Any area, where cooling energy/power has to be produced from heat energy without using any additional energy are to be viewed as areas of application for this technology. The areas of application for this patent include all areas where apparatuses can be designed and produced for the production of cold energy/power through using heat energy without any additional energy.

In today's world cooling systems work with compressors, operated by electrical motors. The technology of absorption and the apparatuses, which are designed and produced to operate based upon the technology, are generally and widely used. Furthermore, there is the technology of adsorption and the apparatuses based upon the technology.

Background of the invention

The problems with the current levels of technology:

According to the current level of technology, compressors need electric energy for their operation.

The problems of the absorption technology are to be discussed separately as there are two widely used procedures. In this technology one of the procedures is using a mixture of water-ammonia and the other one uses a mixture of Li-Br-water. The problem with the water-ammonia mixture is that it is dangerous because it uses ammonia. The procedure operates under pressure, and the ammonia is dangerous to humans and the environment. Furthermore, a distillation-tower is necessary for the purification of ammonia from the water-ammonia mixture. The usage of distillation-tower is unstable because it requires a stable heat source. The technology, which uses Li-Br-water mixture, has the problem that Li-Br is corrosive. Li-Br is at danger of crystallization under several operating conditions, such as input temperature lower than 80°C, so the input heat energy's temperature needs to be at least 85°C. Because of this crystallization problem the machine should be shut down out of operating condition. The Li-Br should be replaced regularly, because the Li-Br will not work properly after several years of operation. Li-Br is a material, which cannot be disposed of in large quantities. As the apparatus operates with using water as refrigerant, it operates under high vacuum. To re-cool the material, a cooling tower is necessary.

According to the current level of technology, the adsorption technology is the one with the least problems. The benefits of the technology include the facts that there is no crystallization in the process because of the materials used, which means that there is no necessity to maintain the temperature of 85°C for the input heat. The apparatus does not use any kind of materials dangerous to humans or the environment. The problem with the regular adsorption technology is that it operates under high vacuum. This means that the operation under high vacuum brings up many problems. Hence the apparatus operates under high vacuum, the volume of the adsorbate-refrigerant is big, and therefore the handling of the adsorbate-refrigerant is difficult. This is the reason why current adsorption apparatuses need to be made as a one big body full-integrated machine. A further problem is that to secure the operation, large size cooling-towers are necessary.

The goal is the development of an adsorption technology and the apparatuses of a chilling machine that operate based upon the technology, which do not operate under high vacuum, therefore the volume of the adsorbate-refrigerant is not big and can be easily handled, so each apparatus can be separated into compressors, evaporators and condensers and so on connected through a piping system. Since the operating pressure is not vacuum, the heat exchange rate of the apparatuses will be increased, at the same time decreasing the size of the apparatus. A further goal is that the technology and the apparatuses, which are designed and produced to operate, based upon this technology do not utilize materials dangerous to humans or the environment. Another goal is that large size cooling-towers should not be necessary.

The technology and the apparatus, which are designed and produced to operate based upon the technology described in this patent uses the under described naturally found gases as adsorbate-refrigerants, which do not need high vacuum to be condensed.

Adsorbate-refrigerants can be primarily but not exclusively, every hydrocarbon gas, including but not exclusively propane, propylene and among others butane and methane. Adsorbents can be among others, but not exclusively natural and artificial silica gel, zeolite and activated carbon.

The proving calculations of a general case of the technology, which we calculate for 3.5 kW cooling capacity, we use the currently to us known best adsorbent, the natural silica gel, and the best adsorbate-refrigerant the propane. The calculations are made for the case of two ATC heat exchangers operating simultaneously in opposite cycles.

See the Propane Pressure Enthalpy Diagram in Drawing 1 for the understanding of the above calculation.

See the Process Function drawings of Drawing 3 for the understanding of the technology and the apparatuses, which are designed and produced to operate based upon this technology.

For the understanding of the calculation, see the Process Function Description in Drawing 3 is necessary.

This calculation explains the case of 15°C evaporation, 40°C condensation and 200°C regeneration temperature for propane. The cycle time is 4 minutes. Naturally, the results of the calculation change with the alterations of the baseline data or the adsorbent and adsorbate-refrigerant.

The calculations proving the process function of the technology in an general case, which we calculate for 3.5 kW cooling capacity, we use the currently to us known best adsorbent, the natural silica gel, and the best adsorbate-refrigerant the propane, are the following:

Using propane in the adsorption process, the capacity of the silica gel is the following:

The condensation temperature of propane is 40°C. It regenerates at the temperature of 200°C. In this case the partial pressure ratio of the propane is 0.986. This you can see the Silica Gel and Propane Isotherm Diagram in Drawing 1. Under such conditions, 1g of silica gel contains 0.05ml of propane. The evaporating temperature of propane is 15°C and the cooling temperature of silica gel is 40°C. In this case the partial pressure ratio of the propane is 0.5346. You can see that under these conditions 1 g silica gel adsorbs 0.38ml of propane from the Silica Gel and Propane Isotherm Diagram in Drawing 1. Therefore, the difference of these two partial pressure ratios gives us the adsorption capacity of 1 g silica gel, which is 0.33ml.

The density of propane is 0.47kg/l at the temperature of 40°C hence 0.33ml of propane weights 0.155g. Accordingly, 1kg of silica gel can adsorb 0.155kg of propane.

The cooling capacity of the propane

The enthalpy of the saturated liquid propane at 40°C condensation temperature is 150 kcal/kg, which can be seen in Drawing 2. The enthalpy of the saturated gaseous propane at 15°C evaporation temperature is 216.67 kcal/kg, which can be seen from the point marked with 2, in Drawing 2. Accordingly, the cooling capacity of 1kg propane is 66.67 kcal/kg.

The required propane flow for 1TR in other words 3024kcal/hour cooling capacity, can be calculated from dividing the 1TR cooling capacity by the cooling capacity of 1kg of propane as 45.36kg/hour.

Using proper heat exchanger apparatus the silica gel adsorbs the propane for 4 minutes and then gets saturated. In order to secure the continuity of the process it is necessary to calculate the propane flow for 4 minutes, where we base the calculations on the flow necessary to achieve 1TR propane's cooling capacity, the propane flow is 3.023kg/4minutes. In order to calculate the necessary silica gel quantity to achieve 1 TR cooling capacity, this propane flow for 4 min divided by the adsorption capacity of 1kg silica gel gives us the result of 19.45kg.

System Function of the technology that is based upon Drawing 3

1.The ATC Heat Exchanger: where the Adsorption Thermal Compressor (ATC) is mainly a two flow or three flow ATC Heat Exchanger #1, which can be made of any metal, that can be used to produce a proper heat exchanger, including but not exclusively aluminum, steel and stainless steel. The heat exchanger needs to be pressure resistant because in the flow of the adsorber the pressure may exceed the pressure of 30bars. If the energy wished to produce is lower than 0°C, this flow of the heat exchanger may operate under vacuum.

The heat exchanger operates in two or three flow sections, which are the following. One flow is the adsorbate-refrigerant flow. The second flow is the flow of high temperature fluid. The third flow is the flow of low temperature liquid or gas, cooling air. The technology can operate with one or more heat exchangers. In the case, when the same fluid can transfer cold and hot energy, it is sufficient to use two flow heat exchangers. The technology may operate with one or more Adsorption Thermal Compressors.

2.Input Hot Heat Energy Heat exchanger or Direct Heat Energy, which heats up the high temperature liquid or gas. The Input Hot Heat Energy Heat Exchanger can be made of materials, which resist high temperature liquid and gas including but not exclusively stainless steel, any fluid can be applied. The Input Hot Heat Exchanger is not essential it can be replaced with direct liquid or gas heat energy.

3.Input Cold Energy Heat Exchanger, which is radiator with or without a ventilator, cooling tower or Direct Cooling Energy. This cooling energy cools down the high temperature liquid or gas. The Input Cold Heat Exchanger can be made of any metal that can be used to produce a proper heat exchanger, including but not exclusively aluminum, steel or stainless steel. The use of this heat exchanger is not essential it can be replaced with liquid or gas in the case of using direct cold energy.

4.Switching Valve #1, switches the flow of the hot heat energy or the cold energy to the 1 ATC Heat Exchanger. This valve functions the same way as 5 switching valve #2.

5.Switching Valve #2 switches the flow of the hot heat energy or the cold heat energy to the 1 ATC Heat Exchanger. This valve functions the same way as 4 switching valve #1.

6.Pump, which circulates high and the low temperature fluid. The 6 pump can be a canned type pump, or it can be made of any material.

7.Evaporator, which evaporates the liquid adsorbate-refrigerant and chills the fluid in the evaporator. We use regular evaporators, or other special evaporators, which can be made of mainly but not exclusively steel, aluminum or copper.

8.Accumulator tank, which eliminates excess liquid from the evaporator. Here we use regular or special accumulator tanks, which are normally made of mainly but not exclusively steel.

9.Condenser: is a special radiator or heat exchanger, which can be made of any metal, that can be used to produce a proper radiator or heat exchanger, including but not exclusively aluminum, steel and stainless steel. The condenser condenses the adsorbate-refrigerant from the 1 ATC Heat Exchanger at the time of regeneration. This process can be done by the use of cooling air, cooling air fans or cooling water. For the cooling of the condenser we can use an additional fan or an additional heat exchanger.

10.Discharge Check Valve, which is located on the discharge line after the 1 ATC Two or Three Flow Heat Exchanger. It is a normal check valve that operates in the refrigeration technologies, which opens at 10mbar pressure difference in the case of using propane as adsorbate-refrigerant.

11.Suction Check Valve, which is located on the suction line before the 1 ATC Two or Three Flow Heat Exchanger. It is a normal check valve that operates in the refrigeration technologies, which opens at 10mbar pressure in the case of applying propane as adsorbate-refrigerant.

12.Liquid flow control, which can be the thermostatic Expansion Valve equipped with thermostatic sensor or Electronic Expansion Valve equipped with electronic sensor or a capillary tube. These components control the refrigerant flow to the evaporator using the signal of the thermostatic or the electronic sensor, in the case of utilizing the capillary tube the flow is fixed and not controlled.

The technology is based on general refrigeration and air conditioning systems. It is similar to those systems, where this technology uses the 6 evaporator, the 8 accumulator tank, and the 9 condenser, which function similar to the ones that operate in general refrigeration and air conditioning systems. It is different from them, where it replaces the regular compressor with the apparatus called adsorption thermal compressor, which is part of this technology.

The 1 ATC heat exchanger has two flow sides. One is the adsorbate-refrigerant flow side and the other is the energy flow side.

The Function of the adsorbate-refrigerant flow side of the 1 ATC heat exchanger

1.) When there is cold energy in the other flow side of the 1 ATC heat exchanger, the 9 suction check valve is open and the 1 ATC heat exchanger sucks the evaporated adsorbate-refrigerant from the evaporator through the accumulator tank. The gaseous adsorbate-refrigerant is adsorbed by in the adsorbent packed between the fins of the ATC heat exchanger. When the adsorbate heats up its cooling capacity drops, which is why in order to maintain the cooling capacity it needs to be cooled. When the adsorbate-refrigerant flow side gets saturated, the 10 suction check valve closes. The 10 suction check valve closes automatically if the pressure drops below the necessary level.

2) When the adsorbent gets saturated, the 1 ATC heat exchanger receives hot heat energy. Due to the hot heat energy the adsorbate-refrigerant gets discharged from the adsorbent and the 11 discharge check valve opens. The 11 discharge check valve opens automatically when the pressure is higher than the necessary level. The adsorbate-refrigerant gets condensed in the 9 condenser. The 8 condenser discharges the heat energy over to the atmosphere. When the adsorbate-refrigerant gets discharged due to the heating of the adsorbent to the certain level of this regenerating condition, the 11 discharge check valve closes. The 11 discharge check valve closes automatically when the pressure drops below the necessary level.

3.) The condensed adsorbate-refrigerant flows from the bottom of the 9 condenser into the 6 evaporator where it evaporates. From here, the evaporated adsorbate-refrigerant gets into the 8 accumulator tank once again.

4.) The 12 liquid flow control regulates the adsorbate-refrigerant flow to the 7 evaporator, at the same time preventing that no liquid adsorbate-refrigerant gets into the 1 ATC heat exchanger, which is further secured by the 8 accumulator tank.

The Function of the energy flow side of the 1 ATC heat exchanger

1. The energy flow side of the ATC heat exchanger receives hot or cold energy at the time of regeneration and adsorption respectively. The system function drawing shows the simplest example, when the ATC heat exchanger is a two-flow heat exchanger and the same

material transfers the hot and cold energy. There is a possibility of re-designing and improving the energy flow side of the 1 ATC heat exchanger with other existing equipments, but it is necessary that the apparatus always provides hot or cold energy at the time of regeneration and adsorption respectively.

2. The 5 pump in the system function drawing circulates the energy flow in the energy flow side of the ATC heat exchanger. The system may require more of these pumps, but it is also possible to omit it, if the energy has direct flow.

3.The 4 and 5 switching valves assure that the energy flow side of the 1 ATC heat exchanger receives hot or cold energy at the time of regeneration and adsorption. In the system, depending on the quantity of the integrated equipments, more of these switching valves may be installed if necessary.

4. The 2 hot heat energy heat exchanger and 3 cold energy heat exchanger transfer the hot and cold energy to the energy side of the ATC heat exchanger. In the case of using direct heat and/or cold energy these heat exchangers may be omitted.

The adsorption thermal compressor also referred to as ATC consists of one or more pieces of ATC heat exchangers. In this case, the continuity of the operation can be assured by that the different ATC heat exchangers operate in opposite cycles.

The apparatuses, which are produced, to operate based upon this technology can be produced in one apparatus unit or more apparatus units. The size and capacity of the adsorption thermal compressor apparatus according to the current level of technology can be anything. The apparatusess can be produced for the small capacity necessity areas of the electronic industry and the largest capacity necessity areas of power plants and such. Therefore, according to the current level of technology the areas of application include but are not exclusively the power plant inlet air cooling apparatuses, the chemical industry's cooling apparatuses, oil refinery plant cooling apparatuses including offshore plant, food industrial cooling apparatuses especially for the beer and alcohol production, paper and pulp industrial cooling apparatuses, cooling apparatuses for industrial production lines, constructional and domestic cooling apparatuses with a solar energy source apparatuses, cooling apparatuses for transportation vehicles and ships including air conditioning and turbo or other inlet air cooling, including cold chain transportation and the vehicles' and ships solar energy source, and the cooling apparatuses for the electric motors and cooling apparatuses for the electronic industry.

The apparatuses are specially and uniquely produced, sized and made by taking the area of application into account with the given technology and given apparatuses. While the planning sizing and production of the apparatus, the proper adsorbent and adsorbate-refrigerant, the materials for the parts of the apparatus need to be determined by taking the available warm energy and necessary cold energy into account.

The technology and the apparatuses, which are designed and produced to operate based upon this technology, utilize the Earth's and the Sun's energy to cool by omitting any additional energy, with exclusively harmless materials to humans and the environment. The technology and the apparatuses, which are designed and produced to operate based upon this technology can be applied at any area of application where industrial, transportation apparatuses produce waste heat, and in the mean time cooling energy/power is necessary. The technology means 10% of energy saving in the non-natural, otherwise industrial processes, and saves 100% of energy in the cases where it uses the heat energy of the Earth or the Sun, in any application area where cooling energy/power is necessary. Apparatuses, which are designed and produced to operate, based upon this technology, can be applied to any area of application where they use materials exclusively harmless to humans and the environment.

Claims

Independent Claims

1. A cooling technology called adsorption thermal compressor can be characterized by which it operates with the omission of water and water mixtures as adsorbate refrigerant, not using high vacuum.

2. Apparatuses that are designed and produced based upon the adsorption cooling technology can be characterized by which the areas of application are primarily using temperature input heat without any additional energy to produce cold energy.

Dependent Claims

3. In reference to claim No.1 whereby the technology uses naturally found gases as adsorbates, which do not need vacuum for the operation.

4. In reference to claim No.1 whereby the adsorption process can be completed without the use of high vacuum.

5. In reference to claim No.1 whereby the adsorbates can be primarily but not exclusively, every hydrocarbon gas, including but not exclusively propane, propylene and among others butane and methane.

6. In reference to claim No.1 whereby the adsorbents can be among others, but not exclusively natural and artificial silica gel, zeolite and activated carbon.

7. In reference to claim No.1 whereby the proving calculations of the process function can be completed with a number of appropriate materials that are described in the patent.

8. In reference to claim No.1 whereby the proving calculation of a general case of the technology, for which we use the currently to us known best adsorbent, the natural silica gel, and the best adsorbate the propane, which is calculated for 3.5 kW cooling capacity, for the understanding of the calculation see the Propane Pressure Enthalpy Diagram and drawing in Drawing 1 and the Process Function drawings of Drawing 3.

9. In reference to claim No.1 whereby the calculation explains the case of 15°C evaporation, 40°C condensation and 200°C regeneration temperature for propane where the cycle time is 4 minutes.

10. In reference to claim No.1 whereby the condensed temperature of propane is 40°C, it regenerates at the temperature of 200°C, in this case the partial pressure ratio of the propane is 0.986, which you can see the Silica Gel and Propane Isotherm Diagram in Drawing 1.

11. In reference to claim No.1, whereby under the conditions given in the calculations, 1g of silica gel contains 0.05ml propane, where the evaporating temperature of the propane is 15°C and the cooling temperature of the silica gel is 40°C in this case the partial pressure ratio of the propane is 0.5346, and you can also see that under these conditions 1 g silica gel adsorbs 0.38ml propane from the Silica Gel and Propane Isotherm Diagram in Drawing 1.

12. In reference to claim No.1, whereby form the calculations the difference of these two partial pressure ratios gives us the adsorption capacity of 1 g silica gel, which is 0.33ml.

13. In reference to claim 1, whereby at the temperature of 40°C the density of propane liquid is 0.47kg/l, hence 0.33ml propane weights 0.155g accordingly, 1kg of silica gel can adsorb 0.155kg of propane.

14. In reference to claim 1, whereby the enthalpy of the saturated liquid propane at 40°C condensation temperature is 150kcal/kg, and the enthalpy of the saturated gaseous propane at 15°C evaporation temperature is 216.67kcal/kg, which can both be seen in Drawing 2, accordingly, the cooling capacity of 1kg propane is 66.67kcal/kg.

15. In reference to claim 1, whereby the required propane flow for 1TR in other words 3024kcal/hour cooling capacity the necessary propane flow can be calculated from dividing the 1TR cooling capacity by the cooling capacity of 1kg of propane calculated as 45.36kg/hour.

16. In reference to claim 1, whereby using a proper heat exchanger apparatus the silica gel adsorbs the propane for 4 minutes and then gets saturated, so in order to secure the continuity of the process it is necessary to calculate the propane flow for 4 minutes, where we base the calculations on the flow necessary to achieve 1TR propane's cooling capacity, the propane flow is 3.023kg/4minutes. In order to calculate the necessary silica gel to achieve 1 TR cooling capacity, this propane flow

for 4min divided by the adsorption capacity of 1kg silica gel gives us the result of 19.45kg.

17. In reference to claim 1, whereby the process function description of the technology was based upon the drawing in Drawing 3.

18. In reference to claims 1 and 2, whereby the ATC Heat Exchanger, Adsorption Thermal Compressor is mainly a two flow or three flow Heat Exchanger #1, which can be made of any metal, that can be used to produce a proper heat exchanger, including but not exclusively aluminum, steel and stainless steel, where the heat exchanger needs to be pressure resistant because in the flow of the adsorber the pressure may exceed the pressure of 30bars, if the output energy wished to produce is lower than 0°C, this flow of the heat exchanger may operate under vacuum.

19. In reference to claims 1 and 2, whereby the heat exchanger operates in two or three flow sections, which are the following, one flow is the adsorbate refrigerant flow, the second flow is the flow of high temperature fluid and the third flow is the flow of low temperature liquid or gas, cooling air.

20. In reference to claims 1 and 2, whereby the technology can operate with one or more ATC heat exchangers, when the cold and hot energy can be transferred by the same fluid it is sufficient to use two flow heat exchangers, the technology may operate with one or more Adsorption Thermal Compressors

21. In reference to claims 1 and 2, whereby the Input Hot Heat Energy Heat exchanger or Direct Heat Energy heats up the high temperature liquid or gas, it can be made of materials that resist high temperature liquid and gas including but not exclusively stainless steel, any fluid can be applied, Heat Exchanger is not essential it can be replaced with direct liquid or gas heat energy.

22. In reference to claims 1 and 2, whereby the Input Cold Energy Heat Exchanger, which is radiator operating with or without a ventilator, cooling tower or Direct Cooling Energy, cools down the high temperature liquid or gas, can be made of any metal that can be used to produce a proper heat exchanger, including but not exclusively aluminum, steel or stainless steel, but the use of this heat exchanger is not essential it can be replaced with liquid or gas in the case of using direct cold energy.

23. In reference to claims 1 and 2, whereby the Switching Valve #1, switches the flow of the hot heat energy or the cold energy to the ATC Heat Exchanger, it functions the same way as switching valve #2.

24. In reference to claims 1 and 2, whereby the Switching Valve #2 switches the flow of the hot heat energy or the cold heat energy to the ATC Heat Exchanger. This valve functions the same way as switching valve #1, if the ATC Heat Exchanger is a three flow heat exchanger, the hot and cold flows can be switched and need to be equipped with valves accordingly.

25. In reference to claims 1 and 2, whereby the pump circulates high and the low temperature fluid. The pump can be a canned type pump, or it can be made of any material.

26. In reference to claims 1 and 2, whereby the liquid adsorbate-refrigerant evaporates and chills the fluid in the evaporator. We use regular evaporators, or other special evaporators, which can be made of mainly but not exclusively steel, aluminum or copper.

27. In reference to claims 1 and 2, whereby the accumulator tank eliminates excess liquid from the evaporator, here we use regular or special accumulator tanks, which are normally made of mainly but not exclusively steel.

28. In reference to claims 1 and 2, whereby the condenser may be a special radiator or heat exchanger, which can be made of any metal, that can be used to produce a proper radiator or heat exchanger, including but not exclusively aluminum, steel and stainless steel, also this condenser condenses the adsorbate-refrigerant from the 1 ATC Heat Exchanger at the time of regeneration, where said process can be done by the use of cooling air, cooling air fans or cooling water, for the cooling of the condenser we can use an additional fan or an additional heat exchanger.

29. In reference to claims 1 and 2, whereby the Discharge Check Valve is located on the discharge line after the 1 ATC Two or Three Flow Heat Exchanger, this is a normal check valve that operates in the refrigeration technologies, which opens at 10 mbar pressure difference in the case of using propane as adsorbate-refrigerant.

30. In reference to claims 1 and 2, whereby the Suction Check Valve is located on the suction line before the 1 ATC Two or Three Flow Heat Exchanger, this is a normal check valve that operates in the refrigeration technologies, which opens at 10 mbar pressure in the case of applying propane as adsorbate-refrigerant.

31. In reference to claims 1 and 2, whereby the Liquid flow control consisting of either a thermostatic Expansion Valve equipped with thermostatic sensor or Electronic Expansion Valve equipped with electronic sensor or a Capillary Tube, these components control the refrigerant flow to the evaporator using the signal of the thermostatic or the electronic sensor, in the case of utilizing the capillary tube the flow is fixed and not controlled.

32. In reference to claims 1 and 2, whereby they use the evaporator, the accumulator tank and the condenser used in general refrigeration and air conditioning systems.

33. In reference to claims 1 and 2, whereby they replace the regular compressor with the apparatus called Adsorption Thermal Compressor, which is part of this technology.

34. In reference to claims 1 and 2, whereby the 1 ATC heat exchanger has two flow sides, one is the adsorbate-refrigerant flow side and the other is the energy flow side

35. In reference to claims 1 and 2, whereby when there is cold energy in the other flow side of the 1 ATC heat exchanger, the suction check valve is open and the ATC heat exchanger is sucks the evaporated adsorbate-refrigerant from the evaporator through the accumulator tank, which is adsorbed by in the adsorbent packed between the fins of the ATC heat exchanger.

36. In reference to claims 1 and 2, whereby when the ATC heat exchanger is regenerating the adsorbate heats up, its cooling capacity drops, which is why in order to maintain the cooling capacity it needs to be cooled, also when the adsorbate-refrigerant flow side gets saturated, the suction check valve closes automatically if the pressure drops below the necessary level.

37. In reference to claims 1 and 2, whereby when the adsorbent gets saturated, the 1 ATC heat exchanger receives hot heat energy. Due to the hot heat energy the adsorbate-refrigerant gets discharged from the adsorbent and the discharge check

valve opens automatically when the pressure is higher than the necessary level, then the adsorbate gets condensed in the 8 condenser, which discharges the heat energy to the atmosphere, when the adsorbate gets discharged due to the heating of the adsorbent to the certain level of this regenerating condition,-the discharge check valve closes automatically when the pressure drops below the necessary level.

38. In reference to claims 1 and 2, whereby the condensed adsorbate-refrigerant flows from the bottom of the condenser into the evaporator where it evaporates, from here, the evaporated adsorbate-refrigerant gets into the accumulator tank once again.

39. In reference to claims 1 and 2, whereby the liquid flow control regulates the adsorbate-refrigerant flow to the evaporator, preventing that no liquid adsorbate-refrigerant gets into the ATC heat exchanger, which is further secured by the accumulator tank.

40. In reference to claims 1 and 2, whereby the energy flow side of the ATC heat exchanger receives hot or cold energy at the time of regeneration and adsorption respectively. The system function drawing shows the simplest example, when the ATC heat exchanger is a two-flow heat exchanger, and the same material transfers the hot and cold energy, there is a possibility of re-designing and improving the energy flow side of the ATC heat exchanger with other existing equipments, but it is necessary that the apparatus always provides hot or cold energy at the time of regeneration and adsorption respectively.

41. In reference to claims 1 and 2, whereby the pump in the system function drawing circulates the energy flow in the energy flow side of the ATC heat exchanger, the system may require more of these pumps, but it is also possible to omit it, if the energy has direct flow.

42. In reference to claims 1 and 2, whereby the switching valves assure that the energy flow side of the ATC heat exchanger receives hot or cold energy at the time of regeneration and adsorption, in the system, depending on the quantity of the integrated equipments, more of these switching valves may be installed if necessary.

43. In reference to claims 1 and 2, whereby the input hot heat energy heat exchanger and input cold energy heat exchanger transfer the hot and cold energy to the energy

side of the ATC heat exchanger. In the case of using direct heat and/or cold energy these heat exchangers may be omitted.

44. In reference to claims 1 and 2, whereby the adsorption thermal compressor, also referred to as ATC, consists of one or more pieces of ATC heat exchangers, in this case, the continuity of the operation can be assured by that the different ATC heat exchangers operate in opposite cycles.

45. In reference to claim 2, whereby the apparatuses can be produced in one apparatus unit or more apparatus units.

46. In reference to claim 2, whereby the size and capacity of the Adsorption Thermal Compressor apparatus according to the current level of technology can be anything.

47. In reference to claim 2, whereby the apparatusess can be produced for the small capacity necessity areas of the electronic industry and the largest capacity necessity areas of power plants and such.

48. In reference to claim 2, whereby according to the current level of technology the areas of application include but are not exclusively the power plant inlet air cooling apparatuses, the chemical industry's cooling apparatuses, oil refinery plant cooling apparatuses including offshore plant, food industrial cooling apparatuses especially for the beer and alcohol production, paper and pulp industrial cooling apparatuses, cooling apparatuses for industrial production lines, constructional and domestic cooling apparatuses with a solar energy source apparatuses, cooling apparatuses for transportation vehicles and ships, including air conditioning and turbo or other inlet air cooling for vehicles and ships, including cold chain transportation vehicles'and ships and vehicles'and ships with solar energy source, and the cooling apparatuses for the electric motors and cooling apparatuses for the electronic industry.

49. In reference to claim 2, whereby the apparatuses are specially and uniquely produced, sized and made by taking the area of application into account with the given technology and given apparatuses. While the planning sizing and production of the apparatus, the proper adsorbent and adsorbate refrigerant, the materials for the parts of the apparatus need to be determined by taking the available warm energy and necessary cold energy into account.

50. In reference to claims 1 and 2, whereby they utilize the Earth's and the Sun's energy to cool by omitting any additional energy, with exclusively harmless materials to humans and the environment.

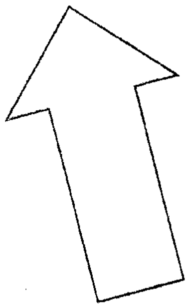
51. In reference to claims 1 and 2, whereby they can be applied at any area of application where industrial and transportation apparatuses produce waste heat, and in the mean time cooling energy/power is necessary.

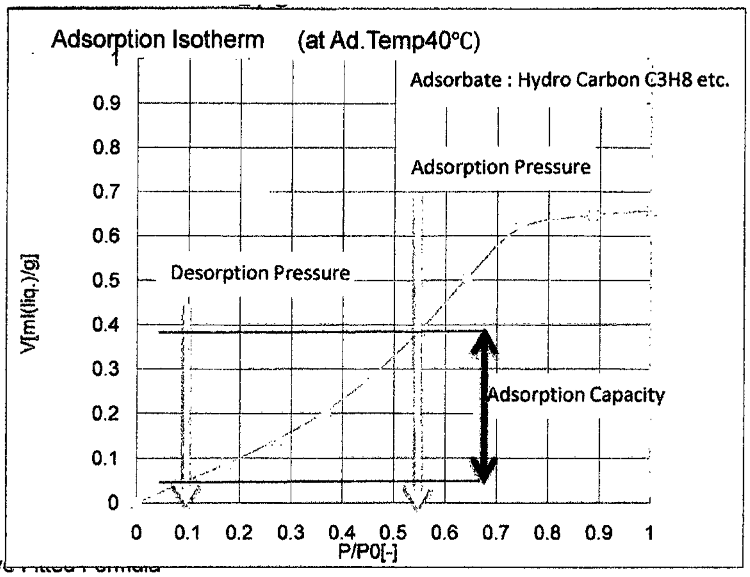
52. In reference to claims 1 and 2, whereby it contributes to 10% of energy saving in the non-natural, otherwise industrial processes, and 100% of energy saving in the cases where it uses the heat energy of the Earth or the Sun, in any application area where cooling energy/power is necessary.

53. In reference to claim 1, whereby the Adsorption Thermal Compressor apparatuses, which are designed and produced to operate based upon this technology, can be applied to any area of application where they use exclusively harmless materials to humans and the environment.

Propane Partial Pressure Racio P/PO

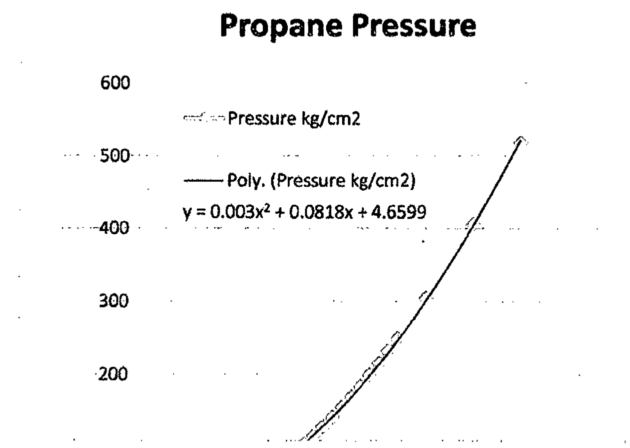
P15/P35	0.599
P35/P200	0.088
P15/P40	**0.5346**
P40/P200	**0.0986**

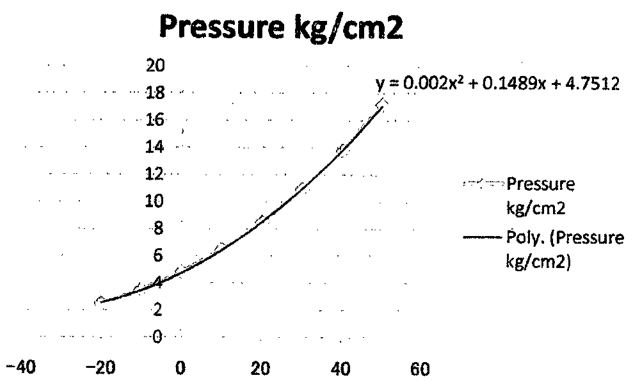




From Curv

Temp °C	Pressure kg/cm2	Pressur kg/cm2	Pressure mmHg	P10/P -	P40/P -
-20	2.485	2.57	1,888.57	2.602	5.550
-10	3.5104	3.46	2,667.90	1.842	3.929
0	4.8231	4.75	3,665.58	1.341	2.860
10	6.466	6.44	4,914.17	1.000	2.133
15		7.43			
20	8.4803	8.53	6,445.00	0.762	1.626
30	10.911	11.02	8,292.06	0.593	1.264
35		12.41			
40	13.793	13.91	10,482.48	0.469	1.000
50	17.165	17.20	13,045.19	0.377	0.804
60	21.061	20.37	16,006.03	0.307	0.655
70	25.511	25.09	19,388.42	0.253	0.541
80	30.544	30.40	23,213.25	0.212	0.452
90	36.183	36.32	27,498.73	0.179	0.381
100	42.448	42.84	32,260.39	0.152	0.325
110	49.357	49.96	37,511.11	0.131	0.279
120	56.923	57.68	43,261.13	0.114	0.242
130	65.156	65.99	49,518.23	0.099	0.212
140	74.063	74.91	56,287.77	0.087	0.186
150	83.648	84.43	63,572.84	0.077	0.165
160	93.914	94.55	71,374.45	0.069	0.147
170	104.86	105.27	79,691.65	0.062	0.132
180	116.48	116.58	88,521.70	0.056	0.118
190	128.76	128.50	97,860.25	0.050	0.107
200	141.71	141.02	107,701.46	0.046	0.097
210	155.31	154.14	118,038.17	0.042	0.089
220	169.56	167.86	128,862.08	0.038	0.081
230	184.43	182.17	140,163.84	0.035	0.075
240	199.91	197.09	151,933.22	0.032	0.069
250	216	212.61	164,159.21	0.030	0.064
260	232.67	228.73	176,830.17	0.028	0.059
270	249.91	245.45	189,933.89	0.026	0.055
280		262.76			
290		280.68			
300	304.89	299.20	231,713.55	0.021	0.045
310		318.32			
320		338.04			
330		358.35			
340		379.27			
350	406.28	400.79	308,771.42	0.016	0.034
360		422.91			
370		445.63			
380		468.94			
390		492.86			
400	517.95	517.38	393,643.33	0.012	0.027





17.42 1989 Fundamentals Handbook

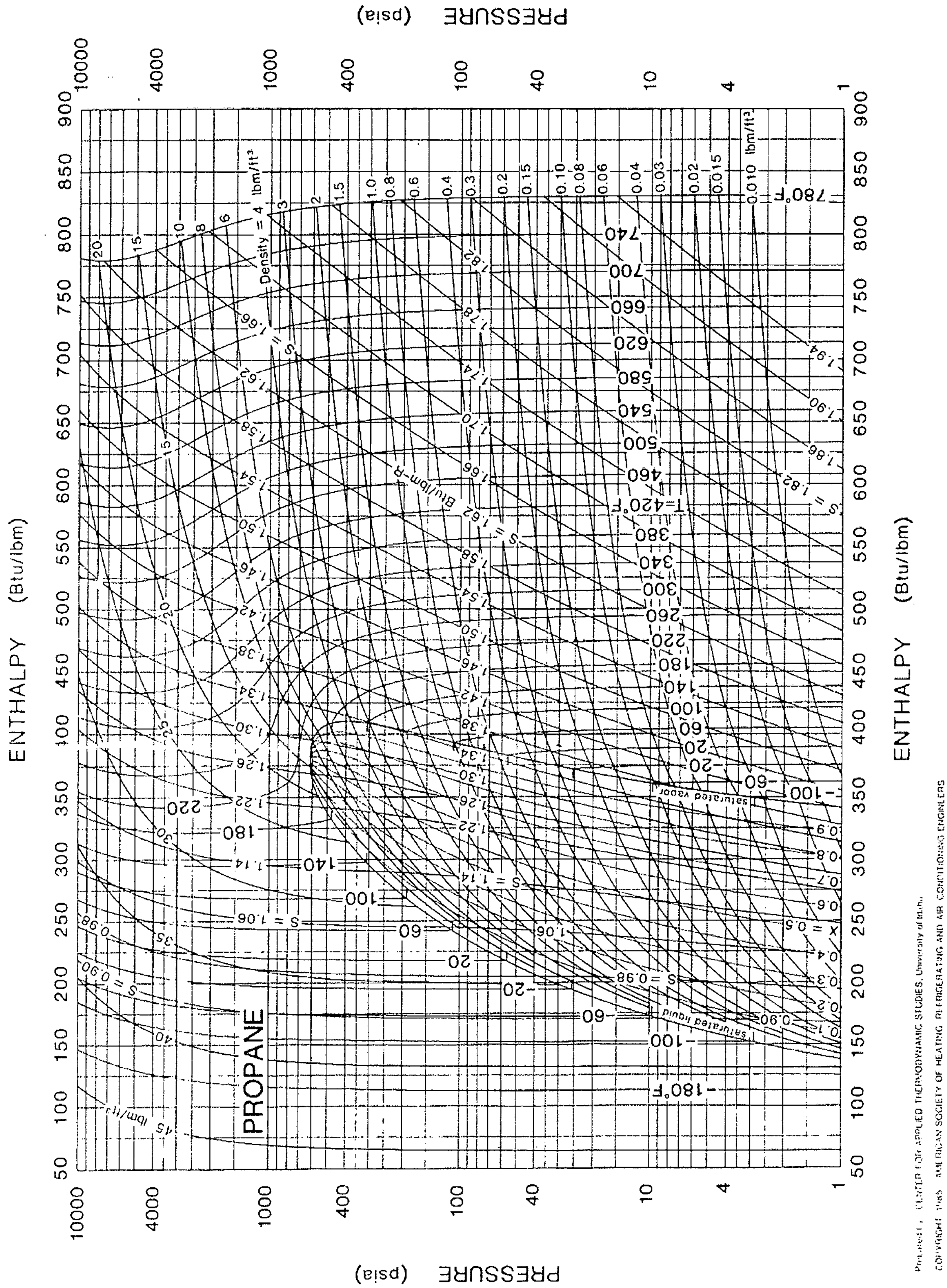
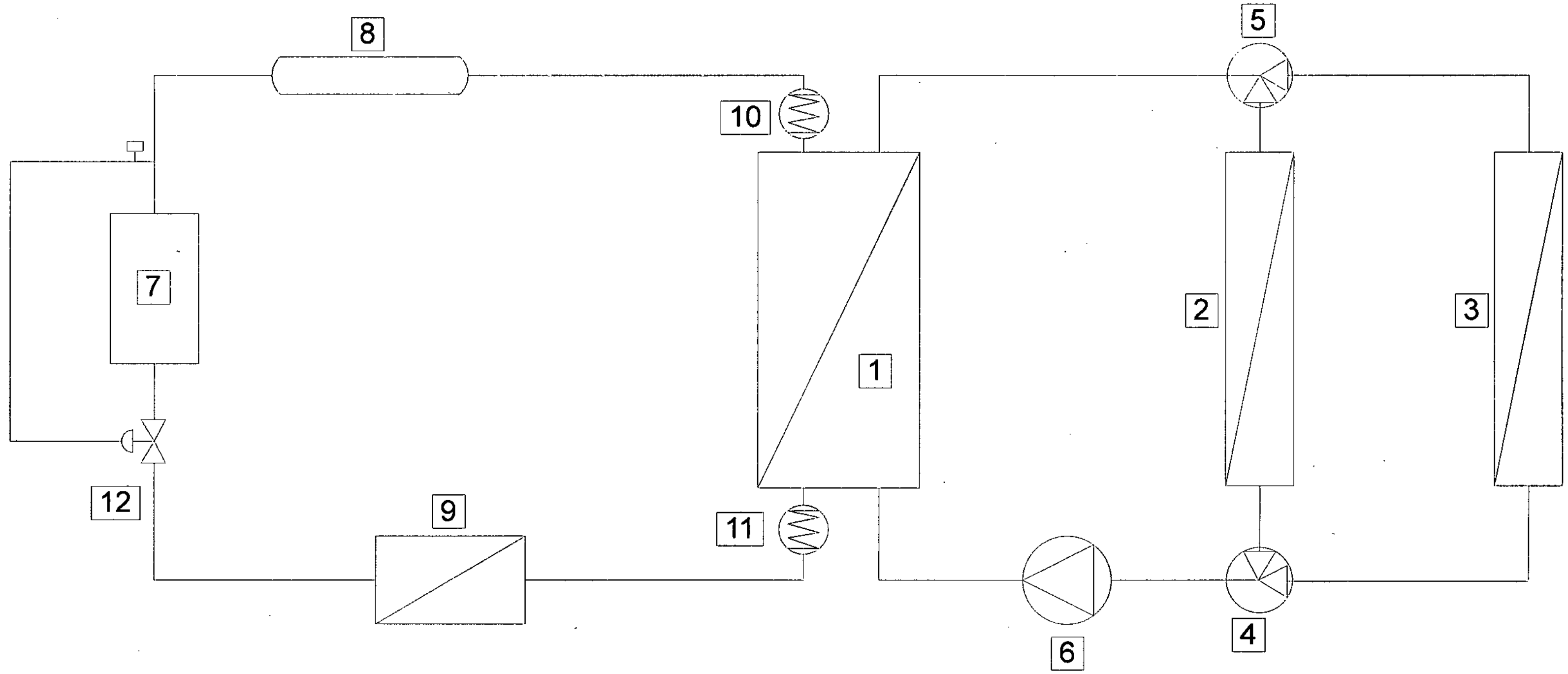


Fig. 20 Pressure-Enthalpy Diagram for Refrigerant 290 (Propane)



1	ATC Heat Exchanger
2	Heat Energy Heat Exchanger
3	Cold Energy Heat Exchanger
4	Switching Valve
5	Switching Valve
6	Pump
7	Evaporator
8	Accumulator Tank
9	Condensor
10	Suction Valve
11	Discharge Valve
12	Liquid flow control

N-02

INTERNATIONAL SEARCH REPORT

International application No
PCT/HU2010/000151

A. CLASSIFICATION OF SUBJECT MATTER
INV. F24F5/00 C09K5/04 F25B15/02 F25B17/08
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F24F C09K F25B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	WO 93/09198 A1 (ATKINSON STEPHEN [NL]) 13 May 1993 (1993-05-13) page 5, line 35 - page 6, line 4; claim 7; figure 1	1-53
X	US 5 802 870 A (ARNOLD EDWARD CHARLES [US] ET AL) 8 September 1998 (1998-09-08) column 10, line 43 - line 51; claims 10, 11	1-53

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 August 2011	08/09/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Valenza, Davide

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

International application No
PCT/HU2010/000151

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