Coefficient of performance range

Heat alone cannot flow from cold to hot object is one way about that second law of thermodynamics. If this were possible, then the heat dumped on the Tlow could just flow back into the reservoir at the hip and the net effect would be the amount of heat and high - the yi is taken on the hip and converted into a job without other changes to the system. Suppose you want to take the heat out of a place in Tlow and reset it in place with a higher hip temperature. You want to build a refrigerator or air conditioner. For such a device, we define the performance factor of the COP as the ratio of the amount of heat removed at a lower temperature to the work entered into the system (i.e. the engine). KC - Evil/ (-B) - Slow/ (High - Slow). Best possible performance factor - COPmax - ylow/ (High - Ylow) max - yulow/ (Elow/Tlow) - Slow/ (Thigh - Tlow) if we have a reversible engine, For a real engine, high is greater than lowThigh/Tlow and the performance factor is lower. For the refrigerator, keeping the internal temperature of 4 oC No. 277 K, running indoors at 22 oC and 299 K, the best possible performance factor is COPmax 277/(299 - 277) - 12.6. The best ratio of the amount of heat taken to the work done is 12.6. Heat cannot flow from the inside of a conventional refrigerator into a warmer room unless we plug in an electric motor that runs on a refrigerant. that easily turns from gas into liquid and vice versa in a wide range of temperatures and pressures. This working fluid moves through the three main components of the air conditioner, compressor, capacitor and vaporizer in a continuous cycle. The working liquid enters the vaporizer indoors in the form of low-pressure liquid at the temperature of the air just outside the room. The vaporizer is usually a snake-like pipe. The liquid immediately begins to evaporate and expands into the gas. The heat flows from the room into this cold gas. It enters the compressor as low-pressure gas at about room temperature. The compressor compresses the molecules of this gas closer together, increasing the density and pressure of the gas. Since gas compression involves physical work, the compressor transfers energy to the working liquid and the liquid gets hotter. The working liquid leaves the compressor as high-pressure gas significantly air temperature. The working liquid then enters the capacitor outside, which usually usually snake pipe. Because the liquid is hotter than the surrounding air, the heat flows out of the liquid and into the air. The liquid then begins to condense into the liquid and it gives up extra heat energy as it condenses. This extra thermal energy also flows as heat into the outer air. The working liquid leaves the capacitor in the form of high-pressure liquid at air temperature just outside. It then flows through the narrowing in the tube into the vaporizer. When the liquid passes through the narrowing in the tube, this pressure drops and it enters the vaporizer like a low pressure liquid. The cycle repeats itself. In general, the heat is extracted from the room and delivered to the outside air. The compressor consumes electrical energy during this process, and that energy also becomes thermal energy in the outer air. The maximum ratio of such air conditioning - COPmax - Troom/ (Toutside - Troom). Refrigerators and heat pumps operate on the same principle. Heat pump refrigerator, inside which is a large street and whose outside room is for heating. The performance factor for a heat pump is the ratio of energy supplied at a higher temperature to the work entered into the system, the COP and the high / high - low. Best Possible Performance Factor - COPmax (heat pump) - (High/ (High - Yulow))Max - Hip/ (Bed - Tlow) - Troom/ (Troom - Toutside) If the external temperature is 41 oF 5oC No 278 K and room temperature 77oF 25oC and 298K, COPmax No 298/ (298 - 278) 14.9. However, if the external temperature drops to 14 oF - -10 oC, Emax - 298/ (298 - 263) - 8.5. Note: The performance rate for the refrigerator/air conditioner and the performance ratio of the heat pump are determined in different ways. For the refrigerator we are interested in how much heat it removes from the cold tank for a given amount of external force work on the system, for the heat pump we are interested in how much heat it delivers for this amount of work done by external forces on the system. Link: Refrigeration Cycle (Youtube) Problem: What is the fridge performance factor that works with Carno efficiency between temperatures -3 oC and 27 oC? Solution: Argument: For the copmax and Tlow/ (Thigh - Tlow) refrigerator. Details of the calculation: The best possible performance factor is COPmax - Tlow/ (Thigh - Tlow) - 270/(300 - 270) - 9. Problem: The fridge has a performance ratio of 5. If the refrigerator absorbs 120 J of thermal energy from a cold tank in each cycle, find (a) work done in each cycle and (b) thermal energy is banished to the hot tank. Solution: Argument: For the refrigerator, the performance factor is COP and Yulow/(-W). Details of the calculation:a) COP and Evil/(-W). (-W) - Evil/KC 120/5 J 24 J. Working on the system. Ordered (electric) energy is converted into thermal energy. (b) (-W) 24 and yuhigh - yulow. High 24 J and 120 J J J. COP or Coefficient Of Performance is the most basic energy efficiency indicator of any thermal engine. This is very useful when comparing heat pumps, refrigerators and air conditioners. Definition: Cop is the ratio of how much useful heat (or cold) a heat pump will produce if we give it a certain energy input. Basically, it tells us how much heat we can generate with each watt of energy. Various COP heat pumpsExample: We have a 1000W heat pump with COP 3.5. This means we're powering it with 1000W and the heat pump gives us back 3500W worth of heat. It is a highly efficient heat pump. It will boil almost 10 gallons of water per hour. By comparison: a 1000W heat pump with COP 2 will boil less than 6 gallons of water per hour. Keep in mind that the amount of electricity used is the same in both cases. Running a 1000W heater for an hour costs about 13 cents. On average, a COP 3.5 heater will boil a gallon of water for less than 1 cent. Cop 2 heater will boil a gallon of water by more than 1 cent. It's pretty obvious that it's much better to have a COP 3.5 water heater than a COP 2 water heater. For example, the best water heaters without tanks are known to have a high efficiency ratio. Example: Even a small electric non-tank water heater powered by 9,000 w. Large ones with 15 GPM can consume as much as 36 kWh every hour. A high cop of such a heat pump is essential for optimizing energy costs. On the other hand, devices that don't spend a lot of energy - something like battery portable air conditioners - have a low cop. Let's see how the COP is calculated, what is the maximum possible cop heat pump, and how the electricity bill depends on HVAC blocks with different cop values. How to calculate the COP? The COP Formula Here is the COP formula (an equation that calculates the performance ratio for any heat pump): COP q/W where the heat heater produces if we give it some amount of work (W). For cooling, q is the heat we carry away from the cold tank. The air conditioner, for example, takes heat from the room (cold tank). Note: It is possible that the cop for heating and cop for cooling is different. The best mini-split heat pumps, for example, are able to cool the space as well as heat it. A good mini-split system tends to have a cooling COP ratio of 2 or more, and a heating COP ratio of 3 or more. If you apply the 1st law of thermodynamics and make a little derivative, we can see the compute values of the cop for theoretically 100% ideal heat pump and perfect air conditioning (we also call that carnot machine). Let's first make a heat pump: COP A Heat Pump Here's how you can calculate theoretically the maximum cop heat pump: COPheat pump Thot/ (Thot-Tcold) Thot is that cozy hot we want to have during the cold winter (say 95F; it's 298 in Kelvin). Tcold is the cold temperature at which the heat pump starts to work (say, 57F or The theoretical maximum COP is calculated as such: COPheat pump No. 298K/ (298K-287K) 27.09 So, in theory, a heat pump can have a COP even above 20. However, the real heat pump cop in practice is much lower. Gold standard: The standard test for measuring the cop heat pump is conducted with Thot No 95F (308K) and Tcold No 32F (273K). This means that in 100% of the ideal case, the maximum COP is 8.8. But in practice it is lower. In fact, the highest cop heat pump can reach is about 4.5. Any heat pump with a cop above 3 has a very high energy efficiency. Here's a graph of how much more effective are high cop heat pumps. We rate COP 2 as zero and are calculated at how much more efficiently higher COP heat pumps. You can see, for example, that a 3.2 cop pump is 60% more energy efficient than 2 COP pumps. The efficiency ratio of air conditioners is OK, let's calculate the maximum theoretical efficiency of the cooling device. Namely: air conditioning or refrigerator. Applying the 1st law of thermodynamics, we can conclude that 'Carnot COP' for the cooling device is calculated as such: COPcooling' Tcold/ (Thot-Tcold) Tcold is the temperature of the cold that you want to have in your room during the summer. Thot is a high heat temperature. Let's look at what would cop the air conditioner be in the standardized Thot No 95F (308K) and Tcold No. 32F (273K) temperature interval. Connecting the temperature in the cooling cop equation above we get 7.8. If you remember, the maximum performance of the heat pump was 8.8. In you are in the market for air conditioning, make sure to get one with a PRICE cop above 2. This is a very high cop for a practical HVAC cooling device. The problem is usually that you won't find the value of COP anywhere, even on the spec sheet. Energy efficiency is generally represented by indicators such as EER and SEER; it's all like a COP-based HVAC split. For example, we compared the best portable air conditioners by comparing their EER ratings. In 2013, a seasonal COP or SCOP, SCOP or seasonal performance factor was introduced. We know that COP is an energy efficiency measure for heating or cooling the device. The measurement SCOP is trying to achieve is to objectively measure energy efficiency during the winter season (for heating) and summer season (for cooling). Basically, the relationship between SCOP and COP is the same as with SEER and EER. SCOP will give a much more realistic view of how energy efficient the HVAC device is in practice; Ie. in the present summer season. However, at the moment SCOP is still considering a very new methodology for measuring seasonal cooling and heating efficiency. This way, you rarely find the SCOP ratio on older devices. In fact, even new devices rarely include SCOP in their specification sheets primarily because they still don't measure it. This is. This is.