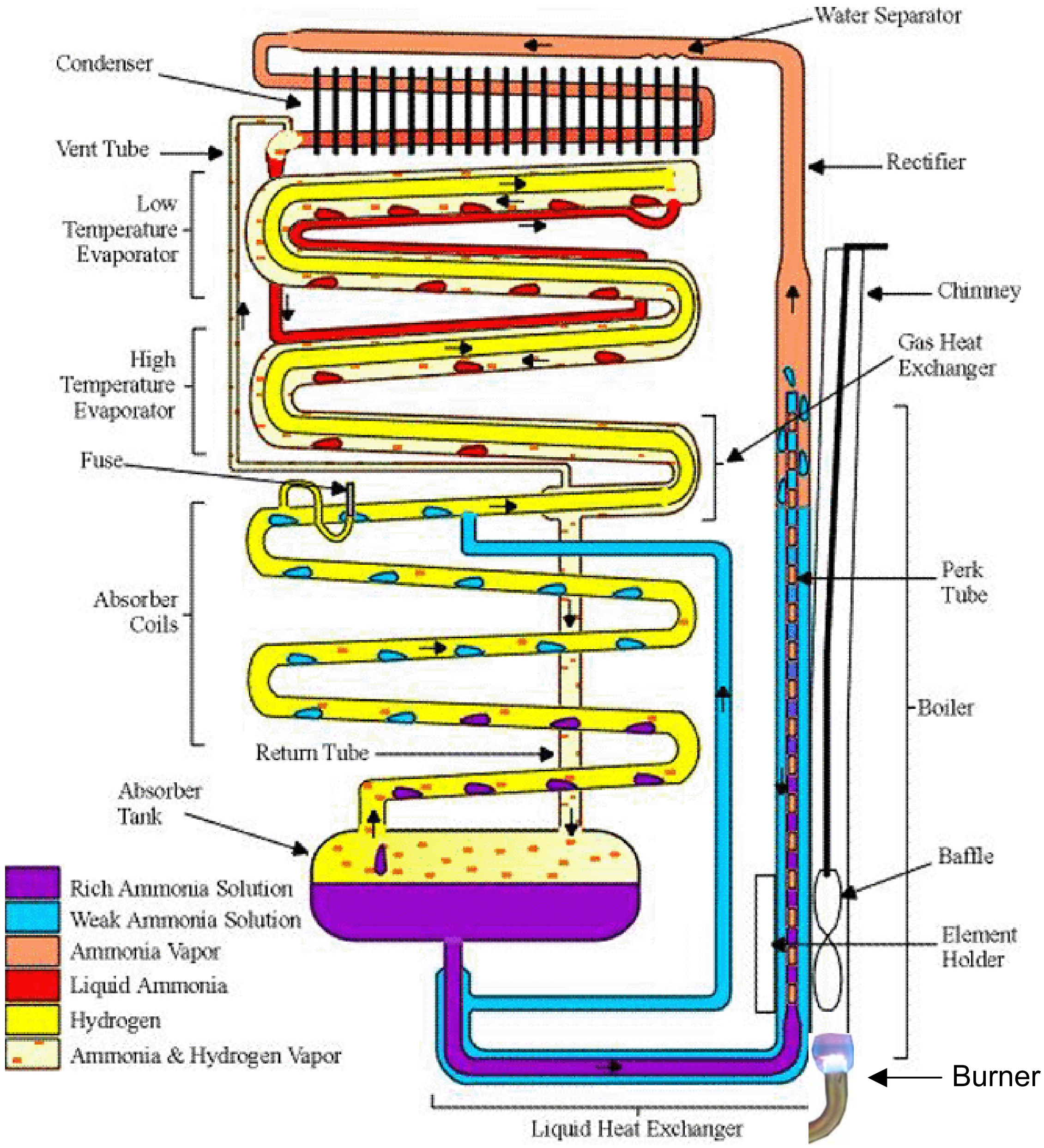
Cooling Unit – How it Works



Cooling Unit – How it Works

Boiler

A precise heat (electric heater element or gas flame) is applied to the boiler to begin operation. Heat is transferred from the outer shell of the boiler through the weak ammonia solution to the perk tube. (Most Zero product has a 110V capability - the Consul, Crystal Cold and the Frostek do not)

The perk tube is provided with a rich ammonia solution (a high percentage of ammonia to water) from the absorber tank. When heated, the ammonia in the rich ammonia solution begins to vaporize (sooner than the water would) creating bubbles and a percolating effect. The ammonia vapor pushes the now weakening solution up and out of the perk tube. The ammonia vapor (gas) leaving the perk tube goes upward towards the top of the cooling unit, passing through the rectifier. The rectifier is just a slightly cooler section of pipe that causes water that might have vaporized to condense and drop back down. The water separator at the top of the cooling unit (only on some models) prevents any water that might have escaped the rectifier to condense and fall back. After this point, pure ammonia vapor is delivered to the condenser. Meanwhile, back at the perk tube, the weaker solution expelled from the perk tube by the ammonia vapor drops into the weak ammonia solution surrounding the perk tube. Here, a little more ammonia vapor is generated and rises. The weak ammonia solution flows down ward and through the outer shell of the liquid heat exchanger, where heat is transferred to the rich ammonia solution on its way to the perk tube. The weak ammonia solution then flows to the top of the absorber coils and enters at a cooler temperature.

Condenser

Ammonia vapor enters the condenser where it is cooled by air passing through the metal fins of the condenser. The cooling effect of the condenser coupled with a series of step-downs in pipe size forces the ammonia vapor into a liquid state, where it enters the evaporator section.

Evaporator

Liquid ammonia enters the low temperature evaporator (refrigerator/freezer) and trickles down the pipe, wetting the walls. Hydrogen, supplied through the inner pipe of the evaporator, passes over the wet walls, causing the liquid ammonia to evaporate into the hydrogen atmosphere at an initial temperature of around -20º F.

The evaporation of the ammonia extracts heat from the refrigerator/freezer. At the beginning stages, the pressure of the hydrogen is around 350 psi (pounds per square inch), while the pressure of the liquid ammonia is near 14 psi. As the ammonia evaporates and excess liquids continues to trickle down the tube, its pressure and evaporation temperature rise. (Based on Frostek 240 Freezer)

The liquid ammonia entering the high temperature evaporator (refrigerator portion) is around 44 psi, while the pressure of the hydrogen has dropped to 325. Under these conditions, the evaporation temperature of the liquid ammonia is +15º F. Heat is removed from the refrigerator box through the fins attached to the high temperature evaporator. The ammonia vapor created by the evaporation of the liquid ammonia mixes with the already present hydrogen vapor, making it heavier. Since the ammonia and hydrogen vapor mixture is heavier than the purer hydrogen, it drops down through the evaporators, through the return tube to the absorber tank. (Based on Frostek 240 Freezer)

Absorber

When the ammonia and hydrogen vapor mixture enters the absorber tank through the return tube, much of the ammonia vapor is absorbed into the surface of the rich ammonia solution, which occupies the lower half of the tank. Now lighter, the ammonia and hydrogen mixture (now with less ammonia) begins to rise up the absorber coils. The weak ammonia solution trickling down the absorber coils from the top (generated by the boiler) is "hungry" for the ammonia vapor rising up the absorber coils with the hydrogen. This weak ammonia solution eventually absorbs all the ammonia from the ammonia and hydrogen mixture as it rises, allowing pure hydrogen to rise up the inner pipe of the evaporator section and once again do its job of passing over the wetted walls of the evaporator. The absorption process in the absorber section generates heat, which is dissipated.

The Fuse.

The fuse on many cooling units and in this graphic is a steel tube, the end of which is filled with solder. The plug is hollow and filled with solder. In either case, the fuse is the weak link of the system. If pressure inside the cooling unit were to rise beyond a reasonable level for some reason, the fuse is designed to blow and release the pressure. This would make the cooling unit inoperable, but is necessary for safety.

Out of Level

At Unique we hear the comment “well, it seems to be working fine”…but, if the cooling unit is operated in a stationary, out of level position (on any heat source), it will eventually become permanently damaged. Before we go any further, there is one more ingredient inside the cooling unit: sodium chromate. The ammonia solution inside the cooling unit is a mild corrosive, and sodium chromate is mixed with the ammonia solution (ammonia and water) to neutralize the corrosive effects of the solution, protecting the inner pipes of the cooling unit.

Since the cooling unit depends greatly on the effects of gravity for moving the liquids and gases inside, running it off level and stationary causes these liquids and gases to collect in unwanted areas and not be recycled back to the boiler. The liquid level inside the boiler begins to drop and become weaker. Eventually, the water in the ammonia solution begins to vaporize with the ammonia and leave the boiler. At some point, the boiler becomes dry and the temperature rises rapidly inside. The sodium chromate which was once in solution with the ammonia solution is left behind and begins to burn and permanently change state from a powder into a sort of sludge that will eventually plug the perk tube. If left to cook long enough, the sodium chromate will become as hard as steel. If the cooling unit were "saved" from this out of level condition by being levelled, or the heat source turned off, any sodium chromate that had changed state would not return to a powder in solution with the ammonia solution. This makes it possible to ruin a cooling unit a little at a time.

Any questions…. Give us a call Toll Free at 1-877-427-2266