Feasibility Analysis of a Micro-Gravity Condensing Heat Exchanger Device for use on the Heat Melt Compactor

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Abstract

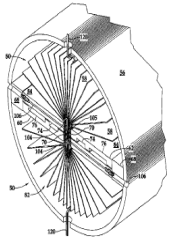
The Heat Melt compactor is a current and ongoing research project at the NASA Glenn Research Center in Cleveland, Ohio. The Project aims to develop a device which will reduce the amount of space that astronaut trash consumes on the International Space Station and in addition to this, recycle any water waste which can be reused. This is to be accomplished through the creation of a compactor device that will crush all astronaut trash and reduce it to a disk shaped clump of waste. During the crushing process, excess water, found in food wrappers and other daily consumables, will be squeezed out and extracted. In order to separate and recycle the water, a mechanism needs to be engineered to evaporate and collect the vapor in a micro gravity environment and condense it in a separate chamber.

Heat Melt Compactor (HMC)

- HMC is needed on International Space Satiation (ISS) to reduce the amount of space waste consumes, ensure the well being of astronauts and minimize water waste aboard the station.
- Compaction device that minimizes the space consumed by waste. In the process, water content is evaporated from the trash and passed through disinfecting filters and eventually evaporated for future re-use.

Candidate for Evaluation

- This study entails the evaluation of the "Fined Type Separator" patented under US Patent 7,193,499.
- The system was selected as part of the eight candidates for its simple and passive mass transfer design.



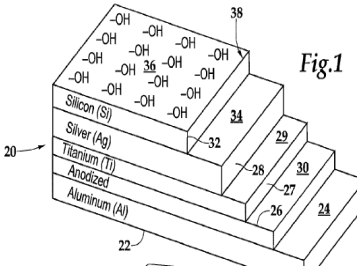
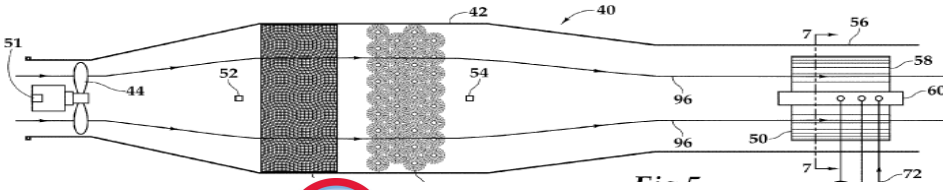


Fig.1

Condensation/Separation Mechanism

- As the humid air begins making contact with the cool heat exchanger, the evaporate will begin condensing.
- The hydro-phillic material covering the fins of the heat exchanger will attract cooling water out of the air.
- The sharp corners of the heat exchanger will create a capillary reaction and gather all of the water into the corners of the device and eventually to a collection reservoir.
- The anti-bacterial coating of the fins will ensure that no bio-films form on the heat exchanger. Bio-films form from contaminates within the water and can clog up the heat exchanger.



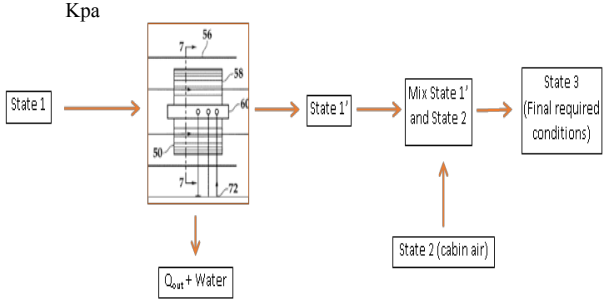
Psychometric Evaluation

State 1:
$T_{db} = T_{wb} = 86^0C$
$\phi = 100\%$
$\omega = 475.73\ g_{water}/Kg_{dry\ air}$
$P_v = P_g = 8.95$ psia $= 61.71$ Kpa
$P_{cabin} = 14.7$ psia $= 101.35$ Kpa
$H_1 = 2498.98$ KJ/Kg

State 1':
$T_{db} = T_{wb} = 35^0C$
$\phi = 100\%$
$\omega = 35.26\ g_{water}/Kg_{dry\ air}$
$P_{cabin} = 14.7$ psia $= 101.35$ Kpa
$H_1 = 128.89$

State 2 (Cabin Conditions):
$T_{db} = 25^0C$
$\phi = 50\%$
$\omega = 9.78\ g_{water}/Kg_{dry\ air}$
$P_{cabin} = 14.7$ psia $= 101.35$ Kpa

State 3 (Desired State):
$T_{db} = 26^0C$
$\phi = 55\%$
$\omega = 11.42\ g_{water}/Kg_{dry\ air}$



Conclusion

In conclusion, the system was recommended to be used abroad the HMC due to its effective separation of the water from the air in the micro-gravity conditions. In addition to this, the system is very affordable and relatively system. Due to the utilization of basic natural physical phenomenon, the system should be further considered, evaluated and tested on the HMC project.