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NASA TECH BRIEF

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Design of a Unit to Produce Hot Distilled Water for the Same Power Consumption as a Water Heater

The problem:

Fresh water can be extracted from waste waters by many processes, the most effective of which is distillation. Operating costs of the conventional distillation process, however, have made distilled water prohibitive except for some special uses. The process is costly because large heating and cooling rates are required: one gallon (4 liters) of distilled water requires approximately 8500 BTU (9.17×10^6 J) of latent heat for evaporation, and the same amount must be extracted for condensation. The need and cost for separate heating and cooling sources has been eliminated by a compression distillation process. Although this method is more efficient than conventional distillation, the only units in use at present are in large land-based and shipboard installations. Nothing of this nature has been available for private homes.

The solution:

Recently, tests have been performed on smaller compression distillation units with a certain degree of success. One unit was operated for 180 days – ten times longer than any previous unit – and required approximately 250 watt-hours (0.930×10^6 J) to produce one gallon (4 liters) of distilled water.

How it's done:

The unit, discussed in detail in a report (see Note), recovers 97% of the water contained in pretreated waste water. Its recovery efficiency could be increased to 98% by condensing water vapor contained in the purge gas. The important factors contributing to this capability are:

1. A cleansing agent is contained in the chemical pretreatment which prevents fouling of the heat transfer surface by highly concentrated waste.
2. The absence of dynamic seals in the design substantially reduces the required purge gas flow rate and the water lost with that gas.
3. Operating procedures include flushing waste materials from the unit whenever it is stopped, to prevent their drying into an insoluble mass.
4. The compressor design provides the higher pressure necessary to distill highly concentrated liquor without penalizing low-concentration performance.
5. The recycle loop maintains a constant flushing process to carry the cleansing agent across the evaporation surface.

The electric motor of the unit is located within a stationary shell and drives the compressor rotors directly, needing no dynamic seals or speed reducers. The stationary compressor housing is part of the central shaft which supports the rotating evaporator and condenser shell (which comprise the centrifuge). Fluid connections are made to the unit through the stationary shaft at the end opposite the compressor. All passage surfaces are stationary, including the waste water feedline. Waste water flows from holes in the stationary ring onto the rotating evaporator surface. The evaporator bowl contains a ring-type dam to assure wetting of the entire evaporator surface.

Excess input flows through holes in the dam into the annular sump where it is picked up by a stationary impact tube and transferred through the stationary shaft to an externally located recycle pump. Condensate is removed by a similar tube originating in the condenser annular sump. The condenser is purged through the stationary shaft from the end opposite the vapor inlet. It is not isolated pneumatically from the outer shell where it condenses (to close the thermodynamic cycle).

The desired liquid level in the evaporator is maintained automatically because the input rate is less than the

(continued overleaf)

removal capacity of the recycle pickup and pump combination. However, a high-level sensor is provided in the evaporator to signal an upset condition.

The centrifuge is driven by a nonlubricated cogged belt and O-ring speed reducer. The mechanical power transmitted through the O-ring is less than 5 watts, and no failure or measurable wear occurred in approximately 2000 hours of operation with the original O-ring.

Note:

Additional information may be obtained from:

National Technical Information Service
Springfield, Virginia 22151
Single document price $15.00
(or microfiche $1.45)

Reference: NASA CR-128878 (N73-20142) Upgrading and Extending Testing of the MSC Integrated Water and Waste Management Hardware

Patent status:

Inquiries concerning rights for the commercial use of this invention should be addressed to:

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