THERMAL ENERGY STORAGE TEST FACILITY

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PROJECT OUTLINE

Project Title: Operation of a TES Test Facility

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Project Goals: Determine the thermal behavior of prototype thermal energy storage units in both heating and cooling modes; develop improved and advanced storage systems, propose performance standards.

Design and build a thermal cycling facility for determining the thermal behavior of full-scale TES units. The facility will have the capability for testing with both liquid and air heat transport, at variable heat input/extraction rates, over a temperature range of 0-280°F. Obtain and test commercial PCM TES systems, design and test improved or advanced systems.

Project Status: Liquid loop design completed and construction started. Design of the air loop has been initiated.

Contract Number: W-7405-eng-26

Contract Period: September 1978 continuing

Funding Level: $20,000

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Division of Energy Storage Systems

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SUMMARY

Two loops making up the Thermal Energy Storage Test (TEST) Facility, using either air or liquid as the thermal transport fluid, are being designed and developed. These loops will be capable of cycling residential-size thermal energy storage units through conditions simulating solar or off-peak electricity applications to evaluate the unit's performance. To date, the detailed design of the liquid cycling loop has been completed and is expected to be operational in March 1980; the design of the air cycling loop has been initiated.

DISCUSSION

The Thermal Energy Storage Test (TEST) Facility will be a set of two loops, using either air or a liquid as the thermal transport fluid, capable of cycling both hot and "cool" residential-size thermal energy storage devices through a series of charge and discharge modes which simulate either solar or off-peak electricity TES applications. The TEST facility will be used to (1) independently evaluate the performance of storage systems using testing procedures which simulate working environments under which the system will operate as well as using procedures proposed by ASHRAE and NBS and (2) to provide support in further R&D work related to TES. Total storage capacity, charge and discharge rates, temperature profiles, and pressure drop across the storage device are, among others, the performance characteristics of interest.

Both cycling loops will be capable of fully charging or discharging a residential-size storage unit [52,800 to 528,000 KJ (50,000 to 500,000 BTU)

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capacity] within four hours [required heat rate of 36.6 KW (125,000 BTU/h)]. The liquid loop will have a temperature range of 0°C to 140°C (32°F to 280°F) and will be able to use either water, ethylene glycol, or salt brine as the working fluid at flow rates between 7.6 ℓ/min and 76 ℓ/min (2 and 20 GPM). The temperature range of the air loop will be from 0°C (32°F) to some maximum temperature as yet undetermined. The loops will possess a high degree of versatility and controlability to produce a variety of input conditions called for by the testing procedures; specifically, they will be capable of providing varying temperature, flow rate, and, for the air loop, humidity input schedules in step function, sinusoidal, and stochastic patterns to fully simulate actual conditions and usage of solar and off-peak electricity storage units.

Three feedback loops, one for temperature control, one for flow rate control, and one for humidity control in the air loop, all capable of sensing loop parameters and making adjustments accordingly, will therefore be required. An integral part of these feedback systems will be an LSI-11 computer which will interface between the sensing and control devices; the computer will also serve as the main data acquisition system. Twenty-eight K of core and two floppy disks provide program and data storage, and, furthermore, the minicomputer will be interfaced with a remote computer to provide additional storage and computational capabilities.

The basic piping and instrumentation layout for the liquid loop is shown in Fig. 1. Mixing value A, functioning with a feedback system initiating from temperature probe D, indirectly diverts the necessary amount of return liquid through either of the thermostated liquid holding tanks, as determined by valve B, and thereby reconditions the working fluid to its required inlet temperature. The loop flow rate will be monitored by a turbine flow meter C, which also feeds back information to the loop flow control valve E. Platinum resistance temperature probes, capable of measuring temperature to within a few tenths of a degree F, will be placed throughout the loop as well as in the storage device itself in sufficient quantity to effectively evaluate the storage system performance and to monitor the loop dynamics. Pressure differential cells complete the major instrumentation requirements of the loop. The air loop will be similar to the liquid loop in its basic layout, control systems, and instrumentation, with the additional requirement of measuring and controlling humidity.

The detailed design of the liquid cycling loop has been completed, and all the instrumentation has been ordered. Specifications for the major loop components (tanks and pump) are currently being prepared, and their procurement will then follow. The LSI-11 computer is on hand. It is expected that the loop will be operational in March 1980. The design of the air cycling loop has been initiated.

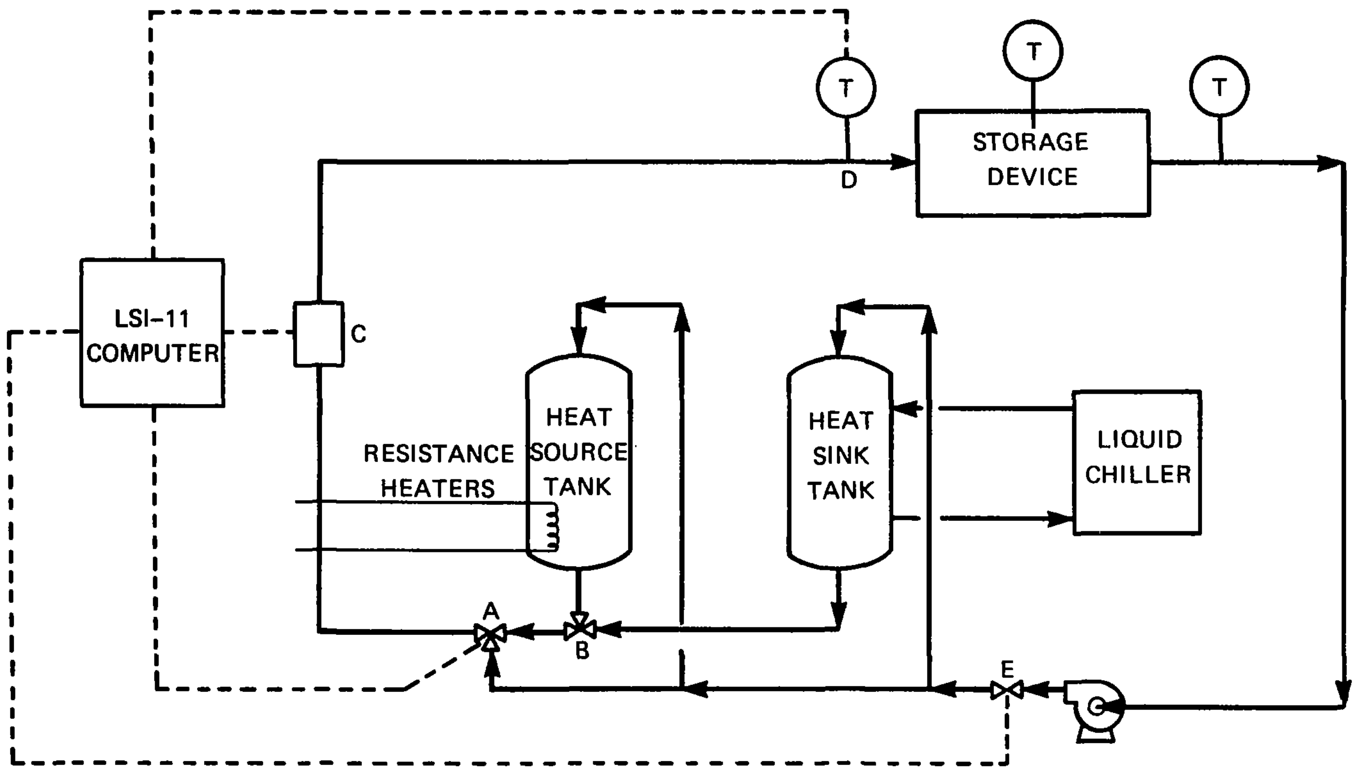

Fig. 1. Thermal Energy Storage Test Facility (Liquid Transport)