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Sandia Laboratories

Albuquerque, New Mexico
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date: November 29, 1979

to: G. E. Brandvold - 4710

from: J. P. Abbin - 2324

subject: Analysis of Test Data on Bakel Pump System

Per your request, I have completed an analysis of the Bakel solar thermal pumping system (schematic attached) being developed by Sofretes in France. The test data are insufficient for a complete analysis, but are sufficient to nominally characterize the engine. Basically, the system is similar to the Willard system with a higher output (31 kW_m vs. 19 kW_m) and a lower peak engine operating temperature (190°F vs. 325°F). The Bakel system uses R11 as the Rankine cycle working fluid. A summary of the test data and analyses based on average values is given below.

Turbine Inlet - 187°F, 86 psia

Condenser Outlet - 97°F, 8.1 psia

Heat Input (R11 Data) - 1.31×10^6 Btu/hr (385 kW_T)

Heat Input (H_2O Data) - 1.50×10^6 Btu/hr (439 kW_T)

Gross Turbine Gearbox Output - 39.7 kW_m

Engine Mechanical Parasitics (estimated if turbine driven)

- R11 Boiler Feed Pump - 1.8 kW_m
- Hot Water Circulating Pump - 2.7 kW_m (does not include collector hot water circulating pump)
- Cold Water Circulating Pump - 4.1 kW_m

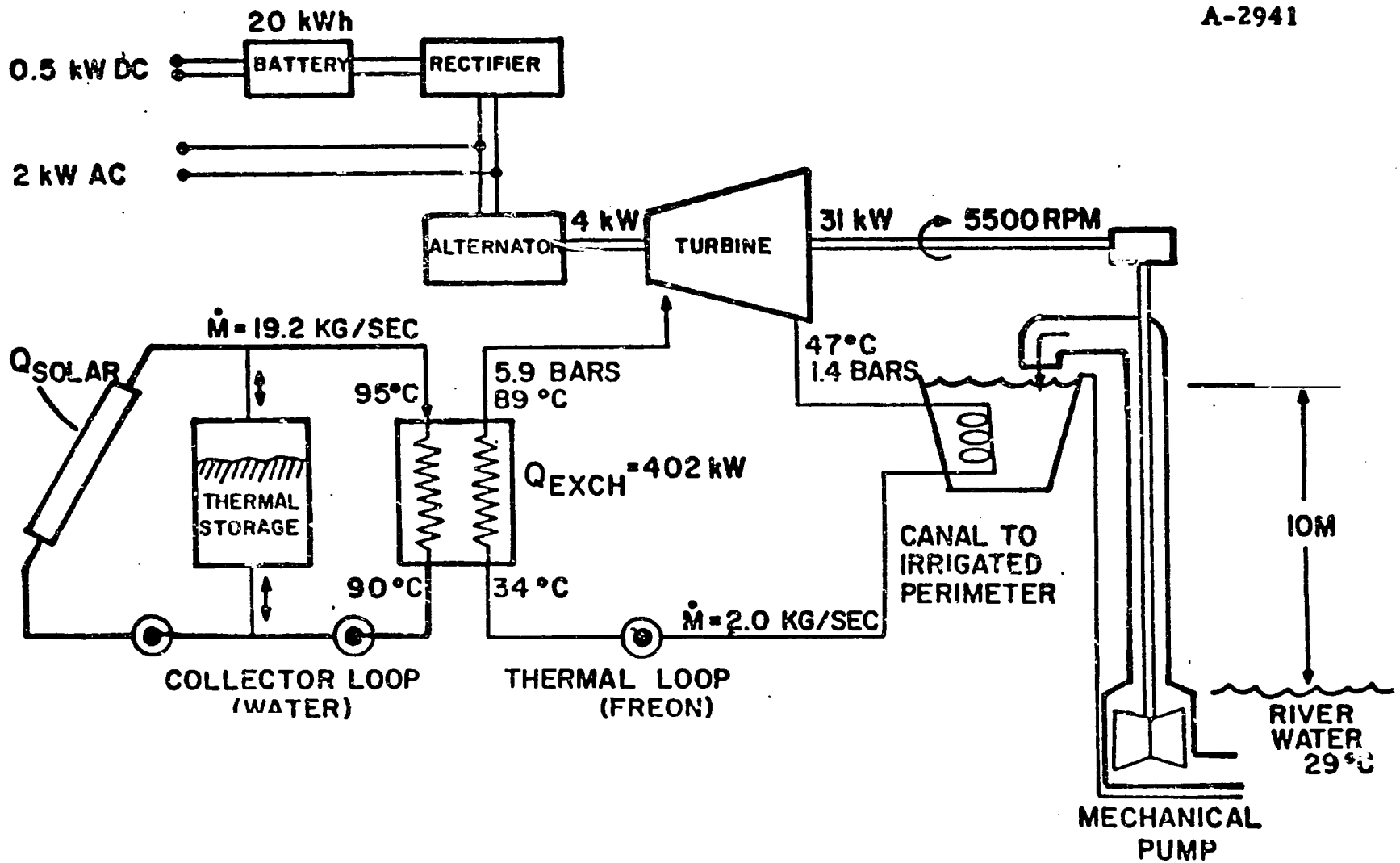
Engine Electrical Parasitics - Negligible

Gross Engine Efficiency - 9.0% (based on H_2O data)

Net Engine Efficiency - 7.0% (based on H_2O data)

It should be noted that the net engine efficiency of 7.0% compares very well with the Carnot efficiency of 13.9% for an ideal engine operating with the same temperature difference.

JPA:2324:lh



BAKEL PUMP SYSTEM