

Performance and Mass Modeling Subtleties in Closed-Brayton-Cycle Space Power Systems

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Performance And Mass Modeling Subtleties In Closed Brayton Cycle Space Power Systems:

Performance and Mass Modeling Subtleties in Closed-Brayton-cycle Space Power Systems Michael J. Barrett, 2005 **Energy Resources and Systems** Tushar K. Ghosh, Mark A. Prelas, 2009-06-04 In the lifetimes of the authors the world and especially the United States have received three significant wake up calls on energy production and consumption The first of these occurred on October 15 1973 when the Yom Kippur War began with an attack by Syria and Egypt on Israel The United States and many western countries supported Israel Because of the western support of Israel several Arab oil exporting nations imposed an oil embargo on the west These nations withheld five million barrels of oil per day Other countries made up about one million barrels of oil per day but the net loss of four million barrels of oil production per day extended through March of 1974 This represented 7% of the free world supply excluding the USSR oil production In 1972 the price of crude oil was about 3 00 per barrel and by the end of 1974 the price of oil had risen by a factor of 4 to over 12 00 This resulted in one of the worst recessions in the post World War II era As a result there was a movement in the United States to become energy independent At that time the United States imported about one third of its oil about five million barrels per day After the embargo was lifted the world chose to ignore the wake up call and went on with business as usual Energy Resources and Systems Tushar Ghosh, Mark Prelas, 2009-06-17 In the lifetimes of the authors the world and especially the United States have received three significant wake up calls on energy production and consumption The first of these occurred on October 15 1973 when the Yom Kippur War began with an attack by Syria and Egypt on Israel The United States and many western countries supported Israel Because of the western support of Israel several Arab oil exporting nations imposed an oil embargo on the west These nations withheld five million barrels of oil per day Other countries made up about one million barrels of oil per day but the net loss of four million barrels of oil production per day extended through March of 1974 This represented 7% of the free world supply excluding the USSR oil production In 1972 the price of crude oil was about 3 00 per barrel and by the end of 1974 the price of oil had risen by a factor of 4 to over 12 00 This resulted in one of the worst recessions in the post World War II era As a result there was a movement in the United States to become energy independent At that time the United States imported about one third of its oil about five million barrels per day After the embargo was lifted the world chose to ignore the wake up call and went on with business as usual **Space Technology and Applications International Forum 2007** Mohamed S. El-Genk, 2007 The proceedings of STAIF 2007 feature a broad spectrum of topics on These topics span the range from basic research to the most recent technology advances and hardware development and testing The proceedings will be of particular interest to program managers practicing engineers academicians graduate students system designers and researchers interested in the fields of space technology and space science *Large Space Structures & Systems in the Space Station Era* ,1990 **Large Space Structures & Systems in the Space Station Era** ,1990 **Scientific and Technical Aerospace Reports** ,1971 **Large Space Structures &**

Systems in the Space Station Era John J. Ferrainolo, George F. Lawrence, 1990 NASA SP., 1990 **International Aerospace Abstracts**, 1990 **Design and Off-Design Performance of 100 Kwe-Class Brayton Power Conversion Systems** National Aeronautics and Space Administration (NASA), 2018-06-24 The NASA Glenn Research Center in house computer model Closed Cycle Engine Program CCEP was used to explore the design trade space and off design performance characteristics of 100 kWe class recuperated Closed Brayton Cycle CBC power conversion systems Input variables for a potential design point included the number of operating units 1 2 4 cycle peak pressure 0 5 1 2 MPa and turbo alternator shaft speed 30 45 60 kRPM The design point analysis assumed a fixed turbine inlet temperature 1150 K compressor inlet temperature 400 K helium xenon working fluid molecular weight 40 g mol compressor pressure ratio 2 0 recuperator effectiveness 0 95 and a Sodium Potassium NaK pumped loop radiator The design point options were compared on the basis of thermal input power radiator area and mass For a nominal design point with defined Brayton components and radiator area off design cases were examined by reducing turbine inlet temperature as low as 900 K reducing shaft speed as low as 50 percent of nominal and circulating a percentage up to 20 percent of the compressor exit flow back to the gas cooler The off design examination sought approaches to reduce thermal input power without freezing the radiator Johnson Paul K and Mason Lee S Glenn Research Center NASA TM 2005 213626 E 15110 **Brayton Power Conversion System Parametric Design Modelling for Nuclear Electric Propulsion** National Aeronautics and Space Administration (NASA), 2018-07-17 The parametrically based closed Brayton cycle CBC computer design model was developed for inclusion into the NASA LeRC overall Nuclear Electric Propulsion NEP end to end systems model The code is intended to provide greater depth to the NEP system modeling which is required to more accurately predict the impact of specific technology on system performance The CBC model is parametrically based to allow for conducting detailed optimization studies and to provide for easy integration into an overall optimizer driver routine The power conversion model includes the modeling of the turbines alternators compressors ducting and heat exchangers hot side heat exchanger and recuperator The code predicts performance to significant detail The system characteristics determined include estimates of mass efficiency and the characteristic dimensions of the major power conversion system components These characteristics are parametrically modeled as a function of input parameters such as the aerodynamic configuration axial or radial turbine inlet temperature cycle temperature ratio power level lifetime materials and redundancy Ashe Thomas L and Otting William D Unspecified Center BRAYTON CYCLE CLOSED CYCLES NUCLEAR ELECTRIC PROPULSION PROPULSION SYSTEM CONFIGURATIONS PROPULSION SYSTEM PERFORMANCE AC GENERATORS AERODYNAMIC CONFIGURATIONS AXIAL FLOW TURBINES COMPRESSORS HEAT EXCHANGERS INLET TEMPERATURE REDUNDANCY REGENERATORS TEMPERATURE RATIO *Summary of Brayton Cycle Analytical Studies for Space-power System Applications* Arthur J. Glassman, 1964 **Models for Multimegawatt Space Power Systems**, 1990 This report describes models for multimegawatt space power systems

which Sandia's Advanced Power Systems Division has constructed to help evaluate space power systems for SDI's Space Power Office. Five system models and models for associated components are presented for both open power system waste products are exhausted into space and closed no waste products systems: open burst mode hydrogen cooled nuclear reactor turboalternator system, open hydrogen oxygen combustion turboalternator system, closed nuclear reactor powered Brayton cycle system, closed liquid metal Rankine cycle system, and closed in core reactor thermionic system. The models estimate performance and mass for the components in each of these systems. 17 refs, 8 figs, 15 tabs. *Performance Estimates for the Space Station Power System Brayton Cycle Compressor and Turbine*. National Aeronautics and Space Administration (NASA), 2018-07-09. The methods which have been used by the NASA Lewis Research Center for predicting Brayton Cycle compressor and turbine performance for different gases and flow rates are described. These methods were developed by NASA Lewis during the early days of Brayton cycle component development and they can now be applied to the task of predicting the performance of the Closed Brayton Cycle (CBC) Space Station Freedom power system. Computer programs are given for performing these calculations and data from previous NASA Lewis Brayton Compressor and Turbine tests is used to make accurate estimates of the compressor and turbine performance for the CBC power system. Results of these calculations are also given. In general, calculations confirm that the CBC Brayton Cycle contractor has made realistic compressor and turbine performance estimates. Cummings, Robert L. Unspecified Center. NASA ORDER C 22187 M. RTOP 474.52.10.

Predictability of Brayton Electric Power System Performance. John L. Klann, Henry John Hettel, 1972. Data from the first tests of the 2 to 15 kilowatt space power system in a vacuum chamber were compared with predictions of both a pretest analysis and a modified version of that analysis. The pretest analysis predicted test results with differences of no more than 9 percent of the largest measured value for each quantity. The modified analysis correlated measurements. Differences in conversion efficiency and power output were no greater than plus or minus 2.5 percent. This modified analysis was used to project space performance maps for the current test system. Design and Off-Design Performance of 100 Kwe-Class Brayton Power Conversion Systems. Nasa Technical Reports Server (Ntrs), 2013-07. The NASA Glenn Research Center in-house computer model Closed Cycle Engine Program (CCEP) was used to explore the design trade space and off-design performance characteristics of 100 kWe class recuperated Closed Brayton Cycle (CBC) power conversion systems. Input variables for a potential design point included the number of operating units, 1, 2, 4; cycle peak pressure, 0.5, 1, 2 MPa; and turboalternator shaft speed, 30, 45, 60 kRPM. The design point analysis assumed a fixed turbine inlet temperature, 1150 K; compressor inlet temperature, 400 K; helium-xenon working fluid; molecular weight, 40 g/mol; compressor pressure ratio, 2.0; recuperator effectiveness, 0.95; and a Sodium-Potassium (NaK) pumped loop radiator. The design point options were compared on the basis of thermal input power, radiator area, and mass. For a nominal design point with defined Brayton components and radiator area, off-design cases were examined by reducing turbine inlet temperature as low as 900 K, reducing shaft speed as

low as 50 percent of nominal and circulating a percentage up to 20 percent of the compressor exit flow back to the gas cooler

The off design examination sought approaches to reduce thermal input power without freezing the radiator

Models for Multimegawatt Space Power Systems Michael W. Edenburn,1990 This report describes models for multimegawatt space power systems which Sandia s Advanced Power Systems Division has constructed to help evaluate space power systems for SDI s Space Power Office Five system models and models for associated components are presented for both open power system waste products are exhausted into space and closed no waste products systems 1 Open burst mode hydrogen cooled nuclear reactor turbo alternator system 2 Open hydrogen and oxygen combustion turbo alternator system 3 Closed nuclear reactor powered Brayton cycle system 4 Closed liquid metal Rankine cycle system and 5 Closed in core reactor thermionic system The models estimate performance and mass for the components in each of these systems *Performance estimates for the space station power system Brayton Cycle compressor and turbine* Robert L. Cummings,1989

Steady-state Analysis of a Brayton Space-power System John L. Klann,1970

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