Computer Code Abstract

SURGTANK

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1. Program Identification: SURGTANK, a computer code for predicting heavy or light water steam surge tank thermodynamic transients caused by liquid in-surge or out-surge beginning from equilibrium conditions.[1-4]

2. Description of Physical Problem Solved: SURGTANK generates the steam pressure, saturation temperature, and ambient temperature history for a steam surge tank (pressurizer) that is initially in a state of thermodynamic equilibrium and is subjected to a liquid in-surge defined by a given time history of liquid levels. It is also capable of providing the pressure and saturation temperature history starting from thermodynamic equilibrium conditions, for the same tank, when it is subjected to an out-surge defined by a given time history of liquid levels. It permits both of these operations for light or heavy water systems. The tank is assumed to have perfect thermal insulation on its outer wall surfaces.

3. Method of Solution: (a) Out-surge problem—surge tank geometry, initial liquid level, and initial saturation pressure are provided as input. The prescribed level history is also provided as a time sequence of levels. SURGTANK assumes a reduced pressure for the end of the first change in liquid level and determines the associated change of entropy for the closed system. The assumed pressure is corrected iteratively until a pressure is obtained for which no change of entropy occurs.[1,3] This pressure is recorded and acts as the beginning pressure for the next level increment. The system is redefined to exclude the small amount of liquid that has left the tank. A solution for the pressure at the end of the second-level increment is then obtained. The procedure is terminated with determination of pressure at the end of the final increment. (b) In-surge problem—surge tank geometry, thermal conductivity, specific heat, density of tank walls, initial liquid level, and saturation pressure are provided as input. The prescribed level history is also provided as a time sequence of levels. SURGTANK assumes a slightly increased pressure for the end of the first level. The inner tank surface is assumed to follow saturation temperature, linearly with time, throughout the interval. Heat transferred to the walls and down into the liquid content of the tank is computed using established techniques.[5] The equation-of-state is utilized to obtain ambient temperature at the end of the interval. Deviations of the steam from perfect gas theory are taken into account. An energy balance is conducted for the end of the interval, in keeping with the first law of thermodynamics. The imbalance of energy is designated as the error, it is stored, and the procedure is repeated with a slightly higher assumed pressure. The assumptions and calculations are repeated until a change in sign of the error is noted. The exact pressure is then converged upon using established numerical techniques. The properties calculated for the end of the first level and time increment are used for the starting properties of the second increment, etc. Calculations are terminated when the final specified level is reached.

4. Related Material: The program is self-contained. No auxiliary programs or data files are required.

5. Restrictions: The program was developed for predicting pressure behavior in vertical axis cylindrical tanks with spherical dome caps. It will be apparent to users that it could be readily adapted to tanks of other geometries such as spherical tanks.[1] Back-to-back in-surges and out-surges are not handled, since each must start from equilibrium conditions. The analysis does not include the effects of heaters, sprays, and safety valves. Possible modifications to include effects of sprays are discussed in Ref. 5.

6. Computer: IBM S/360 Model 65.

7. Running Time: The average running time to obtain a pressure-time history for a prototype steam surge tank was found to be ~14 min for in-surge problems and ~4 min for out-surge problems. Actual real time of the in-surge and out-surge processes was ~2 min.

8. Programming Languages: The code is written in FORTRAN IV.

9. Operating System: OS/360.

10. Machine Requirements: The program executes with less than 100k bytes of memory.

11. Material Available: Source deck, test problems, results of executed test problems, and copies of references. A listing of all symbols is provided with explanations of their significance in the code. All this material is to be made available at the Argonne Code Center, Building 221, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439. Personal enquiries will be answered by the senior author, D. J. Gorman, Department of Mechanical Engineering, University of Ottawa, Ottawa, Ontario, Canada K1N 6N5.

12. *Acknowledgment:* This work was supported in part by the National Research Council of Canada.

13. *References:*

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[2]E. E. DRUCKER and D. J. GORMAN, *Nucl. Sci. Eng.*, **21**, 473 (1965).

[3]D. J. GORMAN, "Steam Surge Tank Transients During Outsurge," ASME Paper No. 69-WA/NE14, American Society of Mechanical Engineers (1969).

[4]R. K. GUPTA, "The Analysis and Computation of Steam Surge Tank Dynamics for Light and Heavy Water Systems," Masters Thesis, Department of Mechanical Engineering, University of Ottawa (1972).

[5]D. J. GORMAN, "Pressure Behavior in Pressurized Steam Surge Tanks," Masters Thesis, Department of Mechanical and Aerospace Engineering, Syracuse University, Syracuse (1962).