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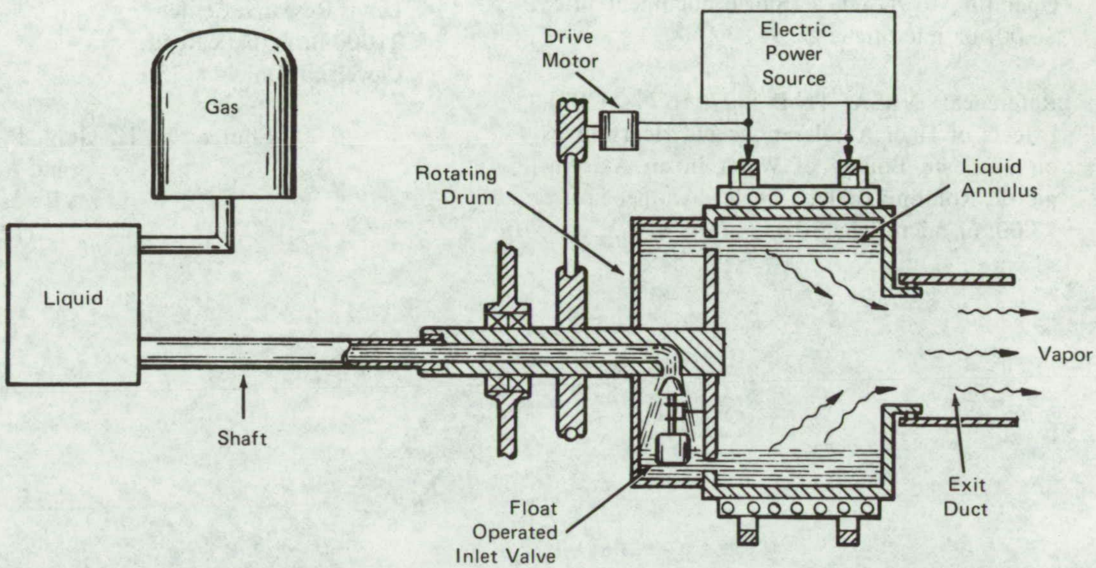
NASA TECH BRIEF
Lewis Research Center

Boiler for Generating High Quality Vapor



A boiler has been devised which is capable of supplying vapor at a very high quality for use in turbines. This boiler imparts a high angular velocity to the liquid to form a liquid annulus in a heated, rotating drum; a sharp interface is produced between the liquid phase and the vapor phase in the drum.

Ordinarily, when a liquid is boiled, turbulence at its surface causes liquid droplets to be dispersed in the vapor. It is desirable that vapor to drive a turbine be of the highest quality; that is, with a low liquid content in the vapor steam. Quality is defined as the ratio of the vapor mass to the vapor plus liquid mass. In systems such as Rankine cycle power generating systems where liquid metals are utilized to produce the vapor, liquid droplets in the vapor can cause severe erosion of the turbine blades. The rotating drum boiler provides a sharp interface between the boiling liquid and the vapor and so inhibits the formation of liquid droplets.

A sketch of the rotating drum boiler is shown in the figure. Liquid enters a hollow rotating shaft through a rotating seal and flows into a larger diameter rotating drum. In this drum, the liquid forms an annulus contained by the drum inner surface and rotates with the drum. The inner wetted surface of the drum is heated causing the liquid to vaporize. The vapor flows toward the center of rotation and into a stationary exit duct through a slip seal. The rotating shaft and drum are supported by bearings and in turn support the drive pulley, internal baffles, valves, and floats. The heat supply may be by radiation, by induction, by convection from another liquid, or by a condensing vapor instead of the electrical resistance elements shown in the sketch. A float-operated valve may be used to control the inlet liquid flow and maintain a constant thickness of liquid annulus.

Experiments have been conducted to determine the effects of acceleration and heat flux on vapor quality from a cylindrical rotating boiler with continuous through-flow of fluid. Stable boiling of water with outlet vapor qualities above 99 percent was achieved at an acceleration of 475 g's and heat fluxes up to 505,000

(continued overleaf)

Btu per hour per square foot (1.59 MW/m^2). Boiling heat-transfer coefficients up to 9000 Btu per hour per square foot per $^{\circ}F$ (51 $kW/(m^2)(^{\circ}K)$) were obtained. Increased acceleration increased the heat-transfer coefficients at low heat fluxes and decreased them slightly at high heat fluxes.

Notes:

1. The following documentation may be obtained from:
   National Technical Information Service
   Springfield, Virginia 22151

   Reference: NASA TN-D-4136 (N68-17566), Boiling Heat-Transfer Coefficients, Interface Behavior, and Vapor Quality in Rotating Boiler Operating to 475 G's (Single document price $6.00; or microfiche $0.95)

   Reference: NASA TN-D-6307 (N71-24202), Effects of High Accelerations and Heat Fluxes on Nucleate Boiling of Water in an Axisymmetric Rotating Boiler (Single document price $3.00; or microfiche $0.95)

2. Technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B72-10135

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,508,402) and royalty-free license rights will be granted for its commercial development. Inquiries concerning license rights should be made to:

Patent Counsel
Mail Stop 500-311
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