N82 18248 1/14

1NT011

WETTING, SPREADING, AND OPERATING CHARACTERISTICS OF BEARING LUBRICANTS IN A ZERO-GRAVITY ENVIRONMENT (1NT011)

C. H. T. Pan
Shaker Research, USA

and

Ann F. Whitaker and Raymond L. Gause
NASA/ Marshall Space Flight Center, USA

Spreading and wetting of a lubricating oil over surfaces occur in all lubrication systems. Examples are listed in Figure III-5. In many circumstances, long-term distribution and movement of the lubricant determine the useful life of the bearing. The phenomenon has many facets (Fig. III-6). Some isolated factors can be measured routinely (e.g., shadow photography of contact angle illustrated at the bottom of Fig. III-6). The total phenomenon cannot be accurately observed in the Earth environment because the relevant forces are overwhelmed by the gravitational force. The prolonged zero-gravity condition in a Spacelab flight provides a unique opportunity to obtain such technological data.

The zero-gravity environment also provides an opportunity for further research on the dynamic stability mechanism of a journal bearing which is believed to be associated with the two-phase fluid boundary. A journal bearing is a common mechanical device which works by developing a load-supporting film under the loaded direction. The thickness (h) of this film is a complex function of the rotating speed (n) and the fluid viscosity (μ) and is an inverse function of the bearing load (w):

$$h = f\left(\frac{n\mu}{w}\right) \quad .$$

In zero-gravity the load w approaches zero, and the bearing theoretically becomes unstable. The proposed experiment will determine the mechanisms of instability and the reaction of fluid films to zero gravity and will also test several concepts for preventing the onset of instability.

Two types of experiments will be conducted [viz., wetting and spreading on stationary surface(s), and two-phase boundary in a journal bearing configuration]. In each case, the fluid-surface combination will be the primary control parameter.

The experiment on stationary surfaces will be performed on a preassembled specimen. Upon commencement of the experiment, an automated dispenser will place a standard amount of the lubricant at the center of the surface specimen. Sequential or cinema photography of the front view will record the progression of the spreading boundary. Inclined mirrors will present simultaneous views showing the geometrical and size variations of the central drop.

Three journal bearing concepts will be investigated. These will include a plain journal bearing, a three-lobed bearing, and a plane bearing with eccentricity locked in. Photographs will be used to observe the movement and response of the fluid films under zero-gravity operating conditions, and vibration or displacement transducers will be used to record the movement of the bearings.

Both the wetting and spreading and the journal bearing portion of the experiment will be located in a drawer in Rack 7 of the Spacelab module (Fig. III-7).

This drawer will contain, in addition to four fluid wetting and spreading modules and three journal bearing modules, associated support equipment such as a camera, film, lenses, three-axis low-gravity accelerometer system, electronic controls, and a power supply.

The data to be obtained will have both scientific and engineering significance. The basic knowledge of fluid behavior in a low-gravity environment will be greatly advanced and provide a sound basis for the design of reliable and efficient fluid handling hardware for future spacecraft. The data generated from the journal bearing experiment should provide fundamental information on bearing and fluid dynamics to support theoretical work on hydrodynamics and engineering design of bearings for long life in a space environment.

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OIL DISTRIBUTION ON ROLLING ELEMENT COMPONENTS:

- **RETAINER**
- **RACES**
- **BALLS AND ROLLERS**

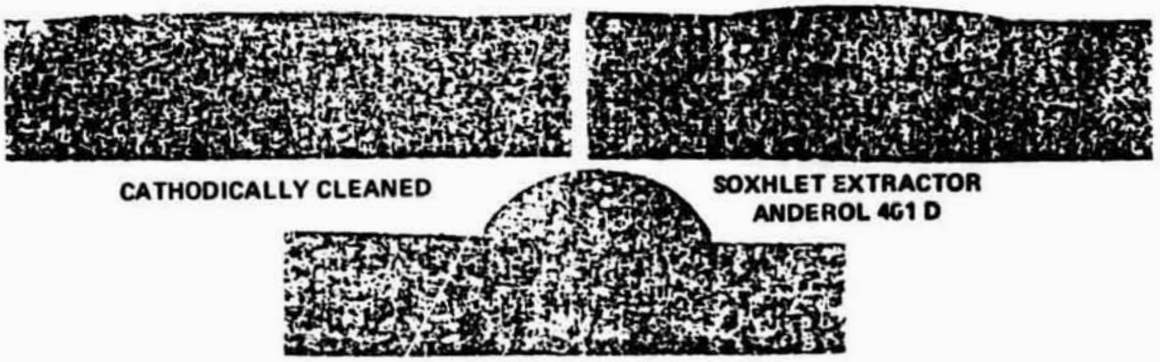
LONG–TERM MIGRATION/DEPLETION:

- **SLIP RING**
- **INSTRUMENT BALL BEARING**

FORMATION OF TWO–PHASE BOUNDARY:

- **JOURNAL BEARING**
- **SQUEEZE FILM DAMPER**

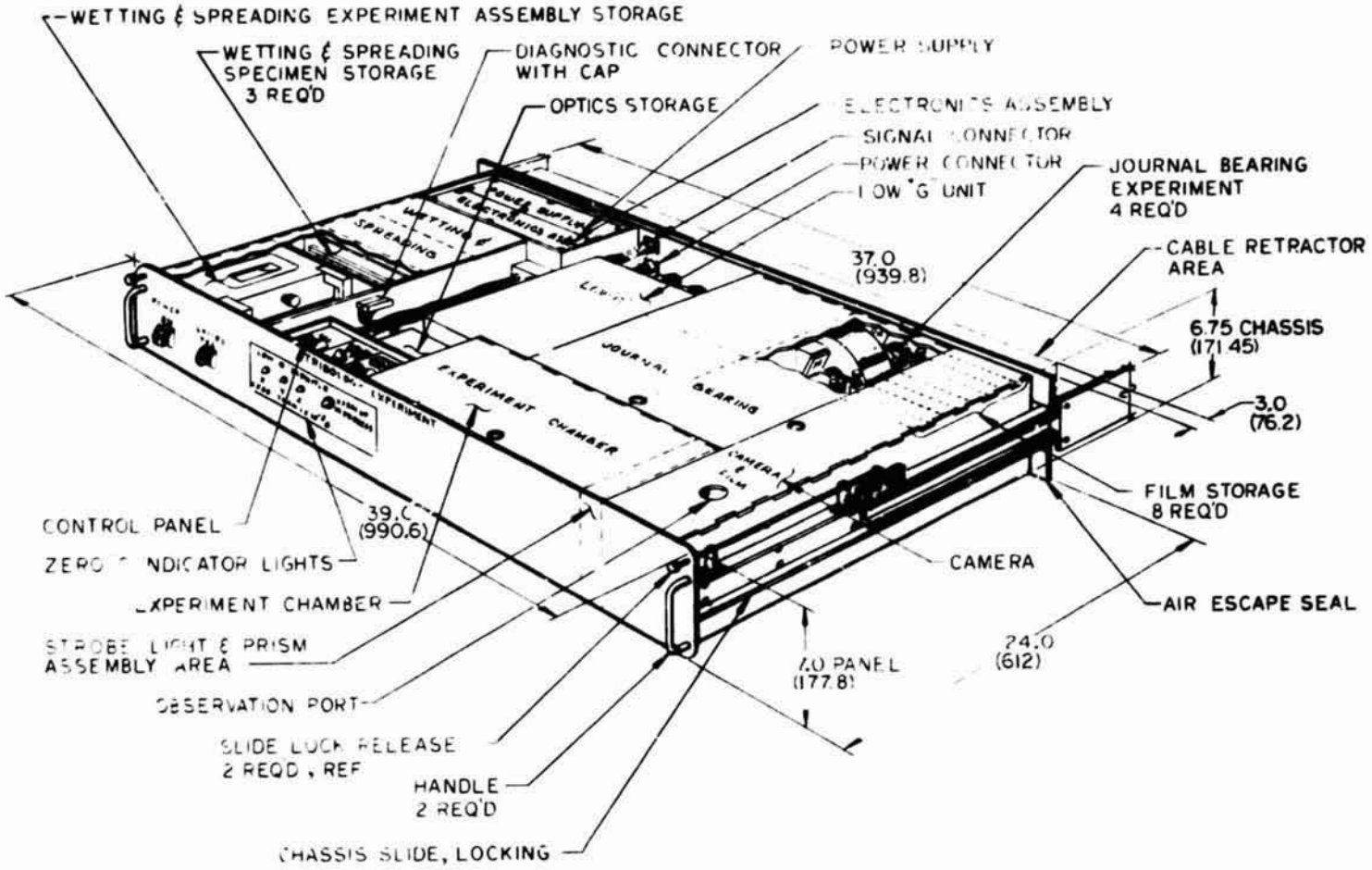
Figure III-5. Roles of wetting and spreading.



ANDEROL 401 D TRAPPED WITHIN BARRIER FILM CIRCLE

- **BASE FLUID PROPERTIES:**
  - **SURFACE TENSION**
  - **VISCOSITY**
- **BLENDING**
- **SURFACE FREE ENERGY**
- **ADDITIVES**
- **SURFACE TOPOGRAPHY/TEXTURE**
- **EVAPORATION**
- **FLUID MOTION**

Figure III-6. Influencing factors.



NOTE: DIMENSIONS IN INCHES (MILLIMETERS)

Figure III-7. Tribology experiment assembly.

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