**LIQUID METAL MEASURING
AND LOADING STATION**

J. A. YOUNT
L. E. CHULOS

MARCH, 1968

**AEC RESEARCH &
DEVELOPMENT REPORT**

ROUTE TO	DATE

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

PACIFIC NORTHWEST LABORATORY

RICHLAND, WASHINGTON

operated by

BATTELLE MEMORIAL INSTITUTE

for the

UNITED STATES ATOMIC ENERGY COMMISSION UNDER CONTRACT AT(45-1)-1830

PRINTED BY/ FOR THE U. S. ATOMIC ENERGY COMMISSION

3 3679 00061 1196

BNWL-705
UC-25, Metals
Ceramics, and Materials

LIQUID METAL MEASURING AND LOADING STATION

By

J. A. Yount

L. E. Chulos

Metallurgy Research Section
Metallurgy Department

March 1968

FIRST UNRESTRICTED
DISTRIBUTION MADE

APR 1 '68

PACIFIC NORTHWEST LABORATORY
RICHLAND, WASHINGTON

Printed in the United States of America
Available from
Clearinghouse for Federal Scientific and Technical Information
National Bureau of Standards, U.S. Department of Commerce
Springfield, Virginia 22151
Price: Printed Copy \$3.00; Microfiche \$0.65

LIQUID METAL LOADING AND MEASURING STATION

J. A. Yount

L. E. Chulos

ABSTRACT

An economical device for the accurate measurement and dispensing of small volumes (30 to 500 ml) of liquid metal is described.

Preliminary oxygen analysis shows the system contamination to be less than 33 ppm with a 20 ppm oxygen supply. This level of contamination is expected to diminish with operation.

LIQUID METAL MEASURING AND LOADING STATION

J. A. Yount

L. E. Chulos

INTRODUCTION

Increasing emphasis on the development of fast breeder reactor technology has produced an accompanying increase in the number of laboratory-scale tests designed to evaluate and test system materials and components. Many of these test environments simulate the liquid metal coolant of the reactor. In those tests involving a static environment, a prescribed amount of liquid alkali metal must be measured into a test chamber. This report describes a relatively small, economical work station that can accurately and reliably measure and load liquid alkali metal into a large number of test chambers in a short time, while maintaining the purity of the liquid metal.

STATE OF THE ART

Since most alkali metals react with or are contaminated by air, a vacuum test chamber or one filled with a high purity inert gas prior to entry of the metal must be used. Thus, direct "eyesight" measurement is impossible under normal circumstances. Also, the corrosive nature of the liquid metal precludes the use of virtually all types of flow or level measuring device that must operate in contact with the metal.

At the present time, two methods have been used with some success to solve this problem. The first makes use of a high purity, enclosed inert gas work station or "glovebox". Here measurement may be made directly by level sighting or by weight indication. The success of this method depends on the purity of the work station atmosphere. In addition, the operator must work restricted by heavy rubber gloves through the openings of the chamber.

The second method employs a high purity flowing sodium loop. One section of the piping is removable and may be replaced by a pipe or vessel of calibrated volume. Sodium is allowed to flow through and fill the calibrated volume; when the system has operated sufficiently to insure the purity of the liquid metal in the vessel, it is valved off, removed, and attached to the chamber to be filled. An operation of this type insures the purity of the liquid metal but demands the availability of a liquid metal loop.

Both of these methods involve a considerable financial investment and far too much operator time for a testing facility in full operation, such as the Experimental Testing Facility, 321A Building, Battelle-Northwest.

SOLUTION

To provide the required dependability and accuracy at an economical price, an inductive reactance level probe was incorporated into the liquid metal measuring system, shown schematically in Figure 1.

The system consists basically of the following parts:

- The liquid metal supply, in this case a barrel of sodium of known purity.
- Inductive reactance probes. These are commercially available and have proven long term reliability in determining liquid metal level in large volume storage tanks. The probe operates inside a stainless steel well and does not come into direct contact with the liquid metal environment.
- The measuring station, composed of two concentric tubes. The thin annulus is filled with liquid metal to a level indicated by the probe inside the inner tube.
- The capsule furnace, a device for heating the irregularly-sized retorts that receive the measured liquid metal.

PERFORMANCE

As indicated in Figure 2, continued use of the liquid metal measuring station has demonstrated an accuracy of ± 1 ml on volumes of from 30 to 500 ml.

Oxide analysis, performed on passing sodium through the system, indicated a contamination level of less than 33 ppm, with an oxide level of 20 ppm in the sodium supply barrel. This contamination level is expected to decrease with operating experience.

LIQUID METAL MEASURING AND LOADING FACILITY

FIGURE 1. Liquid Metal Measuring and Loading Facility

FIGURE 2. Measuring Station Calibration Curve

OPERATION

Operation of the system is quite simple. In the case of sodium filling:

1. The entire system is slowly brought to operating temperature (325 °F for the sodium barrel and 400 °F for the remainder of the system).
2. The test capsule to be filled is evacuated and backfilled with helium at an elevated temperature to insure purity.
3. The liquid level probe instrumentation is zeroed, and the probe is placed at the proper level for the desired amount of sodium (See Figure 2).
4. A slight differential pressure is then established to force sodium from the sodium barrel to the measuring station. The temperature drop indicated by a thermocouple on this line will show flow of the cooler sodium into the warmer line.
5. Sodium is allowed to flow until the electronic readout for the probe indicates the desired level (See Figure 3).
6. The inlet line to the measuring station is then secured, the outlet line opened, and a differential pressure is established to transfer the sodium into the test capsule.
7. If a quantity of alkali metal exceeding chamber capacity is desired, the operation is repeated until the proper amount is transferred to the capsule.
8. Facilities are also provided for sampling or for disposal of the liquid metal from either the measuring station or the capsule.
9. The test capsule oven section may also be used for discharging the sodium from the test capsule upon termination of the test.

FIGURE 3. Sodium Measuring Apparatus

SAFETY FEATURES

Operation of a facility of this kind is potentially hazardous. For this reason, the following safety features have been incorporated into the Sodium Measuring and Loading Station (Figure 4) now in service at Battelle-Northwest.

- An automatic over-temperature cutout is provided on the liquid metal storage barrel.
- All heaters are separately controlled, fused, and thermocouple monitored.
- The gas system is designed to insure that sodium will freeze before reaching the vent.
- An over-temperature alarm is provided on all thermocouples.
- Separate ammeters are provided on all heater controlling devices.
- A separate gas supply is used on the sodium barrel.
- The liquid metal barrel is contained in a welded 3/16-in. steel box, and the space between is packed with insulation.
- Every pressure system is vented.
- Kerosene-filled wash bottles are used on all vents.
- At least two valves are provided on all sodium lines.
- A large volume dump tank is available in the system.
- Thermal insulation is sufficient in all portions of the system to prevent operator injury.
- Electrical insulation is installed according to best current practices.
- Stainless steel bellows-sealed valves and high pressure tubing are used throughout.

FIGURE 4. Measuring Station in Operation

ACKNOWLEDGMENTS

The authors wish to acknowledge the significant advice and assistance provided by W. F. Smith in the preparation of this report. The assistance of W. L. Smith and R. F. Johnson in the assembly of the apparatus is also greatly appreciated.

DISTRIBUTIONNo. of
Copies

1	<u>Argonne National Laboratory</u>
2	<u>AEC Chicago Patent Group</u> G. H. Lee R. K. Sharp
1	<u>AEC Library, Washington, D. C.</u> J. J. Morabito
4	<u>AEC RDT Site Rep., Richland</u> P. G. Holsted (2) L. R. Lucas J. H. Sako
2	<u>AEC Richland Operations Office</u> C. L. Robinson Technical Information Library
3	<u>Battelle Memorial Institute</u>
3	<u>Division of Technical Information Extension</u>
1	<u>Lawrence Radiation Laboratory, Livermore (AEC)</u> James W. Hadley
62	<u>Battelle-Northwest</u> F. W. Albaugh E. R. Astley A. L. Bement T. K. Bierlein G. R. Bloom R. V. Bowersock J. J. Cadwell L. E. Chulos (15) T. T. Claudson L. J. Defferding R. L. Dillon D. R. Doman R. V. Dulin R. W. Hardie

Battelle-Northwest (contd)

R. J. Hennig
R. L. Knecht
D. C. Lehfeldt
M. K. Millhollen
J. E. Minor
R. S. Paul
L. T. Pederson
W. D. Roake
R. H. Scott
D. W. Shannon
F. R. Shober
J. B. Vetrano
J. A. Yount (15)
Technical Information Files (5)
Technical Publications (2)