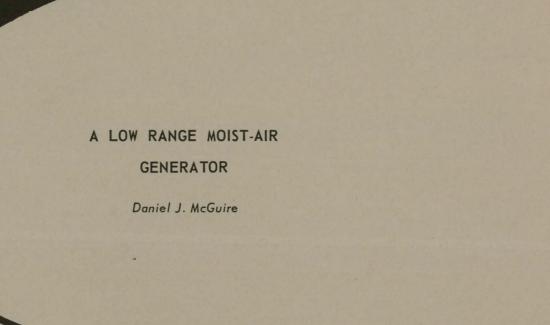
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RFP-1290 June 10, 1969

MASTER





THE DOW CHEMICAL COMPANY
ROCKY FLATS DIVISION
P. O. BOX 888
GOLDEN, COLORADO 80401

U.S. ATOMIC ENERGY COMMISSION CONTRACT AT(29-1)-1106

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A LOW RANGE MOIST-AIR GENERATOR

Daniel J. McGuire

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Special credit is given to L. H. Morrow for the mechanical design of this system, and to other personnel of the Physical Metrology Laboratory for their help in operation and evaluation of the system.

A LOW RANGE MOIST-AIR GENERATOR

Daniel J. McGuire

Abstract. A relatively inexpensive, manuallyoperated, moist-air generator is described. The generator provides moisture levels from 5 parts per million by volume to 50-percent relative humidity. It serves as a stable source of moist air for environmental comparison and calibration of humidity measuring equipment. Construction details of the moistair generator are provided.

INTRODUCTION

Calibration of humidity measurement equipment, such as the CEC Moisture Monitor¹ and the Hygrodynamics electric hygrometer,² requires either a source of gas with known moisture content or a stable source of moist gas with a calibrated comparison instrument. The latter is used at Rocky Flats Plant for humidity calibrations.

Apparatus has been constructed that generates the required moist gas with water-vapor content adjustable over the range from 5 parts per million (ppm) by volume to 50-percent relative humidity. The capacity of the apparatus is dependent somewhat on the moisture level required, but the system currently operates at one liter per minute. Higher volumes, up to the dryer capacity of seven standard cubic feet per minute (scfm) should be attainable, with perhaps some sacrifice in maximum moisture content.

System Requirements: The following criteria were established for the moist-air generator for the calibration system:

- The generator should be adjustable continuously over a wide range.
- The operating point should be stable for reasonable lengths of time with both short- and long-term fluctuations minimized.

 Adjustment to new operating levels should be possible without a long wait for system equilibration.

The generator described herein fulfills the three requirements adequately. However, the operator must have some experience because of the number of interrelated manual adjustments to be made.

Equipment Construction and Operation:

GENERAL - The main features of the moist-air generator are shown in Figures 1 and 2. Figure 3 is a schematic drawing of the generator system.

The items of equipment are an air dryer, a moisturing chamber, a two-stage mixing manifold, and a distribution chamber. The supplied instrument air is dried by a molecular-sieve, self-regenerating gas dryer. The dried air then passes to an adjustable 0 to 30 pounds per square inch gauge (psig) pressure regulator where, after expansion, the moisture content is about 2 to 3 ppm by volume. The air is then metered into the moisturizing and mixing chambers via micrometer-type needle valves.

MOISTURIZING CHAMBER — The moisturizing chamber was made from a 24-inch length of 6-inch stainless steel tubing (see Figure 4). This chamber has a water-sight glass at one end and is flanged at the other for access. Dry air enters the chamber through a ¼-inch stainless steel sparge tube and is bubbled into the chamber through a series of No. 28 drill holes spaced at 1-inch intervals along the horizontal tube. The tank is packed loosely with glass wool to provide a long diffusion path for the moisturized air. The tank, half-filled with water, is operated at room temperature to achieve the required humidity levels.

MIXING MANIFOLD — The two mixing tanks also were made from lengths of stainless steel tubing (see Figure 5). No attempt was made to introduce elaborate vortex mixing paths into either tank.

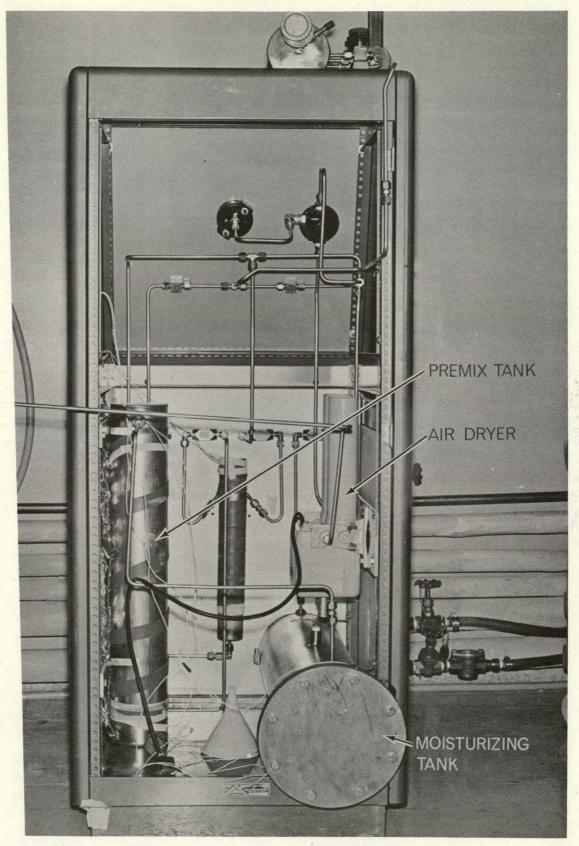
¹Consolidated Electrodynamics Corporation, Pasadena,

² Hygrodynamics, Inc., Silver Spring, Maryland.



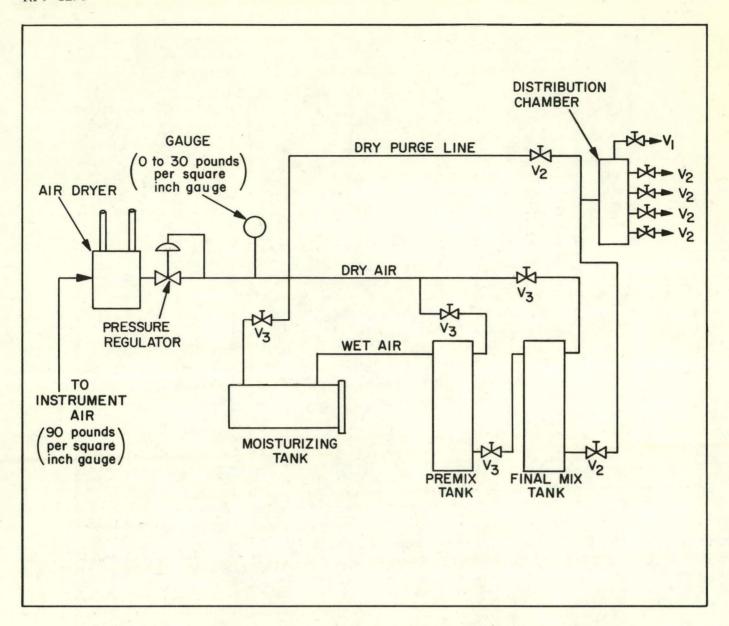
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FIGURE 1. Front View of Moist-Air Generator.



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FIGURE 2. Inside View of Moist-Air Generator.



Legend

V₁ - Hoke Control Bleed Valve No. 1315 G4B, Hoke, Inc., Cresskill, New Jersey.

V2 - Nupro Valve No. B4H, Nupro Company, Cleveland, Ohio.

V₃ - Hoke Micrometer Valve No. 2PY281.

Regulator - Foxboro Type No. 67, Foxboro Company, Foxboro, Massachusetts.

Air Dryer - Wilkerson Model No. WF-200-109, Wilkerson Corporation, Englewood, Colorado.

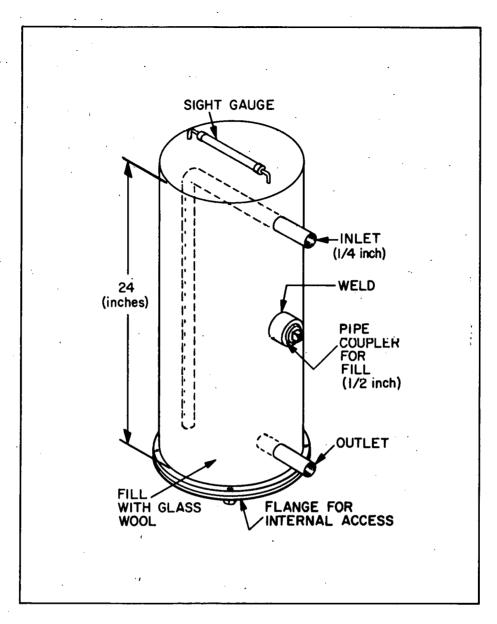


FIGURE 4. Moisturizing Chamber.

All tube connections are right-angle butt welds with the exception of the inlets to the final mixing tank; these have been angled away from the outlet primarily because of the tank's small size. Both mixing tanks have been wrapped with heat tape to help in evaporating surface moisture when changing from extremely wet to extremely dry operational levels. These tapes may be used with a Variac³ to control output air temperature if desired.

DISTRIBUTION CHAMBER – The output from the final mixing stage is fed to a fourth chamber that serves both as a distribution manifold and a stabilizing volume (see Figure 6).

A bleed valve (Hoke) is located on this chamber because (1) at low flow rates and during standby periods, some air must be bypassed for system stability, and (2) a large bypass volume speeds dry down during changeover from one moisture level to another.

³Trademark of General Radio Company, Concord, Massachusetts.

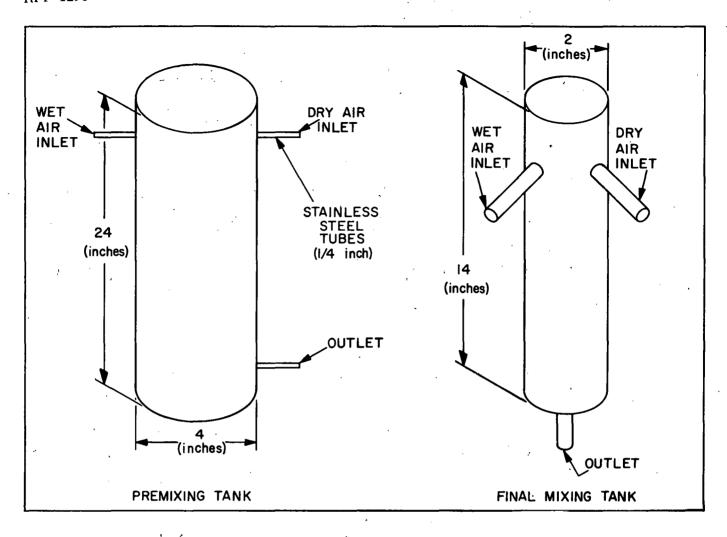


FIGURE 5. Mixing Tanks.

Air may also be introduced directly into the distribution chamber from the dryer through the dry purge line. This will aid rapid drying of the test system without disturbing the moisture level settings of the generator. Four output valves are provided on the distribution chamber for parallel systems under test

SUMMARY

The moist-air generator has been used for calibration service in the laboratory for about a year with no breakdown or serious problems. The design described in this report has evolved from several modifications which have provided more operational flexibility. No further modifications are planned at this time.

Some consideration has been given to automatic control of output moisture levels by a servo-controlled needle valve in the moist-air line which should make it easier to achieve predetermined moisture levels. The drawback to this control would be the concomitant variations in flow rate and pressure. Flow variations are undesirable for current applications. However where small flow variation is no problem, it is believed that automatic control of moisture level could be a valuable adjunct.

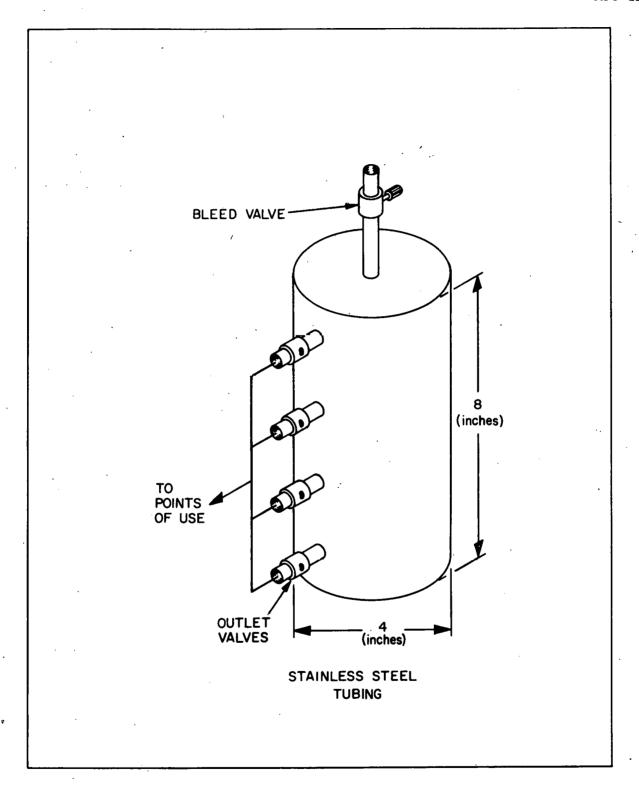


FIGURE 6. Distribution Chamber.