CNRM
国家标准物质资源共享平台

中国计量科学研究院
液体密度标准物质

NATIONAL INSTITUTE OF METROLOGY, CHINA
CERTIFIED REFERENCE MATERIAL (CRM) — LIQUID DENSITY

专 业
Professional

创 新
Innovative

准 确
Accurate

可 靠
Reliable

液体密度标准物质的研制源于工业与科研对高精度密度测量的迫切需求。随着新技术发展，传统测量方法（如比重瓶、玻璃浮计）在精度和效率上已无法满足要求，需建立可溯源的标准化体系。中国计量科学研究院成功研制密度范围在(691~1878) kg/m^3、分辨力分别达到0.001kg/m^{3}和0.01kg/m^{3}的5种液体密度国家一级标准物质和5种液体密度国家二级标准物质，不确定度分别为0.020kg/m^{3}和0.04kg/m^3，指标达到国际先进水平。密度值大于1000kg/m^{3}的密度点，选择不易挥发，对人无毒害的氟油作为标准物质，以替换国际通常采用的四氯乙烯。

该系列标准物质的量值可通过国家密度基准，溯源至质量和长度的SI基本单位千克、米。所使用的“固体密度基准装置（国基证(2010)第113号）”，相对测量不确定度达到2×10^{-7}(k=2)。依据“NIM-ZY-LS-RL-210固体密度基准装置操作规范”，利用固体密度基准量传装置，通过静力称量法为固体密度标准硅球赋值，相对测量不确定度3×10^{-6}(k=2)。最后利用高精度液体密度测量装置，通过静力称量法实现固体密度标准硅球对液体密度标准物质的定值。

该标准物质采用安瓿瓶封装，每瓶含有15 mL液体，安瓿瓶开启后一次性使用。应贮存在阴凉、干燥、避光的洁净环境中，无需冷藏，常温运输。必须使用玻璃注射器吸取液体密度标准物质，如果使用塑料注射器会造成标准物质特性值改变。

该标准物质主要用于振动式密度仪、浸没式密度仪等密度测量设备的校准，是密度量值传递体系的基础测量标准。该系列标准物质可配套JJF 2165-2024《实验室振动式液体密度仪校准规范》、JJF 2164-2024《在线振动管液体密度计校准规范》、JJF 1866-2020《浸没振动式电子液体密度仪校准规范》等多项密度相关的计量技术法规使用。

高精度液体密度标准物质的研发可以很好的提升我国液体密度量值传递的水平。依托高精度液体密度标准物质的研制，能够满足我国高精度液体密度测量仪器的量值溯源，摆脱长期以来需要进口国外高精度液体密度标准物质的制约，有助于我国高精度液体密度测量仪器的研发和产业升级。

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序号 No.	名称 Description	名称 Description	标准物质编号 Code	20 ℃时密度值 Density Value Measured at 20 ℃ (kg/m^3)	不确定度 Uncertainty (kg/m^3) (k=2)	规格 Unit of Issue
1	异辛烷密度标准物质	Isooctane Density	GBW13984	692	0.020	15mL
2	十三烷密度标准物质	Tridecane Density	GBW13985	756	0.020	15mL
3	PAO 润滑油密度标准物质	PAO Lubrication Oil Density	GBW13986	815	0.020	15mL
4	超纯水密度标准物质	Ultra-Pure Water Density	GBW13987	998	0.020	15mL
5	氟油密度标准物质	Fluoro-oil Density	GBW13988	1878	0.033	15mL
6	异辛烷密度标准物质	Isooctane Density	GBW(E)130850	692	0.04	15mL
7	十三烷密度标准物质	Tridecane Density	GBW(E)130851	756	0.04	15mL
8	PAO 润滑油密度标准物质	PAO Lubrication Oil Density	GBW(E)130852	815	0.04	15mL
9	超纯水密度标准物质	Ultra-Pure Water Density	GBW(E)130853	998	0.04	15mL
10	氟油密度标准物质	Fluoro-oil Density	GBW(E)130854	1878	0.05	15mL

The development of liquid density reference materials originates from the urgent demand for high-precision density measurements in industrial and scientific research. With the advancement of new technologies, traditional measurement methods (such as pycnometers and hydrometers) have become inadequate in terms of accuracy and efficiency, necessitating the establishment of a traceable standardization system. The National Institute of Metrology (NIM) of China has successfully developed five national primary reference materials and five national secondary reference materials for liquid density. These materials cover a density range of (691~1878) kg/m^3 with resolutions of 0.001 kg/m^3 and 0.01 kg/m^3, respectively, achieving measurement uncertainties of 0.020 kg/m^3 and 0.04 kg/m^3. These specifications meet international advanced standards. For density points exceeding 1000 kg/m^3, the institute has selected non-volatile and non-toxic fluorinated oil as the reference material to replace the internationally commonly used tetrachloroethylene.

The metrological values of this series of reference materials can be traced back to the SI base units of mass (kilogram) and length (meter) through China's national density primary standard. The "Solid Density Primary Standard Device (National Primary Standard Certificate (2010) No. 113)" used in this process achieves a relative measurement uncertainty of 2×10^{-7} (k=2). In accordance with the "Operation Specification NIM-ZY-LS-RL-210 for the Solid Density Primary Standard Device," the solid density standard silicon spheres are calibrated using the solid density primary standard transfer device via the hydrostatic weighing method, achieving a relative measurement uncertainty of 3×10^{-6} (k=2). Finally, the high-precision liquid density measurement apparatus employs the hydrostatic weighing method to realize the certification of liquid density reference materials based on the solid density standard silicon spheres.

This certified reference material (CRM) is sealed in glass ampoules, each containing 15 mL of liquid. The ampoule must be used immediately after opening and is strictly for single use. Storage should be in a cool, dry, light-protected clean environment; refrigeration is not required, and transportation can be conducted at ambient temperature. A glass syringe must be used to withdraw the liquid density CRM. Use of plastic syringes may cause alteration of the certified property values.

This certified reference material (CRM) is primarily used for calibrating density measurement devices such as oscillation-type density meters and immersion-type density meters, serving as the foundational measurement standard in the metrological traceability system for density. The series of CRMs can be applied in conjunction with multiple density-related metrological technical regulations, including: JJF 2165-2024 Calibration Specification for Laboratory Oscillation-type Liquid Density Meters, JJF 2164-2024 Calibration Specification for Online Oscillation-tube Liquid Density Meters, JJF 1866-2020 Calibration Specification for Immersion Oscillation-type Electronic Liquid Density Meters.

The development of high-precision liquid density reference materials will significantly enhance the level of liquid density metrological value transfer in China. By advancing the research and production of such materials, it will enable traceability for high-precision liquid density measurement instruments domestically, breaking free from the long-standing reliance on imported high-precision liquid density reference materials. This progress will further facilitate the development and industrial upgrading of China's high-precision liquid density measurement instruments.

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为测量提供标准！

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