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Weighing Applications in the Fields of Chemical Engineering With Sartorius Cubis® II Premium Balances

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Abstract

Laboratory analytical balances are crucial instruments used in various interdisciplinary fields of research. Remarkable developments achieved in recent years concerning both electronics of the weighing systems and workflow guidance via software applications made weighing processes traceable, more intuitive, and more efficient. Sartorius Cubis® II balance portfolio is the performance benchmark in its field. It offers attractive built-in software and hardware solutions (e.g., Cubis® QApps, calibration, leveling, variety of sample holders), modularity and state-of-the-art interfaces. With these features Cubis® II interacts with different technologies of lab 4.0, linking the scale with processes and data with each other for faster and traceable workflow and data management. In this guide, you will find an overview of various weighing applications from the fields of chemical engineering published in peer reviewed academic journals.

Introduction

Chemical engineering is a discipline influencing numerous industries (biotechnology, pharmaceuticals, or environmental engineering). Taking interdisciplinarity to the next level, it combines life and physical sciences with applied mathematics and economics to transform and/or produce chemicals, materials, living cells, energy, etc., into novel forms with altered functionality, and innovative products.[1] Among the broad range of applications[2] (solution preparation and water content determination in Karl-Fischer Titration, binary mixture preparation and concentration determination, density determination, solubility and swelling ratio measurements, etc.) used for these technological processes, an accurate and precise mass determination is critical for successful experimentation.

For example, the presence of contaminants, like pharmaceuticals in the environment, is prompting the search for new methods in wastewater treatment in order to concentrate and remove them from soils, sediments, and effluents.[3,4] To achieve this, novel biocompatible aqueous biphasic systems have been designed for extracting non-steroidal and anti-inflammatory drugs from aqueous streams.[5,6] These systems are trending, because of their content of a myriad of anions and cations (acting as salting out agents), which opens up countless possibilities. During characterization of the aqueous biphasic systems, the solubility data needs to be obtained. This is done by mixing known amounts of the surfactant and ionic liquid in a dry chamber, covering the entire mass fraction range, where the precise determination of the concentration of these points requires semi-micro balances with a readability of 10 mg.

Another challenge in this field is the isolation of biotechnology-derived products from the medium. The interest in biomass-derived chemical products is permanently growing. Several studies considered integrating an *in situ* liquid-liquid extraction step into the total production processes, in order to separate the desired product form the reaction medium.[7] However, electrolytes are known to have a strong influence on the mutual solubility of water and organic solvents, as well as on partitioning of a product between water and the organic solvent. Thus, the systematic study of the salt effects on liquid-liquid equilibria (LLE) of involved liquid mixtures is a prerequisite for the design of extraction separation processes.[8] All the components used for the determination of the LLE data requires precise gravimetric determination. Further, the water content has to be determined as well, classically by Karl-Fischer titration, where an analytical balance is directly connected to the titrator.[9,10]

An important aspect of environmental science, and at the same time a challenge in the field of chemical engineering, is to stabilize and prolong the lifetime of cassava-based films (CBF) via increasing their resistance to chemical reactions. CBF have a great potential in the replacement of non-biodegradable plastics, because they can be broken down by natural processes, leaving no byproducts as waste, and are economically feasible. Film solubility and swelling ratio measurements, as well as absorption testing of CBF, also require gravimetrical tests.[11]

For a more detailed overview of publications using Sartorius Cubis® laboratory balances in the fields of chemical engineering please refer to Table 1.

Table 1: Weighing Applications in Chemical Engineering

Field	Topic	Details	Type of Sartorius Cubis® Balance	Application	Ref.
Environment and Public Health	Wastewater treatment	New strategy to selectively separate pharmaceutical contaminants in wastewater deriving from hospitals	Cubis® MSA-125 Semi-Micro Balance	Surfactant and ionic liquid mixing for characterization of binodal curves	5
Public Health	Wastewater treatment	Design of a biocompatible aqueous biphasic system to extract non-steroidal, anti-inflammatory drugs from aqueous streams	Cubis® MSA-125 Semi-Micro Balance	Concentration determination of binary mixtures	6
Biotechnology	Isolation of biotechnology-derived chemical products	Influence of electrolytes on liquid-liquid equilibria	Cubis® Precision Balance	Water content determination, Karl-Fischer Titration	9
Chemistry	Aggregation behavior of ionic liquids in aqueous solutions	Implementation of alternative experimental techniques enables users to understand better the aggregation behavior of ionic liquids in aqueous solutions	Cubis® MSA-125 Semi-Micro Balance	Solution preparation for volumetric behavior and density determination	12
Environment	Replacement of non-biodegradable plastics with cassava biobased films (CBF)	Analysis of impact of novel cassava-assisted processing on fluid transport phenomenon in stressed bio-derived films	Cubis® Analytical Balance	Film solubility and swelling ratio measurements	11
Biotechnology	Systematic investigation of salt-influence on aqueous | organic systems	Salt influence on MIBK/water liquid-liquid equilibrium: Measuring and modeling with electrolyte Perturbed-Chain Statistical Associating Fluid Theory (ePC-SAFT) and the thermodynamic model COSMO-RS	Cubis® Precision Balance	Solution preparation for liquid-liquid equilibria measurements, Karl-Fischer Titration	10
Biotechnology	Solubility characterization of Aqueous Biphasic Systems (ABS)	Triton-X surfactants are proposed as candidates to form ABS	Cubis® MSA-125 Semi-Micro Balance	Weight quantification to determine the ternary system compositions	13
Thermodynamics	Zinc-rich alloys, as new materials for latent heat storage application	New zinc-rich eutectic alloys, as phase change materials with melting temperature below 400° C and high energy densities are new materials for latent heat storage application	Cubis® Precision Balance	Obtaining the stoichiometric amounts of the primary metals	14
Chemistry	Suspension plasma spraying	Titanium- and chromium-based carbides as attractive coating materials using suspension plasma spraying	Cubis® II Micro Balance	Weight loss measurements	15
Elemental Analysis	Use of macromolecular biomaterials as auxiliary chemicals	Exploration of the properties of crosslinker-free PEC gels and freeze-dried PEC sponges based on CS and CRG precursors	Cubis® Micro Balance	Measurement of 1–2 mg of lyophilized samples	16
Purity Determation	NMR method to determine purity of Neat Agent T	NMR method to determine NIST-traceable quantitative weight percentage purity of Neat Agent T	Cubis® Micro Balance	Weight measurements	17
Nanoparticle-biological interactions	Biological recognition of graphene nanoflakes	Development and study of few-layered graphene nanoflakes	Cubis® Ultra-Micro Balance	Measurement of the mass concentration of graphene nanoflakes	18
Applied Chemistry	Study of the chemical composition of fine particulate matter	Chemical composition of THC, CO and NOx from gasoline and diesel vehicle emissions	Cubis® Micro Balance	Filter weighing of particulates	19

Discussion

Whether it is a titration process, impurity test, elemental analysis, particulate matter determination or other process, during these analytical workflows, samples are weighed multiple times each day. This application guide presents a series of examples showing how laboratory balances are integrated into processes used in highly diverse and dynamic areas of chemical sciences. The Sartorius Cubis® II series of weighing systems fulfill the highest requirements at the level of accuracy and precision. These balances were designed for an intuitive operation, further aided by intelligent software assistance systems which always ensure the correct usage of the balance. This guarantees a higher degree of repeatability of the different workflows, while lowering the probability of human error during the measurement steps. Lastly, via offering stand-alone (plug-and-play) connectors, our scales decrease complexity and simplify IT maintenance to provide seamless integration of our balances into lab systems (e.g., LIMS, ELN).

To gain more information: www.sartorius.com/chemicals and www.sartorius.com/cubis-ii

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