Developments in sludge dewaterability characterization

Ludovico Spinosa
CNR, ludovico.spinosa@fastwebnet.it

DEVELOPMENTS IN SLUDGE DEWATERABILITY CHARACTERIZATION

Ludovico Spinosa*

** CNR Senior Scientist (retired), Bari (I)*
Convenor of CEN/TC308/WG1 and ISO/TC275/WG6
E-mail: ludovico.spinosa@fastwebnet.it

The management of sewage sludge in a sustainable manner is one of the critical issues facing modern society.

However, to:

- properly perform the utilization and disposal operations;
- correctly fulfil the legal requirements;
- build stakeholder and public confidence,

the establishment of defined outlet procedures/routes is needed and a good sludge quality must be guaranteed.

Characterization is, therefore, a tool of primary importance in sewage sludge management, as it allows chemical, biological and physical properties of sludge to be evaluated, and its behaviour predicted.

It is also to put in evidence that fundamentals of procedures adopted in characterization methods are often basically known and accepted everywhere, but each laboratory or analysis textbook follows and/or proposes different equipment size, accessories and procedures.

As a consequence, the development of standardized characterization methods and procedures becomes an additional necessary prerequisite.

Following considerations that characterization and standardization are necessary tools in sludge management, the European Committee for Standardization (CEN) established the Technical Committee 308 (TC308) whose main tasks are the production of Standard methods for the chemical, biological and physical characterization of sludge, and of Guidelines for good management practice.

Work of CEN/TC308 has been organized in 3 Working Groups dealing with the:

- standardization of methods for determining chemical, biological and physical sludge parameters (WG1, Convened by L. Spinosa)
- preparation of Guidelines of good practice for the different options of sludge use and disposal (WG2)
- preparation of documents on the current and future needs in sludge management, and with the development of guidance to preserve and extend utilisation and disposal routes (WG3)

More recently, the International Organization for Standardization (ISO) has established the Technical Committee 275 (TC275) aimed at the standardization of methods for characterizing, categorizing, preparing, treating, recycling and managing sludge or biosolids and outputs from their treatment and handling.

ISO/TC 275 work is organized in 7 Working Groups:

WG 01 "Terminology"

WG 02 "Characterization methods"

WG 03 "Digestion"

WG 04 "Land application"

WG 05 "Thermal processes"

WG 06 "Thickening and dewatering"

(Convened by L. Spinosa)

WG 07 "Inorganics and nutrients recovery«

Everybody interested in joining the CEN/TC308 and the ISO/TC275 programmes must contact their National Standardization Body (UNI, AFNOR, DIN, BSI, etc.).

It is well recognized that the effectiveness and cost of sludge treatment and disposal operations are strongly affected by its volume and, consequently, by its water content or solids concentration

The consequence is that one of the crucial steps to move forward within the context of a reduced impact on environment is the minimization of sludge mass/volume to reduce amount and costs of subsequent sludge handling, including transportation

Strategies for reducing sludge mass/volume include two options:

- *reducing* sludge production in the wastewater treatment stage through appropriate technologies and operating procedures (e.g. cellular lysis, increasing sludge age, ozonation, using membrane technology, MicroSludge process, Cannibal process, CAMBI thermal hydrolysis process)

- *reducing* in the sludge stage the mass/volume produced in the preceding wastewater treatment stage (e.g. thickening, dewatering, drying, incineration, gasification, pyrolysis and many other combined processes)

With specific reference to mechanical dewatering operations, Physical properties are of great importance.

They are often considered of secondary importance with respect to chemical and biological parameters, but this is fundamentally wrong because the knowledge of physical properties allows the prediction of sludge behaviour when handled and submitted to almost all treatment, storage and utilization/disposal operations, including storage, pumping, transportation, land-spreading, dewatering, drying, incineration, landfilling.

For evaluation of sludge dewaterability,

- Settleability,
- Thickenability,
- Drainability,
- Capillary suction time (CST),
- Specific resistance to filtration,
- Compressibility

are parameters of primary importance.

The Settleability determination is used for calculating the rate of sludge settling and the sludge volume index, and for evaluating the performance of settling tanks, while the laboratory determination of Thickenability allows the amenability of sludge to further concentrate suspended solids in gravity thickeners.

Drainability of flocculated sludge is an important parameter for evaluating its suitability to be thickened by means of a draining process, and for giving indications on the choice of flocculant and its dosage for sludge thickening through a filtering medium.

The Capillary suction time (CST) is a fast and simple way to evaluate sludge dewaterability by filtration; CST should also make possible the evaluation, although only qualitatively, of sludge dewaterability by centrifugation through measurement of floc strength.

The Specific resistance to filtration is the typical parameter indicating suitability of sludge to be dewatered by means of a filtration process. The value of the specific resistance to filtration has great importance in dewatering processes as it can be useful for estimating the performance of full-scale filtering devices mainly pressure filters, and comparing dewaterability characteristics of sludge produced in different plants.

Compressibility is complementary to that of Specific resistance and gives information on the best range of pressure to be adopted in filtration processes.

However, mentioned parameters are specific to the method of treatment, and not able to give more basic information on sludge as other parameters (e.g. the rheological properties, particle and floc size, and water distribution) are able to do.

The rheological characterization has been widely applied in the past to the study of slurry flow, in particular to the suita-bility for pumping, but the existence of some correlations between the rheolo-gical properties and other material characteristics have also been evidenced.

The *physical consistency* is a characteristic strictly linked to the rheological properties, and is of fundamental importance in sewage sludge and waterworks sludge *characterization*, as it strongly affects almost all treatment, utilization and disposal operations.

In fact, the selection of the *most suitable equipment and procedure* for land application, storage and transportation of sludge, is strongly connected to its consistency. Similarly, *compacting* sludge in a landfill or *forming a pile* in composting is depending on sludge shear strength rather than on its solids concentration.

In addition, references to the physical consistency are often reported in european legislation on sludge as a characteristic to be evaluated for fulfilling the regulations requirements.

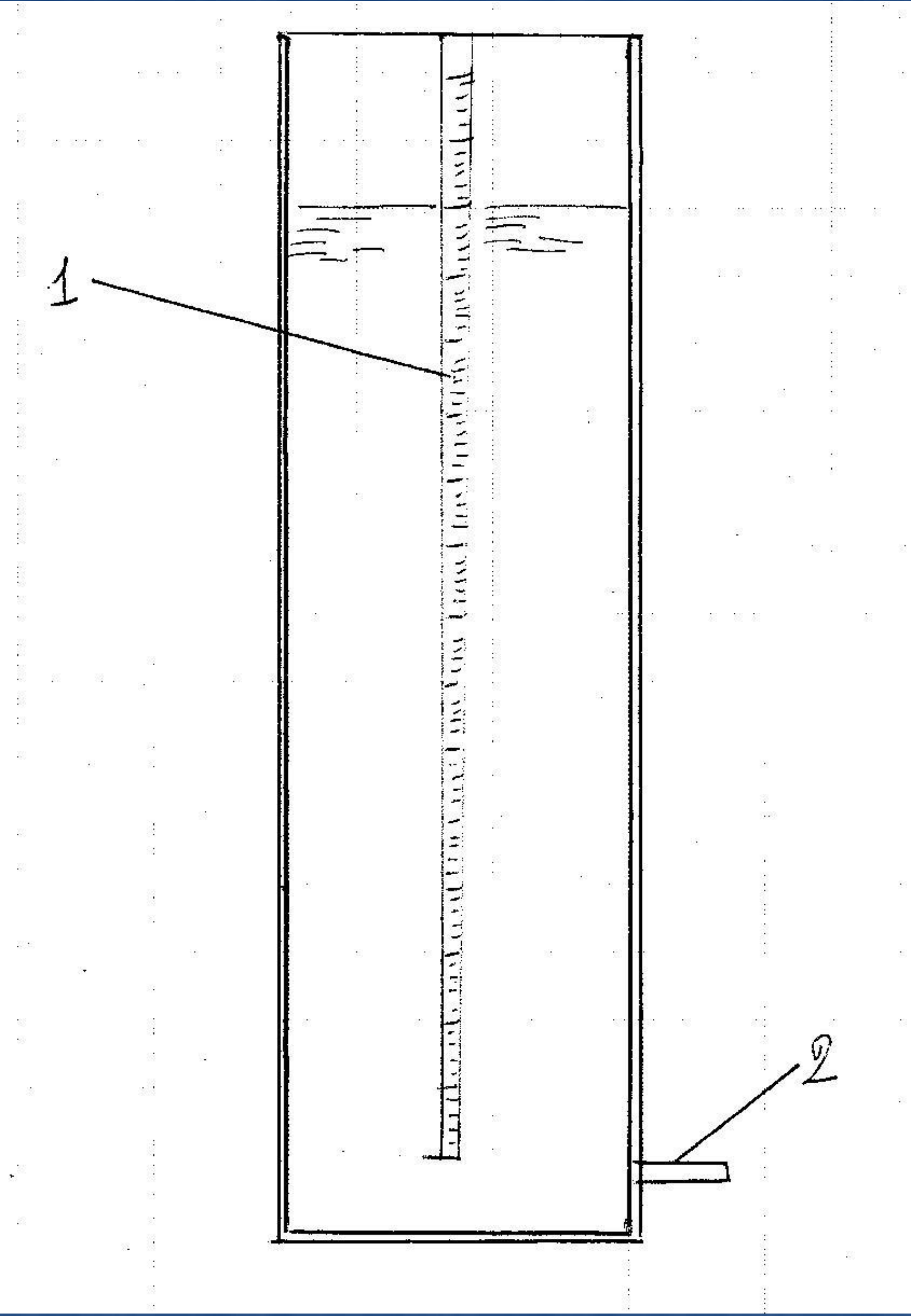
However, the evaluation of this property is a very complex matter which requires the preliminary definition of the physical states of the sludge and the standardization of the relevant measuring procedures. These procedures must also be simple to operate and applicable on the field.

According to CEN/TC308, three different behaviours have been defined for sludges:

- *liquid*, sludge flowing under the effect of gravity or pressure below a certain threshold
- *paste-like*, sludge capable of continuous flow under the effect of pressure above a certain threshold and having a shear resistance below a certain treshold
- *solid*, sludge having a shear resistance above a certain threshold.

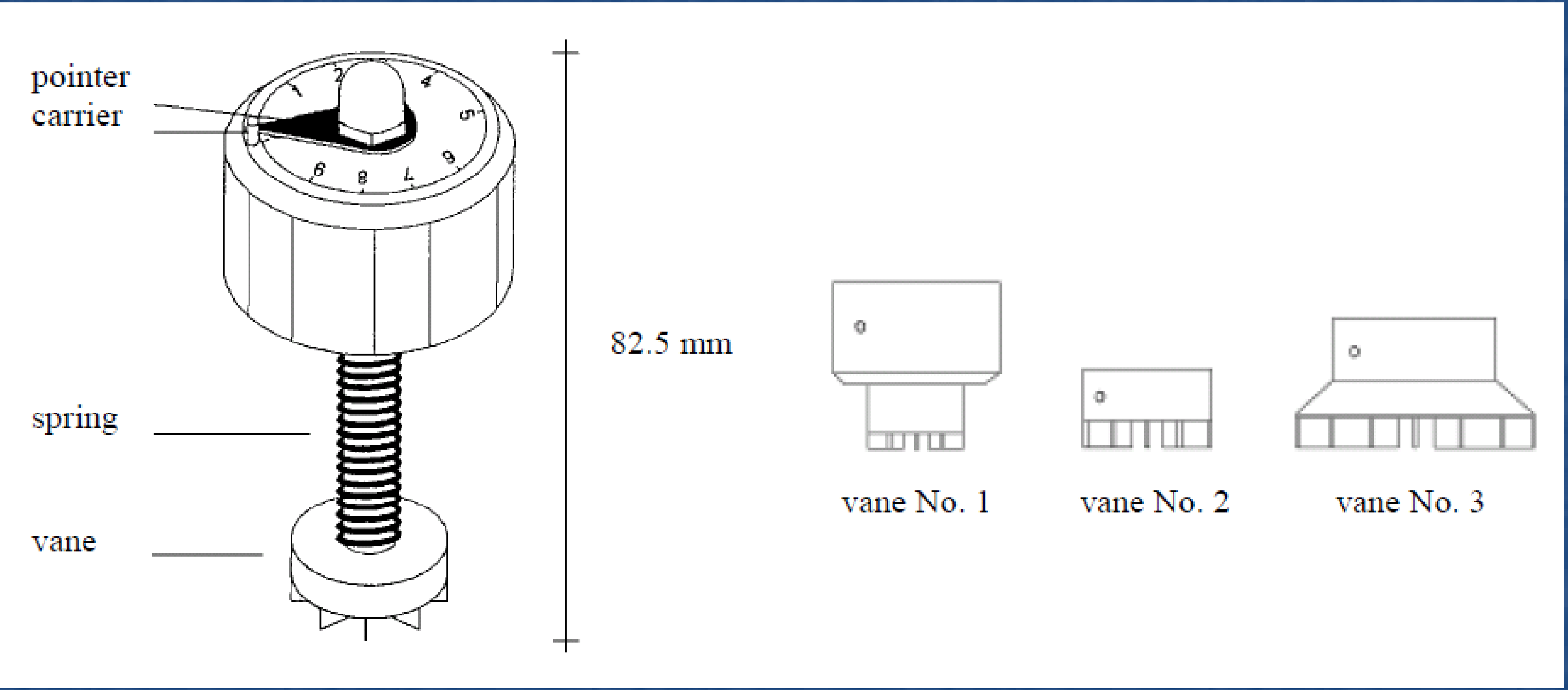
The Flowability limit defines the boundary between liquid and paste-like behaviours, while the Solidity limit the boundary between solid and paste-like behaviours.

Recommended method for evaluation of *flowability*



Extrusion tube apparatus

Recommended method for evaluation of *solidity*



Pocket vane shear apparatus

Other parameters included in the CEN/TC308 Workprogramme to be standardized in the future are:

- ✓ Centrifugability
- ✓ Dryness limit
- ✓ Plasticity (which is in practice the characteristic between Flowability and Solidity)
- ✓ Electrical conductivity
- ✓ Water distribution
- ✓ Fibers content
- ✓ Cake discharge index
- ✓ Freeze-Thaw conditioning procedure

CONCLUSION - 1

Moving the sludge management to the future requires the development of sustainable, multiple and diversified option strategies aiming at reducing the amount of sludge to be handled, without increasing the consumption of natural resources, and producing higher quality sludge for maximization of material/energy recovery, and minimization of impact on environment

CONCLUSION - 2

Various alternatives are available to reduce the water content of sludge, but in all cases the choice of the well adapted equipment should be primarily addressed to get a

final solids concentration

not less, not more

than needed depending on the

intended final outlet

CONCLUSION - 3

Most important decisional criteria derive from:

- ***Qualitative*** characteristics of sludge to be treated
- ***Energy*** consumption, including transportation

CONCLUSION - 4

For the evaluation of the

Qualitative

characteristics of sludge to be treated, the lab characterization through application of

Standardized methods and Procedures

is the necessary prerequisite.

CONCLUSION - 5

With reference to energy aspects, it is to be observed that the

overall energy balance

of

all the system

and not only of part of it, has to be carefully evaluated to avoid a negative balance due to the use of more energy-consuming operations coupled to a lower energy recovery from produced sludge

CONCLUSION - 6

Finally, other decisional criteria must derive from:

- investment and maintenance costs
- need for space of machinery and storage
- operator availability and skill, and infrastructure
- specific local constraints or opportunities

THE END …

MANY THANKS …

… FOR YOUR ATTENTION