CST Equipment

Manual covers:

Mains and Battery operated CST

Stirrer/Timer

Triton Electronics Ltd.

Contents

Introduction

This manual covers the operation of CST equipment including the stirrer/timer and muli-purpose CST units. Capillary Suction Time has been established as a reliable method for assessing sludge filterability. The equipment was originally developed for use with sewage sludge and it is for this reason that the quoted examples predominantly deal with sewage sludge, however the CST technique can be used on any colloidal aqueous suspension. In particular the petrochemical industry has developed the CST to assess bore hole sludge.

The method is simple and fast to use, and the results generated can be related to the Buchner funnel and American Petroleum Institute filtration procedures.

Description

The CST is derived from the time taken to draw a known volume of filtrate from a suspension by the capillary suction pressure generated from standard CST filter paper.

A CST test unit comprises:

- Test Head
- Control Unit
- Filter Papers

The Stirrer/Timer unit comprises of:

- Timer unit
- Stirrer
- Test beaker

The CST is independent of the hydrostatic head in the funnel as the capillary suction pressure generated by the filter paper is much greater than the head. The capillary suction pressure is considered to be between 5,000Pa and 10,000Pa depending on the viscosity of the filtrate. The hydrostatic head is of the order of 100Pa.

Test Procedure

Sample Preparation

It is important to ensure that the sample is homogenous and representative of the overall sludge. The sample should be sieved to remove large bodies, a 5mm mesh is adequate.

To minimise variations due to the sample temperature it is recommended that the sample is allowed to reach room temperature prior to the test.

It is not a good idea to store sludge samples for a long time as biological degradation will affect the result.

CST Test routine

1. Plug the test-head assembly in the CST unit.
2. Ensure that the two perspex blocks are clean and dry.
3. Place a filter paper, rough side uppermost, onto the base. Place the electrode block onto the filter paper, ensuring the electrodes contact the filter paper, slight hand pressure should only be applied. It is possible to bruise the filter paper with too aggressive a downward pressure.
4. Select either the 1cm diameter funnel for a ‘fast’ filtering sludge or the 1.8cm funnel for a ‘slow’ sludge, and insert it into the electrode block. Rotate the funnel, applying slight downward pressure when in position to ensure even contact to the filter paper.
5. Press the re-set button and check that the counter is at zero.
6. Pour sludge into the reservoir. The amount is not critical as long as there is sufficient to complete the test. If at the end of the CST

there is no sludge in the funnel, i.e. there is only cake, a greater volume of sludge is required, and the test should be repeated.

7. Make a note of the CST, it is lost on pressing the reset.

8. Remove the top perspex block complete with the funnel.

9. Remove the filter paper; clean the block and funnel with paper tissue.

Stirrer/Timer Test routine

1. Measure 100 ml of the sludge into a 250ml beaker; place the beaker onto the Stirrer/Timer.

2. Select 10 seconds stirring button, during which time 20ml of water should be added into the sludge, using a pipette.

3. Remove the beaker and transfer into a separate vessel and back again into the beaker - determine the mixture CST.

4. Replace the beaker back onto the stirrer/timer and stir for a further 10 seconds.

5. Again transfer between beakers as before - determine CST.

6. Repeat the procedure after stirring for a further 30 seconds

7. Determine the CST

8. Finally, stir the mixture for a further 60 seconds

9. Determine the CST

10. The process should now be repeated, but with known amounts of conditioner instead of the 20ml of water.

Following this procedure will produce a matrix of results, for various levels of conditioner against expected shear. As each stir is consecutive the total stirred time for the three tests becomes 10, 40 and 100 seconds.

Interpretation of the CST results

Generally, the lower the CST the better the sludge filterability. As target figures, the following CSTs are considered acceptable for a typical sludge of 5% solids concentration, using the 1.8cm funnel:

Filter-belt press	Less than 10 but increasing with shear
Filter press	15 to 20 but stable with shear
Centrifuge	15 or less but very stable with shear

CST measurement accuracy

The general error for CST measurements is around a 6-10% variation. A variance of more than 10% indicates the test procedure should be improved.

Water will produce a CST of about 4s with the 1.8cm funnel and 10 seconds for the 1cm funnel. As the CST of a sludge approaches that of water, the results will become less meaningful.

Variability associated with the sludge

The sludge must be homogenous and well mixed, just before testing the sludge should be transferred back and forth between two beakers to ensure adequate mixing and that the sludge has not settled.

The viscosity of the filtrate being withdrawn from the sludge can effect the CST.

If the liquor is poured into the funnel it is not a valid test of the entire sludge, however the result can be of value. If the CST is higher than the CST achieved with water, it indicates there is surplus polyelectrolyte present. The polyelectrolyte will increase the liquor viscosity and so increase the rate of absorption by the filter paper.

Both temperature and humidity will affect the CST, however not significantly for most applications. Estimates of possible variation are; a 16^{o}C reduction in temperature will cause a 20% increase in CST, similarly an 80% reduction in relative humidity will cause the same increase in CST.

Variability associated with the filter paper

Filter Paper Specification

CST filter paper is always supplied batch numbered. The paper is cut so the grain runs along the 9cm length.

Basis weight (g/sq. m)	440
Thickness (mm)	0.92
Porosity (sec/100ml/sqin)	9
Tensile strength (m/d g/15mm)	4525

To improve reliability the rougher side of the filter paper should be placed uppermost.

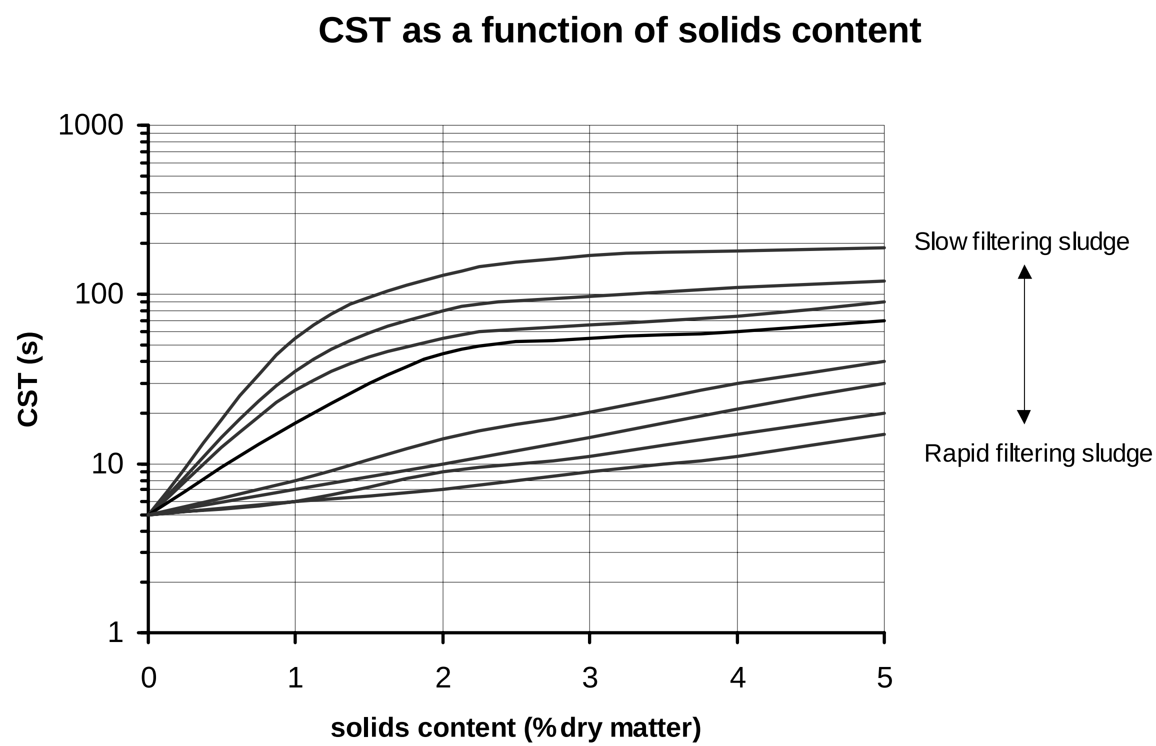
The filter paper can be kept for at least 12 months if stored in a cool, dry atmosphere.

Other variables

The accuracy of the pins in the test head is critical as CST varies with the 4 power of the probe radius. If the pins become corroded, damaged or misaligned the head will require re-machining or replacement.

Care should be taken to check that the filtrate has spread evenly across the filter paper. Because of the grain in the paper the filtrate stain should be circular or slightly oval, following the grain.

It is important to consider the dry solids (DS) content of sludge. The DS will have a major effect on the CST. The effect of DS is illustrated in the graph opposite.


CST as a function of solids content
1000
100
10
1
CST (s)
0
1
2
3
4
5
solids content (% dry matter)
Slow filtering sludge
Rapid filtering sludge

Examples

Determining the effectiveness of a polyelectrolyte as a sludge conditioner.

The following results were obtained from a series of tests completed on an anaerobically-digested sludge. Various doses of a sludge conditioner (a cationic polyelectrolyte) were subjected to a period of stirring to simulate shear.

Dose of conditioner		CST (s) – 18mm reservoir			
(kg/tonne)	(mg/l)	Stirred time (s)			
		0	10	40	100
0	0	596	659	813	852
0.1	5.2	425	492	665	854
0.2	10.4	307	456	562	789
0.4	20.8	154	261	429	716
0.8	41.6	136	185	316	516
1.6	83.3	17*	83	182	317
6.4	286	30*	8*	21	52

* Visibly super-flocculated

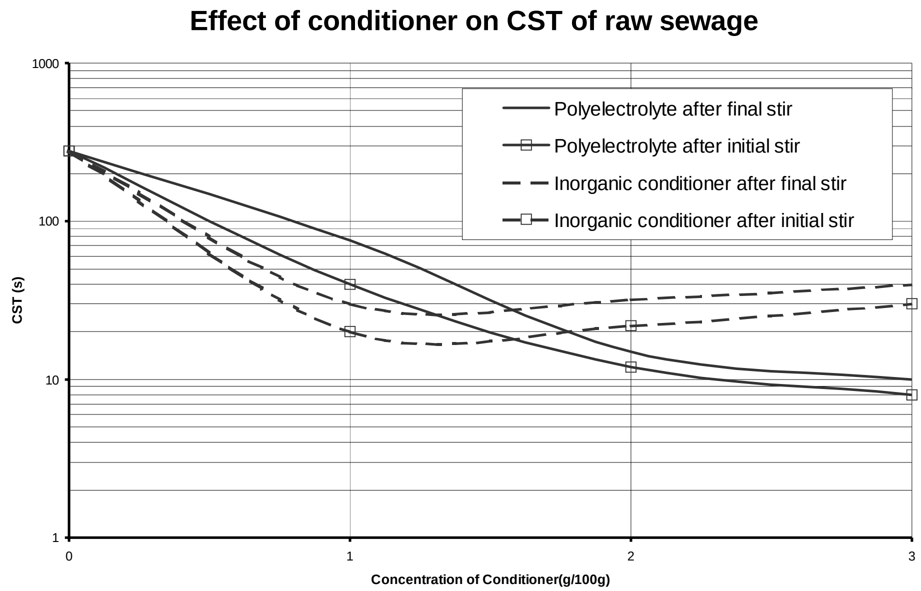
Taken from ‘Laboratory Techniques for Predicting and Evaluating the Performance of a Filter Press’ Baskerville, Bruce and Day.

The super-flocculated mixtures were possible to pour only liquor, rather than sludge solids. The change in CST after the period of stirring indicates the strength of the sludge flocs and the presence of unabsorbed polyelectrolyte. A sharp rise in CST with stirring indicates weak flocs and no surplus conditioner. However, if the CST remains constant or decreases it is usually indicative of an initial surplus of polyelectrolyte that is absorbed in the sludge as it is stirred.

The results demonstrate that the additional dose of conditioner improved the sludge filterability at the shear stress expected in a filter press.

Comparison between two conditioners

Two sludge conditioning additives were compared. The test programme involved stirring taking 66 measurements. Following the above guidelines it was possible to complete the programme in less than 2 hours. Raw sewage was 7.6% DS.



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