Raven Settlometer Kit C-101

Procedure for use of the Raven Settlometer Kit C-101

Notice: Used to perform the 30-minute Settling Test referenced on pg. IV-14 of U.S. Environmental Protection Agency's Process Control Manual for Aerobic Biological Wastewater Treatment Facilities, EPA - 43-/9-77-006, March, 1977, Municipal Operations Branch, Office of Water Program Operations, Washington, D.C. 20460. Obtains results similar to Settlometer Test referenced on pg. 20 of U.S. Environmental Protection Agency's, Operational Control Procedures for the Activated Sludge Process, Part II, EPA-330/9-74-001, May, 1974 written by the late Alfred W. West, P.E., National Training and Operational Technology Center (NTOTC), Cincinnati, OH 45268/

The Raven C-101 Settlometer kit assists wastewater treatment plant operators in performing the very important sludge quality control test that relates to performance of secondary clarifiers. The settlometer test is used to indicate solids/liquid separation capabilities of sludges. The test commonly makes this determination on activated sludges entering secondary clarifiers. Another common use is in the operation of aerobic digesters, to determine the downtime of digesters during decanting of the supernatant.

The kit is shipped with the following items:

1. Raven C-10102 Settlometer
2. Raven C-10103 Paddle
3. Raven C-10104 Lid

The settlometer is used to determine per cent (%) volume or settled sludge volumes (SSV's). Used in conjunction with Aeration Tank mixed Liquor Concentration (ATC) data, the SSV data can generate Settled Sludge Concentrations (SSC) with time, a valuable tool for assessing sludge quality.

EQUIPMENT

Constructed of clear, transparent plastic, the unit is designed for accurate measurement of settled sludge volumes. Distinct, bright, white markings contrast vividly with normal sludges encountered in municipal treatment facilities. Made of the same material, the paddle will not scratch the settlometer with normal use. The soft plastic lid snaps tightly on the settlometer so that samples may be transported without spilling. Both plastics are compatible with normal sludge samples encountered at municipal treatment systems.

Maintenance

1. Use a warm detergent solution and rinse with tap water.
2. Never use abrasive material such as steel wool or scouring powders, which could scratch the plastic.
3. Use only the paddle provided. It is designed for use with the settlometer. Other materials of higher hardness values, such as most metals, might scratch the softer plastic.

Test Procedures

Collect Sample

1. Collect approximately 1.5 liters from aeration tank in a wide mouth container and deliver to lab within 15 minutes.

Mix Sample

2. Mix gently and transfer contents to settlometer.
   Note: Since lid is provided, you may wish to use the settlometer to collect and transport the sample.

Pour Sample into Settlometer

3. Fill settlometer to a level slightly above the 100% (SSV=1000) line and mix forward and backward with the paddle immersed to the bottom. This allows for gentle mixing which precludes floc degradation.

Fill to Mark

4. Remove paddle from jar and immediately (using a small beaker or cup) remove enough liquid to align liquid level with exactly 100% line. While aligning, keep eyes at the same level as the liquid surface.
   Note: You may wish to use a portion of the removed sample for solids concentration determination (by volume), e.g. ATC.

Mix Contents

5. Insert paddle to settlometer bottom and mix back and forth as described in step 3 until entire contents appear thoroughly mixed.

Stop Mixing

6. Hold paddle stationary in middle of settlometer until all motion from turbulence has stopped.

Remove Paddle and Start Timing

7. Slowly, remove paddle avoiding further turbulence and immediately start a timer for five (5) minutes for mixed liquors and fifteen (15) minutes for aerobic digestion
   Note: The scale at the left (%) represents per cent of original volume. The scale at the right (SSV) represents cubic centimeters of solids per liter sample ($cm^3/l.$). Each graduation represents 1% or 10 $cm^3/l.$ Record all results on a data sheet. When measuring settlometer values, keep eyes at the same level as the sludge blanket.

For Activated Sludge Mixed Liquors

8. After five minutes have elapsed, read the sludge blanket level (the interface between solids and clear liquid above the solids.

9. Continue to read and record at <u>5-minute intervals</u> until you have recorded 5, 10, 15, 20, 25, and 30 minute values. Then continue to measure at <u>10-minute intervals</u> (40, 50, and 60-minutes values).
   Note: When sludge settles very slowly (bulking condition) the settlometer test period should be extended beyond the standard one-hour. Ultimate sludge compaction may be determined for a more thorough process evaluation by measurements at 30-minute intervals for up to four hours (4 hr.) or more (until two measurements are identical, indicating ultimate compaction).

For Aerobic Digesters

8. After fifteen (15) minutes have elapsed, read the sludge blanket level (the interface between the solids and the clear liquid above the solids.

9. Continue to read and record at 15-minute intervals until you have recorded 15, 30, 45, and 60-minute values. Then continue to measure at 60-minute intervals (until two measurements are identical, indicating ultimate compaction).

Rise Time

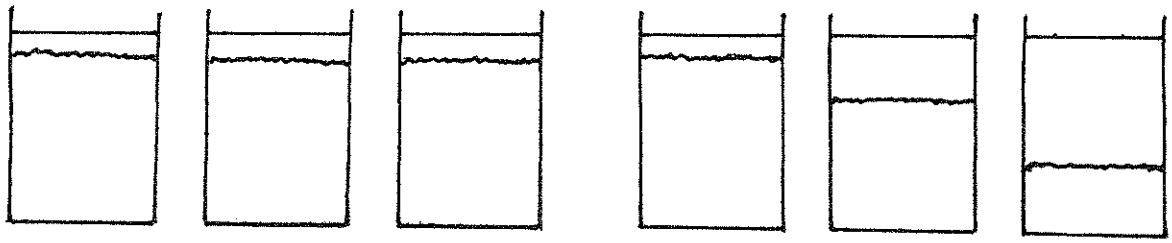
10. After ultimate compaction, if the sample is permitted to sit undisturbed, the sludge may swell and even rise to the surface (due to gasification via denitrification or septic conditions). Observation of this occurrence corresponds with operational similarities within secondary clarifiers for activated sludge or within aerobic digesters. Routinely, record the time of occurrence and observe trends, e.g. denitrification occurred sooner today than yesterday, indicating impending denitrification in secondary clarifier.

Multiple Dilution Test (Variation)

Many times it is difficult to determine if slow settling is caused by physical floc characteristics (e.g. a young, bulky sludge) or by hindered settling (e.g. an old, highly concentrated or glutted system). A simple test variation of the settlometer test can be performed to differentiate.

This variation consists of diluting the sludge (with unchlorinated final effluent) to different concentrations to eliminate the effect of concentration on settling, i.e. hindered settling. If a sludge settles slowly due to the nature of the floc particle, little difference will be noted between 100%, 75%, and 50% sludge samples. However, if a sludge settles slowly because of hindered settling, variations in corresponding SSV's for diluted samples, leaving a stair-step appearance when samples are placed in dilution order, will occur.

Illustration of Mixed Liquors Diluted with Unchlorinated Secondary Effluent



---------- EXAMPLE "A"----------

SLOW SETTLING DUE TO
FLOC CHARACTERISTICS

---------- EXAMPLE "B"----------

SLOW SETTLING DUE TO
HINDERED SETTLING

SUPPLEMENTAL MATERIAL

Here is a data sheet from a 60 minute settleometer test. (We have filled in both the SSV and SSC values.) Let's see how the SSC values are computed. The formula for calculations is as follows:

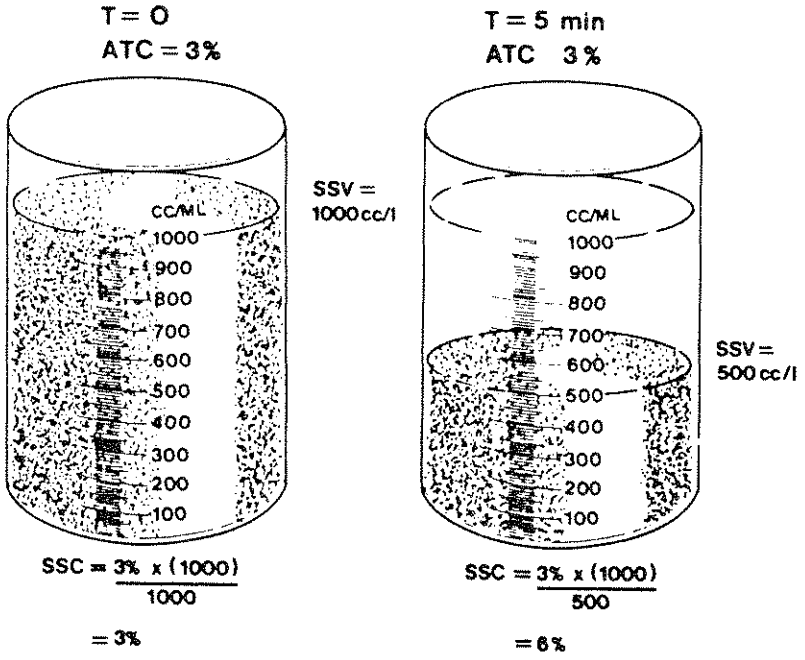
$$SSC = \frac{ATC\ (1000)}{SSV}$$

Where the ATC is the Aeration Tank Concentration in percent as determined by the centrifuge test.

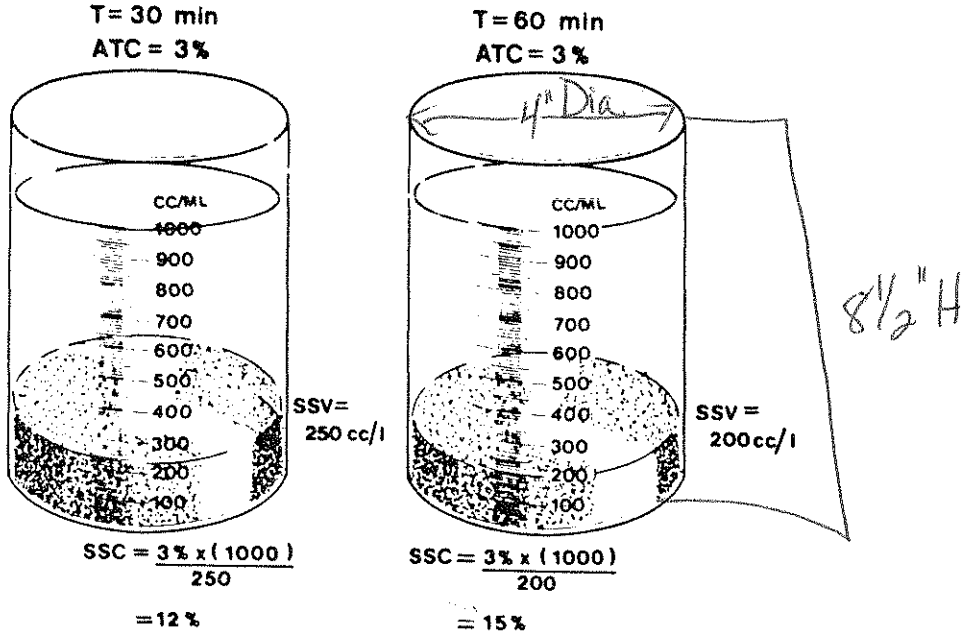
Time of Test 1

Time	SSV CC/L	SSC %
0	1000	3
5	500	6
10	400	7.5
15	325	9.2
20	290	10.3
25	260	11.5
30	250	12
40	220	13.6
50	200	15
60	200	15

Four examples from the above data should serve to give a direction in this calculation. We have chosen T = 0, time = 5 minutes, time = 30 minutes, and time = 60 minutes.



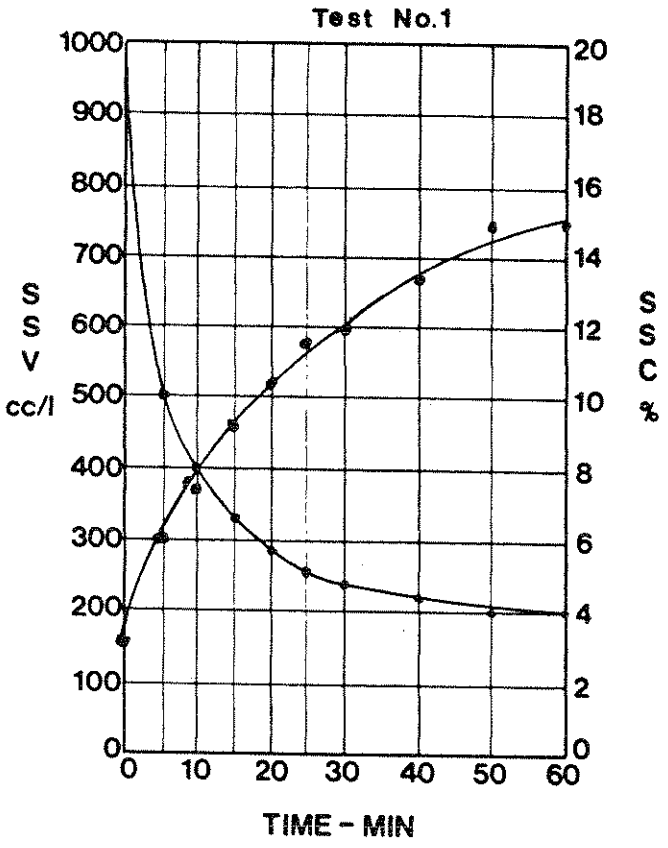
Notice that when the sludge has settled to 1/2 of the volume (500 cc/l) that the concentration will double. Isn't that what you would expect? The sludge is now contained in 1/2 of the volume. It therefore must be twice the concentration. Here are the other two examples:



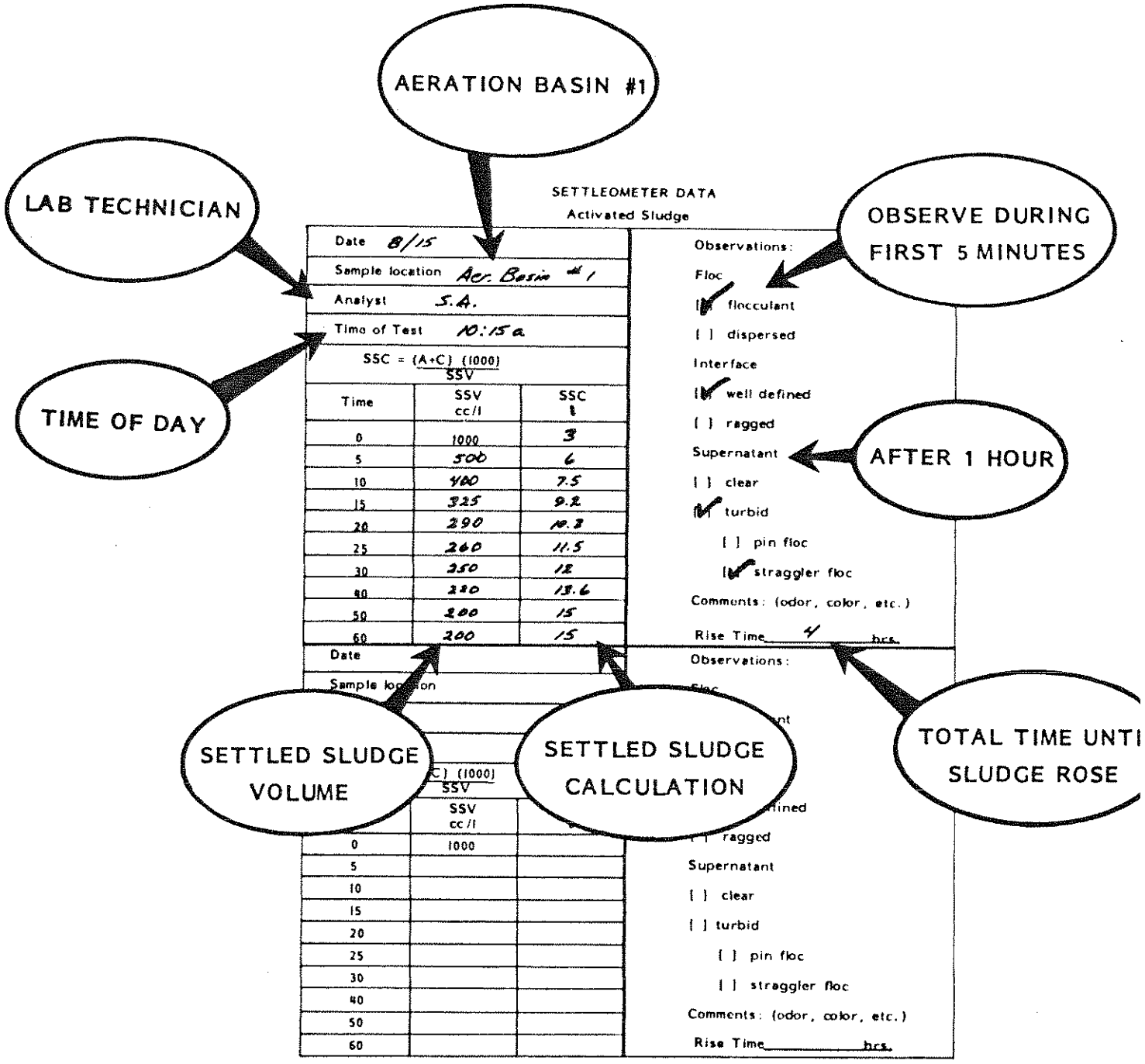
SSV CURVES

The data can also be plotted on a curve. This becomes useful in making operational control decision.

Time of Test 1		
Time	SSV CC/L	SSC %
0	1000	3
5	500	6
10	400	7.5
15	325	9.2
20	290	10.3
25	260	11.5
30	250	12
40	220	13.6
50	200	15
60	200	15



SAMPLE DATA SHEET



SETTLEOMETER DATA

Activated Sludge

Date	
Sample location	
Analyst	
Time of Test	
$SSC = \frac{(ATC)\ (1000)}{SSV}$	

Time	SSV cc/l	SSC %
0	1000	
5		
10		
15		
20		
25		
30		
40		
50		
60		

Observations:

Floc

[ ] flocculant

[ ] dispersed

Interface

[ ] well defined

[ ] ragged

Supernatant

[ ] clear

[ ] turbid

[ ] pin floc

[ ] straggler floc

Comments: (odor, color, etc.)

Rise Time_____ hrs.

Date	
Sample location	
Analyst	
Time of Test	
$SSC + \frac{(ATC)\ (1000)}{SSV}$	

Time	SSV cc/l	SSC %
0	1000	
5		
10		
15		
20		
25		
30		
40		
50		
60		

Observations:

Floc

[ ] flocculant

[ ] dispersed

Interface

[ ] well defined

[ ] ragged

Supernatant

[ ] clear

[ ] turbid

[ ] pin floc

[ ] straggler floc

Comments: (odor, color, etc.)

Rise Time_____ hrs.

SETTLEOMETER DATA

Aerobic Digestion

Date _____

Sample Location _____

Analyst _____

Time of Test _____

Time	SSV cc/l
15 min.	
30 min.	
1 hr.	
2 hrs.	
3 hrs.	
4 hrs.	
5 hrs.	

Rise Time _____

Observations:

Supernatant

☐ clear

☐ turbid

Comments: (odor, color, etc.)

Date _____

Sample Location _____

Analyst _____

Time of Test _____

Time	SSV cc/l
15 min.	
30 min.	
1 hr.	
2 hrs.	
3 hrs.	
4 hrs.	
5 hrs.	

Rise Time _____

Observations:

Supernatant

☐ clear

☐ turbid

Comments: (odor, color, etc.)

PROCEDURE SUMMARY

PROCEDURE

1. Collect 2.5 liters sample
2. Deliver to lab within 15 min.
3. Mix sample
4. Pour 2 liters into settleometer
5. Stir
6. Stop motion of sludge

ACTIVATED SLUDGE

1. Read every 5 minutes for first 30 minutes and every 10 minutes for next 30 minutes.

AEROBIC DIGESTOR

1. Read at 15 and 30 minutes
2. Read rise time

Settleometer

The above procedure summary is designed as a laboratory aid. It may be cut out and attached to a 5" X 7" index card for convenient reference at the laboratory bench. To protect the card you may wish to cover it, front and back, with clear, self-adhesive shelf paper or similar clear material.

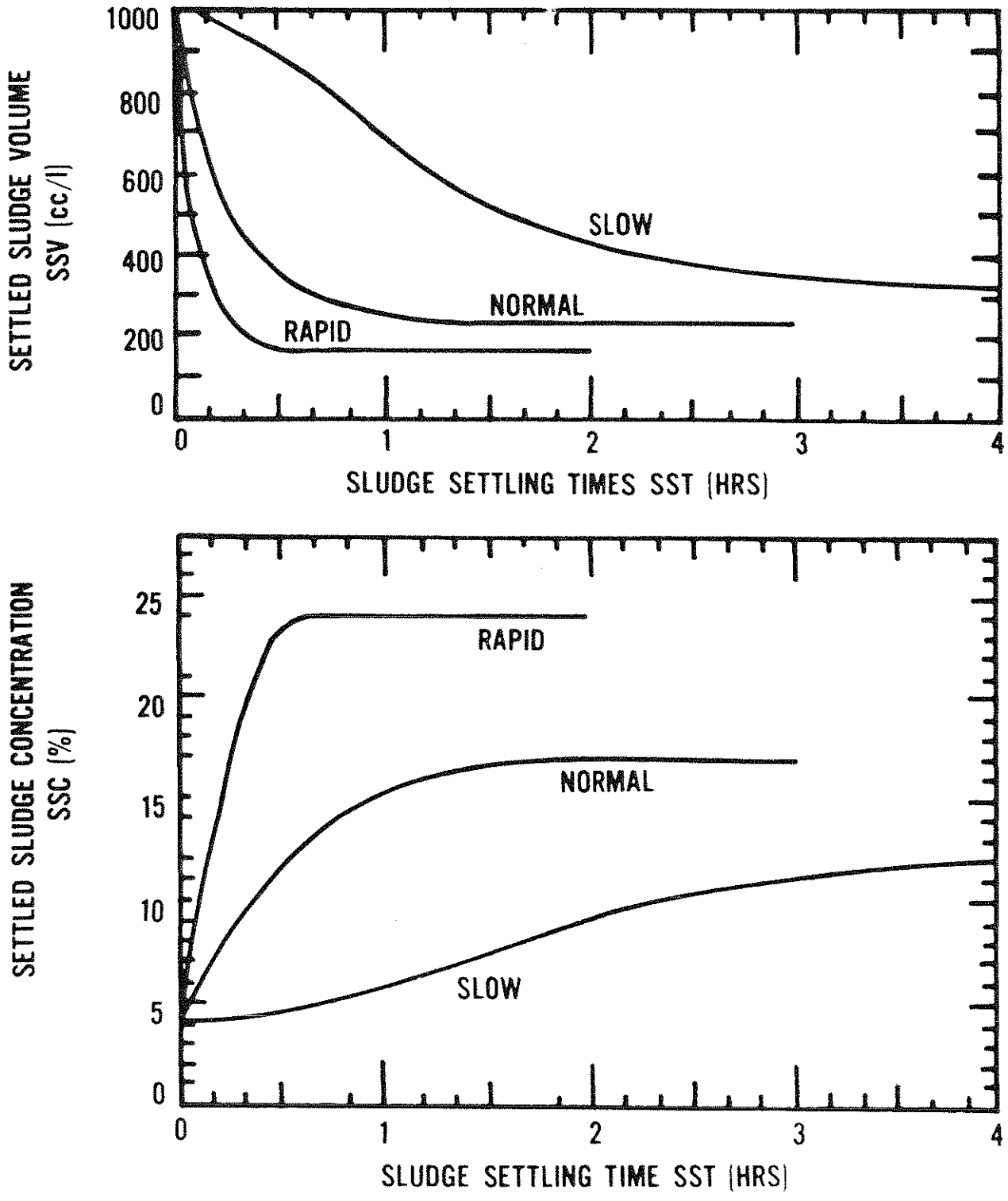


FIGURE 1.– SSV and SSC CURVES for Slow, Normal and Rapid settling and concentrating activated sludges.