Application of Continuous Scroll Discharge Centrifuge for Dewatering Paper and Pulp Mill Sludges

By

Mr. P. N. Pastakia
Pennwalt India Limited, Bombay 400 033

A. Introduction :

Strictor government legislation and a growing awareness of the social consequences of environmental pollution are putting increasing pressure on the pulp and paper manufacturers to reduce river and stream contamination by suitably treating the waste streams. Sharples equipment viz. Vibroscreens, and Decanter. Centrifuges play an effective role in removal of the unwanted suspended solids from these waste streams. In the main, it is my intention to introduce the continuous Scroll Discharge Centrifuge (also termed Super-D-Canter, SDC) by highlighting its design features and the scope of its applications in the treatment of paper mill wastes.

B. SDC Design Features :

The continuous Scroll Discharge Centrifuge is essentially a high speed rotating assembly consisting of a cylindrical bowl with a conical end piece, an internal helical conveyor (the scroll), and a two stage epicyclic differential gear box which transmits the torque from the bowl to the helical conveyor. The differential gear box enables the conveyor to rotate at a slightly slower rpm relative to the bowl and scroll (convey) the sedimented solids towards the conical section and up the beach (of the conical section). The differential speed between the centrifuge bowl and the scroll is a function of the reduction ratio of the gear box, and is at its maximum when the gear box pinion shaft is held stationary by a torque-arm arrangement. In addition, a torque release mechanism is incorporated in the standard machine wherein the torque-arm is set to trip at a given load and release the pinion shaft, thus protecting the gear box from damage. On tripping, the torque arm also triggers a microswitch which automatically switches off the centrifuge feed pump and main drive motors.

The continuous scroll discharge centrifuge (figure 1) generally rotates about a horizontal axis and produces a settling force of 2000 g-3000 g. It is, therefore, a sedimentation centrifuge and its main purpose is to achieve a substantial clarification of liquids by settling and removal of unwanted solids.

The slurry to be dewatered is pumped through the feed tube and is distributed via the feed nozzles located in the conveyor barrel. The solid particles settle quickly under a centrifugal force of approximately 2100 g at the normal operating bowl speed of 3250 rpm, get scrolled up the 10° beach (conical and piece), out of the liquid (the pond) and get discharged at the end of the conical section from the solids discharge ports. The clarified liquor gets displaced in the opposite direction and spills over a weir (ring dam) at the opposite end of the bowl.

C. SDC Variables :

A very important characteristic of the SDC is its ability to accept a wide range of feed materials and feed concentrations. Thus it will seperate solid particles from 10μ to that which can be pumped through the fled pipe. Also, there are a number of centrifuge and process parameters which can be adjusted by the process or commissioning engineer to obtain optimum centrifuge performance. These parameters are :

Pond Depth
Scroll Differential
Bowl Speed
Feed Rate Flocculant
Dosage

In general, the following effects are noticed:

1. Increasing the pond depth produces a wetter solids discharge but a clearer centrate. This is because deeper ponds permit a thicker moving layer, thus reducing interference with sedimented solids.

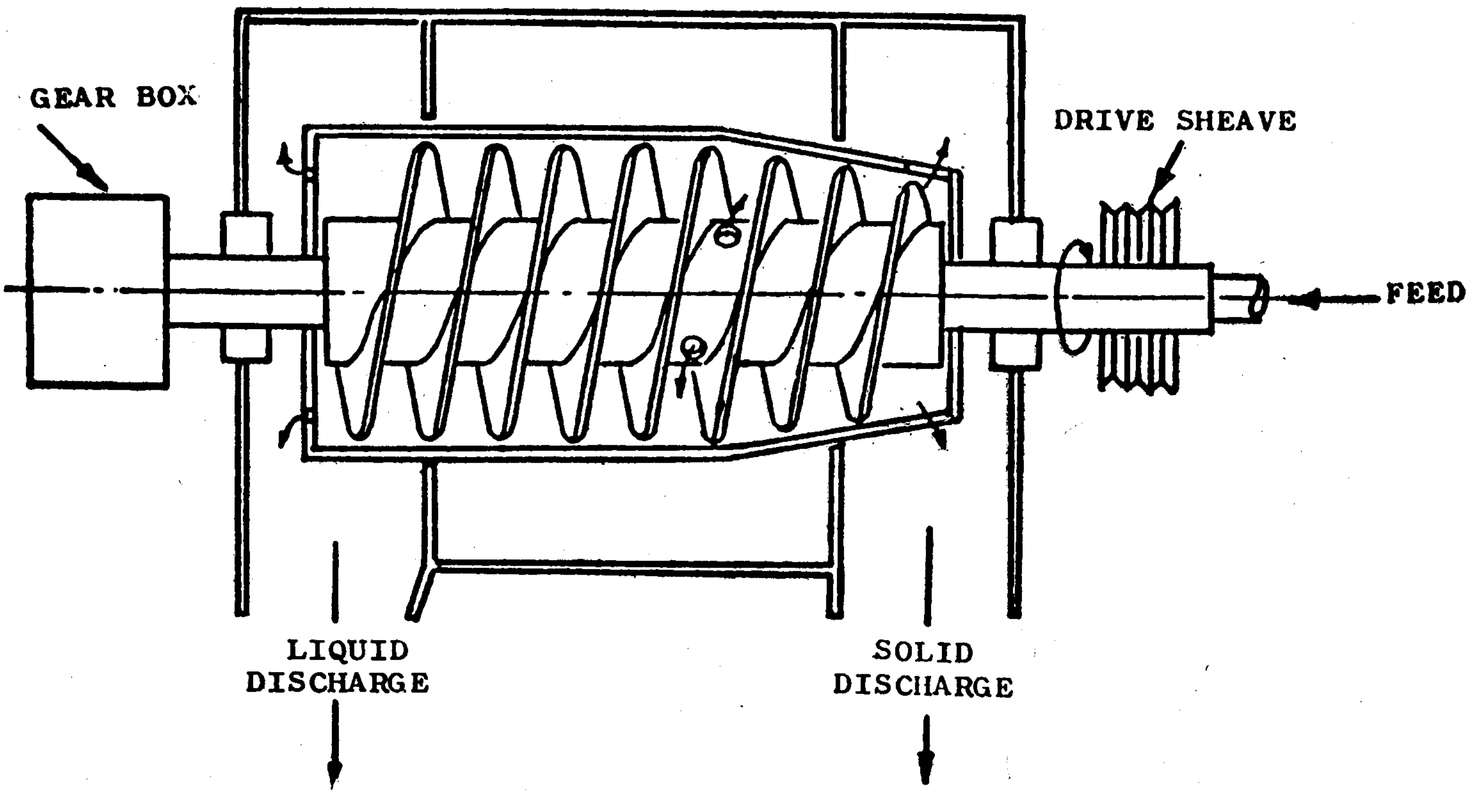

Fig.1 - Schematic Diagram of the SUPER-D-CANTER

2. Increasing the scroll speed differential generally induces more turbulence, and therefore centrate clarity deteriorates due to reentrainment of the solids. In addition, it can also produce a wetter discharge. However, the solids throughput increases.

   Reducing the scroll speed differential, generally improves dryness of the discharge cake. However, at the lower limit, the equilibrium level of solids in the bowl increases with the result that the centrate clarity deteriorates, the conveyor torque and these factors in turn restrict the capacity of the machine.

3. Increasing the bowl speed will create a higher g-force with the result that centrate clarity will generally improve and a drier cake will be discharged. However the conveyor torque will increase and there will be greater wear on the conveyor flights as more effort would be required to scroll out the solids. Thus, if the solids fail to scroll out, then reduction in the bowl speed and increasing the pond depth should be considered.

   The objective normally is to maximise the feed rate at which the desired centrate clarity and cake dryness can be achieved by manipulating the parameters discussed in the above items 1, 2 and 3.

4. If from the first few tests, it is apparent that the centrate clarity is going to fall far short of that required, then flocculation should be considered. Various inorganic chemicals e.g. Aluminium Sulphate, Aluminium Chloride, Aluminium Chlorohydrate (minimises lowering pH which occurs with hydrolysis of Aluminium Chloride), Ferrous and Ferric Chlorides and Sulphates, and Lime can be used but the dosage required is generally high. Alternatively, synthetic organic long-chain polymers, termed polyelectrolytes, may be used. The number of polyelectrolytes available in India as yet is very limited and imports are restricted. However, should a suitable polymer be avail-

able, the Pennwalt Super-D-Canter can be obtained with special floc tubes featu e, whereby the polymer solution can be added at on appropriate location in the setting zone (cylindrical section).

There are in addition, a wide range of mechanical variants which are fixed at the specification stage, based on customers requirements and/or pilot scale test results. A few of the more important ones are listed below:-

Conveyor Variants	: Flight pitch, number of leads, polished surfaces, hard surfacing, sanitary finish, knife edge.
Bowl and Beach Variants	: Bowl Diameter, bowl length, bowl liner, plain/grooved/ribbed/tiled beach, beach angle, split angle beach.
Drive and differential Variants	: Star-Delta starting, direct-on-line starting, Gear box reduction ratio, mechanical backdrive, Eddy current brake, torque overload, torque sensing.

D. SDC — Applications :

1. *Drum Barker Effluent :* One of the operations in the process of wood-pulp preparation, is that of bark removal in what is termed, "the barking drum". Logs of wood may be immersed in water in one or more of the drum sections to assist the barking action and wash the wood. The wash water (effluent) from the drum barkers can be passed through 4-5 mesh rotary screens into a primary clarifier tank. The settled sludge (underflow) is fed to a Super D-Canter and the thickned discharge is then combined with the initial screenings for pressing. The combined sludge (solids content=45%) is then suitable for incineration.

   The advantage of this approach is that it ensures continuous operation without the attendant problems of fine screen blinding. In addition, the high clarification ability of the SDC, ensures maximum recovery of solids. Throughput upto 90 gpm. can be obtained with a P3400 machine.

2. *De inking :*

   Where waste paper forms a part of a mills' feed material, a de-inking process is incorporated for removal of inks and other impurities in waste paper. The effluent from this process can be concentrated by floatation or settling but the sludges obtained are wet in consistency. Further de-watering is therefore required to minimise handling costs, and this application is therefore well suited for the Super-D-Canter. Thus the P3400 will handle approximately 2500 gallons per hour of feed containing 6% by weight of suspended solids (clay, Ti 02, fibre) in a circular clarifier. With lime treatment 95% solids recovery can be obtained and the sludge discharged from the centrifuge has a consistency varying from 25-35%.

3. *Effluent and excess water treatment :*

   Effluent from the mill passes through a coarse screen to a primary clarifier (settling tank). These tanks are able to given high effluent clarities but can only produce a thickened sludge at 5%-7% W/V solids concentration. This sluge is therefore ideal for the Super-D-Canter Centrifuge which will dewater this sludge suitable for burning or for transport away to a suitable site. The solids content of dewatered sludge and recovery will depend upon the individual sludge and can vary from 20-40% W/V. Table 1 shows results obtained by our associates in U.S.A. on the P3000 decanter, on a variety of waste water streams. (P 3000 is the model of indigenous production).

   Similar results would be obtained at double the capacity on P3400 and four times the capacity on P5000.

4. *Causticizing :*

   A possible application could be in separation of lime mud from causticizing plants in an alkaline pulp mill where feed to the centrifuge can vary from 20-40% W/V solids.

E. Some Test Results on Indian Paper Mills.

1. *Paper mill sludge :*

TABLE 1

	Sluge	Feed Conc. % W/V solids	Loading Rate US. GPM/ Rated HP	Cake Discharge % W/V Solids	Solids Recovery %
1.	Fine Paper mill (15% fibre)	5-12	0.5-0.8	20	80-90
2.	Tissue	2-3	0.5-1.0	20-35	85-92
3.	Board Mill	2-5	0.7-1.5	22-30	85-95
4.	Bleached Kraft Pulp	1-5	1.0-3.0	22-34	82-95
5.	Fine Paper Mill 30-50% fibre	3-5	1.0-1.5	22-30	88-95

A paper mill was undergoing an 18% expansion in capacity and the management were contemplating installation of complete effluent treatment system. There were existing primary clarifiers and therefore various sludges dewatering systems were being investigated by the paper mill to obtain comparative performance data. Effluent streams from the Decker Section, Bleach Plant and machine water poured into the primary clarifier, from which, the underflow was at a consistency of 3 5% W/W. Our P2000 test machine was installed near the primary clarifier, and underflow from the clarifier was fed uniformly to the decanter via a holding tank. The P2000 Super-D-Canter could dewater all three types of sludges either singly or in combination, at feed rates of 2.5-3.5 m³ per hour to a concentration of 15% W/V solids in the discharge which could be easily handled and the centrate had a suspended solids of 0.15% - 0.34% W/V. The solids recovery obtained was thus 94%-98%. Alum was used as an additive in some of the runs but did not give any significant improvement.

2. *Pulp Mill Sludge :*

The mill discharged the overflow from their clarifiers directly into the river stream but since a power station was being built down stream, the mill was under pressure to treat the sludge. After unsuccessful attempts with the rotary vacuum filter, (which involved heavy lime dosage and had screen blinding problems), the P2000 SDC was tested. At feed concentrations of 0.43 0.45% W/V solids, the discharged cake from the Super-D-Canter contained 23% W/V solids and the suspended solids in the centrate were 0.01% W/V. This gave a solids recovery of 97%, at a feed rate of 7.2-7.8 m³ per hour.

3. *Rayon Grade Pulp Mill Primary Sludge :*

Effluent from various sections of the mill was directed through a feed well into a primary clarifier. The underflow fed to the P2000 Decanter had a solids concentration of approximately 3% W/V and the sludge discharged from the decanter contained around 50% W/V solids. The centrate contained 1% W/V suspended solids and thus the recovery obtained was only in the region of 70%.

It is therefore clear from the results that centrate clarity and the recoveries were not very good. In this application therefore, the results could perhaps be further improved if a good polyelectrolyte was available to flocculate the colloided fines. Unfortunately, none of the indigeneously available polymers were effective.

In conclusion notwithstanding all the above data, it is absolutely essential to carry out pilot and field trials on each individual sludge to determine the maximum throughput obtainable in each case within the stringent constraints of centrate clarity and dryness of the discharged sludge that are required for effective pollution control.