SULZER

Energy Savings through Internal Flows in Stock Tank

Energy Savings through Internal Flows in Stock Tank

Introduction

Paper stock normally contains more than 95 % of water. This means that a mill which produces 100,000 tons per year must handle about two million cubic meters of stock. All this stock is pumped from the beginning of the process to its end through several tanks. And the filtrate water, about 95 % of that two million cubic meters, will also be pumped in the opposite direction back to the beginning of the process.

For all this, a considerable amount of pumping energy is needed, both for transfer pumping and for internal pumping in tanks to keep the stock homogenous for the process. This internal pumping is carried out with agitators. The size of the tanks is normally calculated on the basis of the stock flow from the tank in order to achieve a certain retention time. To comprehend the real retention time, we must understand what happens inside the tank. There is a combination of many internal flows.

Basic flow pattern

We have the main flow created by the agitator. The agitator is selected so that a certain volume of stock is in motion. If the purpose of agitation is only to prevent sedimentation, e.g. to keep the bottom zone in motion, the power needed is smaller than if the total volume is agitated. The agitator maker always selects the agitator for a given volume and a given stock furnish and consistency. For his calculations, he also needs the shape of the tank. Sharp corner areas are difficult to agitate and the upper part of a slim but high tank may be impossible to reach with a side entry agitator.
Higher consistency stock needs more energy if the same agitated volume is desired as for a lower consistency stock. Very often, agitators are selected for a consistency higher than what the real operational consistency is. 4 % stock can be agitated with only 60 % of the energy that 5 % stock with the same volume requires.

Influence of pipework

But the agitator is not alone in the tank. There is always also an inlet flow and a discharge opening. If the discharge nozzle is located too near the propeller, the pump must draw the stock from the suction side of the propeller. Then we have two horses drawing into different directions.

Sometimes the pump is stronger and sometimes the agitator. The only certain thing is that energy is wasted. The pump nozzle must be located far enough from the propeller. Pipework designers connect the pipes into the tank just the way they like. Unfortunately, they may lead the inlet flow precisely against the main flow and cause problems in agitation. Or if the inlet flow can make a shortpass to the discharge side, it is pumped out instead of becoming mixed. For instance, dilution water often escapes this way. These kinds of problems can be solved by increasing the agitation power. Instead of wasting energy and money, transferring the pipe to a better location will also help. Figure 1 shows how this should be done.

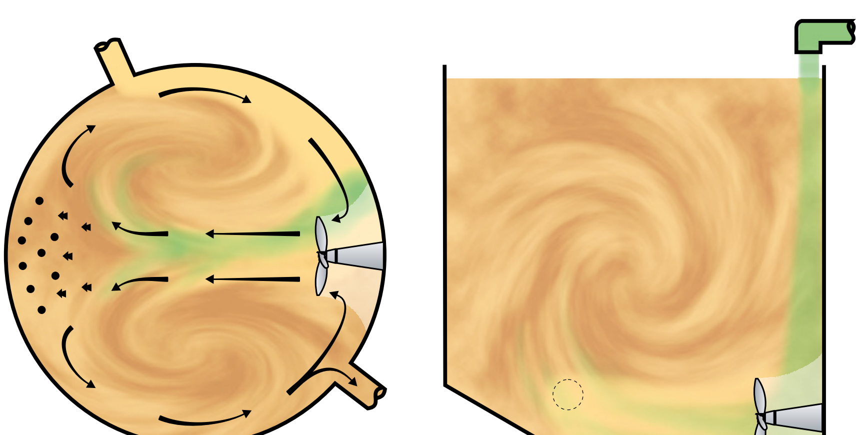

Fig. 1. The discharge nozzle is far enough from the vacuum zone behind the propeller and the inlets are on the opposite side of the agitator to the discharge. Inlets flow smoothly with the main flow.

Influence of shaft length

The low pressure zone between the propeller and the tank causes an internal flow. A lot of energy can be lost if the tank/agitator configuration is not taken into consideration. If the propeller is very near the tank wall, the agitator loses much of its pumping capacity due to the throttled flow behind the propeller. Most side entry agitators have too short a shaft as we can see in Figure 2. Figure 3 shows a modern SALOMIX™ agitator with a long shaft so that the propeller can work with high efficiency.

Bottom fillets, dilution

Tank bottom fillets play an important role when it comes to internal flows:

Slope

Especially in LD towers, it is desirable to have a rather large bottom volume to be agitated to equalize the property variations in the stock and to thus enable as small outpumping variations as possible. The slope strengthens the vertical flow, also increasing agitation in the upper part of the tower. Figure 1 shows the flow forming principle of a slope.

Plough

The natural internal tower flow in the upper part of the tower is vertical but in some cases it is undesirable to have a vertical flow in the mixing zone of the tank. Especially MC towers suffer from vertical stock flow because uncontrolled amounts of stock at MC consistency “drop” into the mixing zone causing severe problems in agitation leading to unacceptable consistency variations in outpumping. To prevent this unwanted vertical flow, we apply a fillet called plough. The plough divides the agitation into two horizontal flows keeping the strong agitation force only in the bottom zone, Figure 4. The volume of the agitated zone is small compared to the total storage volume, and thus the retention time in the mixing zone is only some minutes. A small agitated volume needs less energy than a large volume.

Fig. 2. Agitator with too short a shaft has lost one propeller blade. The farthest agitator has lost all three blades and the one in the middle is in the workshop. All these agitators had 30 kW motors and 1,000 mm propellers. All of them suffered from frequent fatigue failures.

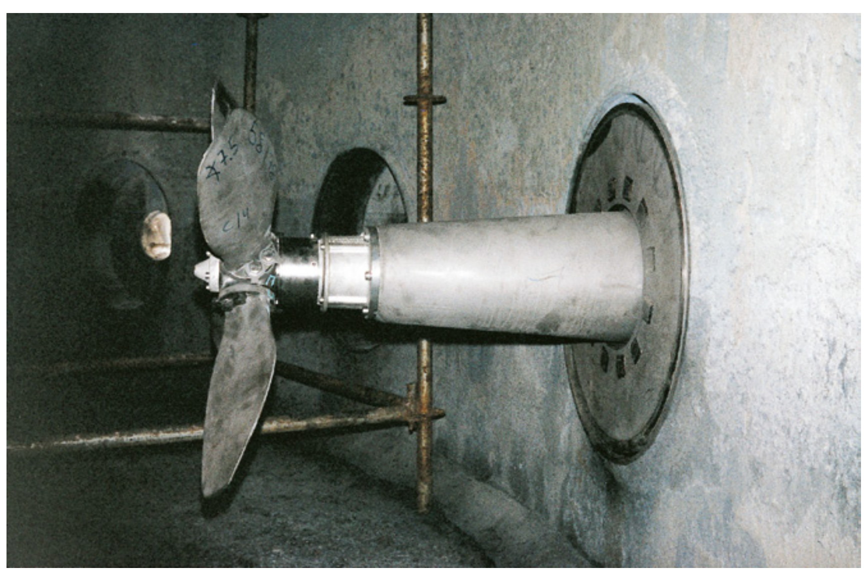

Fig. 3. A modern SALOMIX™ agitator with a 30 kW motor and 1,000 mm propeller. This agitator was mounted into a 1,200 m³ Green Liquor Stabilization Tank in February 1997, and it alone has replaced the three agitators shown in Figure 2.

Dilution

High density stock is diluted before being pumped out of the tower. To make the dilution process most effective, Sulzer recommends the use of DILCO, a dilution cone. The dilution water is pumped and blown through the DILCO into the center of the propeller where the turbulence is highest and thus mixing of the water and stock is also at its best, Figure 4. By using DILCO, dilution can be carried out with less energy, and sometimes even a smaller agitator can be selected.

Upper part of a tower

When we talk about agitation in a stock tower, we must understand that there is a border zone between the low density and high density zones. The high density stock should only flow downwards corresponding to the rate of stock discharge from the tower. The agitator has no role above the interface towards the MC zone. In that part of the tower, the internal flow is created by gravity and the kinetic energy of the inflowing stock.

Unfortunately, the upper part of the tower is not under control in many towers. In most towers, some sort of channeling is created through the MC zone into the bottom zone and this costs a lot of money to the mills. If the stock hits the center of the tower, the question is how it could be transferred to the periphery to create a uniform downflow.

This channeling may cause many kinds of problems: increased air content in the stock, dewatering, brightness variations, and disturbed agitation zone causing consistency variations in outpumping. Sulzer Pumps Finland Oy has developed a Top Entry Spreader (TES) to reduce channeling in the MC zone. The principle of TES is shown in Figure 5.

Some bleaching towers are operated at even 30 % consistency, and the stock is diluted to low consistency in the bottom zone of the tower. These towers need a lot of dilution water and very strong agitation. To control the consistency, it is important that the internal flow in the tower is correct.

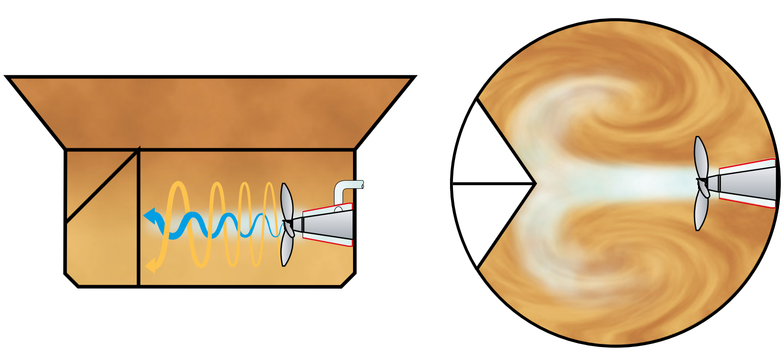

Fig. 4. Flow divider Plough keeps the agitation only in the bottom zone of an MC tower. The small agitated volume needs less energy than a bigger volume. Also, consistency control of a small volume is quicker than the control of a big volume. Dilco feeds dilution water into the center of the propeller.

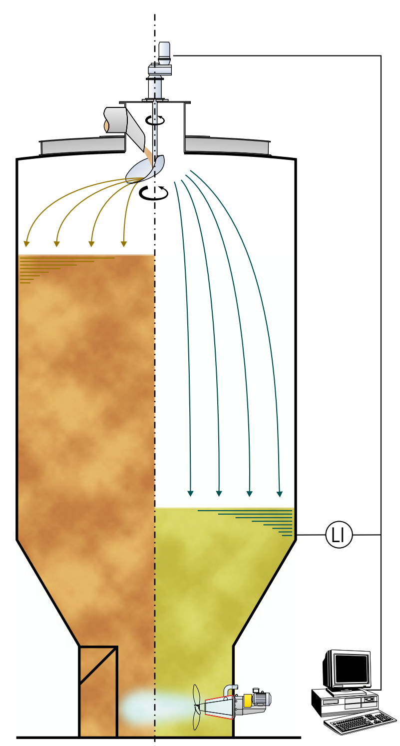

Fig. 5. SALOMIX™ Top Entry Spreader is a rotating unit which is mounted on the roof of the tower. The variable rotating speed of TES is controlled by a computer so that at any stock level, an even layer of fresh stock is spread into the tower. The amount of stagnant stock is thus considerably reduced.

Under level charging

Some large storage towers are normally operated at a rather low level so that the inlet pipe enters the tower through the tower roof. The pump lifts the stock all the way up and then it is allowed to fall down 10 maybe 30 meters depending on the height of the tower and the operational stock level. When the stock finally hits the surface, the splashes of stock mix a lot of air into the storage zone. Later on in the system, this air must be removed by some energy consuming way. A lot of energy is wasted just by pumping the stock onto the roof of an almost empty tower, added by the trouble caused by the air and the cost of air removal. We shall also remember the channeling of stock which may cause stagnated zones and deteriorated stock with lower quality and probably smelling gases.

Sulzer has developed a charging method where it is not necessary to pump stock high up and let it fall back down again. In this Vertical Under Level Charging Arrangement (Vulca), stock flows upwards like magma from the earth through a volcano. The tower can be filled in the same way as a volcano grows layer by layer, with no air being mixed into the stock. Pumping energy can be adjusted according to the stock level in the tower. Figure 6 shows the Vulca system in a tower.

A Finnish pulp mill installed the Vulca system at the end of 1997 to a blow tank after batch digesters. After this modification of the blow tank, they have reached annual energy savings exceeding 85 000 EUR. Before Vulca, their washing plant suffered from a high air content in stock. Now the air content has been reduced roughly by 50% giving much better runnability at the washing plant. They have also noticed that the discharge time of the digesters is now shorter.

The patented Vulca system can be used in storage towers for filtrate water, broke or LD stock.

A study of internal flows in the tank may bring considerable savings in energy costs, but also the process operation may improve and pay back the study in a short time. This concerns both old and new tanks. We at Sulzer are willing to carry out such studies.

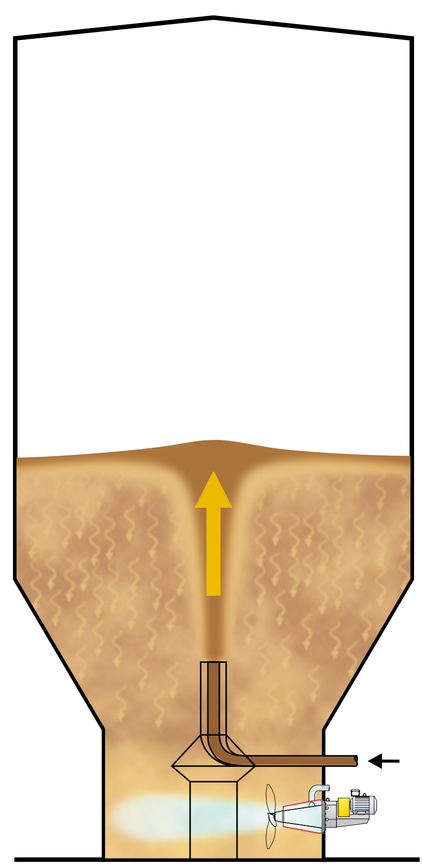

Fig. 5. SALOMIX™ Top Entry Spreader is a rotating unit which is mounted on the roof of the tower. The variable rotating speed of TES is controlled by a computer so that at any stock level, an even layer of fresh stock is spread into the tower. The amount of stagnant stock is thus considerably reduced.

www.sulzer.com
ppi-info.pumps@sulzer.com

E00527 en (4) 2.2014, Copyright © Sulzer
This brochure is a general product presentation. It does not provide a warranty or guarantee of any kind. Please, contact us for a description of the warranties and guarantees offered with our products. Directions for use and safety will be given separately. All information herein is subject to change without notice.