Dewatering and its Technique

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HISTORY

If you look at the development of sewage treatment you discover that, more often than not, problems have been solved using empirical methods and rules of thumb.

The reasons for this are to be found in many places. For one thing the authorities have placed comparatively moderate demands on sewage treatment and grants given for research and development have been quite modest . As far as sludge is concerned the attitude has been to get rid of a residual product in the simplest possible way. Nor have there been many restrictions on the disposal of sludge to land, or other means of dumping.

Things have changed quite a bit during tne seventies and demands for environmental measures have gradually increased. Important contributions have been made to the knowledge of the physical, biological and chemical processes in sewage treatment. One of these is sludge dewatering, the theme for today's confernce. By and large sewage plants have already been supplied with the mechanical means of dewatering. The problems is therefore one of quality, supplementing and improving equipment as well as process techniques.

Sludge dewtering is a central if restricted subject and it could be claimed that it dces not lend itself to being isolated. It starts in the actual sewage treatment process and extends through into the thickening and stabilization stages.

It also branches out into agricultural handling, composting and dumping. The problems surrounding sludge dewatering are further restricted since only mechanical dewatering is being dealt with at the conference.

There are very few places where the economically exclusive thermal drying of sludge can be said to be applied. It will be seen from the papers today that we are aware of the connection between sludge dewatering and affiliated processes. We are also very conscious that the responsibility not only for the treatment of the sludge but for its subsequent handling lies with the client.

Without involving myself in the matters to be dealt with later on I would like to say that there are no suitable methods available for characterizing sludge.

Which factors affect the dewaterability of sludge and which additives should be used in different cases to give sludge the desired properties? Polymers, those strange tentacled molecular chains, have surely come to stay.

There is a lot of mystique surounding them and

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a lot of unanswered questions. It almost brings to mind the old detergent commercials combining pictures of multicoloured particles and charging stallions symbolizing strength and effectiveness. How should polymers be tested and assessed ? They are an expensive part of the dewatering process.

From 1969, when the first belt filter press was installed in a municipal sewage plant, until 1976– 1977 there was a great expansion in municipal and industrial (mainly pulp) waste treatment plants thanks to a government grant scheme.

Since all energy was spent on supplying as much as possible as quickly as possible, the development of new improved dewatering devices took second place.

We who were involved were conscious of situation but unable to do anything about it.

Nor had we any help from foreign suppliers in Sweden, since we were in many respects one of the pioneering countries.

When things calmed down at the end of the seventies we then entered a period of belt filter press development. When looking back today we should make use of the experience gathered and not make the same mistake others have made.

We know it is difficult-we all like innovations-and why not, one learns a lot from small mistakes.

WHAT IS EXPECTED FROM DEWATERING ?

It would really be best to put off the purchase of sludge dewatering equipment until the first sludge arrives and it's easier to know what sort of a daily volume there is and what the sludge is like.

Unfortunately we can't always get what we want.

When a factory or sewage plant is working a certain amount of sludge is produced every day – so how do you deal with it until a reasonable solution is found ?

There you are with your unwanted wet sludge which soon starts creating problems, particularly once the media get told of the story.

We need to get as much information and experience from the customer as possible concerning the constitution of the sludge mixture etc.

To revert to the question what is expected. A supplier can not tell you. We can only design the equipment on the basis of the information we receive-the more data we are given the better the equipment will be suited.

A customer should know the following :

— Local by–laws

— How is the sludge to be disposed of, dumping, burning or composting

— Cost of transport

When working out transport costs it is not possible merely to work on reduction in volume, in relation to higher dry–content output, without taking the packing factor into consideration.

If possible trial runs should be done to obtain the answers to many of these questions.

What to do to get good results from a sludge which is hard to dewater ?

You try to make the sludge a bit more dewaterable–for example try increasing the proportion fibre or the like.

THE ROLE OF POLYMERS IN SLUDGE DEWATERING

It is well known that the addition of a so-called polyelectrolyte can bring about the agglomeration of particles in the sludge, after which dewatering is done mechanically either by belt filter presses or centrifuges. The chemical process which brings about the agglomeration of sludge particles is known as conditioning and the practical problems associated with this can briefly be summarized as follows.

1. Which polymers should be used ?
2. How much of it should be added to the sludge ?
3. What are the factors determining the dosage ?

There are a great many polymers available today, most of them in powderform and classed as 100 %.

Nonpowdered types are supplied in an emulsion and usually classed as 50 %.

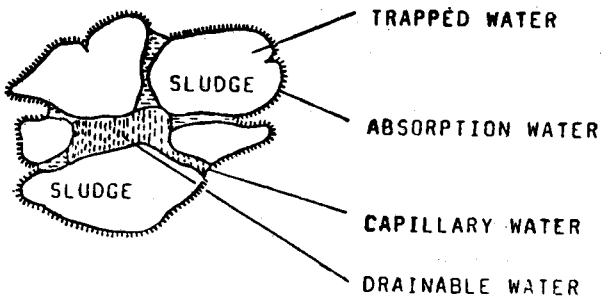
Polymers are either cationic, non-ionic or anionic:

Cationic polymers are used usually when the sludge is acid, pH up to 7, anionic with an alkaline sludge pH 7 +, and non-ionics when the sludge is neutral pH 6 9 – 7.2.

Polymers are also useful for thickening. The object of this information is not to get involved in the effect of polymers on the thickening result. Many articles have been written giving rational theories on the dimensioning of thickeners in which penetrating analyses of the thickening process and the effect of polymers on the dewatering result have been made.

The fact thaa a sludge holds water means that energy must be brought to bear in order to remove that water.

To get good results the water must be separated from the sludge phase . By adding polymers to a sludge phase a sludge floc as shown below is obtained.



Different types of water in the sludge. Drainable water is found in the higher voids and can be removed by gravity. In the smaller units we find the capillary water held in place by capillary forces.

Abjacent to the sludge floc is absorption water. The water found next to the absorption water is often called the adhesion water. Within the flocs there is trapped water, cell fluid and hydrostatic water.

The effect of polymers on the dewatering result can briefly be described as follows:

— Improved drainage in the gravity zone which improves capacity.

— Good drainage means that the necessary minimum levels are reached to prvent the sludge shearing out between the filter cloths.

— Improved reject.

The dewatering of sludge can be done without polymers, that is if the above conditions can be obtained without them.

WHAT IS MEANT BY DIMENSIONING A PRESS FOR DEWATERING

When dimensioning a belt filter press consideration must be given to the hydraulic loading and to the loading of solid matter. It is easier to become less dependent on the hydraulic loading by paying attention to the following :

1. A reliable thickening system
2. Add polymers
3. Select a press which will stand higher hydraulic loads
4. Supplement equipment by a separate pre-drainage system
5. Select a filter cloth with higher permeability
6. A combination of points 1 – 5

Dimensioning a belt filter press for dry solid loading often means knowing what outgoing dry content is required.

Generally a higher loading per unit of time gives a lower outgoing dry content. There are exceptions, where the proportions of cell bound water are very high.

The choice of eyuipment for different purposes will be dealt with later as a separate item.

SLUDGE BUFFER-SUPPLY FLUCTUATIONS

To dewater most economically fluctuations in the supply of sludge should be reduced to a minimum. Let us assume the following case :

Capacity 20 m^3/h=pump capacity

Input 2% dry solid=normal figure

Solid loading : 20×20=4 0 kg DS/h on the press. If input sludge is changed to 3% DS the DS loading would be : 20×30=600 kg DS/h with an input of 1% DS sludge the loading would be : 20×10=200 kg DS/h.

The fluctuations in DS loading between max and min will be big.

At what loading should a polymer be used ?

What happens when sludge spreads ?

If a buffer can be arranged to reduce fluctuations in supply to ± 0.5% from the normal then good progress has been made.

The alternative to having a buffer is to have the equipment manned and that the supply is regulated manually.

EQUIPMENT FOR DEALING WITH ELUCTUATIONS

To obtain good running economy the loading o dry matter on a belt filter press should be as constantf as possible. If there are substantial fluctuations the dewatering equipment should be augmented as follows :

1. The sludge input should be calibrated by a concentration gauge. This equipment is available and works better on some types of sludge than others due to accumulation of particles. It is also expensive.

2. The sludge cake can be measured in the draining stage using an optical signal. This works well if the sludge layer is level. An uneven cake produces the wrong signals.

3. Our belt filter presses are always fitted with a sludge spreader/sludge control function which tells the press that sludge is on the way. This sludge control function can be combined with an angle indicator. The position of the sludge plate indicates the thickness of the sludge cake. You decide on a normal height which gives the best dewatering results. This height should be code calibrated.

4. Departures from the norm activate a signal to vary the capacity of the sludge pump. When there are large variations in the ingoing dry-content the angle indicator must also give an impulse to the press drive motor and regulate the speed of the filter cloths.

DEWATERING TIME / RESERVE TIME

The following points should be observed when dimensioning dewatering equipment :

How long can the equipment stand idle ? From experience we know that equipment can be at a standstill for many reasons, both internal and external. If there is a standstill how much of a buffer supply is there if the equipment has been designed for 24 hours a day running at full capacity ?

Will sludge production increase in the near future ?

What will it cost to let the dewatering equipment stand idle even at weekends for example. Let weekend time be spare time.

Normally equipment should be dimensioned to be used at 8)% of maximum capacity.

HOW MUCH SHOULD THE EQUIPMENT COST

Generally speaking if demands are high this will cost money, and here we come back to the views put forward on page 39 under the leading "What is expected from dewatering" and above concerning dewatering time/reserve time.

An extra look at the plants reserve system can be useful–pumps and discharge systems for example.

MATERIALS

SALTEC belt filter presses have the following standard construction :

Frame

The structural frame is made of hot-dipped galvanized carbon steel.

Inner troughs

All troughs in SIS 2333 material.

Rolls

For belt filter presses up to 2 metres in width press rolls are made in SS 2333. Belt filter presses of 2.6

metres width are made in carbon steel and Rilsan treated.

We can make departures from our standard program and supply frame and troughs in SS 2343.

In addition to this belt filter presses can be painted according to customers requirements.

Choice of materials and finish should be determined by the degree of acidity of the sludge.

TYPES OF PRESS

Abreviations can be a bit confusing so to simplify matters we should like to give you a short description of our belt filter presses for conventional dewatering.

HP = High pressure hydraulically operated press
HP-F= As above but with extended drainage zone
MP = Medium press, pneumatically operated
CP = Compact press pneumatically operated
RF = Rotating predrainage unit
LP = Linear press

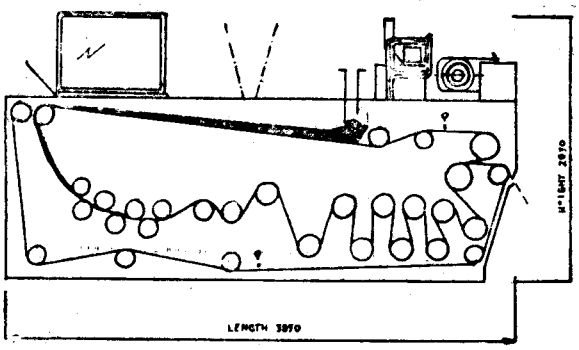
In addition we have custom-made belt filter presses for peat, minerals and for the food processing industry.

We have also built presses for laboratory work.

A press of ours with the designation HP 1500 F will be of the following type :

High pressure, 1500 mm wide filter cloth with extended drainage zone.

HP-Press



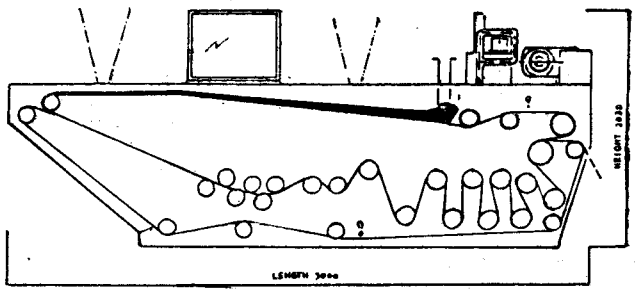
The above belt filter press is our basic machine and has all the features necessary to give good results.

Here are some of the features :

— Rising drainage zone
— Low and increasing pressure (wedge zone)
— Moderate rising shearing forces
— Long dwell time through press

The HP-press is very suitable when the sludge input has a dry content of more than 2.5%.

HP-F press



What distinguishes an HP press from a HP-F press is the extended drainage zone. The HP-F press is preferable when the hydraulic loading is high in relation to the dry content loading.

The extended free drainage zone also provides space for extra spreader plates which also improved drainage.

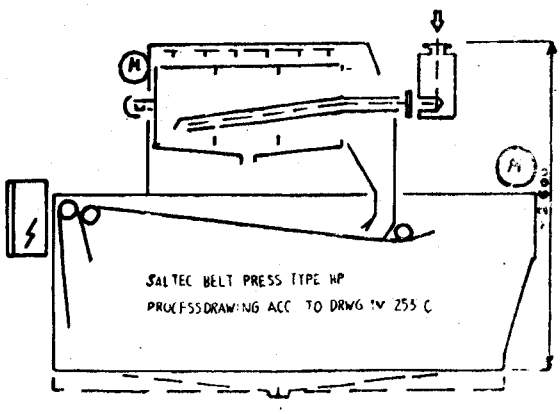
The HP-F press is suitable for sludges with an ingoing dryness of 1.5—3%.

These are the two models which give the best dewatering.

In plants with an inadequate thickener or with no thickener at all the belt filter press can be supplemented by a rotating pre-drainage unit type RF.

The RF pre-drainage unit can be made with 1, 2 or 3 parallel screen drums, the number of drums depending on the flow to be handled. Each drum is designed for 15—18 m³/h with an ingoing dry content of up to 2%.

The pre-drainage units are fitted as shown in the diagram.



Under normal loading the outgoing dry content from a pre-drainage unit is 7—9%. Briefly; a pre-drainage unit works like this. The drum consists of a steel net and has one closed end. A skrinkable filter cloth is then fixed on to the drum. Sludge is pumped into the drum towards the closed end. As the drum rotates (see diagram) into water drains away through the filter cloth and a sludge phase is formed which is then arrested by the welded rings inside the drum.

The rotation of the drum makes the sludge phase begin to roll (see arrow 1) and thanks to the rotation of the drum the sludge phase is always located over a clean part of the screen.

Normally if the sludge to be dewatered has a low ingoing dry content it costs more in polymer per ton dry matter than if you increase the dry-content of the sludge by means of a pre-drainage unit.

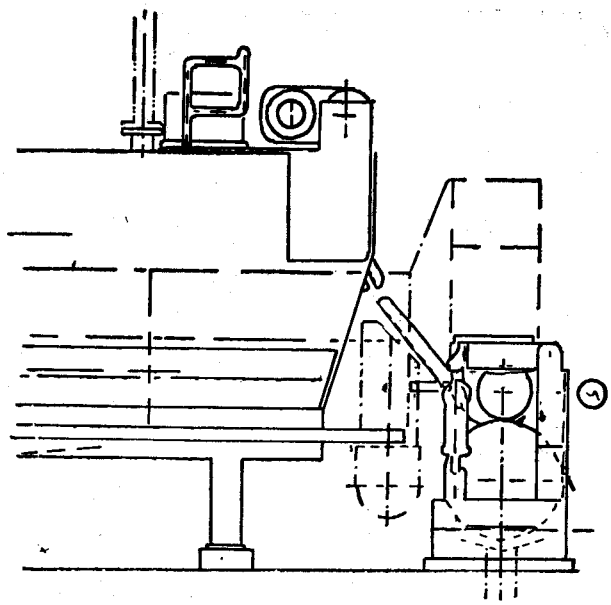
The water phase has to some extent to be covered by the polymer solution.

Dry-contents given for different types of machine are approximate. Only when it is known what type of sludge is to be dewatered and other data can the most suitable equipment be recommended.

Sometimes customers require extremely high outgoing dryness in order to be able to burn the dewatered sludge. Here it is possible to add a linear press to the equipment as shown in the diagram.

A precondition for a linear press to work properly is that the sludge has a fibre content.

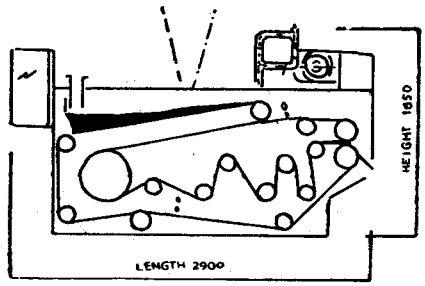
Without fibre or with too low a fibre content it is difficult to ensure a proper feed to the linear press.

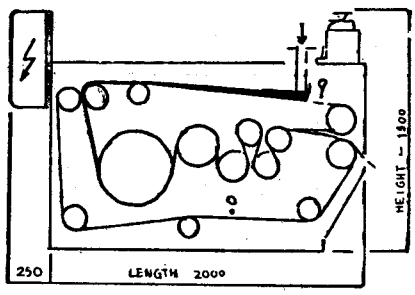


The linear press rolls are rubberized and the lower one groove turned.

Tests made with our installations have increased a dry content of 27-28% to 40-42%. For a dewatered sludge to have any fuel value the dry content must exceed 35%.

MP and CP Presses





With a sludge to be dewatered and only moderate demands on outgoing dry content belt filter presses of types MP and CP are best.

WHY A BELT FILTER PRESS LOOKS THE WAY II DOES ?

To obtain the best dewatering results these preconditions must be met :

1. High pressure
2. Long dwell time
3 Good drainage
4. No threshold in flow

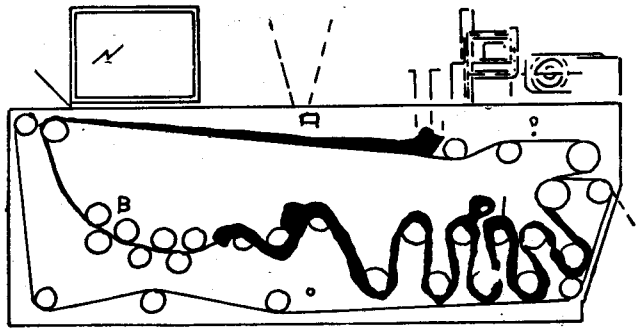
To obtain good results with pressure alone means that the sludge must have a carrier/reinforcement. A high proportion of fibre in a sludge provides reinforcement. Fibre helps to keep the sludge together and prevents sideways shearing.

If a sludge wont take high pressure the dewatering time must be extended and start at low pressure.

With the HP series of presses SALTEC have come a long way in combining the above preconditions.

If the sludge to be dewatered has a dry content of 2-3% this cannot be put under pressure straight away. Generally speaking the higher the pressure to be applied the dryer the sludge must be.

This means that higher threshold values must be obtained at each stage in the process.



After zone A in the drainage stage the sludge should be so dry that the pressing forces in zone B do not press the sludge out sideways. The pressing/ shearing forces in zone C are higher and therefore demand a higher dry content. The dewatering is then finished off by increasing shearing forces in zone D. Shearing forces are regulated by the pressure on the cradle and these increase the greater the wrap round the press rolls and the higher the filter cloth tension.

VARIABLES

Every sludge to be dewatered has a character of its own and can even change during the course of the day. In order to get maximum effect from a belt filter press the following functions should be variable :

— Filter cloth speed
— Filter cloth tension
— Pump capacity
— Cake thickness

Filter cloth speed is either changed manually by mechanical variator or by an actuator.

Filter cloth tension is regulated by selecting pressure on the hydraulic mechanism.

Pump capacity is normally varied by altering r.p.m.

Cake thickness is changed by altering the height of the inflow slot. Doing this also means a change in the dwell time if capacity is not regulated at the same time.

OPERATIONAL MONITORING

All our presses are automatically monitored by functions on the press and from the automatic control box The latter pre-regulates and controls all electrical units and is made so that start and stop sequences work in the correct order. The control functions of the belt filter press consist of sludge control and polymer control. The purpose of the sludge control is to make sure that there is sludge available to avoid the sludge pumps running dry. Apart from checking that there is polymer the purpose of the polymer concontrol is to also check for too low dosage. Should any of the control functions be cut off the alarm is given and the belt filter press spray cleaning program comes into operation.

In addition there is a limit switch for the filter cloths should there be any tracking problems. The automatic control box is not equipped for time controlled starting since we consider that this should be done manually, thereby providing the opportunity to check that everything is properly set. A time controlled shut-off is standard.

In addition to the fault alarm it is also possible to get operational indications.

IMPORTANT PARTS OF EQUIPMENT

All parts of a belt filter press have job to do, although some are more important than others. The most important are these :

1. Filter cloths
2. Cloth equipment
3. Electrical equipment
4. Hydraulic equipment
5. Doctor blades

Filter cloths

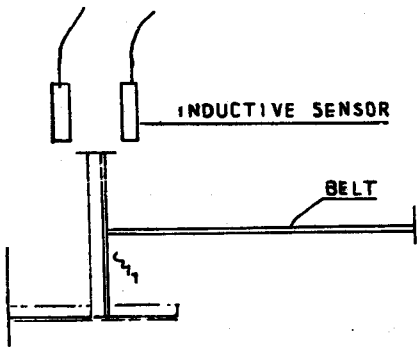
These must be in good condition–clean and intact. Their drainage properties depend on how clean they are kept. Care should be taken to avoid grease or oil getting on to the cloths as these are difficult to wash off.

When dewatering wood room sludge and certain types of fresh wood resin can be deposited on the cloths which has to be removed using solvents, how often depending on the amount of resin.

If any welding is being done the filter belts should be covered to avoid sparks burning holes in them.

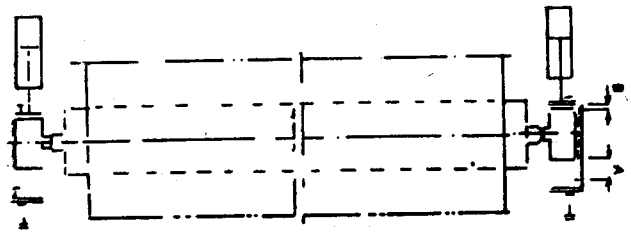
Cloth tracking

This is an important function and works like this :



A spring loaded metal paddle rests against the edge of the cloth When the cloth is running properly in the machine this edge-sensor is exactly midway between two inductive indicators.

If the cloth drifts from the central position the paddle follows the edge and then has a contact function through an inductive indicator.



The inductive indicator gives a signal to the cloth tracking cylinder through a solenoid valve to track the cloth back to the middle. As long as the inductive indicator is in contact the belt tracking cyliner is in operation. When contact is lost the cylinder returns.

In order to obtain a smooth running cloth the action of the belt tracking cylinder is delayed. Each filter cloth has a tracking cylinder on both edges which means that it is possible to set both the mid-point and the amount of travel manually.

Electrical equipment

The automatic control box is the heart of the equipment both as regards operation and monitoring. Care should be taken so that it is not affected by dampness. If in a damp place it should be well ventilated or have a heating element fitted.

Hydraulic equipment

The purpose of this is to take care of both tension and tracking. Checks should be made for leakages in valves or pipes.

Doctor blades

Doctor blades should be checked to make sure they are not worn or that deposits are preventing good contact with the filter cloth. If the doctor blade is not working the reject water will suffer.

CHOICE OF ANCILLARY EQUIPMENT

For dewatering equipment to work well it is important for all other equipment to be of good quality and be operationally reliable.

The most common cause of operational interruption are the feed pumps. A centrifugal pump is used to give high capacity and you try to reduce capacity by throttling the flow. Unfortunately this often causes clogging and stoppages ensue. Pumps for the polymer solution are put in that vary the capacity depending on the input pressure.

We think that displacement pumps should be used and the capacity regulated by altering the r.p.m.

Another factor which can interrupt operation is equipment for removing dried sludge cake. It ought to be possible to keep on dewatering even while changing container.

SPARES

When estimating the amount of spares to be kept the following would be observed :

1. How long can the equipment remain at a standstill ?
2. How long does it take to get hold of replacement parts ?
3. Wearing parts.
4. Price of spare part ?

We have tried as far as possible to build machines with equipment of international standard, equipment which is relatively easy to obtain internationally.

Wearing parts which should be kept in stock :

1 set Filter cloths

1 set Doctor blades

1 set Rubber seals

5 no Shower nozzles

1 no Limit switch

1 no Inductive indicator

Wearing parts for ancillary equipment should also be kept in stock.

GOOD AMBIENT ENVIRONMENT

Our belt filter presses are completely enclosed as standard with easily removable panels and connections for evacuation. The idea of enclosing the equipment is to create a pleasant working atmosphere. It also provides protection for moving parts. Unfortunately the panels are not always in place when the press is operating, which is contrary to our recommendation.

CARE AND MAINTENANCE

Daily

1. Inspect the press
2. Check spray pipes/nozzles for clogging
3. Clean scrapers
4. Clean floors from polymers (slipping risk)
5. Check that all protecting covers and plates are mounted when the press is operating

Weekly

1. Rinse (flush) the press, including troughs
2. Check proper function of limit switches for belt guiding and emergency shutdown
3. Check polymer preparation equipment
4. Lubricate press drive, gears and chains
5. Lubricate slide bars for guide rolls

Monthly

1. Trim scrapers
2. Lubricate rolls
3. Check that control cabinet is dry
4. Check pump functions
5. Check sludge indicator functions

Every six months

1. Check oil levels of moters
2. Restore protective paint coating damages

Yearly

1. Change oil in motorgears

SUMMARY

The idea of this general information is not that everyone should be able to know everything about belt filter Presses and mechanical dewatering.

We hope however that we have managed to create some interest and the right atmosphere for useful cooperation between customers and supplier. As you have seen there are many questions to be sorted out.

Our aim is to supply reliable equipment which works well, requires only short stoppages and has good operating economy in other words we went a satisfied customer.