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Cake Washing - A Decisive Step for Filtration Processes

The process of washing a filter cake whilst within the filter press is often a requirement of the basic process.

Examples of Cake Washing

An example of this is in the sugar industry where the filter cake can be 'de-sweetened' by in-situ cake washing giving an improved sugar yield.

In the production of pigments, the formed filter cake requires the removal of 'salts' which affect the quality and the onward processes of the product.

A further example is during Titanium Dioxide production where excessive Sulphuric Acid must be removed or neutralised.

Washing the Filter Cake

Latham International elements can be designed to allow the process of in-situ cake wash to take place.

The purpose of a cake wash is either to wash out any remaining mother liquor and replace it with an alternative liquid or to reduce the concentration of soluble salts that may remain trapped inside the particles that form the cake as described above.

Generally, there are two different ways of in-situ cake washing as described below:

Simple Wash

A simple wash is performed by passing the wash medium through the feed channel and out through the filtrate channels (picture 1).

The basic concept is that the washing medium can follow the flow path of the original feed and therefore enter the cake in the centre and wash through the two partially formed filter cakes.

The wash medium must be such that it maintains pressure within the chamber to prevent cake slump which would allow the wash water to by-pass the filter cake. It is also important to prevent the cake from cracking as again this would allow the wash water to bypass the filter cake.

This type of washing also allows the formed filter cake to hold the wash medium often forming a wetter cake. However, this can be dramatically improved by using membrane filter plates to squeeze the cake dry after the washing process has finished.

It is also possible when using membrane plates to apply a pre-squeeze to form a homogenous filter cake and prevent cake slump during the washing process. This method of in-situ cake wash is by design the simplest to add to a filter press installation as it only requires a slight pipe work modification.

Thorough Wash

The second method of washing the cake is termed 'thorough' and requires the plate pack to be designed to allow for the wash media to back wash through individual chambers.

This process is achieved by alternating pressure and wash plates though the filter pack.

A pressure plate is designed with filtrate ports on one side of the plate only whilst the wash plate is designed with filtrate ports on the opposite side of the plate only.

This design then allows for the cake wash media to be directed through either one or two filtrate ports on one side of the press.

The centre feed, if applicable, is closed so once the wash water has entered the chamber behind the filter cloth the only route out is through the formed filter cake and out through the filtrate ports on the adjoining plate.

The principle relies on the wash water entering one side of the press and leaving on the opposite side, but it is possible to reverse the flow after an initial period to give an even a more intense wash.

With this type of wash, it is also possible to allow the cake to form in a dryer condition as we do not require a wet centre to ensure the wash water cover all the cake area and again the inclusion of a membrane plate allows for a pre-squeeze to stabilise the cake and a final squeeze to obtain the best cake solids achievable.

Main Factors for Cake Washing

The initial wash media relies on the feed pressure to pass through the formed filter cake in both formats but once the avenues of washing are opened the pressure declines.

The main factors in respect to type and efficiency of cake washing are down to the chemical composites of material involved.

When defining the washing process it can be-seen that there are three stages:

1) The substance to be washed out must diffuse to the surface of the particle. The moving force for diffusion is only determined by the difference in concentration from the surface to the inner parts of the particle. Velocity of diffusion can only be increased by reducing the surface concentration.

2) From the surface of the particle, the substance must move to the wash liquid. The difference in concentration between the wash liquid and the particle surface is the responsible factor for this diffusion. The velocity of moving over from the surface to the wash liquid can only be increased by increasing the difference in concentration.

3) The substance to be washed out must be removed by the wash liquid.
This step is mainly pre-set by the solubility of the substances in the wash liquid and its flow velocity. Only this step can be increased by faster flow of wash liquid.

Also increasing temperature can generally speed up each step during washing as the molecular movability of the substances to be washed out improves.

Limitations for Washing

The basic requirement for a homogeneous and fluid saving wash is a homogeneous flow through the cake. This is being met by an even cake build up.

Cake washing is made complicated by a phenomenon called shrinkage cracks. Due to the washing out of soluble substances in the cake and the resulting loss in volume, cracks occur which build up short circuits for the wash liquid.

The borders of the filter chambers may also work as such short circuits. In both cases wash liquid cannot pass the cake homogeneously.

As previously stated with thorough wash, the use of membrane filter elements provides a big advantage. By squeezing the cake with pressure slightly higher than the feed pressure of the wash liquid, the cake is permanently compressed during the wash cycle. Due to this, occurrence of shrinkage cracks and short circuits are minimised or avoided. Furthermore, the compression of the cake results in a more homogeneous permeability and therefore more efficient wash.

In comparison to the thorough wash with recessed chamber filter elements or filter plates and frames, the use of membrane filter elements shows the following advantages

1) A pre-squeeze removes a large amount of free-flowing mother liquor which in turn takes any soluble salts with it.

2) The cake is homogeneous thus reducing the amount of wash water required.

3) The actual cake wash cycle can be reduced to increase the efficiency of the press.

4) A final squeeze can be carried out to obtain the required cake dry solids.

Control and Regulation of the Wash Cycle

Regulation of the wash cycle is based mainly on the monitoring of the chemical and physical attributes of the wash liquid including pH value, electrical conductivity or turbidity. If these easy to monitor characteristics are not sufficient for control and regulation during the wash cycle, periodically a chemical analysis in a laboratory must take place.

Furthermore, it must be noted that only the characteristics of the outgoing wash liquid can be determined when monitoring these values. From these the content of the substances to be washed out can be calculated, although this indicates nothing about the actual washing result of the cake. A precise control of the wash result is only possible with a continuous mass balance of the substances washed out during the washing cycle.

Therefore, based on the solids fed during filtration the amount of substance to be washed out must be estimated. Used wash liquid multiplied by the average content of washed-out substances is the value of the remaining substances in the cake.

TYPICAL CAKE WASHING SEQUENCE

1) FILL FOR A KNOWN VOLUME AND PRESSURE CLOSE FEED VALVE
2) INFLATE MEMBRANES TO FIRST PRESSURE
3) CARRY OUT FIRST AIR BLOW
4) START CAKE WASH ALWAYS WASH FROM MEMBRANES IF POSSIBLE
5) CARRY OUT WASH NORMALLY 1-3 TIMES PRESS VOLUME OF WATER DISPLACEMENT
6) NOTE WASH AND AIR PRESSURES SHOULD BE 1 BAR HIGHER THAN MEMBRANE PRESSURE
7) HOLD MEMBRANES ON FOR DURATION OF WASH CYCLE
8) ALWAYS WASH DIAGONAL AND UPWARDS
9) ALWAYS AIR BLOW DIAGONAL AND DOWN
10) CARRY OUT SECOND AIR BLOW
11) INCREASE PRESSURE ON MEMBRANES TO FINAL SQUEEZE PRESSURE

TYPICAL CYCLE

A) FEED VOLUME AND TO 6 BAR
B) SQUEEZE TO FIRST PRESSURE 7 BAR FOR 2MINUTES
C) FIRST AIR BLOW 6 BAR FOR 2 MINUTES
D) WASH 8 BAR NORMALLY 1-3 TIMES THE PRESS VOLUME
E) SECOND AIR BLOW 5 BAR NORMALLY 1-5 MINUTES
F) INCREASE MEMBRANE PRESSURE TO 7-8 BARS FOR FINAL SQEEZE