A New Stainless Steel Membrane Support for Horizontal Pressure Leaf Filters

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This paper was originally presented at the MBAA 112th Anniversary Convention, Keystone, Colorado, 1999

ABSTRACT

Precoat filtration on horizontal pressure leaf filters has proven to be both an efficient and economic method for the filtration of beer. Therefore, this filtration process is established in hundreds of breweries all around the world and is still state of the art. In the following article, the new stainless steel membrane Durafil® is presented, which, when used as precoat support, allows a more efficient and more economical precoat filtration. In addition to advantages in kieselguhr consumption and time savings, a better performance characteristic with lower particle counts and lower turbidity in the filtrate and a more stable filtration can be achieved.

Keywords: horizontal pressure leaf filter, precoat support, precoat filtration

PRINCIPLES OF PRECOAT FILTRATION

For precoat filtration with filter materials like kieselguhr, cellulose or perlite, horizontal pressure leaf filters are used quite frequently. Figure 1 shows the different steps taking place during a precoat filtration.

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SINTÉSIS

La filtración de revestimiento en filtros de hoja de presión horizontales se ha comprobado ser un método tanto eficiente como económico para la filtración de la cerveza. Por lo tanto, este proceso de filtración está establecido en cientos de cervecerías alrededor del mundo y aún se considera como lo mejor y más moderno. En el artículo siguiente, se presenta la nueva membrana de acero inoxidable Durafil, la cual, cuando se usa como soporte de revestimiento, permite una filtración de revestimiento más eficiente y más económica. Además de las ventajas del consumo kieselguhr y del ahorro del tiempo, se pueden obtener tanto un rendimiento que se caracteriza por un conteo de partículas bajo y una turbiedad baja en el filtrado como una filtración más estable.

On the precoat support, a first precoat is applied that is mostly made of coarse, calcinated or flux-calcinated kieselguhr. The first precoat serves as drainage and support for the second precoat, which can be made from medium or fine kieselguhr. The openings of the precoat support are bigger than the filtered particles and bigger than the particles of the kieselguhr. Therefore, in the beginning, these particles partly pass the precoat support. During the precoat phase, the kieselguhr particles form bridges covering the openings of the precoat support. Thus a filtration-active layer is formed, which is capable of removing both the kieselguhr particles and the turbid matter of the filtered beer.

After this, the actual filtration starts, in which a mixture of beer and constantly added filter material is applied. During the filtration, a filter cake develops, which consists of both of the filter material and the turbid matter removed from the filtered beer. In order to achieve a good filtration, the structure of both the filter cake and the precoat is essential. Filter cake and precoat should have a loose structure, which removes the turbid matter, but at
the same time does not cause a high pressure drop during filtration. The structure of the precoat support is essential for the formation of the precoat and therefore is very important to achieve good filtration.

**IMPORTANT PROPERTIES OF PRECOAT SUPPORTS**

On discharge of the filter cake and the following filter rinsing, the precoat support is subject to high mechanical, chemical and heat strain. The following properties are, therefore, important:

- high mechanical stability
- high chemical and heat stability
- good cleanability

These three features are essential for an effective operation of the filter. However, for an optimum precoat and thus for an optimum filtration run with a good filtration result (low turbidity, low particle count and low pressure increase), additional points have to be considered.

**COMMON PRECOAT SUPPORTS**

In practical use, mostly stainless steel slot plates or stainless steel mesh are used as a precoat support.

Stainless steel slot plates are mechanically, chemically and thermally very stable, have the advantage of a smooth surface and can be very well cleaned. However, the manufacturing of flat material is very expensive. Therefore, in breweries, almost exclusively stainless steel mesh is used in horizontal pressure leaf filters. For stainless steel mesh, the pore size as well as the free area are mainly determined by the texture and the wire size. Small pore diameters are realized using very fine wire. In this case, the mechanical stability of the mesh tends to be lower.
THE NEW PRECOAT SUPPORT DURAFIL®

The suitability of a precoat support for an optimum precoat is influenced not only by the flow features of the precoat support, but also by its interaction with the different types of filter materials (kieselguhr, etc.) during the precoat phase. The following essential parameters have been determined in experimental studies of commercial materials as well as of new materials:

- pore size
- pore geometry
- surface structure
- flow resistance
- free passage area of the precoat support

The new precoat support, DuraFil®, was developed based on the above essential parameters and successfully tested in a large brewery under production conditions.

DuraFil® is a perforated stainless steel membrane with a gauge of 0.4 mm and very good mechanical, chemical and thermal stability. Moreover, DuraFil® distinguishes itself by the following design features (see Figure 3):

- optimized slot width (35 µm)
- optimized slot geometry
- optimized surface structure
- optimized free passage area

The slots of a width of 35 µm and a length of 2 mm are arranged to form an ideal surface structure for a homogeneous buildup of the filter cake. Blocking of the filter support is prevented by the slot geometry widening towards the filtrate side. The free passage area was chosen to guarantee the correct initial resistance for an optimum precoat formation of the kieselguhr particles and a homogeneous distribution of the precoat of the filter plates.

EFFECTS OF DURAFIL® ON FILTRATION BEHAVIOR

The design of DuraFil® results in the following advantages of the new precoat support:

- high mechanical, chemical and thermal stability
- smooth surface and therefore easy cleaning of filter elements
- no first precoat necessary and, consequently,
- no coarse kieselguhr necessary for first precoat
- higher stability of the precoat against pressure shocks
- improved filtrate quality (haze and particle counts)

The improved filtration behavior of DuraFil® was validated in tests under production conditions and in production scale in a large brewery. Figure 4 compares the filtrations in two horizontal pressure leaf filters, whose filter elements were equipped in one case with stainless steel mesh (KPZ), in the other with DuraFil® as filter support. In both filtrations, the same beer was filtered. Due to the fact that in the filtration with DuraFil® a precoat is not necessary, the curve belonging to it was “cut apart” and shifted parallel to the x-axis to be able to compare both curves directly.

It is evident that the beer filtered with DuraFil® elements has particle counts which are lower by more than factor 10. In addition, the more stable filtration behavior of elements equipped with DuraFil® becomes apparent, in which the particle counts react clearly less sensitive to pressure shocks during filtration.

Also, the haze (90° EBC) of the beer filtered with DuraFil® elements is lower than the haze of beer filtered with a customary precoat support. In the example shown in Figure 5, the haze in the first stage of filtration is approx. 50% lower; only after approx. 3 hours do the two curves approach each other.

ECONOMIC ADVANTAGES OF DURAFIL®

The economic advantages of DuraFil®, however, are as interesting as the advantages in filtration quality. To be emphasized there are:

- saving of kieselguhr
- saving of time
- higher capacity of the filter
- logistic advantages

As already mentioned, when using DuraFil®, the filtration can be performed without a first precoating of coarse kieselguhr/cellulose. With an average volume of 800 g/m² for the first precoating, this results in a kieselguhr saving of 80 kg per filtration cycle in a 100 m² filter.

Because the first precoating becomes unnecessary, a saving of time can be achieved. Due to the reduced precoating volume, a higher sludge volume is available for the actual filtration. This results in longer filtration cycles, a shorter filtration time per beer volume and, with this again, a higher efficiency of the filtration.

If coarse kieselguhr types are used for the first precoating, which are not required anymore for the second precoating or the actual filtration, separate logistics (purchasing, transport, storage) are necessary for these kieselguhr types. Since the first precoating becomes unnecessary with DuraFil®, these logistics can be omit-
HIGH GRAVITY BEER
Particles in filterline 1 (KPZ 55) and filterline 3 (Durafil®)

FIGURE 4
Comparison of particle counts in a filtration using stainless steel mesh elements and Durafil® elements.

HIGH GRAVITY BEER
Turbidity in filterline 1 (KPZ 55) and filterline 3 (Durafil®)

FIGURE 5
Comparison of turbidity (90° EBC) in a filtration using stainless steel mesh element and Durafil® elements.
ted, and, in this way, a further saving of investment costs (warehouse, storage tanks, etc.) and working time can be achieved.

**INCREASED WORKPLACE SAFETY WHEN USING DURAFIL®**

It has long been known that some materials, when inhaled as fine dust, can cause silicosis. According to the present legal regulations, kieselguhr is deemed to be safe when used following the safety instructions.

Kieselguhr can be classified into three different types: natural diatomaceous earth, calcinated kieselguhr and flux-calcinated kieselguhr. While natural diatomaceous earth contains no crystalline silica, both calcinated and flux-calcinated kieselguhr, which are the medium and coarse types of kieselguhr, caused by their production process contain a substantial amount of crystalline silica (cristobalite, tridymite, quartz). These coarse kieselguhr types are mainly used for the first precoat.

In June 1997, the IARC (International Agency for the Research on Cancer), an organ of the World Health Organization, re-classified crystalline silica from Group 2A “probable human carcinogen” to Group 1 “human carcinogen” [1].

Although the statement of the IARC has no legal character and is only a recommendation based on scientific results and discussion, it should not be ignored. Even when putting aside legislative measures that may follow the IARC recommendation, it should be considered to improve workplace safety for those employees having contact with kieselguhr containing crystalline silica.

The best way to avoid a risk is not to get in contact with it; avoiding the use of calcinated or flux-calcinated kieselguhr when possible seems to be a good way to avoid this possible harm. When using Durafil®, no first precoat with coarse Kieselguhr is necessary. Therefore, Durafil® offers a way to improve workplace safety.

**REFERENCES**