Filtration in Larger and Smaller Breweries

- Candle Filter Used for Diatomaceous Earth Filtration in Smaller Breweries

- MBAA Education Committee: Seminar
  at Westin Bristol Place Hotel, January 24, 2008

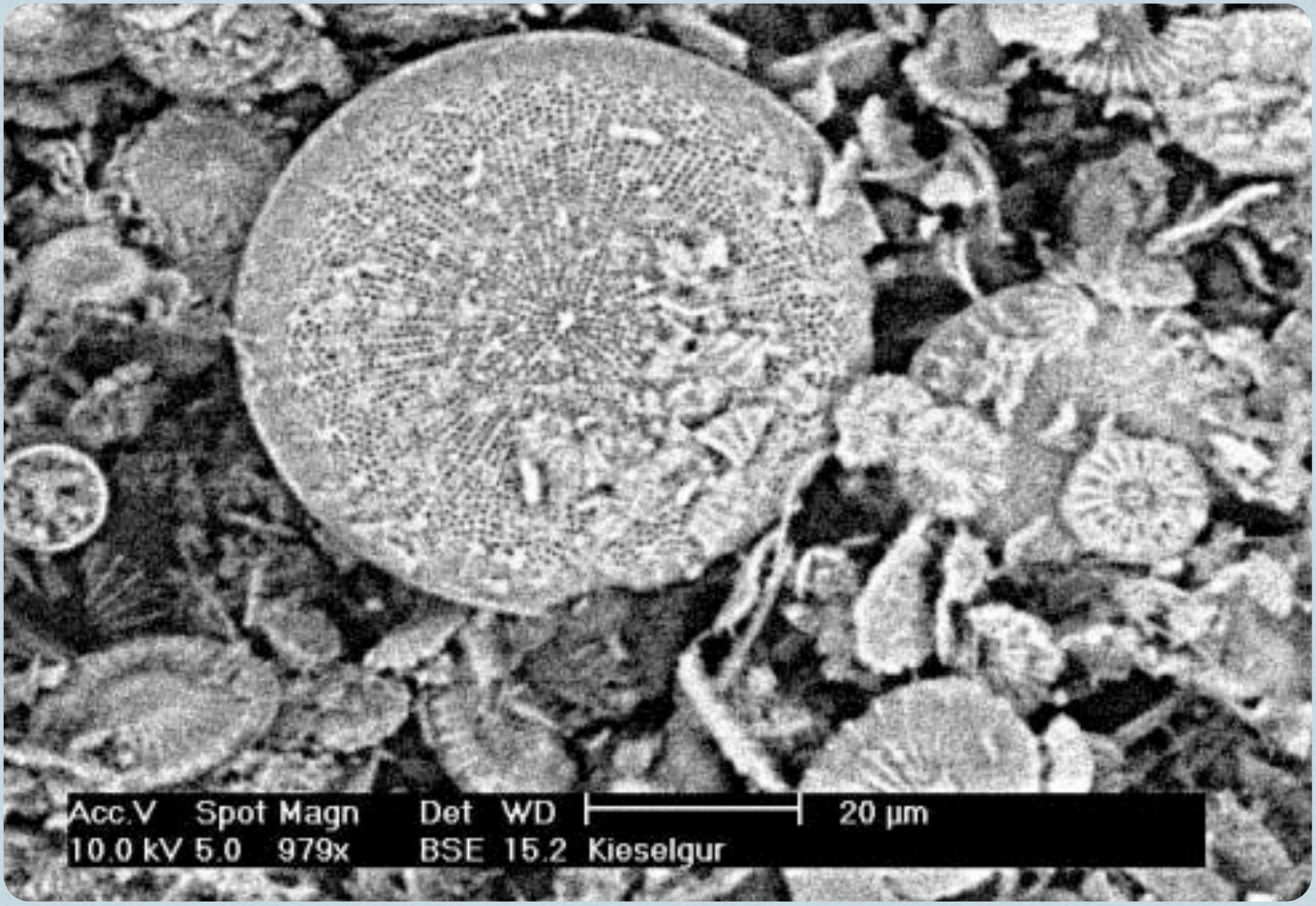
- Ueli Schrader, Ph.D., P.Eng.
  Beverage Engineering Inc.
  http://www.beveng.com

Candle Filter For Smaller Breweries

- Why have more manufacturers developed candle filters recently? Why are candle filter widely used in larger breweries?
- Are other types of filtration available / affordable for smaller breweries?
- What is special in DE filtration used in smaller breweries?
- SECUjet B with standing candles in a small housing allowing residual filtration is a nice machine for this!

Candle Filters might not be very common in smaller breweries, but they are for larger breweries.
Candle filters were manufactured by different manufacturers for some years now. I want to cover the questions listed.

Diatomaceaous Earth

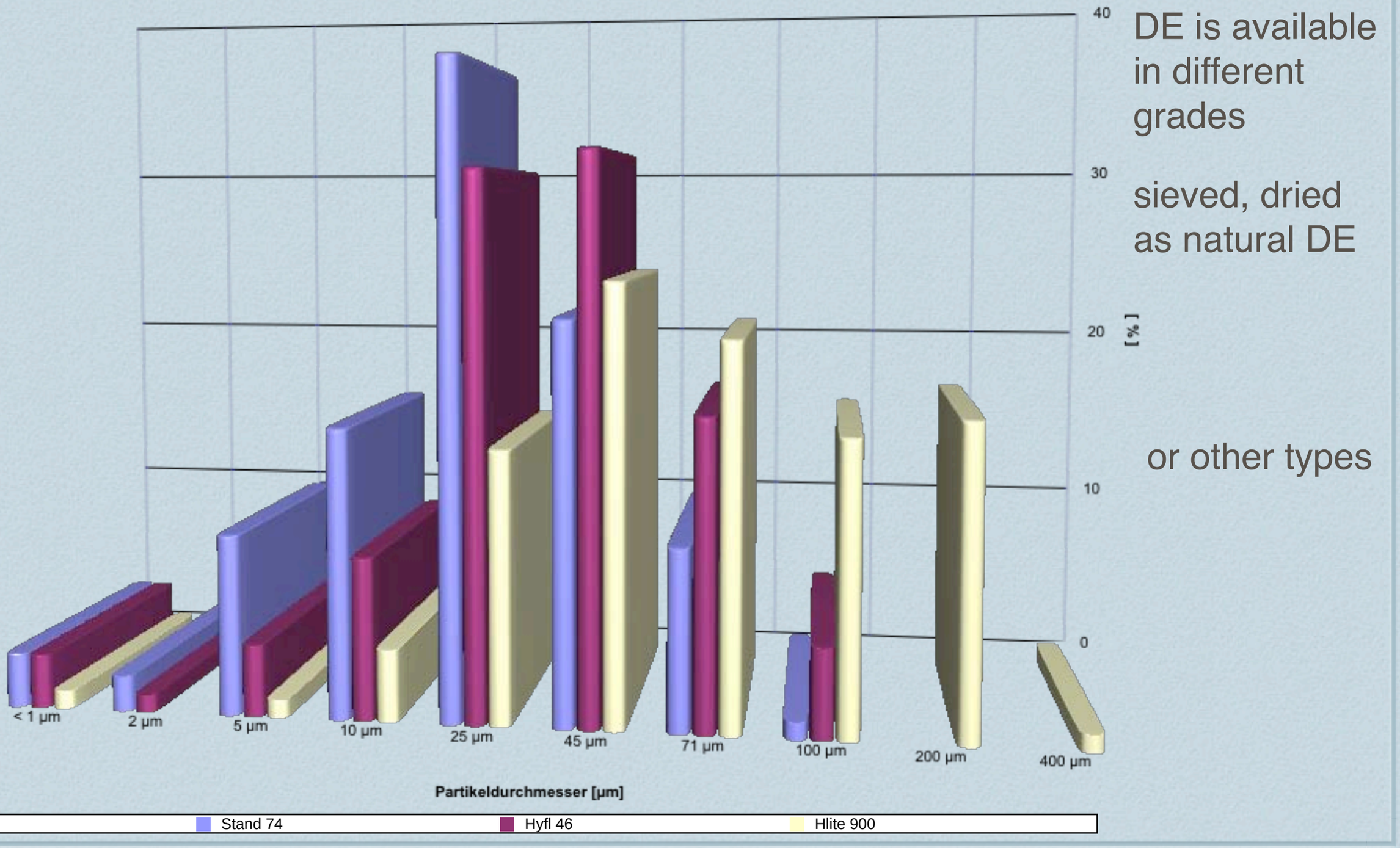


These are the working horses filtering the beer

NOT the equipment ...

Diatomaceous earth (DE) is produced from sediments of cell walls from diatoms. Diatoms are beautiful microscopic algae and are able to stabilize their cell walls with amorphous silica (hydrated silicon dioxide). Thus forming a sand like material with diverse microscopic biological forms. DE is stable against most acids but caustic can attack it.
Follow safe work rules: Nobody should inhale any dust. The dry DE powder can form dust and contains crystalline silica in varying percentages. Crystalline silica is found to be carcinogenic if inhaled in high concentrations and over a longer period of time.

Diatomaceaous Earth



DE is available in different grades

sieved, dried as natural DE

or other types

Three different typical grades of diatomaceous earth and perlite are shown re the particle size distribution.
Compare the particle size to the width of the gap in the filter element, which is about 70 µm wide.

Types of Pre-Coat Filters

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Plate and Frame

vertical square on filter sheets

open filter, manual discharge

forgiving and flexible

higher investment, labor intensive

Horizontal Leaf

horizontal donut shaped

spin elements after draining liquid

modern filter, enables stop of flow

maintenance

Candle

vertical around porous rod

wash out, short turn-around time

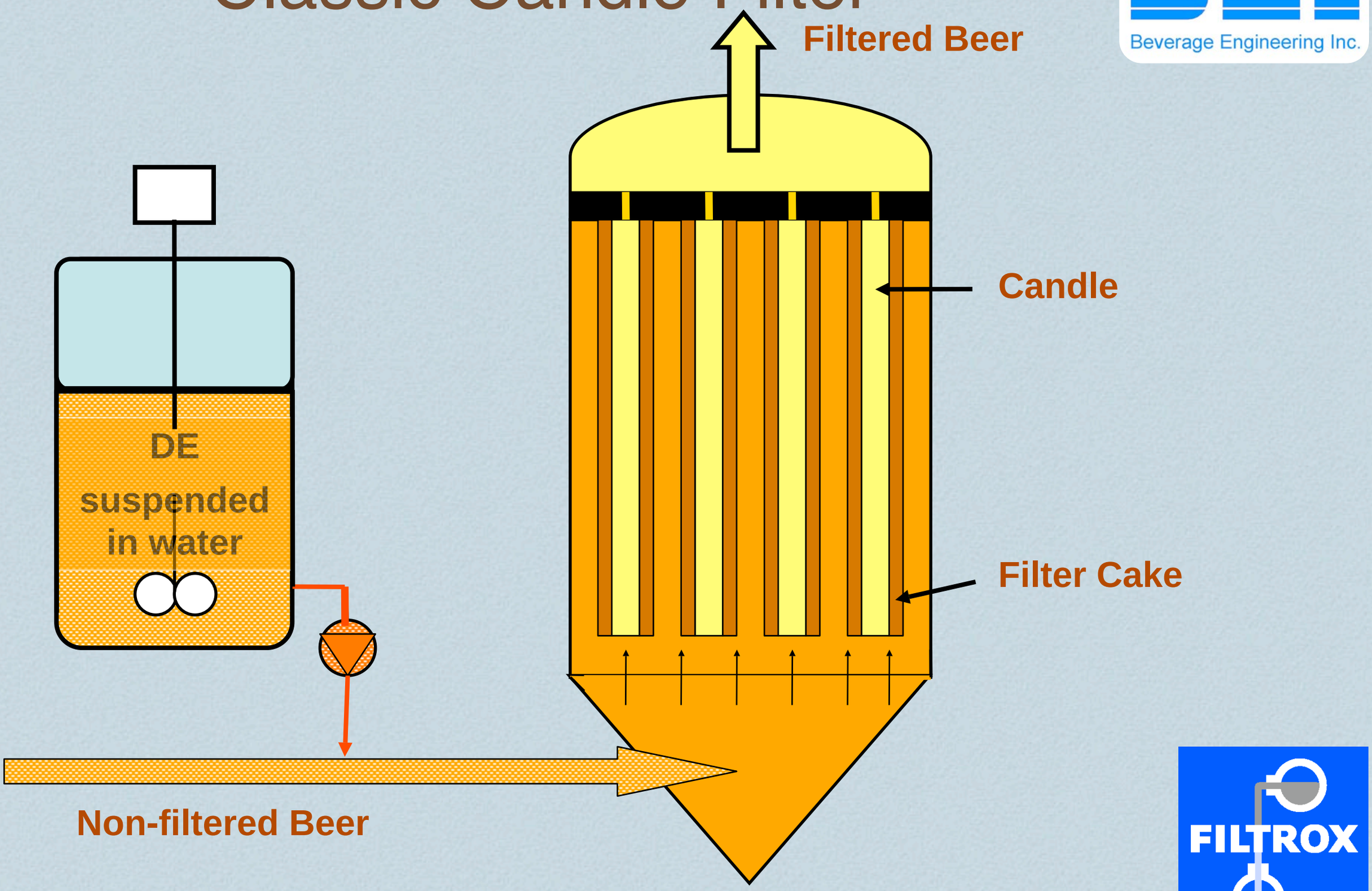
high filtrate quality, low maintenance

pre-and last runnings

FILTROX

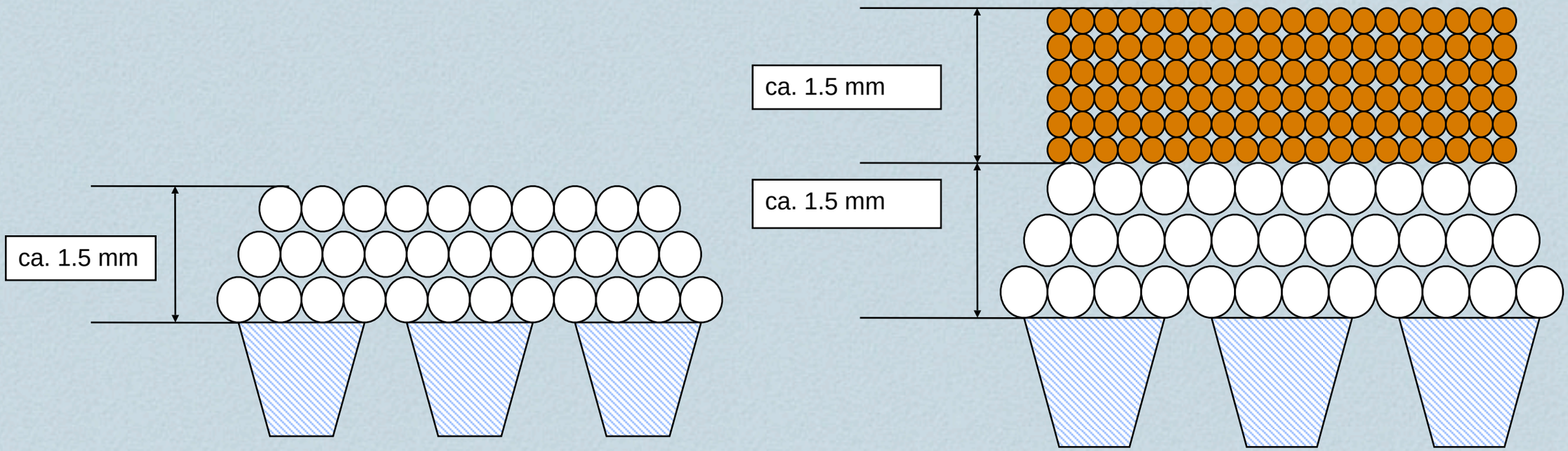
The equipment provides an area which can hold back the DE particles but let the liquid pass through.
Vertical filter area requires a constant flow to keep the filter cake pressed onto the filtration area. Machines having horizontal filter area are can handle flow interruptions.
For smaller breweries there are a lot of wine filters on the market. Please note that wine filtration is different to beer filtration. Wine is filtered normally with very fine DE at higher flow rates.
Filter pumps, dosing pumps and flow meters normally do not fit for beer filtration. Additionally the wine filters do pre-coating with product and vent the filtrate back into the dosing vessel.

Classic Candle Filter



This is the classic principle for pre-coat filtration. In this case we use diatomaceous earth. Other material which might be used is cellulose.
Candle filters are using candle shaped filter elements, hanging vertically down from a plate or pipe arrangement which holds them in place.
Main advantages of candle filters: No moving parts inside the vessel; only valves and pumps are used to push the beer through the filter cake and to flush out the used filter cake after the filtration batch is finished. Typically high filtrate quality and very low maintenance costs.
Main limitations: constant flow is required / pressure shocks are to be avoided / any flow interruptions induce immediate end of batch and start of getting all liquid and DE out of the vessel / batch start and end are normally done with pre- and last runnings (head and tails).
Larger breweries have special equipment to re-use the pre-and last runnings so that extract loss can be avoided.

Classic Candle Filter



The thickness of the layers of DE particles after the first and second pre-coat (idealized).

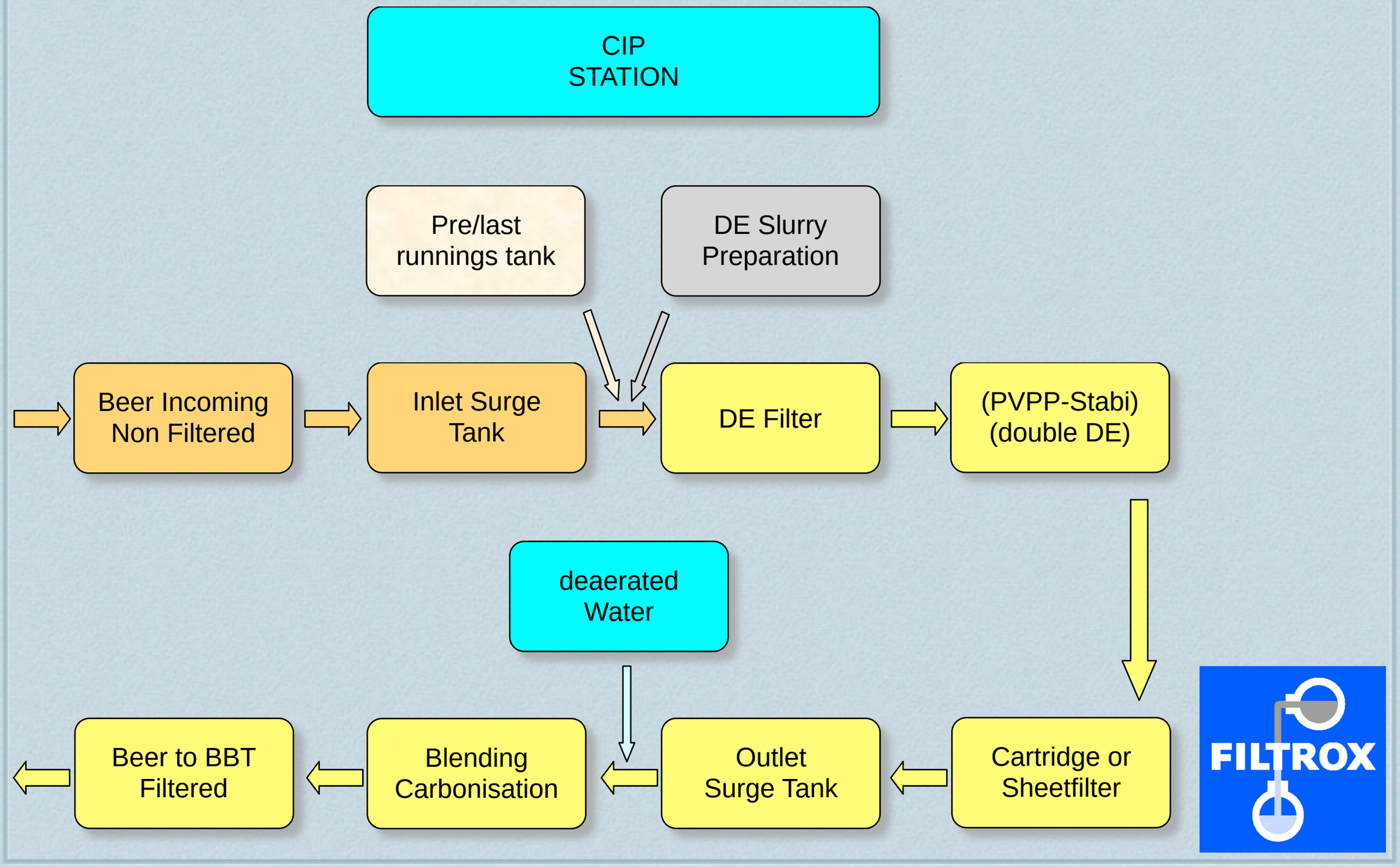
Classic Candle Filter

Beverage Engineering Inc.

FILTROX

Shown are two candle filters. Such a configuration can for example be used to double-filter the beer or to stabilize with PVPP in the second filter.
The equipment shown is to be installed in a fully automated environment.
Those filters are available in sizes for 100 hL/h and higher flow rates.

Filter Cellar Equipment



This is a typical schematic for beer filtration equipment.

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A small candle vessel filter for pre-coat filtration of beer.

no moving parts inside, no moving seals but solid, stain-less steel construction.

no need to open vessel for sludge discharge or operation.

Best filter cake support using stainless steel candles for high filtrate quality.

FILTROX

This filter is specially designed for small breweries for 20 hL/h to 50 hL/h flow.
The candles are not hanging from a top plate but standing on a bottom plate.
Residual filtration allows to empty the filter vessel at the end of the filtration run to avoid last-runnings.

A look inside

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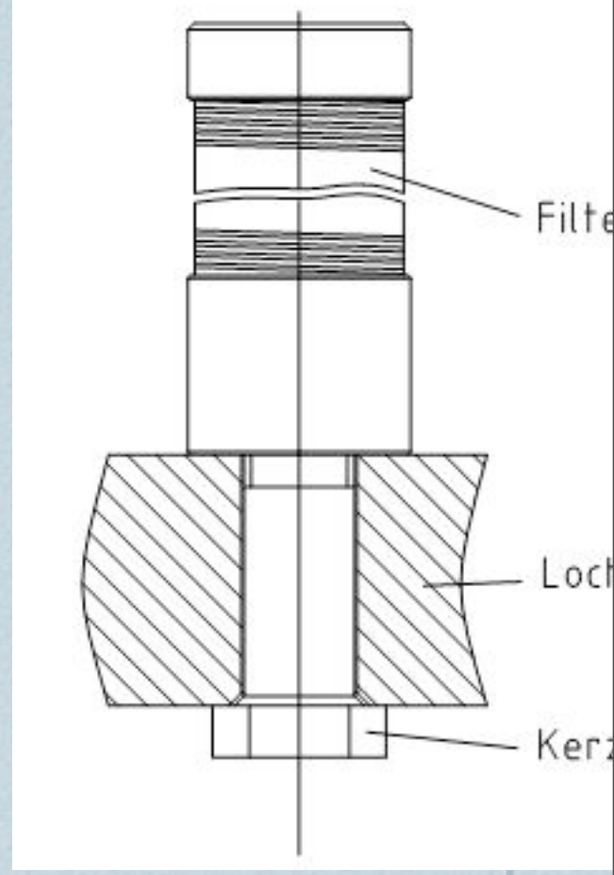
long main filter candles

outer ring spray tube
for efficient cleaning

smaller residual filtration
candles

central lower inlet
serving for sludge
discharge as well



FILTROX

Special for this filter are
- the central lower outlet for sludge discharge serves (during filtration) as inlet
- residual filter elements for emptying the vessel at the end of the filtration run.
- standing vertical filter candles.
- complete unit with pumps, piping and all necessary valves a compact unit.

Technical Data

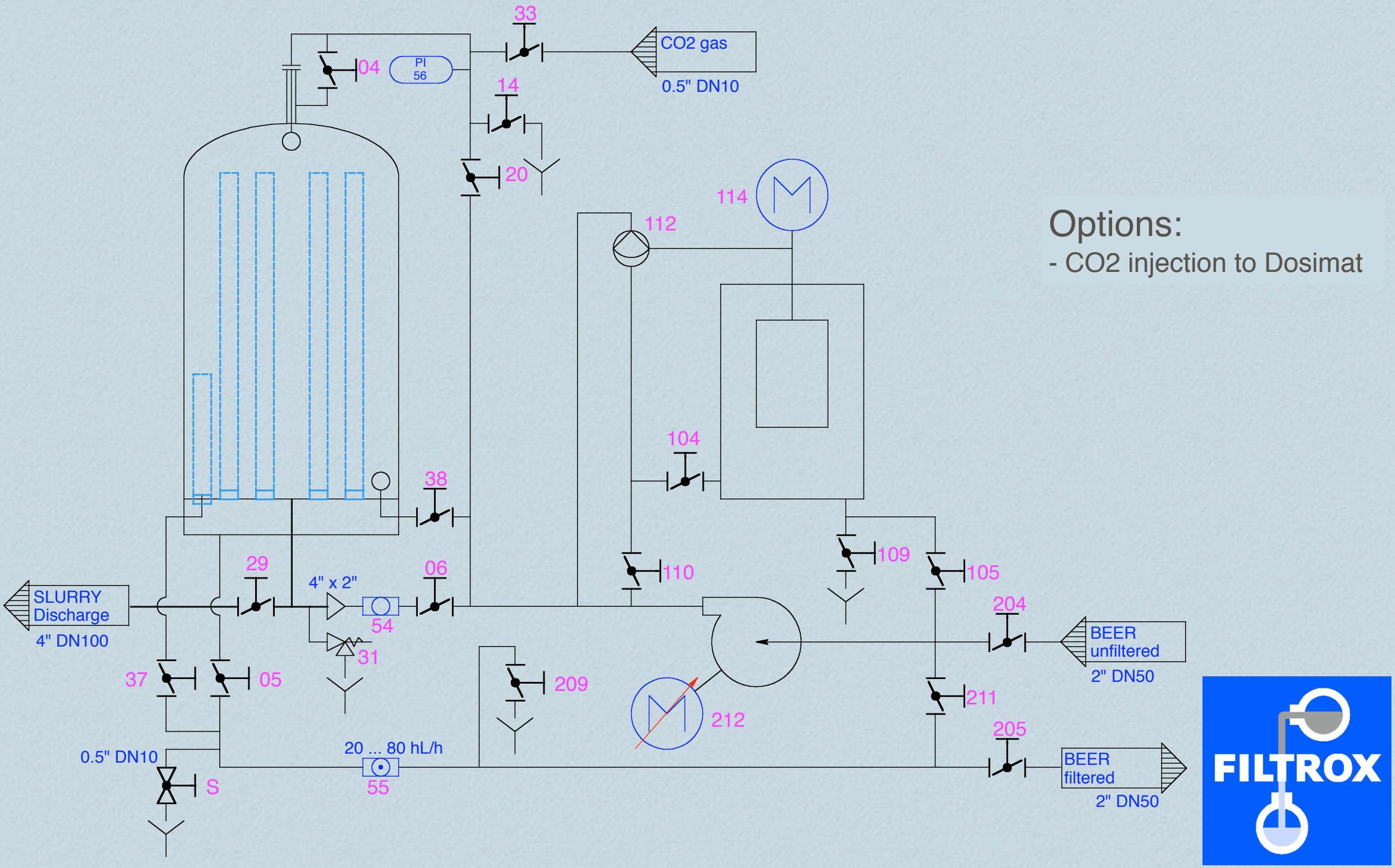
Filter Size	**Secujet 60 / 445 Liter**
Operating Pressure (min ... max)	***0 ... 6 bar*** ***0 ... 88 psig***
Operating temperature	0 ... 100°C 0 ... 212°F
Max. filtration flow rate for beer filtration	9.0 hL / (m^2 h) ≈ 50 hL / h
Min. filtration flow rate	3.8 hL / (m^2 h) ≈ 21 hL / h
Sludge volume	***158 L ≈ 41 USG***
Filter Surface Area (candle surface area)	***5.6 m^2 ≈ 60 ft^2***
Volume dosimat	***130 L ≈ 26 kg ≈ 57 lb DE***
Agitator velocity	60 Hz => 38 rpm slow frame agitator
Power of dosing pump	Filtrox = 0.75 kW ≈ 1 hp
Dosing capacity 60 Hz	16 - 160 L / h ≈ 76 ...760 g / hL
Mains voltage 575V/60Hz	t b d
Power of centrifugal pump with frequency converter	7.5 kW ≈ 10 hp
Weight dome, (to be lifted for maintenance)	94 kg ≈ 207 lb
Weight filter complete, empty	606 kg ≈ 1’336 lb
Operating weight	1’250 kg ≈ 2’756 lb

The filter surface area - I recommend to use the candle surface area instead of any other definition - defines the filtration flow. The larger the area the better.
The sludge volume (space to house the solids (DE and trub particles)) defines the maximum amount of DE to be dosed / maximum filtration run. The more the better.
The total vessel volume defines the liquid volume involved in pre-coat, re-circulation etc. The smaller the better.
There is a smaller version of the same filter, available. The smaller version uses shorter candles. resulting in 4.0 m2 filter surface area.

Process

- The following section should show how to operate the filter and how the last-running is eliminated with this construction.

Overview P&ID

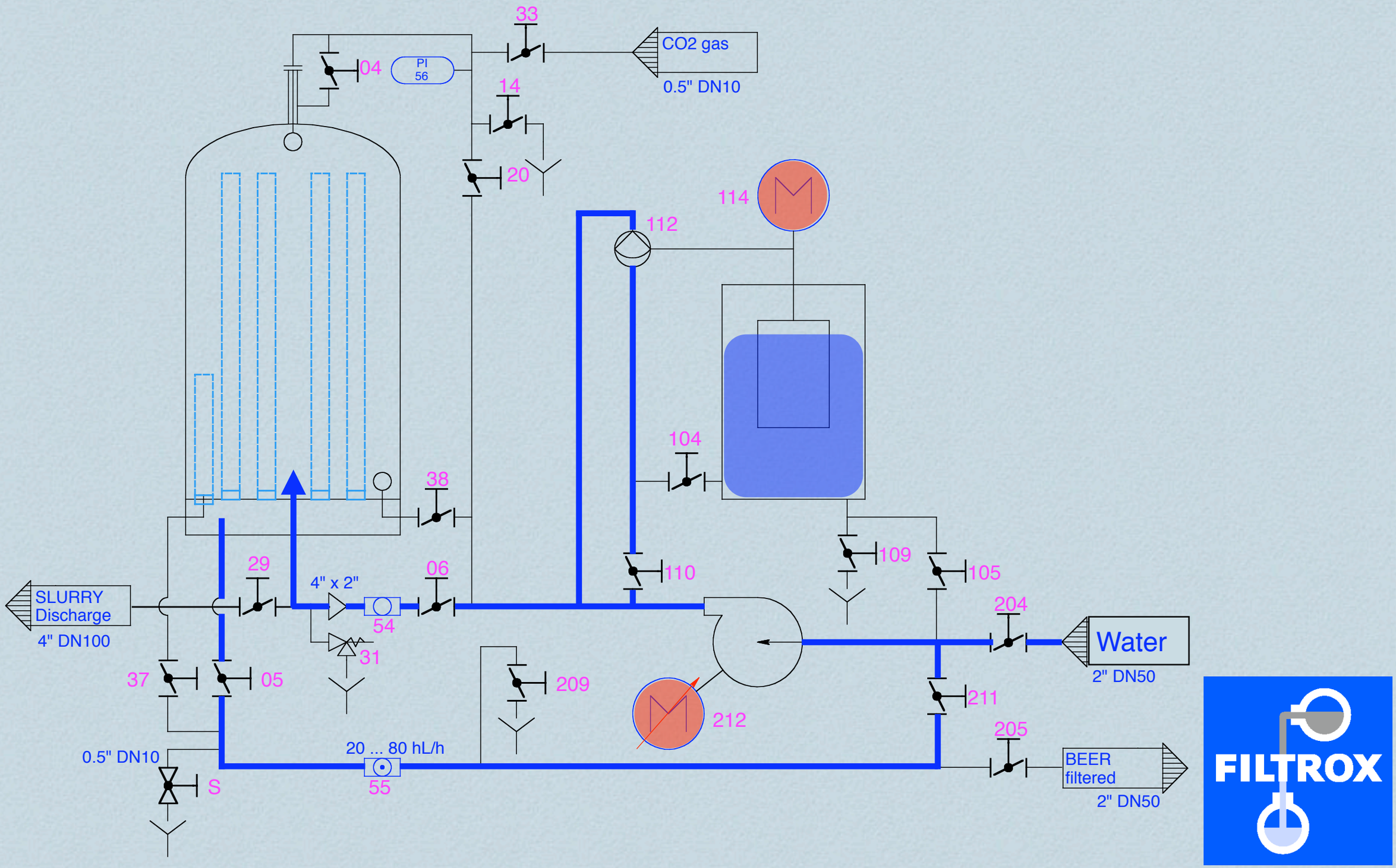


Options:

- CO2 injection to Dosimat

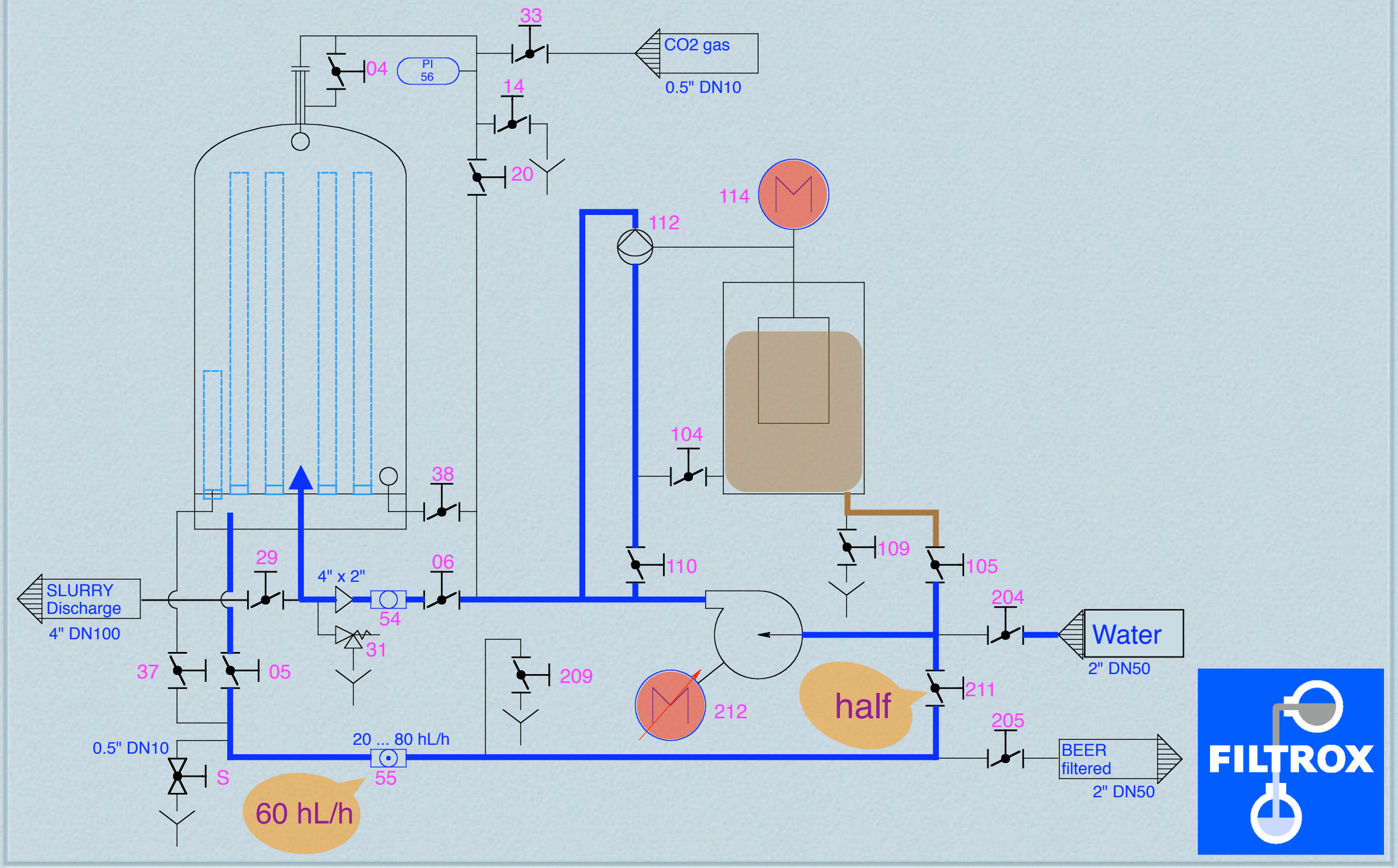
Simplified Piping and Instrumentation Diagram. Normally there are more details to be shown like flow rates, volumes, horse-power etc.
The filter vessel shows the vertical candles. In this case there are two different sizes the taller main filtration candles and the smaller residual filtration candles. On the top a spray ball is installed. Around the lower end a spray donut is installed to help to flush the diatomaceous earth out.
The dosing vessel has a slowly rotating frame stirrer. The motor is coupled with the reciprocating dosing pump 112. The speed of the stirrer and of the dosing pump is fixed. The amount of filter aid to be dosed can be adjusted by varying the stroke of the pump 112.
The pipe system with the main beer pump 212 is done using DIN DN50 pipe. At the inlet and outlet 2” Triclamp connections enable easy connection to existing hoses or piping.

Fill and vent filter



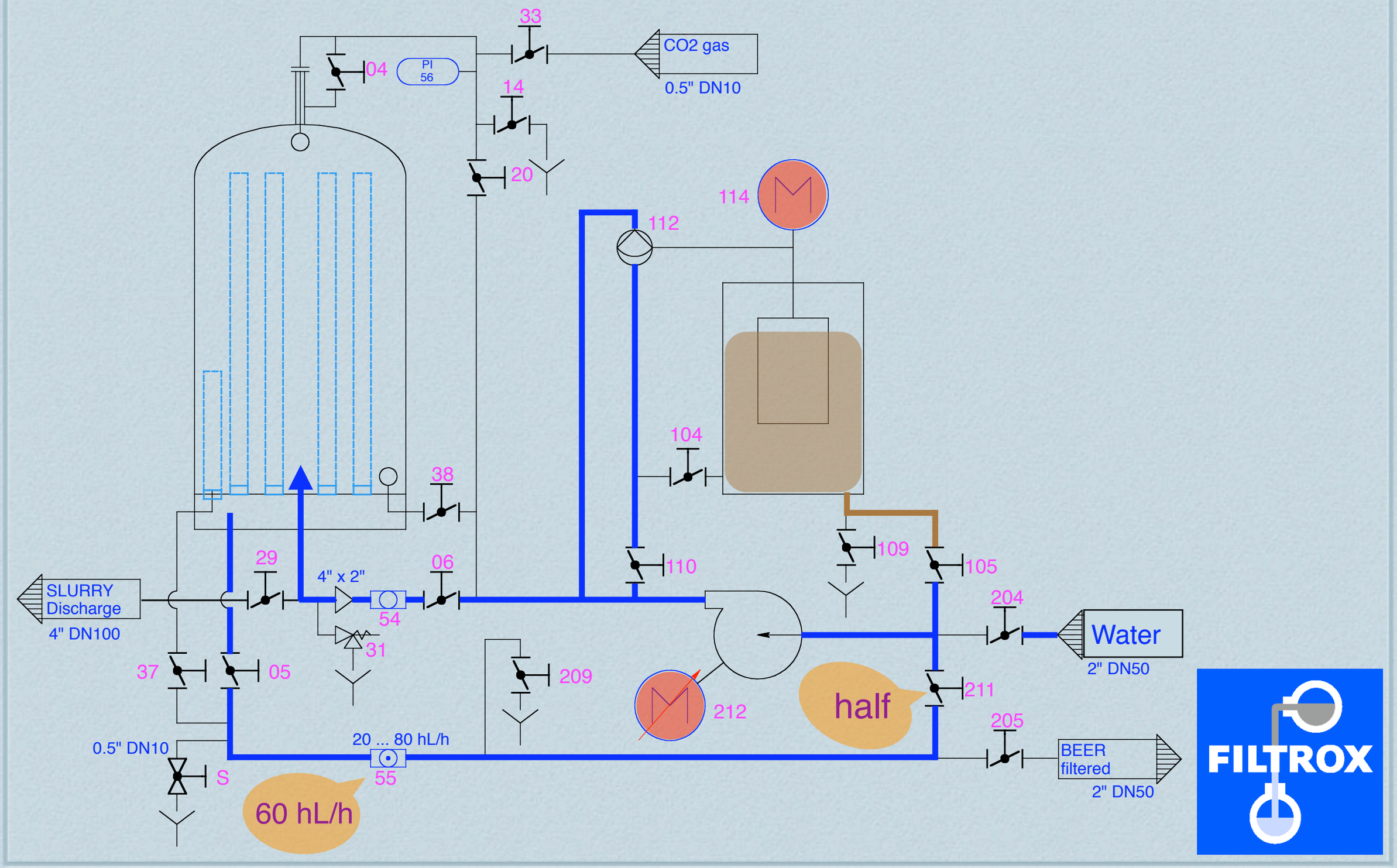
connect water to the inlet fill the vessel and vent all pipes.
switch on the main filter pump 212 at low speed.
fill the dosing vessel from bottom up
switch on the the dosing pump / stirrer motor 114
vent all pipes again

Prepare Pre-coat



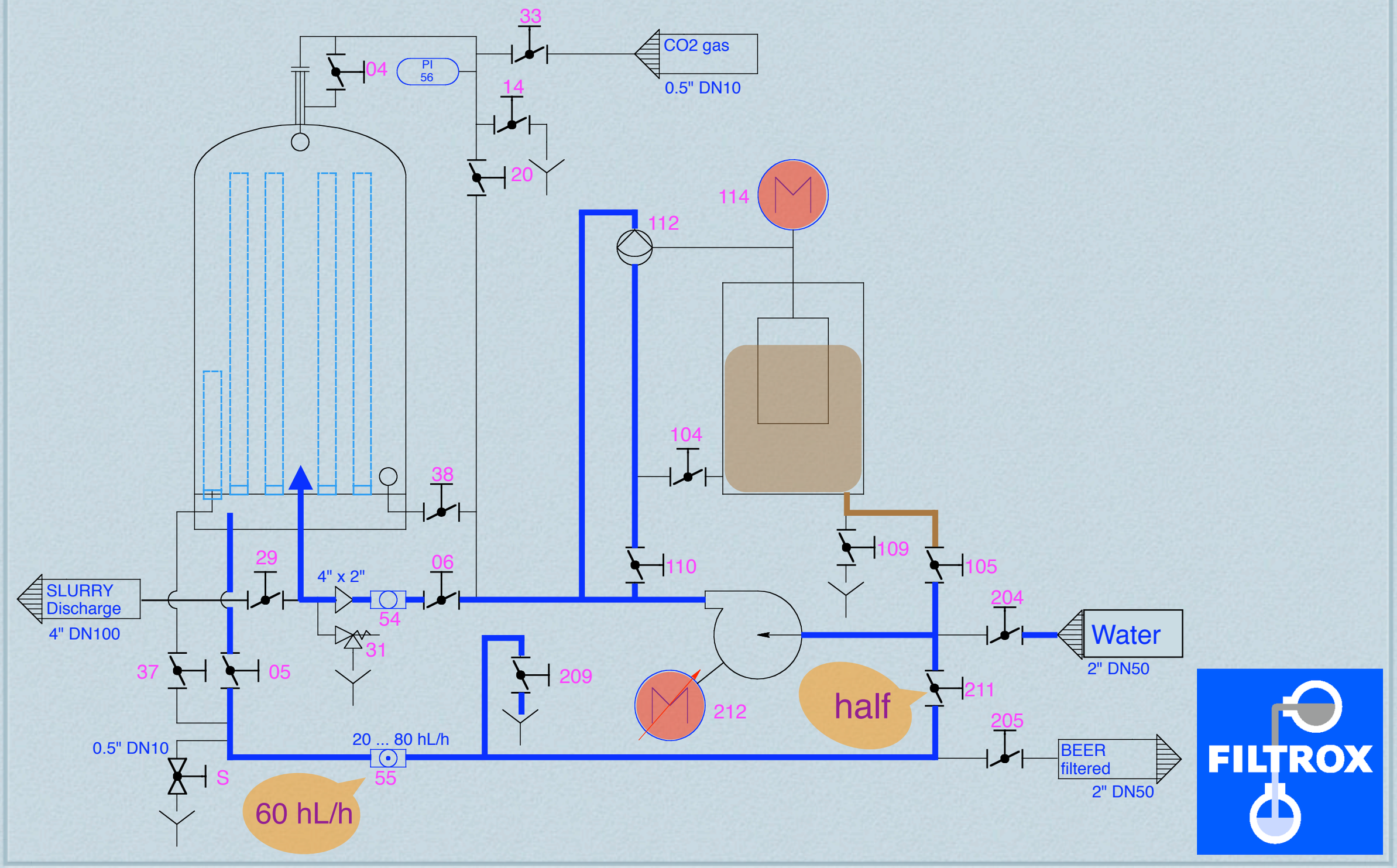
to separate two different pre-coats it takes about 30 L water and 4.2 kg / 9.2 lb of coarse DE.
If only one pre-coat is used then 50 L of water and 8.4 kg / 18.5 lb of medium coarse DE is to be applied to the dosing vessel.
this leaves space for 38 kg or 83 lb body-feed which is enough to dose 190 g DE / hL beer and achieve a total batch of 200 hL.

Bring-in Pre-coat



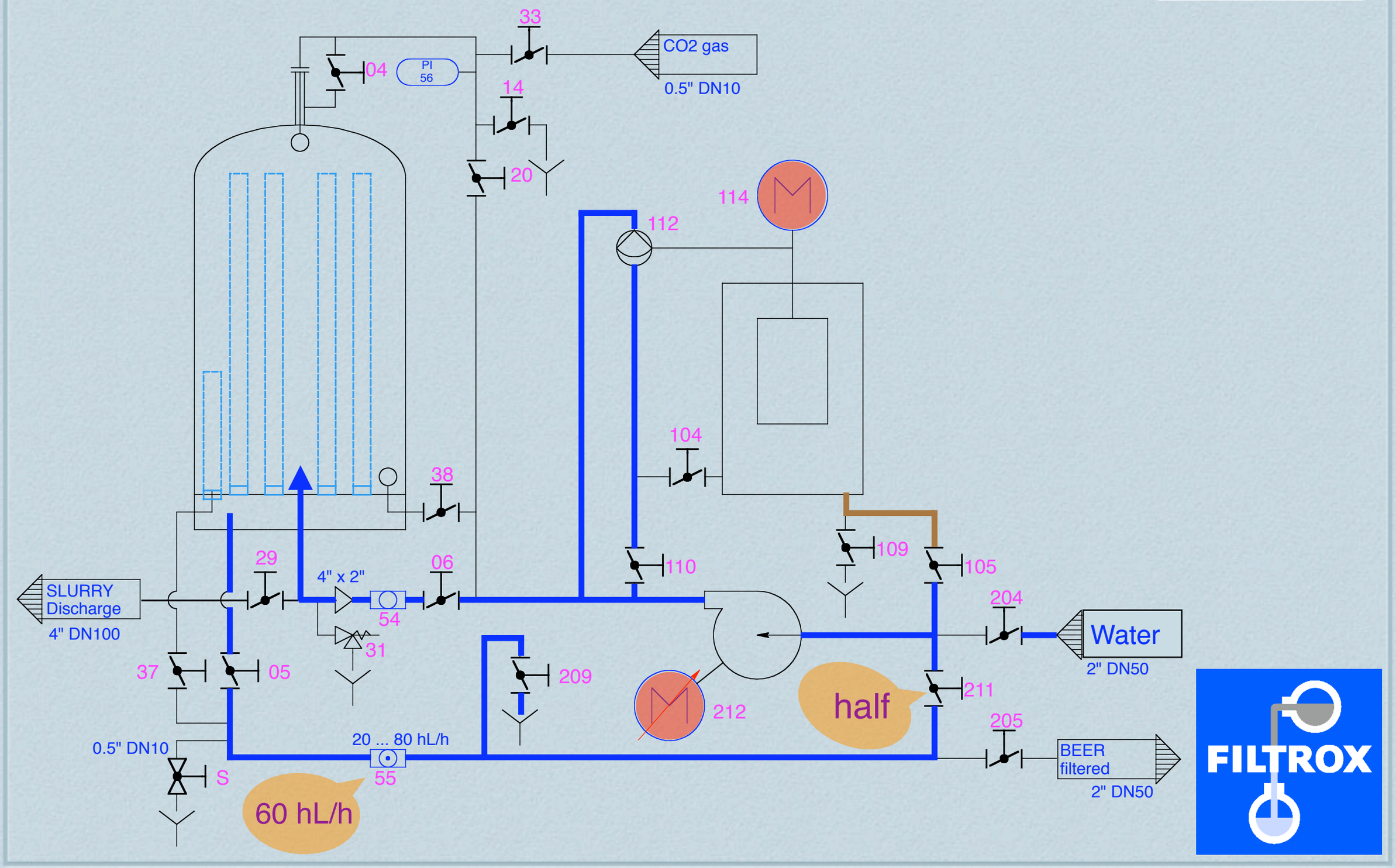
The first pre-coat should come in at a certain pace, best time between 4 and 7 minutes for bigger filters up to 10 minutes.
Normally the dosing pump is too small for this task. It is better to use a trick with the valve 211.
Achieve a re-circulation with the water and open the necessary valves (see P&ID) completely except valve 211. Open this valve only that much that it creates a pressure drop and you need some 40% of the pump's rpm (turn knob at inverter) to achieve some 60 hL/h flow at recirculation.

Bring-in Pre-coat



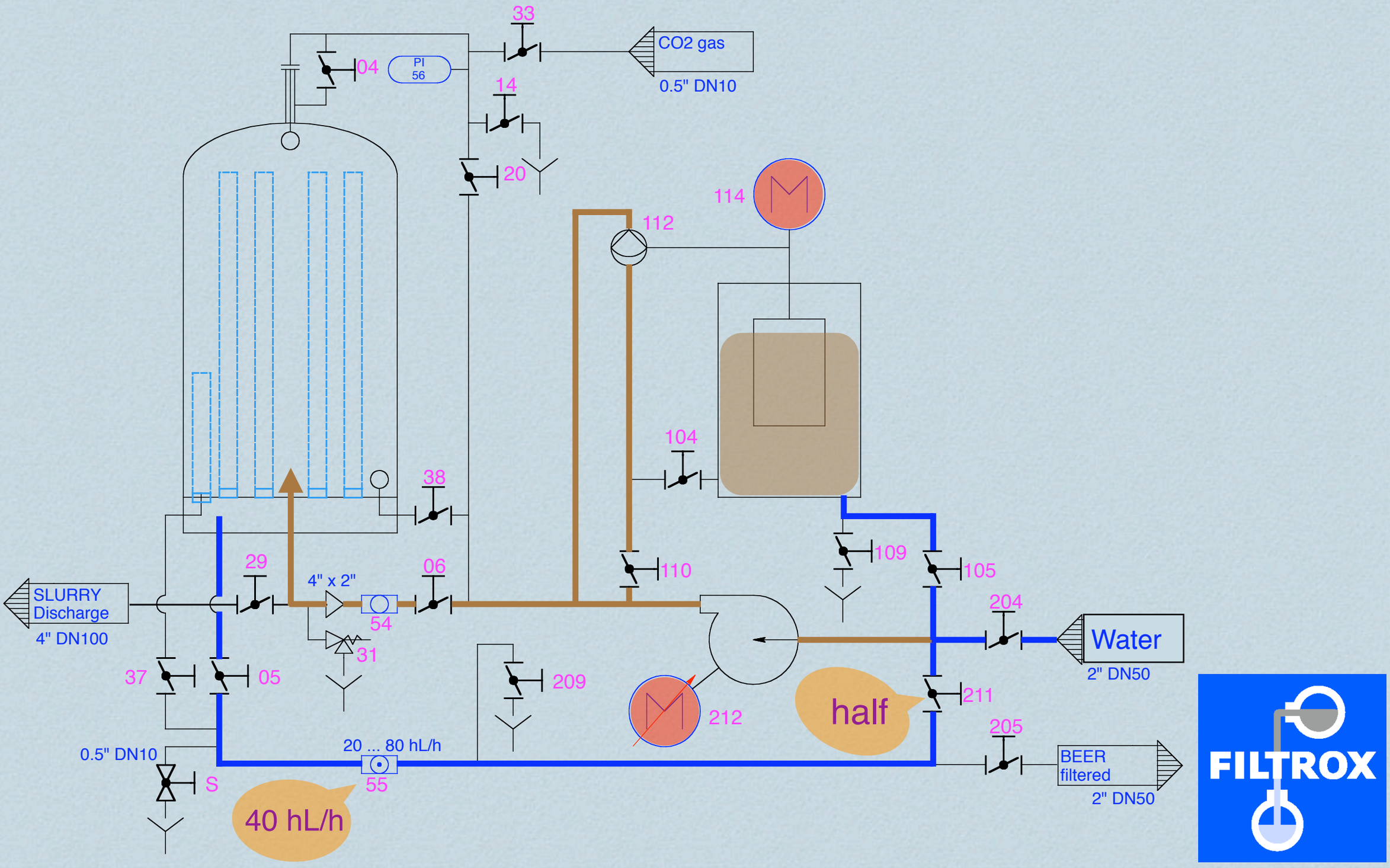
The first pre-coat should come in at a certain pace, best time between 4 and 7 minutes for bigger filters up to 10 minutes.
With the opening of the valve 209 you can control the velocity of emptying the dosing vessel. Open it slowly and close it again when the pre-coat is in.

Bring-in Pre-coat



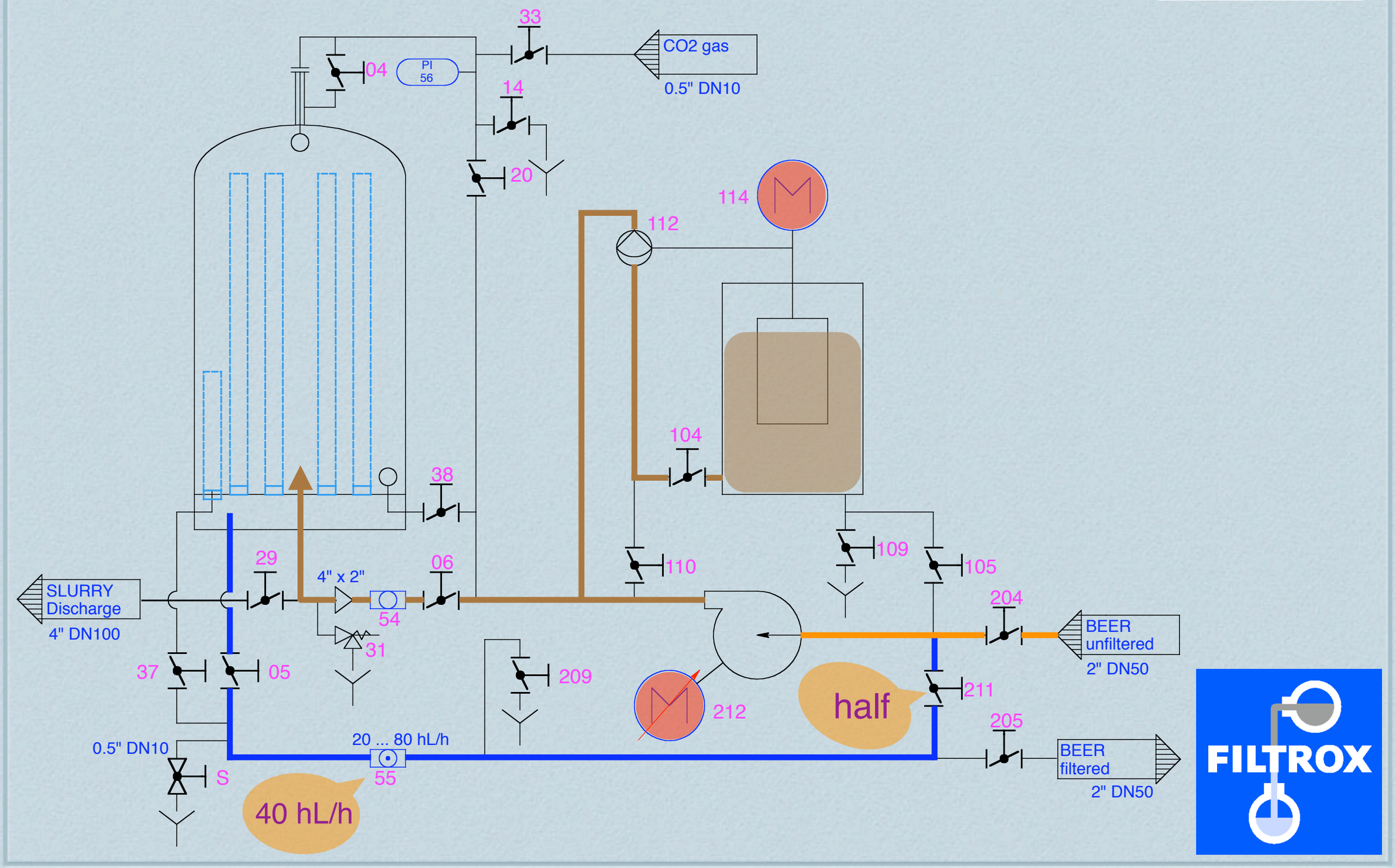
The first pre-coat should come in at a certain pace, best time between 4 and 7 minutes for bigger filters up to 10 minutes.
With the opening of the valve 209 you can control the velocity of emptying the dosing vessel. Open it slowly and close it again when the pre-coat is in.

Prepare Body-Feed



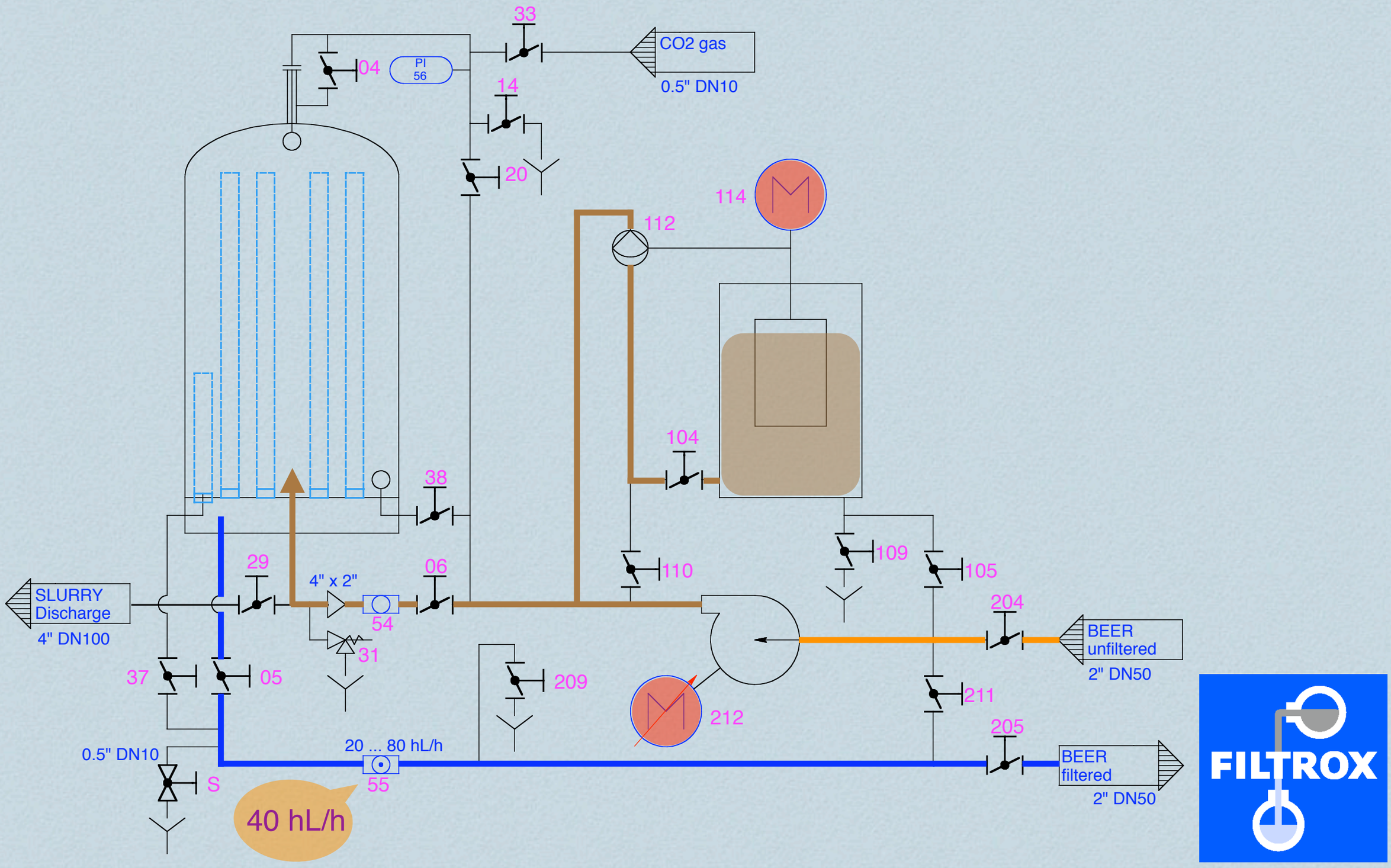
A slightly different procedure now for the body-feed.
Use the water supply to refill the dosing vessel from the bottom. Then reduce the pump's rpm a little bit to achieve filtration speed. Reduce the flow only slowly.
Fill the dosing vessel only half. Then fill in the first bag for the body-feed. A bag is normally 22.7 kg / 50 lb. Now you can fill the vessel to the level of about 120 L slurry volume.

Prepare Beer Filtration



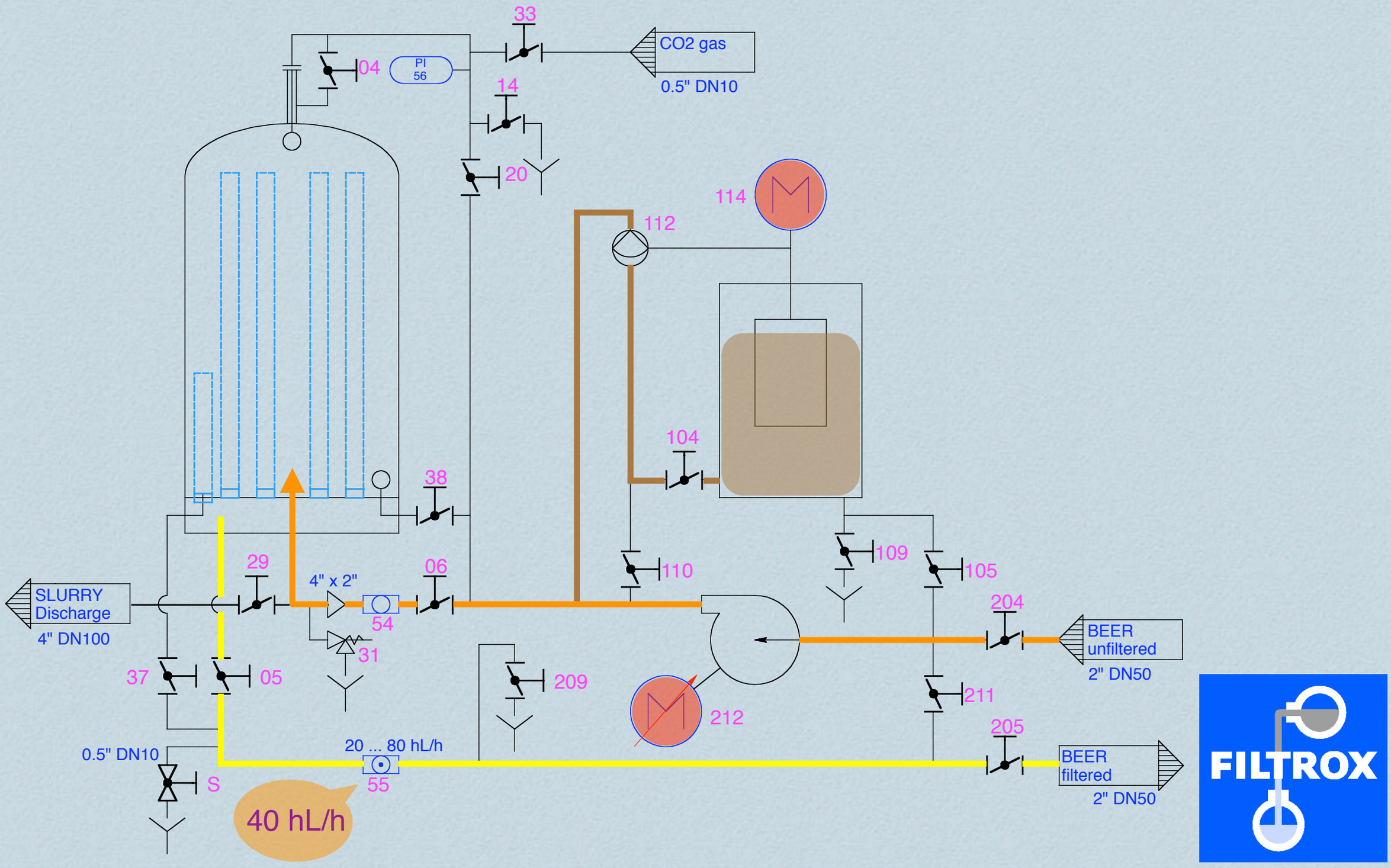
first connect the beer to the inlet of the beer filter. Open valve 203 slowly to adjust to the new pressure level for re-circulation.
Then switch the dosing pump into action by opening valve 104 and closing valve 110 simultaneously. check the function of the dosing pump with the sight-glass 54.
Check the flow through the filter.

Start Beer Filtration



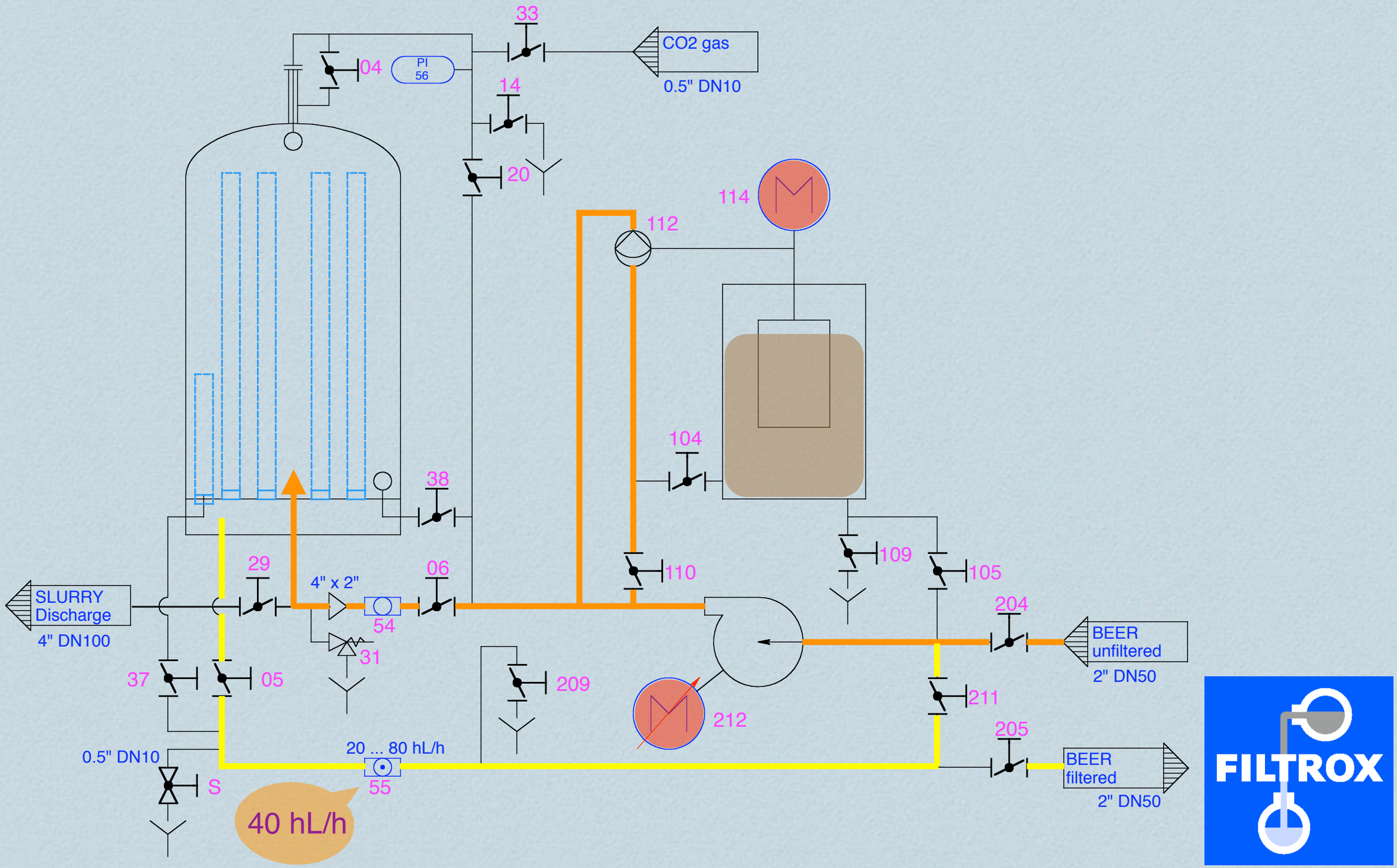
Finally start the beer filtration by opening valve 205 and closing valve 211 simultaneously and slowly.
Check the flow through the filter. The quality of the filtration is defined now by the absence of shocks regarding flow and pressure.

Beer Filtration



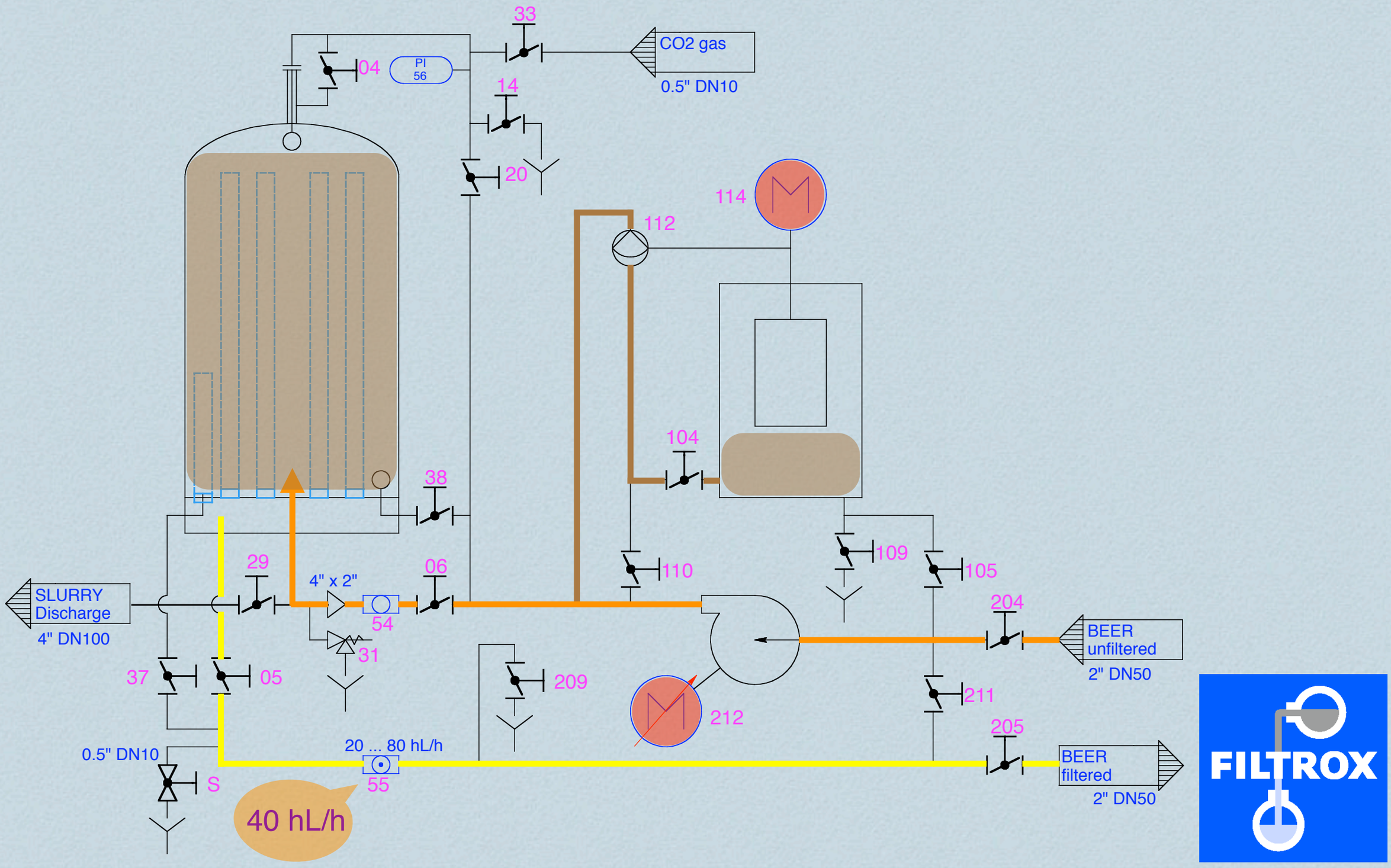
Check the flow rate from time to time and adjust the pump's rpm accordingly. Apply these adjustments slowly.
It is good practice to keep the filtered beer tank at a slightly higher pressure than the unfiltered beer supply. This eases the control function of the beer pump and enables proper switches to re-circulation.
Regarding recirculation: It should be avoided if possible. During re-circulation the temperature rises, the same beer comes into repeated contact with the diatomaceous earth and picks up a higher level of iron.

Beer Filtration / Recirculation



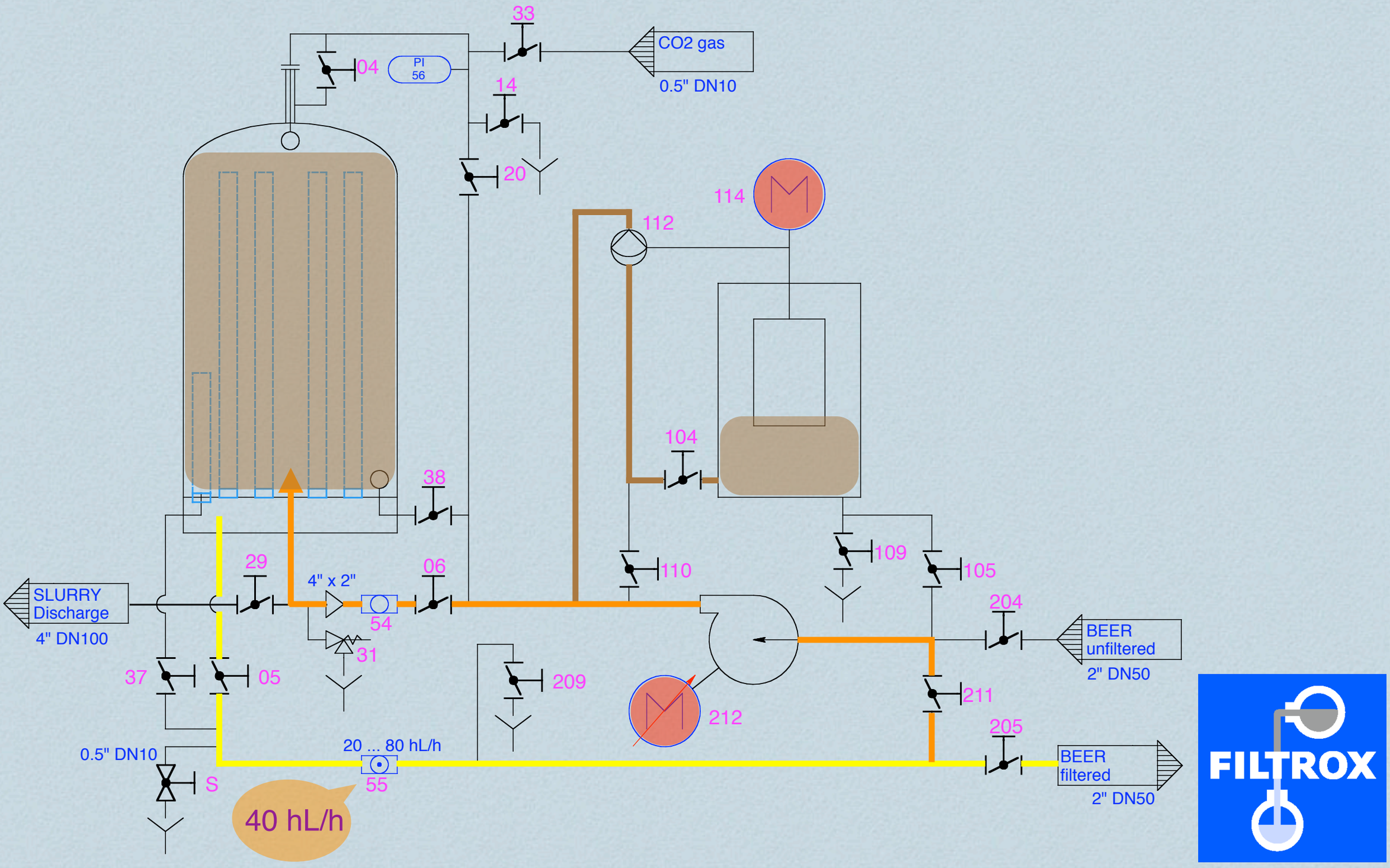
Check the flow rate from time to time and adjust the pump's rpm accordingly. Apply these adjustments slowly.
Switch into recirculation by simultaneously and slowly opening the valve 211 and closing the valve 205.
then stop dosing diatomaceous earth by simultaneously opening valve 110 and closing valve 104.
Regarding recirculation: It should be avoided if possible. During re-circulation the temperature rises, the same beer comes into repeated contact with the diatomaceous earth and picks up a higher level of iron.
To switch out of re-circulation first ensure that filter aid gets into the beer by simultaneously opening valve 104 and closing 110.
Then switch the main beer flow by simultaneously and slowly opening the valve 205 and closing the valve 211.

End of Filtration



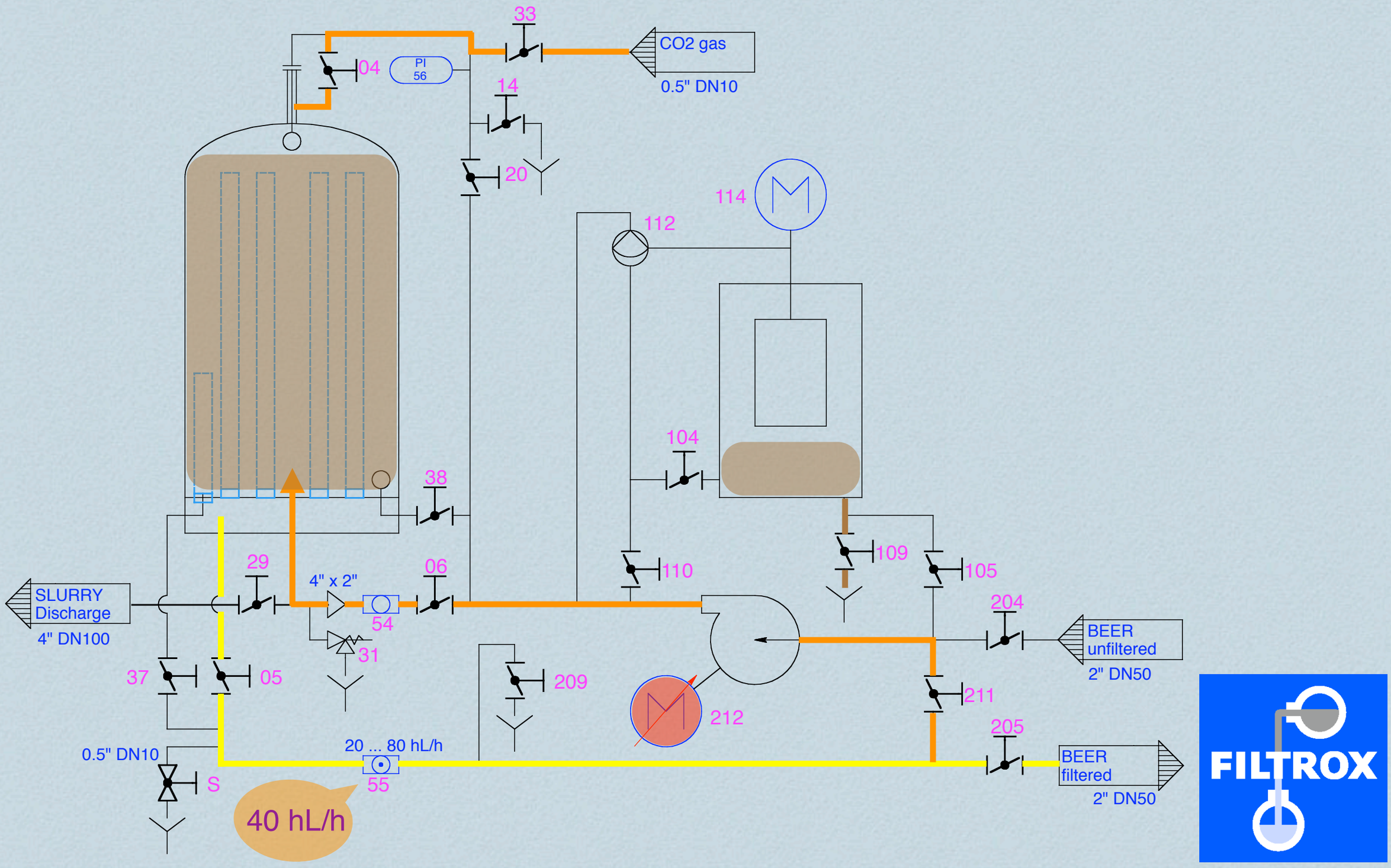
At the end of filtration the dosing vessel is normally nearly empty and the filter vessel is nearly filled with filter aid.
The beer pump now is running at high rpm to overcome the pressure drop through the cake.

End of Filtration



First we switch slowly into re-circulation by simultaneously and slowly opening valve 211 and closing valve 205. At first we close the filtered beer line and keep the unfiltered beer line open. Count to five and then we switch to reopen the filtered beer line and close the unfiltered beer supply by closing slowly valve 204 and then re-opening slowly valve 205. We keep the filtered beer outlet open while the beer filter is in re-circulation.

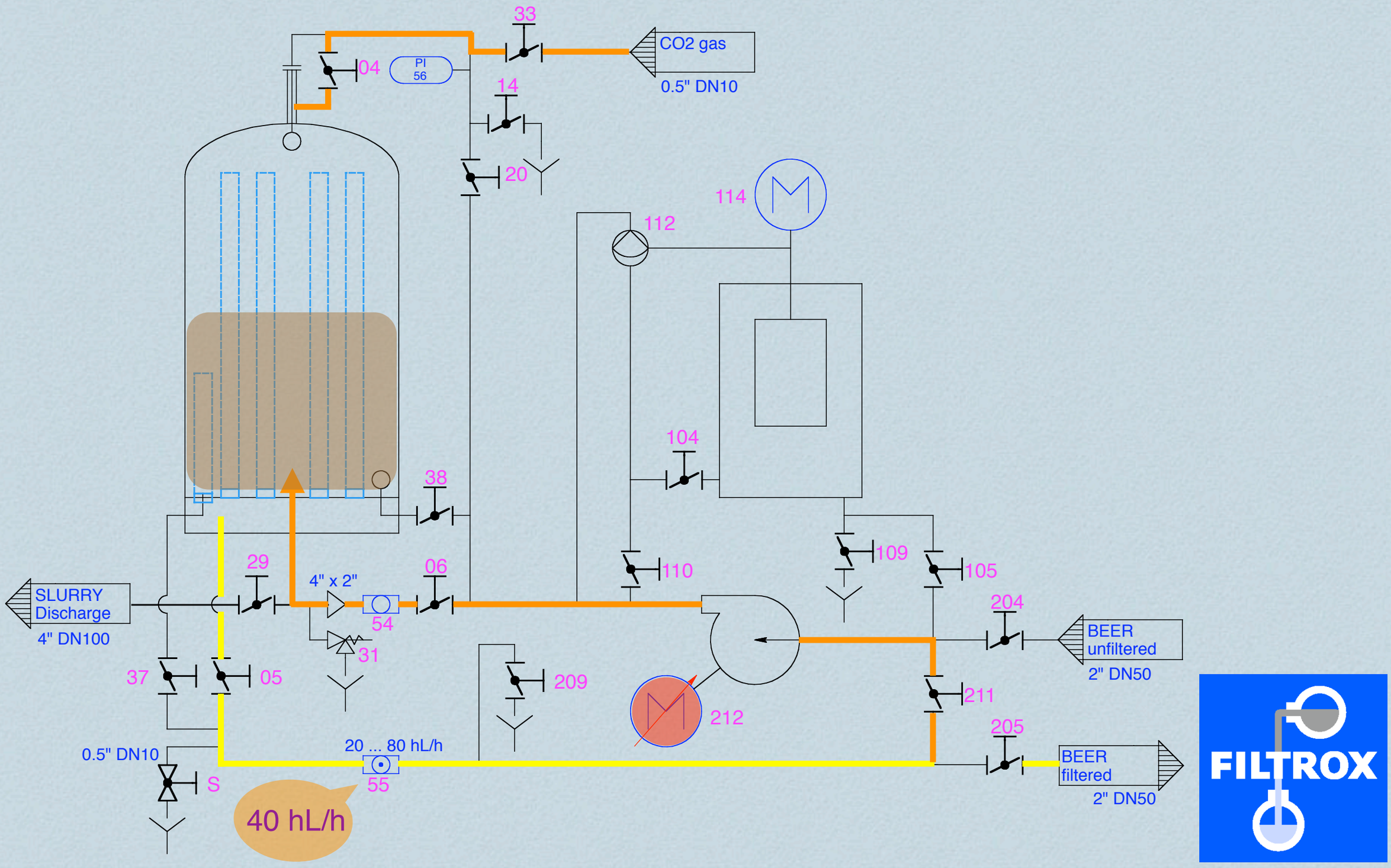
End of Filtration



Switch off the motor 114 and stop the dosing and stirring the dosing vessel.
Close valve 104. Empty the dosing vessel by opening valve 109.

Prepare to empty the filter vessel by supplying CO2 gas to the top of the filter. Open valve 33 and valve 04 slowly. The CO2 pressure should be high enough to push the beer through the filter cake and into the filtered beer tank (BBT).

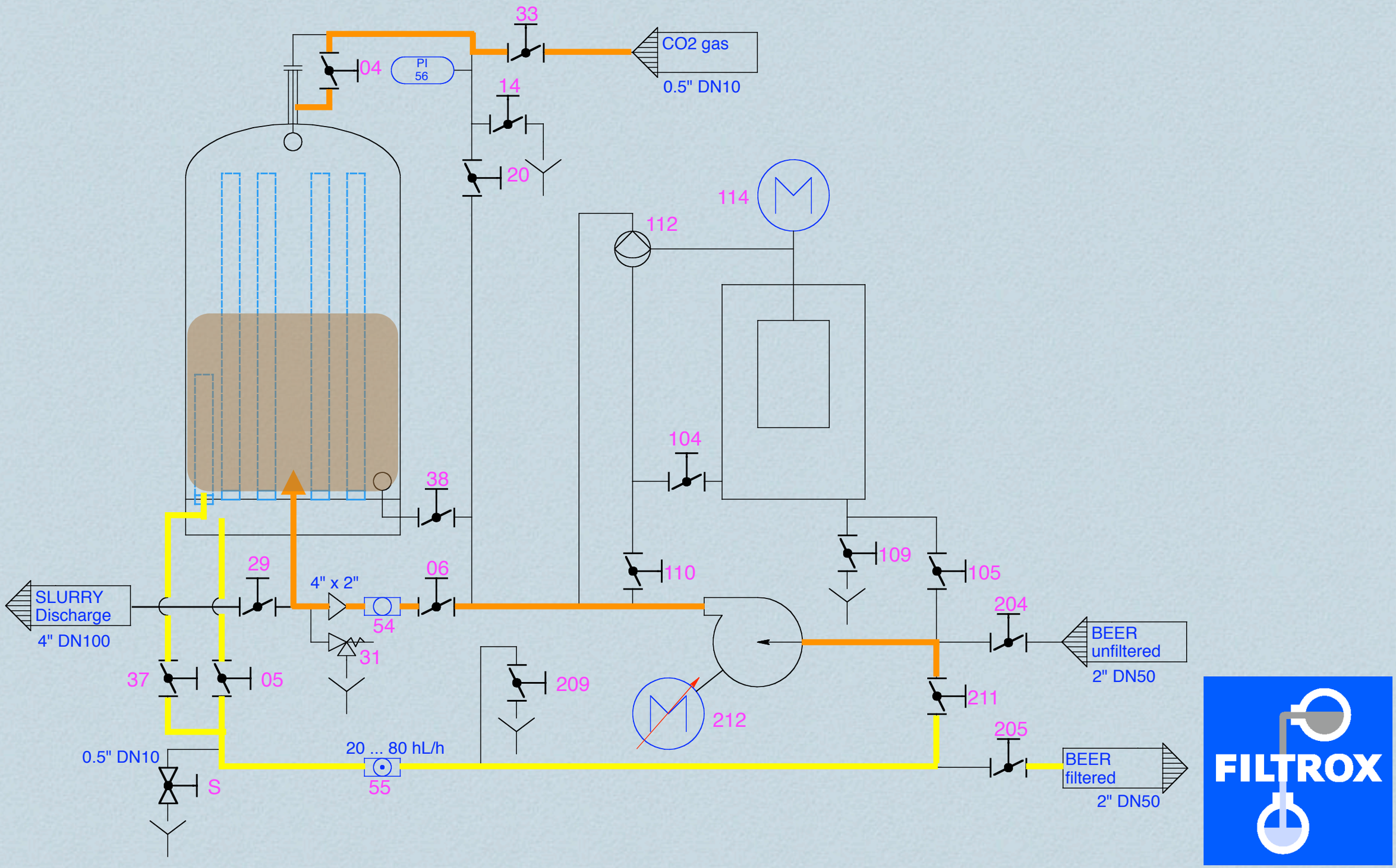
End of Filtration



the first half of the vessel can be filtered through all filter elements.

Then close valve 205 slowly.

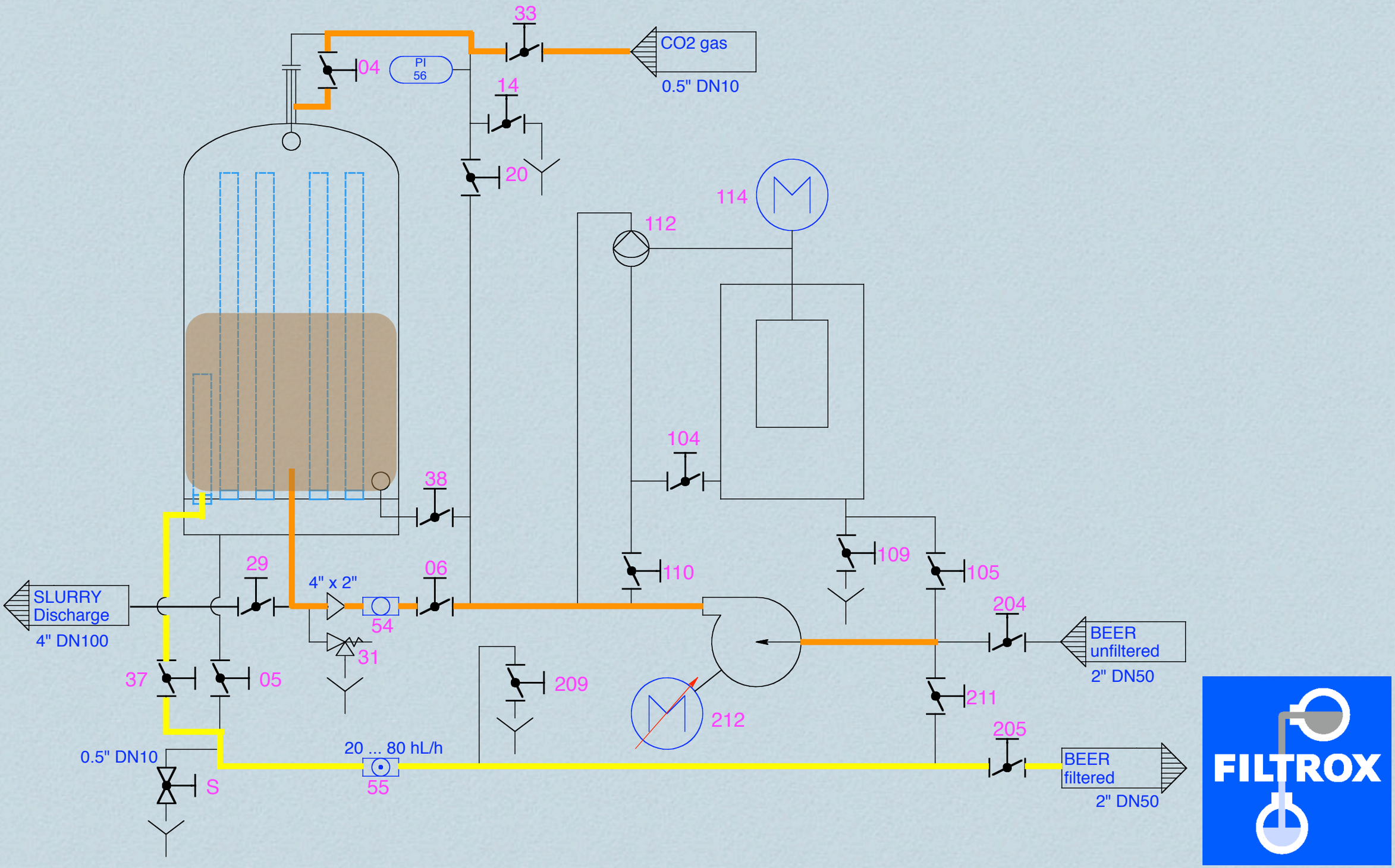
Switch to Residual Filtration



Open the residual filter elements by opening valve 37.

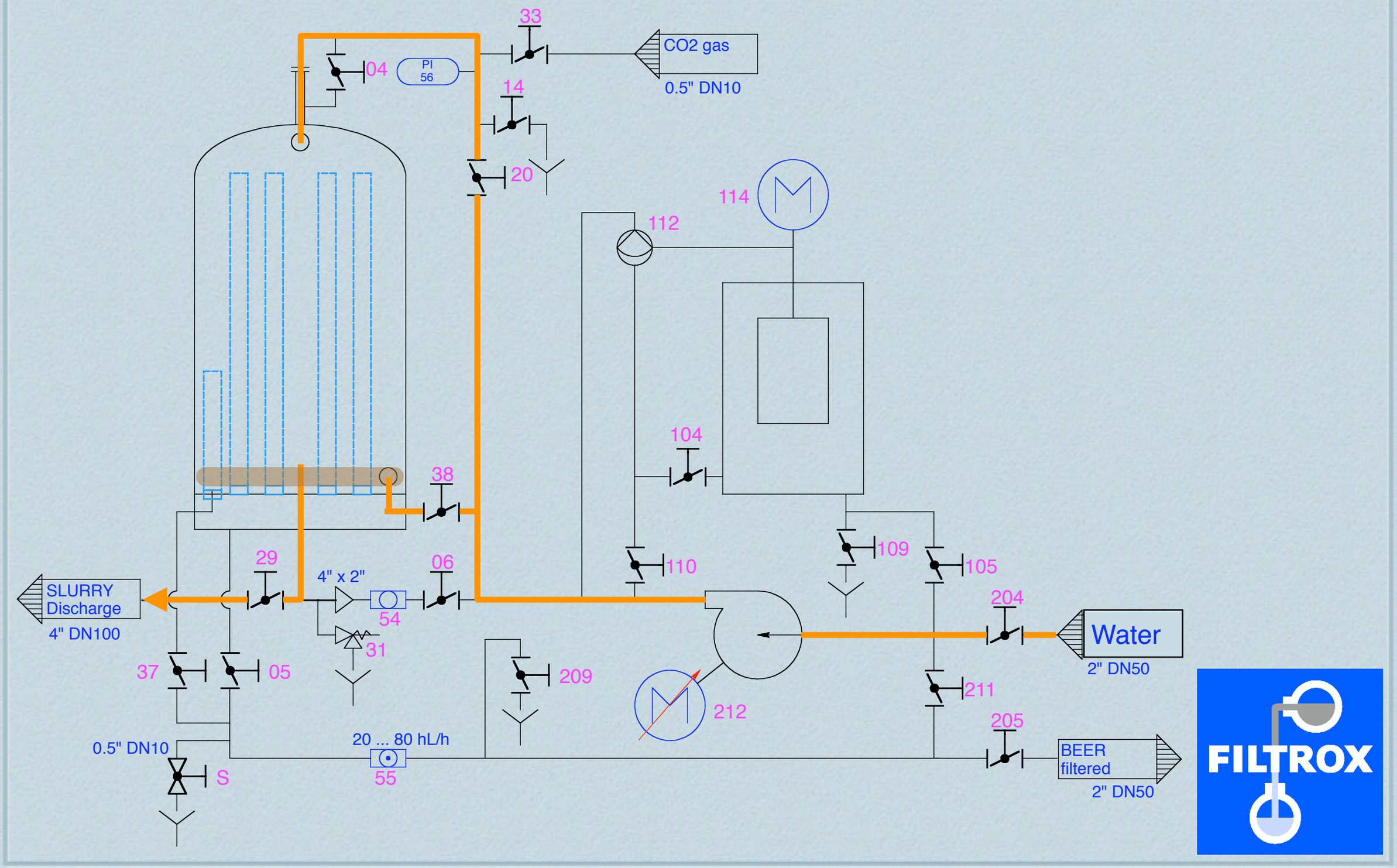
Reduce the flow through the filter slowly and switch the beer pump off. Close valve 211 slowly.
Close valve 211 and valve 05.

Residual Filtration



Re-open valve 205 to start residual filtration.
The gas pressure is used to empty the filter vessel as far as possible.
The filtration is finished with this step. The filtration but not the work for the operator.

Sludge Discharge and Rinse



For the sludge discharge depressurize the filter first. Close valve 33 and open valve 14 slowly for this purpose. Open valve 37 and valve 05, keep valves 04, 14, 110, 105, 211 and 205 closed.
Connect water supply to the inlet of the filter. Close valve 06 and open valve 29 to prepare the sludge discharge.
We will use the spray tube in the bottom of the filter vessel to flush the diatomaceous earth out of the filter. Open valve 38 in intervals. The valve 20 might be opened to clean the upper part of the vessel.
Open valve 211 for a short time. This pushes the filter cake from the candles. Continue to open and close valve 38 in intervals until the run-off through valve 29 is clear.
Rinse all pipes and valve thoroughly to remove remaining product and / or filter aid. Apply caustic CIP to the filter (fill the filter with caustic, let it stand for some 30 minutes and empty it. Rinse the filter carefully. This helps to keep the filter clean.
A sanitation using hot water (acidified using phosphoric acid to pH 5) for longer than 20 minutes is recommended after each use.
If you store the filter, keep the last sanitation water in it and keep the CO2 supply (valve 33, 20, 06, 05, 37, 211 and valve 110) open. Close all other valves. Prior to re-use the filter take a sample of the water inside using the sample valve. Does the water smells clean? You might take a biological sample.

Candle Filter For Smaller Breweries

- Why have more manufacturers developed candle filters recently? Why are candle filter widely used in larger breweries?
- Are other types of filtration available / affordable for smaller breweries?
- What is special in DE filtration used in smaller breweries?

√ **SECUjet B with standing candles in a small housing allowing residual filtration is a nice machine for this!**

Thank You! (Ueli) www.beveng.com

finally I am at the end of my presentation.
I wanted to show that the SECUjet is a suitable filtration machine for smaller breweries. And therefor proof that good candle filters exist for both smaller and larger breweries.
thank you for your time and for listening