How to Effectively Judge Press Felt Trials

About Assessing And Improving Paper Machine Clothing Performance

By Marcel F. Lensvelt, founder and CEO of Feltest Equipment BV

Abstract

Many papermakers have a love-hate relationship with their Paper Machine Clothing (PMC), and their press felts in particular.

This paper aims to give you the insights you need as a papermaker to effectively judge press felt trials, so that you can increase the machines bottom-line through better performing felts.

Press felts are probably the mechanical components that change the most over the course of their life in the machine, typically a number of weeks. By connecting output data of the machine with the life of the each felt – and the changing felt properties per day – new insights are gained.

These insights, presented as fact-based charts, give both the papermaker and the felt supplier an objective reference to judge the performance of trial, making the process to better press felts faster and more worthwhile.

Introduction

Many papermakers have a love-hate relationship with their Paper Machine Clothing (PMC), and their press felts in particular. But what makes optimizing the performance of press felts a 'special class' challenge?

A combination of many factors.

First of all, the complexity of press felts as a product. The designer has to make a selection from several base designs, choose the numbers of batt layers with the appropriate fineness's. To needle the batt on the base, the designer must choose the best of many different needling procedures and different types of needles. After needling several finishing procedures can be combined to create the best result. All-in-all the felt designer has to make decisions from roughly a hundred million theoretical variants.

Another factor is the significant change that press felt properties undergo over the course of their few weeks of life. We believe that the press felt is probably the single most changing mechanical component in a running paper machine with already thousands of variables. That makes press felts what we call a true variable!

What can a paper maker do to improve press felt performance?

You will discover that dealing with the assessment and improvement of press felts is a real science…

… but it's not rocket science.

Knowledge is power | Take control

Step one in successfully improving the performance of your press felts is **understanding how your current felts change over the course of their lifetime**. And how these changes affect (the output of) your total machine.

This understanding comes from monitoring the felt properties on a daily basis and this is not a task you can delegate to your PMC supplier. A papermaker can only create a consistent basis for judging his current and future press felts when the **papermaker himself takes control** of his best interest.

And it is in a papermaker's best interest to know his own machine better than anyone else.

*"NEVER forget that **your** press felts do not perform in a laboratory environment or at somebody else's mill. They perform in YOUR machine"*

-Marcel Lensvelt

Plan for structural improvement

I like to stress the importance of doing measurements at regular intervals for establishing a culture of **structural improvement**. Later on you will learn about which data to monitor and how to support your suppliers to come with continuously better felts and fabrics for your machine.

Example 1: Pick up felt
The pickup felts of supplier A are connected to a 1% higher production output per day, compared to supplier B. Because of the complexity of the machine, you cannot make 100% conclusive statements based on this data, but you do need to record this information as an important signal of the relation between pickup felt A and the overall performance of your paper machine.

Example 2: Felt cleaning agents
If you measure and record chemical use as a variable, you may notice that the consumption of felt cleaning agents for felts supplied by supplier B is 5% lower per ton output.

As you see in both examples, the differences in measured variables can be small, but if you add all differences they can result in significant production gains or losses. And because the variations are small, it is important to use accurate data, either from your machine control systems or high precision measuring instruments.

We recommend collecting data for a minimum of 12 months to determine how the performance of your felt relate to the performance of your machine.

You are in this for the long haul, so after these 12 months you can start reaping the benefits by working on improving the performance of your PMC by basing your decisions on fact-based information, instead of supplier based benchmarks or your own gut feeling.

*"If you work with true data, your improvements will be **real**"*

-Marcel Lensvelt

Picture yourself monitoring one of the relevant variables for a felt (for instance: compaction). Unless there is a huge deviation from the benchmark values, you can't possibly know if the compaction value you measure is of positive or negative influence on the overall performance. You need more information.

What data to collect

To get a clear picture of the performance of each of your felts we suggest to collect two types of data: machine data and felt data.

Machine data

Machine data covers the output of the machine and factors that affect the cost price of your product. We look for machine data that can be measured per day or per ton. The aim of collecting machine data is to show how the performance of your press section relates to the overall performance (output) of your machine.

Examples of relevant machine data:

- Production in ton/day
- Felt washing chemicals in lbs/ton
- Number of breaks per day (better than "time lost due to breaks")
- Steam consumption in the pre-dryer section in ton/ton
- Power consumption in kWh/day for the press section's vacuum pump

Of course there is much more. Important to realize is that we choose to focus on data that is measured per day or per ton, because it allows us to start comparing the machine performance per day with the life of each individual piece of Paper Machine Clothing.

Although you can't allocate the general output data point to a specific part of the paper machine, this data does provide a signal about how the individual parts of the complex system work together.

Normally all the machine output data is already recorded and saved in the paper machine's control system. Extracting relevant machine data should not be a problem for mills with a qualified IT staff. The trick is to organize the data in such a way that it can be easily used for comparison with data from the felts that are running in the machine.

Felt data

The second type of data we need is the felt data. When we monitor how felt properties change over time, we get signals on how these properties influence the total machine performance, which is directly related to the bottom line results.

If we want to structurally improve the performance of press felts, we have to take into account that felts have a very wide range of properties. The difference between felt weights

for one position can be up to 50% (E.g. a 1200 - 1800 g/m2 range). Therefore it is better to monitor “relative data” than “absolute data”.

Example 1 Felt Data : Compaction Curves

A papermaker monitors the felt caliper and measures a value of 1.66 mm. This measured value in itself doesn’t provide much useful information (which is the case for any stand-alone measurements that are within the benchmark value range). So we need to put the measured caliper value into perspective by knowing if the felt weight is for example 1200 g/m^2 or 1800 g/m^2. Calculating the compaction percentage is the solution to this challenge.

When the felt goes into the nip it will be compressed and at the nip exit it will expand back. During the lifetime of the felt, this expansion will decrease and the felt becomes compacted. Compacted felts absorb less water than non-compacted felts. Therefore the caliper of the felt should be judged in conjunction with the felt weight.

Below Figure 1 is a simplified picture of 1 m^2 of running press felt. Normally, felt material and water are distributed over the full volume, but for easy understanding all the felt material is projected on the bottom and all the water is projected on top.

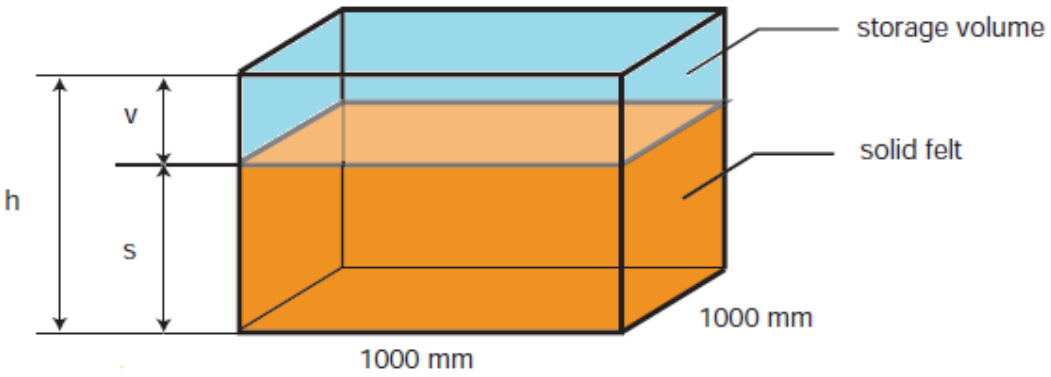

Figure 1 - wet press felt

h = measured caliper (height) of the wet felt [mm]
s = solid (non-absorbing) part of the felt [mm]
v = void (absorbing) part of the felt [mm]

The “solid” part of the felt can be calculated, as we know the density of the felt material (being PA) and the surface (being 1m^2).

F = actual weight of 1m^2 felt [g/m^2]
ρ = density of press felt (approx. 1.14 for PA) [g/cm^3]

This makes $s = \frac{F * 10^3}{1.14 * 10^6}$

Now the compaction of a felt can be defined as percentage of the solid felt part in the total measured height, or in a formula:

COMPACTION [%] = $\frac{s}{h}$ *** 100%**

This formula is easier to calculate (if you work in the metric system) when you use the adjusted formula:

COMPACTION = $\frac{F}{h}$ * **11.4%** or in words:

Compaction is felt weight F (in g/m2) divided by the measured caliper h (in mm), multiplied by 11.4.

Figure 2 underneath shows an example of compaction curves for a nip dewatering machine.

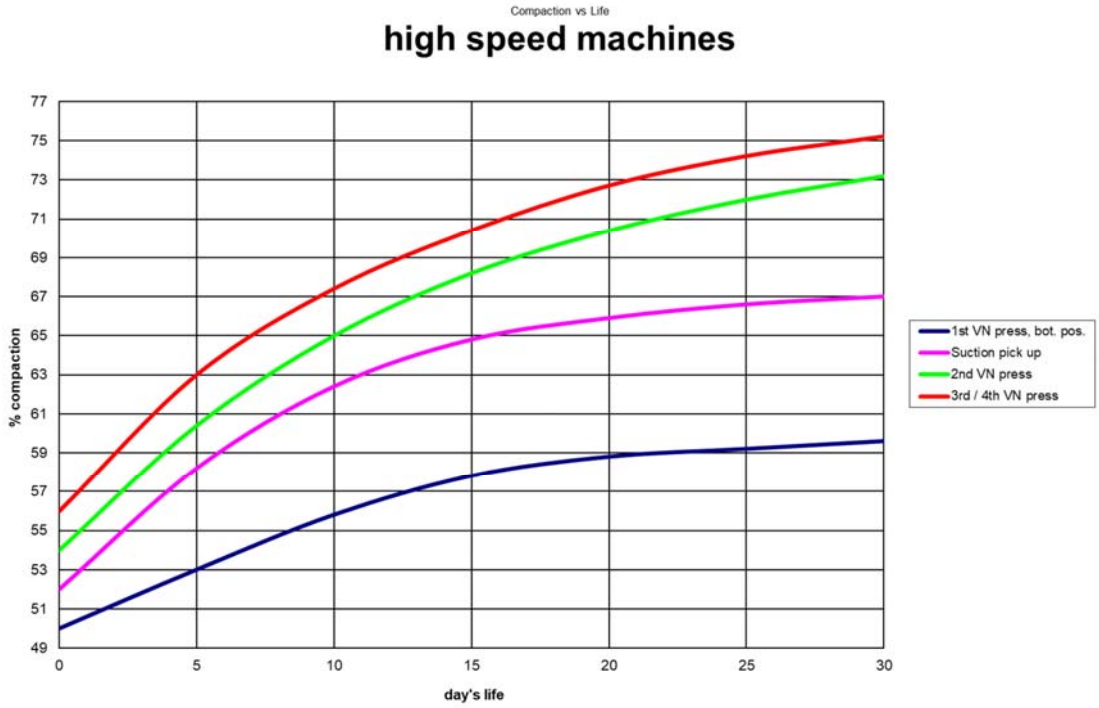

Figure 2 - Compaction curves for a LWC machine

Example 2 Felt Data : Permeability

Another important and well known parameter is the felt permeability. A good and affordable indicator for felt permeability is the metric for airflow through the felt at the Uhle boxes.

However, the airflow is not only determined by the permeability of the felt. The applied vacuum plays a major role. Therefore, it is smart practice to convert the measured airflow value to a standardized vacuum level.

For instance, if you measure an airflow of 8 m/s over the Uhle box with an applied vacuum of 40 kPa, you can standardize by anticipating the value of the airflow at a vacuum level of 10 kPa. This is the Dynamic Felt Permeability (DFP). In this example the DFP is 2 m/s @ 10 kPa.

A directive for judging press felt performance

Collect both machine and the felt data, on a daily basis.

Below you find an example table of the felt life of every position in the paper machine.

Date	Prod	Breaks	Steam	Life felt Pos 1	Comp. Pos 1	Dyn Perm Pos 1	Life felt Pos 2	Comp. Pos 2	Dyn Perm Pos 2
1/6/20	980	2	1.1	21	56.1%	1.12	21	65.6%	1.08
1/7/20	970	3	1.1	22	56.3%	1.15	22	66.1%	1.07
1/8/20	680	2	0.8	1	49.1%	2.36	23	66.7%	1.05

Table 1 - sample machine and felt data

For each PMC we know the installation dates and removal dates. This knowledge allows us to connect the running days of each felt with the output performance data you collected earlier.

Make charts for every press position. On the X axis the days life, starting at 1 until as long as you have data. On the Y axis you put your machine and felt data. Take the average of all daily productions when felt 1 was 1 day old, then when it was 2 days old, etc.

After some time you get the insight into how specific cloths influence the overall performance of the entire paper machine.

The longer the period, the better the quality of your chart. It is best practice to use the collected data/averages for a period of at least 12 up to 24 or 36 months as a rolling average. By using such a long period, your averages will be statistically reliable without being influenced by totally different machine setups or other ghosts of the past.

Example charts

Below in figure 3 we have made a chart of machine data during seven weeks. This imaginary machine runs in a two week shutdown cycle and with every shutdown a new pickup felt is installed. The first and third press felt have a life of four weeks, but they are never installed at the same time.

The number of daily breaks (the red bars in the chart) seems somewhat correlated to the steam consumption, the green line in the chart. The blue line shows the daily production. It is clear to see that after a shutdown the machine does not immediately gets to maximum output. Just before a shutdown, daily output drops a bit and the number of breaks go up.

When you watch closely, you will see that at the end of the first cycle the machine has up to 6 breaks per day. At the end of the second cycle you also have more breaks, but ‘only’ 4 per day.

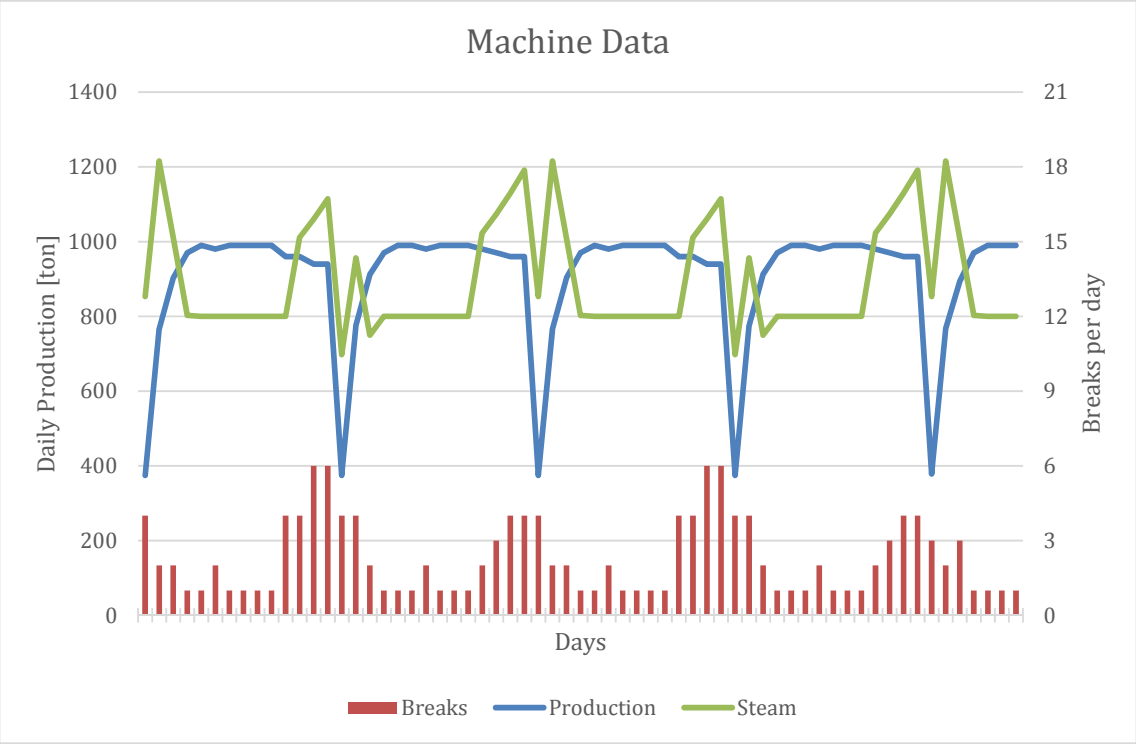

Figure 3 - chart of machine data

Now after collecting machine data of several days with “pickup felt life = 1”, “pickup felt life = 2” etc. and combining that with the felt data, we can make a charts for every press felt in the machine as the example in figure 4.

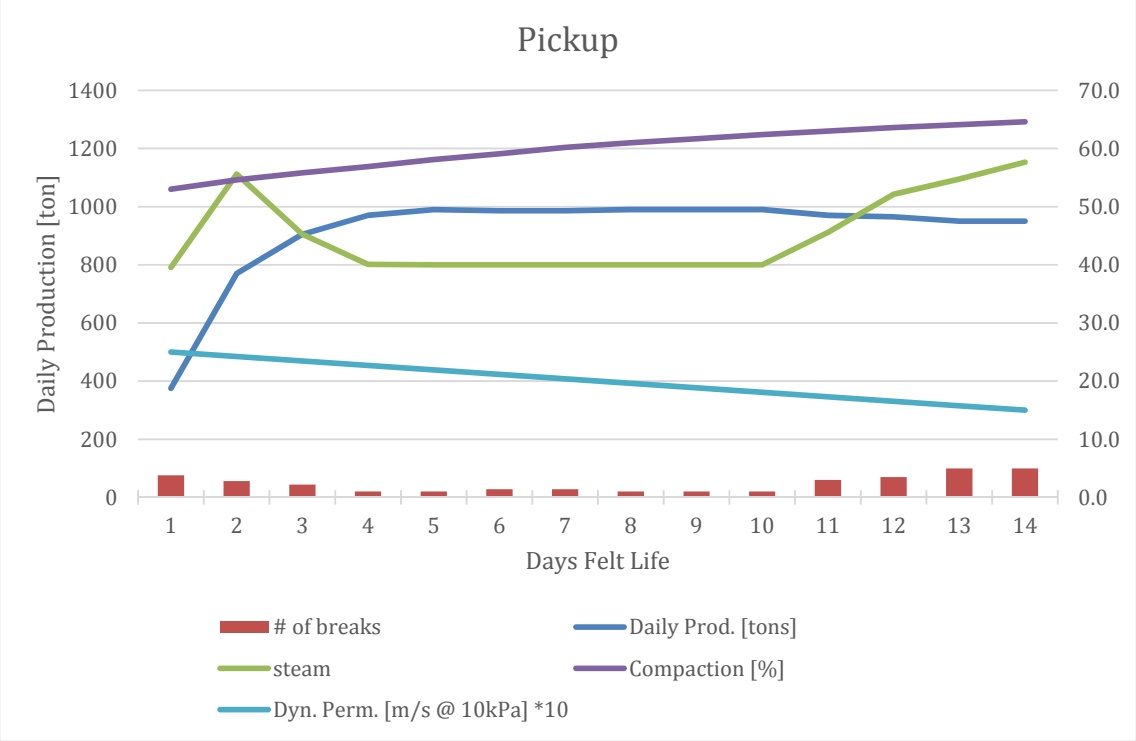

Figure 4 - machine data and felt properties over pickup felt life

From this chart can be deducted that only from day 5 the machine reaches its maximum output. The first 2-3 days the steam consumption is relatively high, as are the number of breaks. After day 10 the end-of-life becomes noticeable: the steam consumption goes up – indicating less dewatering by this felt - and so does the number of breaks. This could have two possible (felt related) causes: maybe the felt compaction has a maximum value of approx. 63%, or this position has a critical dynamic felt permeability of approx. 1.7 m/s @ 10 kPa.

Looking at the chart, most can be won by reducing the break-in period of the pickup felt. This should be the target for a new trial felt. It is up to the felt supplier to decide **how**; he can play with the permeability, the level of pre-compaction, the felt surface with other batt layers and different needling procedures… as long as the machine achieves more daily output during the first 5 days.

When the trial felt is in the machine, just plot the trial felt's data into the chart above and the supplier and the papermaker have an excellent baseline to judge the performance of the trial.

Time to Improve

When a papermaker has recorded sufficient and solid "normal" performance data for its machine, he can use this valuable information as the reference to work with his PMC supplier in developing new and better performing press felt designs.

In **closing** this paper…

… you are invited to **open** your eyes and actually **SEE** your felts performance.

Therefore, we advise you to make **visual charts** that show how your felt properties change over time and their effects on your total paper machine performance. Visual charts are a powerful tool for communicating with your PMC suppliers.

Keep things as simple as possible. As a papermaker you'll want to pick one goal to improve (and **ONE** goal only, that should be clear from this paper).

Encourage your PMC suppliers to develop better felts for you by sharing your data with them. Showing PMC suppliers your visual charts and they will SEE that you are seriously empowered to improve and help them kickstart innovative press felt trial processes.

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How To Assess Press Felts

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FELTEST Equipment BV

FELTEST
EMPOWERING PAPERMAKERS

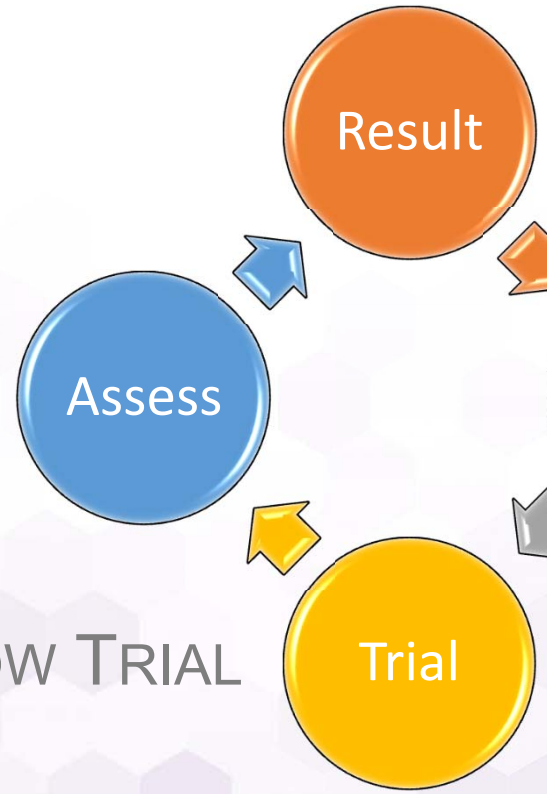
WHY

More Machine Output

Through Better Performing Felts

Requires Targets, Trials and Evaluation

TOWARD BETTER FELTS



MILL DEFINES TARGET

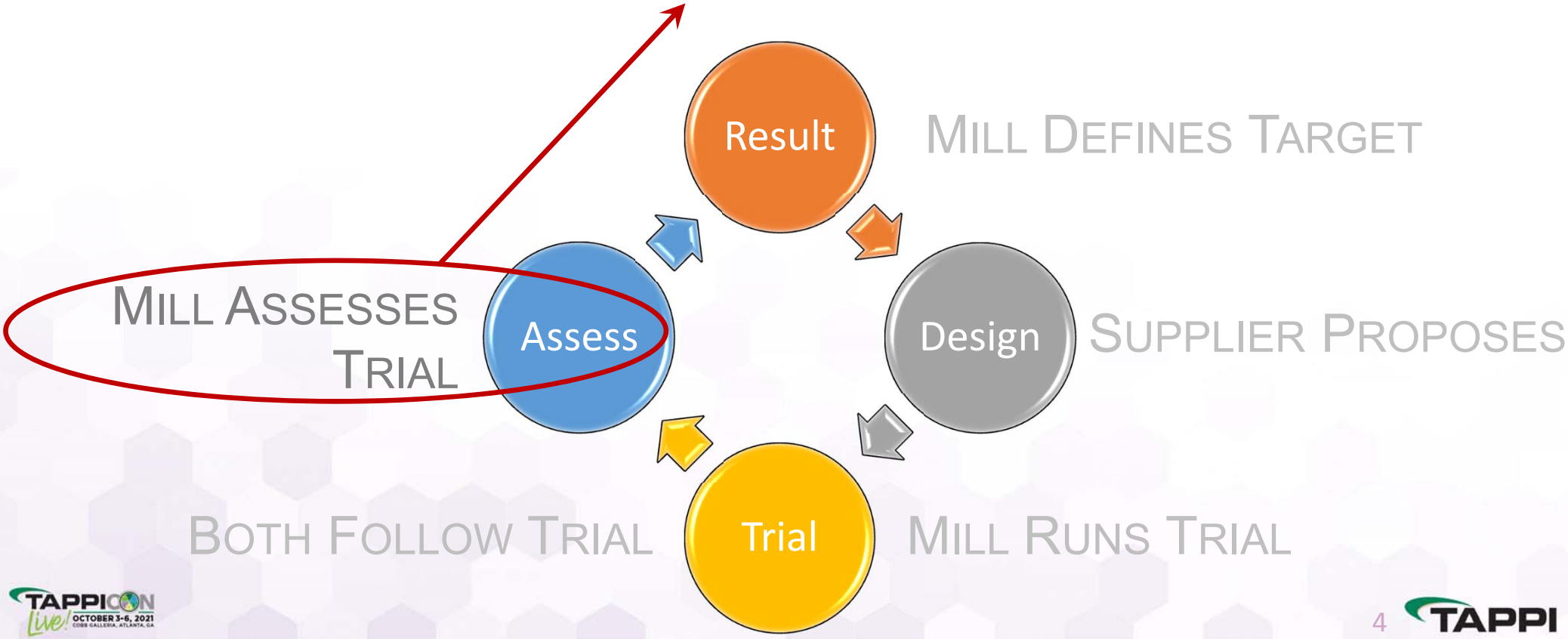
SUPPLIER PROPOSES

MILL RUNS TRIAL

BOTH FOLLOW TRIAL

MILL ASSESSES TRIAL

TOWARD MORE OUTPUT

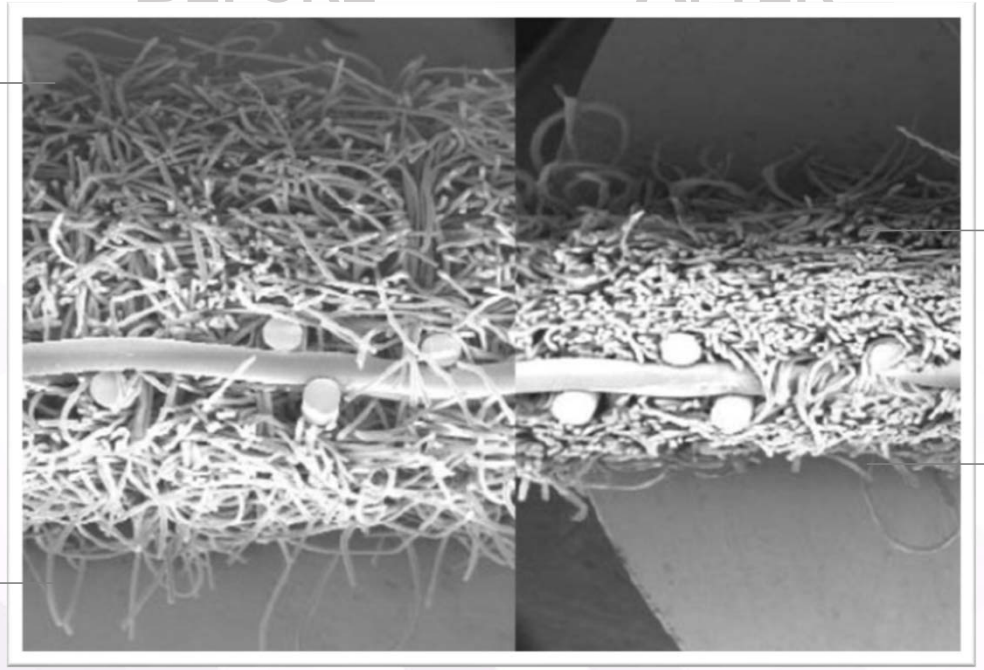


IMPROVING FELTS CONSIDERED COMPLICATED?

1. Felts Are Complex Products
2. One of Many Variables in the Machine
3. Behavior Changes Over Lifetime

CHANGING FELT BEHAVIOR

BEFORE AFTER



COMPACTION & WEAR

Main Felt Properties

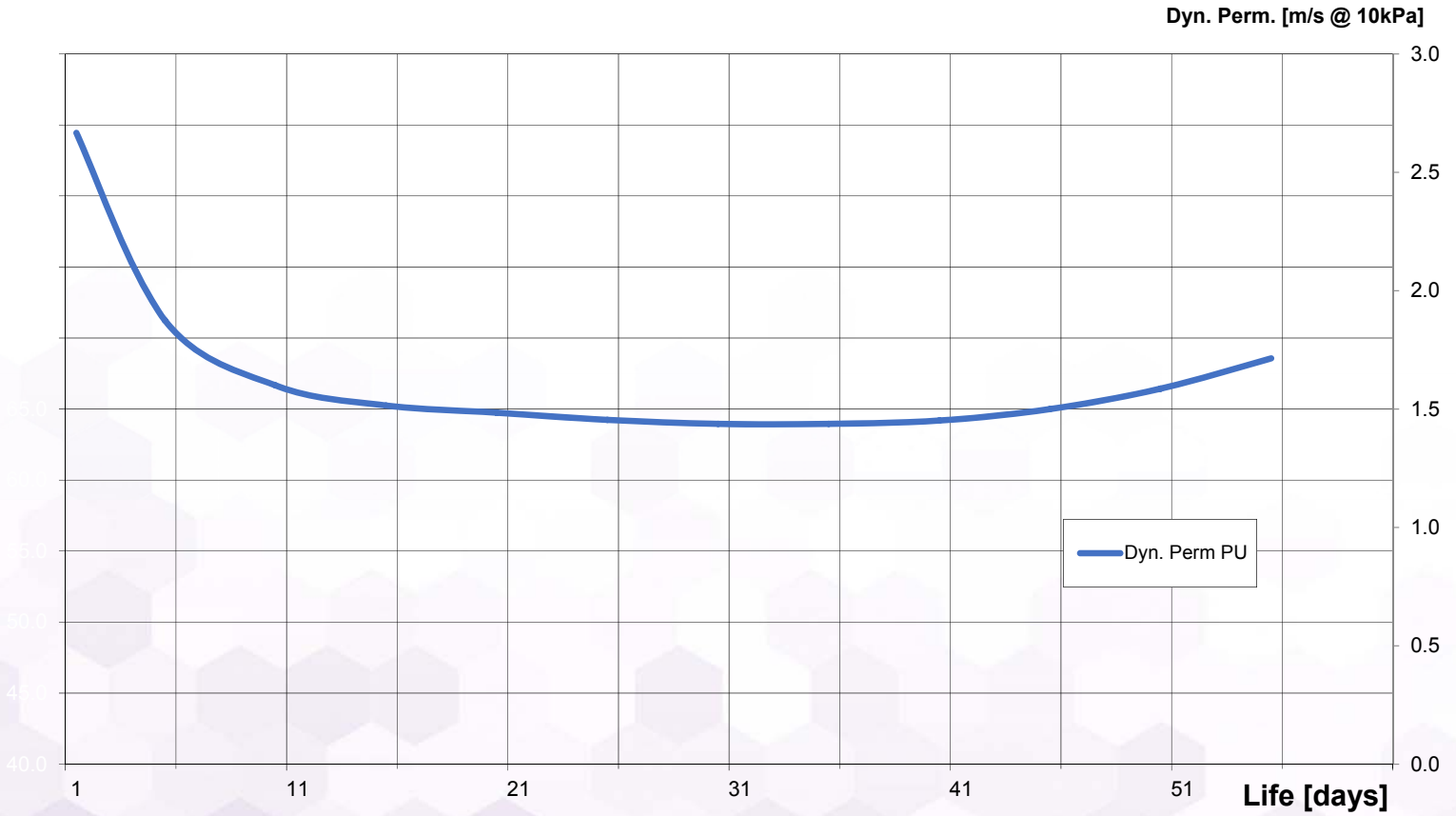
Permeabilty and Felt Caliper

Dynamic Perm.	Felt Caliper	Situation
▼ LOW	▲ THICK	Contamination
▼ LOW	▼ THIN	Compaction
▲ HIGH	▲ THICK	Break-in period
▲ HIGH	▼ THIN	Worn

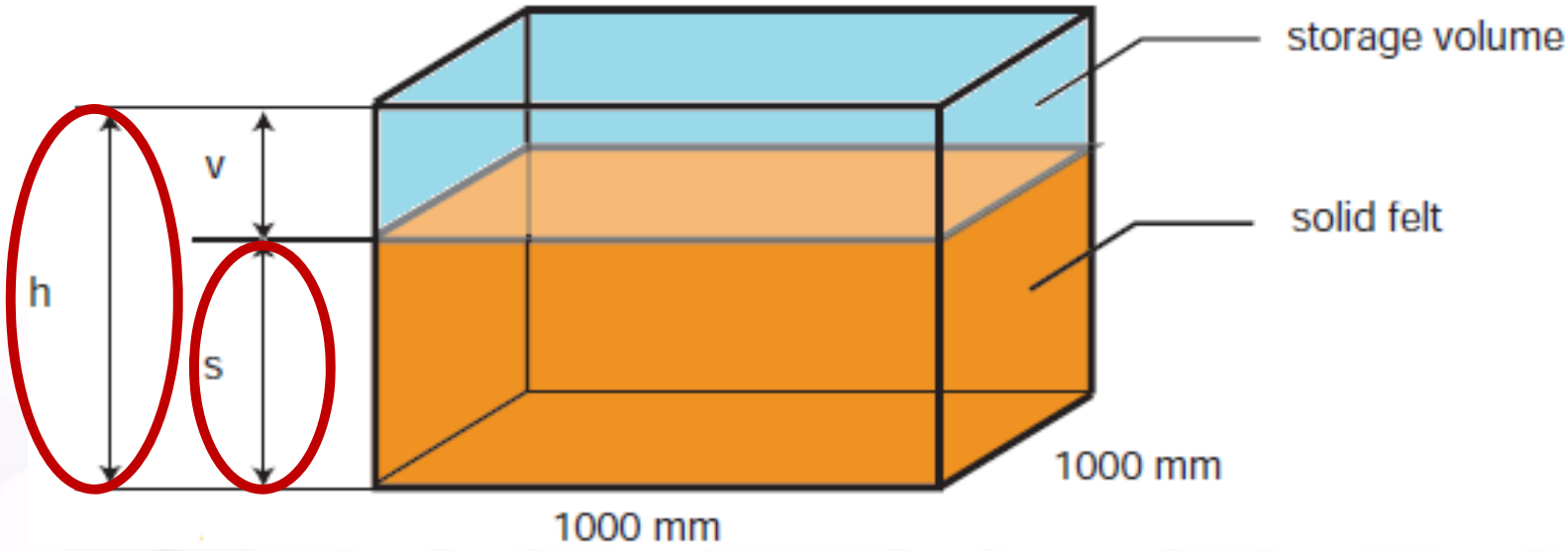
DYNAMIC PERMEABILITY

AIRFLOW AT STANDARDIZED VACUUM → M/S @ 10 KPA

BASELINE DYN. PERM. OVER LIFE

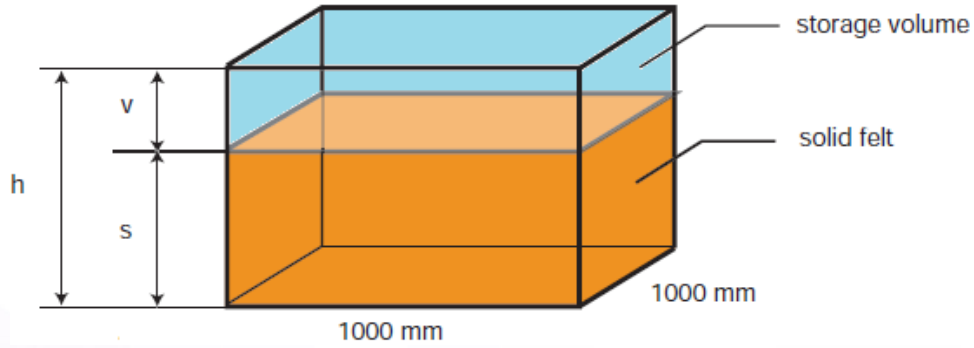


COMPACTION



COMPACTION = S / H [%]

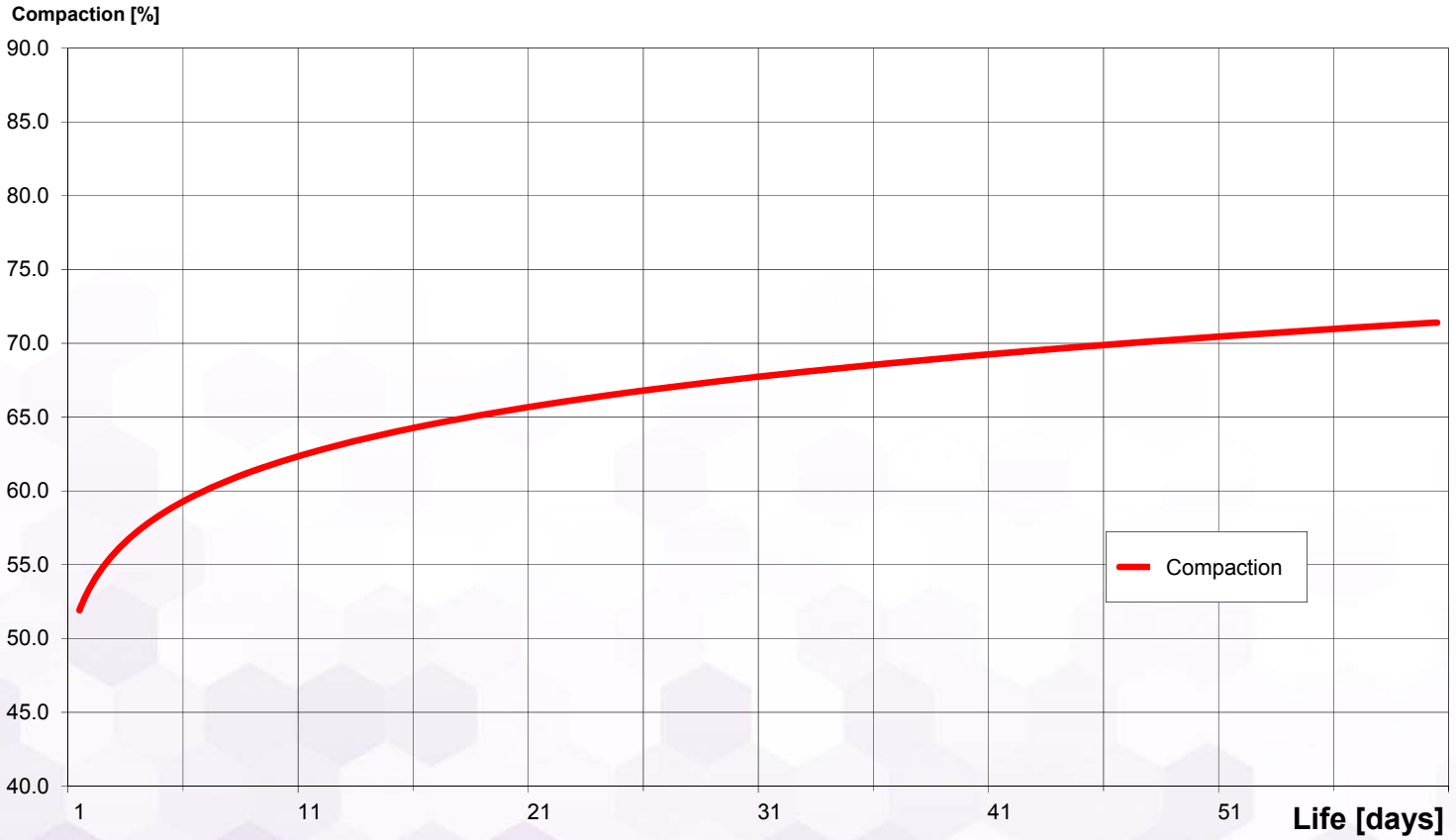
COMPACTION = s / h [%]



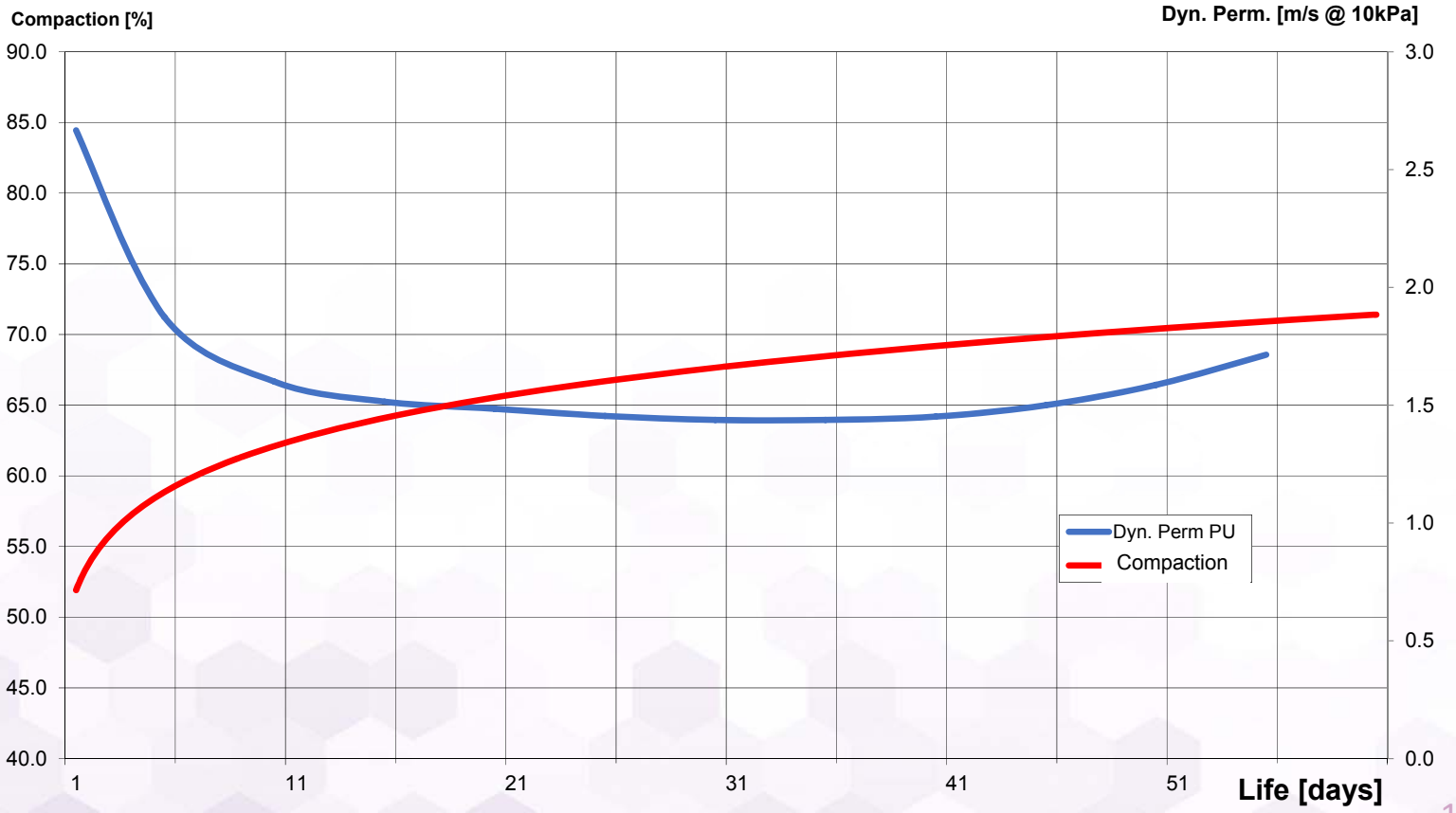
$$\textbf{Compaction}\ [\%] = \frac{\textbf{Felt weight}\ [\text{gsm}]}{\mathbf{11.4}\ * \mathbf{h}\ [\text{mm}]}$$

11.4 For Full Polyamide (PA) Felts

BASELINE COMPACTION OVER LIFE



COMPACTION, DYN. PERM. OVER LIFE



STEP 1:

MAKE BASELINES

BASED ON

DAYS OF FELT LIFE

STEP 2: ADD MACHINE KPIS

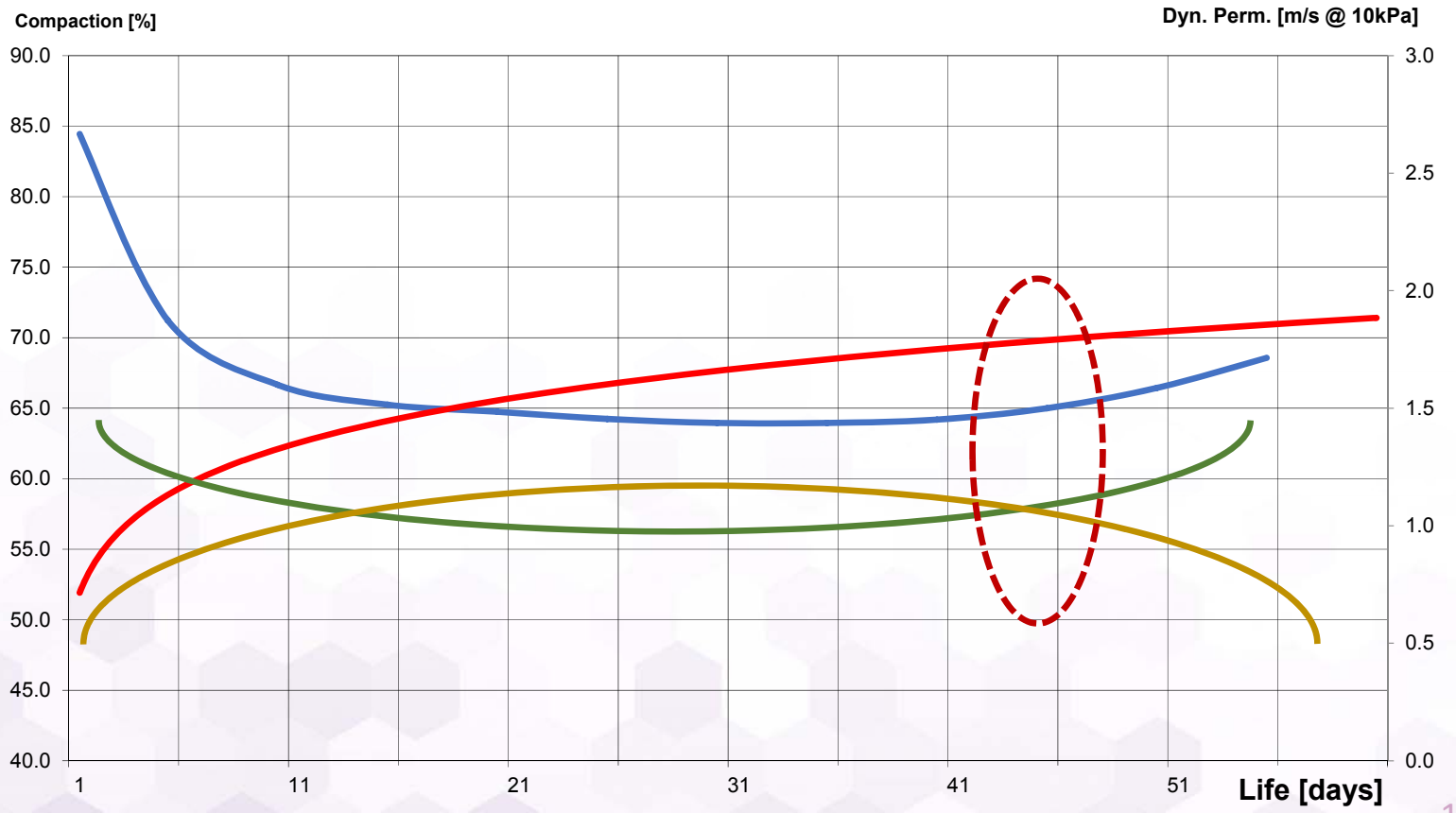
per Ton or per Day

- Production [ton/day]
- Felt Cleaning Agent [gal/ton]
- Breaks/Day
- Power Consumption in [kWh/ton]

Organize Data to Felt Life

Life	Prod.	breaks	steam	Compaction	Dyn. Perm.
1	375	3.8	791	53.0	2.50
2	770	2.8	1112	54.6	2.43
3	905	2.2	905	55.8	2.34
4	970	1.0	802	56.9	2.26
5	989	1.0	800	58.1	2.19
6	986	1.1	800	59.1	2.11
7	986	1.0	800	60.2	2.03
8	992	0.9	800	61.0	1,96
9	990	1.0	800	61.7	1.88
10	995	0.9	800	62.4	1.81
…	…	…	…	…	…

KPI & Felt Properties over Life



START OPTIMIZING

1. COLLECT RELEVANT MACHINE DATA
2. DAILY MEASURE RELEVANT FELT DATA
3. ORGANIZE YOUR DATA ON FELT LIFE DAYS
4. SHARE YOUR DATA WITH SUPPLIERS
5. COMPARE TRIALS WITH THE BASELINE

REMEMBER 1 THING:
DAILY DATA POWERS PRODUCTION

Feel free to contact:
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