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SELECTION CRITERIA OF PPS AND PPS/PI BLENDS FOR USE IN POWER STATION APPLICATIONS

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ABSTRACT
The use of PPS in CFBs is not new, in fact the since the introduction of the original fibre Ryton ® introduced by Phillips Co many thousands of filter bags have been installed and operated satisfactorily.

Today's challenges are however substantially more demanding than they were 20 or even 10 years ago. Power Station Managers are not happy with bag lifetimes of two or three years as was the case on many of the earlier installations, the quest today is for lifetimes to meet with Power Station GO's. This can mean bag lifetimes of > 48000hrs. This for a textile can be a huge demand, it is achievable but in turn Power Station Managers must also understand the factors which can affect the fabrics lifetime. These factors take three basic forms, chemical, thermal and physical.

The PPS fibre performance is the first issue and this is examined relative to the flue gas analysis and the operating temperatures inside the bag filter. Once established that the PPS fibre can withstand the chemical/thermal conditions then the construction of the needlefelt is taken into consideration. To achieve long lifetimes it is necessary to design a high efficiency needlefelt which would require less cleaning cycles than a normal PPS felt offers. These designs can take two basic forms. Firstly by applying a PTFE coating and secondly by blending PI fibres into the surface structure of the needlefelt.

Today we have the possibility to compare the standard PPS filter bag with the more sophisticated designs using a filter test rig according to VDI/DIN 3926. The rig allows us to compare the filtration performance of different fabrics under defined conditions.

The conclusion of the testing allows us to have more confidence in the selection of the correct filter media. We must however combine the gas data and the ash data to be able to make the correct selection.
Laboratory tests can of course only be used as indicators the experience gathered in from actual applications is and always will be the most effective criteria for fabric selection. Our experience in the field is extensive and from a wide reference list we highlight two interesting installations.

Gutsche introduced the first PTFE coated fabrics and the first blended fabrics in the mid 80s, the PTFE coated PPS has been successfully installed in many earlier stations such as Rooiwal and Kelvin Power Stations in South Africa, the first blends also being installed at Arnot Power Station in South Africa and Hohot Power Station in China.

The use of PPS in CFBs is not new, in fact the since the introduction of the original fibre Ryton ® introduced by Phillips Co many thousands of filter bags have been installed and operated satisfactorily, one case in particular is Rooiwal Power Station in South Africa which recorded a lifetime of 72000 hrs, admittedly at a very low load capacity. There have been instances of failure but in most cases the cause has been the operation of the installation outside the known parameters for the fibre.

There have been many changes since the first introduction of the Ryton ® fibre. The supply chain has changed, Ryton® no longer exists as a fibre for filtration, and the two main suppliers are now Toray Japan supplying Torcon ® and Toyobo Japan supplying Procon®. It must be stated here that the resins used for the production of the fibres are chemically the same as for the original fibre, and so the known operating parameters are the same.

Today's challenges are however substantially more demanding than they were 20 or even 10 years ago. Power Station Managers are not happy with bag lifetimes of two or three years as was the case on many of the earlier installations, the quest today is for lifetimes to meet with Power Station GO's. This can mean bag lifetimes of > 48000hrs. This for a textile can be a huge demand, it is achievable but in turn Power Station Managers must also understand the factors which can affect the fabrics lifetime.

Firstly we need to understand the limitations of the PPS fibre. In the early days the operating parameters and limits of PPS where very loose, through experience we are now much better informed. Let us consider these operating parameters in more detail. There are two areas which need to be considered, the chemical/thermal information which is derived from the gas analysis, and the more physical aspects such as ash analysis and filtration velocity.

Twenty years ago the fibre manufacturer advised that the maximum operating temperature of PPS was approximately 200Deg C today, for operation in CFB's, this temperature has been dramatically reduced to 160Deg C, reasons for this are explained a little later. The influence of NO_2, high O_2 and strong acids such as H_2SO_4 can also have an effect on the performance of the fabric. These parameters derived from the gas analysis need to be followed closely in order to achieve required the lifetimes.

The relationship between temperature and oxygen is well documented by fibre suppliers and experience has shown that in order to achieve lifetimes of 48000 hrs then the ideal would be continuous operating temperature below 150Deg C and oxygen less than 5%. The lifetime figures are also influenced by the formation of NO_2 and again the temperature is the key factor, the higher the temperature then the lower the amount of NO_2 allowed. Fortunately in most power station applications the NO_2 levels are well below the critical values, there have however been some recent cases in China where the levels are of concern. Generally to achieve 48000hrs the amount of NO_2 should be below 5mg/Nm^3 and even lower if the continuous operating temperatures are above 130Deg C.

The formation of strong acids caused by excursions through the acid dew point can also be detrimental to the fabric lifetime, so the coal/fuel being burned needs to be examined in detail. The filter inlet temperature should be above the acid dew point temperature during operation. The ash analysis is also important from the fabric selection aspect, some fly being more abrasive and less reactive.

So far we have only discussed the selection of the PPS fibre from a chemical suitability, what about its ability to filter efficiently, the construction details of the needle felt are of highest importance. The simple fact is, the more you pulse a filter bag the shorter will be its lifetime. It is therefore necessary to investigate the filtration efficiency of the filter fabric and try and reduce the number of cleaning cycles.

To achieve the lifetimes presently demanded then it may be necessary to improve the filtration efficiency the basic PPS needle felt construction. This can be achieved in two ways, firstly by applying a PTFE coating to the surface of the fabric or alternatively by blending PI fibres in to the surface. The application of a PTFE coating was first introduced by MGF Gutsche in 1985, and is used to change the morphology of the fibre surface. The cross-section of a PPS fibre shows it as cylindrical with a smooth surface, the application of a PTFE coating can change this surface structure and improve the filtration efficiency. The P84 fibre in cross-section is totally different to that of PPS, each P84 fibre has an irregular cross-section, this means more surface are per unit weight of fibre, again a factor which helps to improve the filtration efficiency. This is of course the theory and in the past very difficult to prove even in an actual installation.

Today we have the possibility to make very accurate comparisons of filter media using a filter test rig according to VDI/DIN 3926. The rig allows us to compare the filtration performance of different fabrics under defined conditions, a test dust is circulated at elevated temperature through the system, passing through the test material. After a period of ageing of the fabric (continuous pulsing 10000 cycles) the sample fabric is allowed to reach a pre-set pressure drop and then pulse cleaned. This is repeated for a fixed period and then the number of cleaning cycles recorded. The outlet dust emissions are also recorded as to the residual pressure drop after cleaning. All measurements are repeated for the other samples and comparisons made.

Comparing standard PPS, PPS with a PTFE coating and Optivel® PI (blended PPS with P84® fibres) the results are very interesting and confirm the theory. The basic results after aging the fabrics are detailed in *Table 1*.

Table1. VDI/DIN 3926 Test Results

	Residual pressure drop Pa	Cycle time seconds	Clean gas emissions mg/Nm^3
Standard PPS	640	72	1.0
PPS + PTFE coating	590	138	0.58
Optivel ® PI PPS/P84® blend	500	233	0.29

The conclusion of the testing allows us to have more confidence in the selection of the correct filter media. It can be seen from *Table1* that the blended Optivel® PI construction achieve the following results;

i) 71% lower dust emissions compared to standard PPS and 50% less than the PPS + PTFE coated fabrics.
ii) 22% lower pressure drop than standard PPS and 15% lower than PPS + PTFE coated fabrics
iii) 3.2 times longer cleaning cycle compared to standard PPS and 1.3 times longer than PPS + PTFE coated fabrics.

The relationship between the number of pulses a filter bag receives and the lifetime it achieves is well known through on site experiences. The conclusions of laboratory results confirm therefore that the lifetime of the filter bags can be increased considerably by using PTFE coated fabrics and even more so by the installation of filter bags with a blended surface structure as the Optivel® PI bags.

Laboratory tests can of course only be used as indicators the experience gathered in from actual applications is and always will be the most effective criteria for fabric selection. Our companies experience in the field is quite extensive and from a wide reference list we highlight two interesting installations. The first Optivel® PI blended bags to be installed in a coal fired power station was at Hohot Power Station in China, and no more severe a test could be envisaged, as the temperature range is quite high and a little erratic.
Excursions outside the projected temperature range were significant and did have a detrimental effect.

Table 2. Operational details Hohot Power Station

Gas volume Am^3/hr	Temperature °C	Fabric area m^2	Flue gas composition	Dust load g/Nm^3
1,738,000	140 -170 180 max	28,000	N_2 74.4% Vol. CO_2 13.9% Vol. O_2 3.9% Vol. H_2O 7.6% Vol. SO_2 1650 mg/Nm^3	32.00

The filter plant at Hohot operated successfully for a long period of time (>3years) but the high temperature excursions caused some localized problems. Laboratory examinations during operation showed the dust cake at the surface of the filter bag confirming that the theory of surface filtration.

One other installation which surely should be included in any reference list for the use of blended fabrics in Power stations is the large unit at Arnot Power Station. This was the first large Power Station to install a blended PPS with PI fibres into the surface.

Table 3 Operational Details Arnot Power Station

Gas volume Am^3/hr	Temperature °C	Fabric area m^2	Flue gas composition	Dust load g/Nm^3
2.57×10^6 per unit	125 - 160	40,000 per unit	O_2 6.0 % Vol. H_2O 7.6% Vol.	34.00

The filter plant at Arnot has three units each unit housing approx 11000 bags. The original bags achieved excellent lifetimes, over 43000hrs in one some units. The replacement Optivel® PI bags are now installed on all three units and the design of the fabric modified slightly in an attempt to achieve even longer operating hours. The surface structure is the same using a PI blend into the PPS fibres, the change for this set of bags has been the introduction of 33% PTFE into the scrim yarns. It is not yet known if this will have the desired outcome, only time will tell.

Concluding, it has been more than twenty years since PPS made its entrance into the filtration market, and it has proven to be the desired filter media for fabric filters handling the flue gas from coal fired boilers. Experience has given the reputable fabric supplier enough information to be able to advise end users on the limitations of the fabric and to predict operating lifetimes. Power Station Managers are also gaining there own experience and recognise that fabric filters can work successfully. There are limitations to the PPS fibres and these limitations are now much more defined. Lifetimes can be improved by selection of PTFE coated fabrics and the now familiar Optivel® PI blends.