Working to enhance the performance of paper

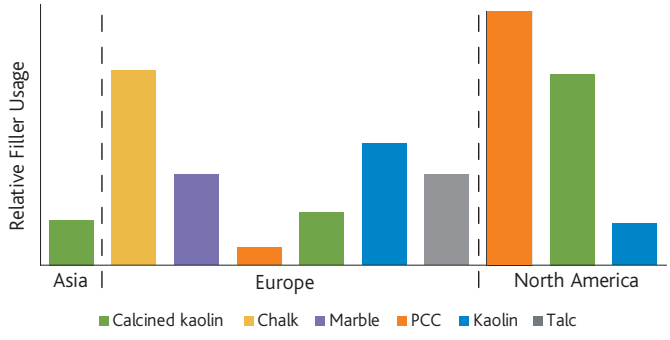
Fillers for Newsprint

Worldwide newsprint production is about 42M tonnes/year and uses a relatively low level of fresh filler of between 2 and 12%. Mechanical and/or recycled fibres are the primary furnish for most newsprint mills and the cost of these fibre streams have been increasing significantly due to energy costs, increased demand and limited availability of raw materials.

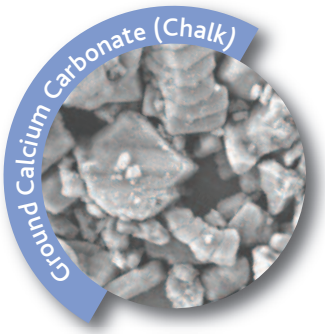
Thus, significant savings can be made by replacing fibre with fillers, as standard fillers typically cost less than the fibre. Although recycled fibre contains a significant level of mineral, fresh filler may be used to control the total ash level. However, the amount of filler that can be added is usually limited due to the strength reduction.

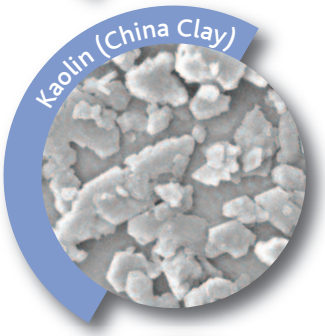
Standard filler is a broad term which encompasses ground natural calcium carbonate (GCC), either chalk or marble, and kaolin. Structured fillers, such as calcined kaolin, synthetic alumino-silicates and precipitated calcium carbonate (PCC), contribute more benefits at low addition levels, but they impart a greater loss in strength per unit weight compared to the standard fillers.

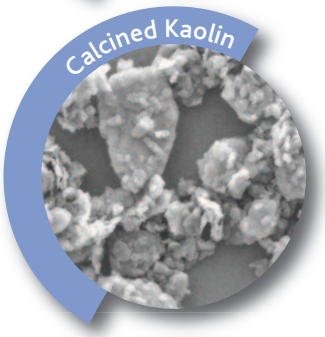
Apart from the cost savings associated with fibre replacement, the main reasons for using filler are to improve optical performance, control friction (through the absorption of pitch and stickies) and better printability (by controlling porosity, smoothness and ink penetration). Fillers may also improve drainage and therefore contribute to reduce drying energy. A lower proportion of fibre in the sheet means that potential issues may include a reduction in strength (including tensile and stiffness), lower bulk, poorer formation and a higher chemical demand.

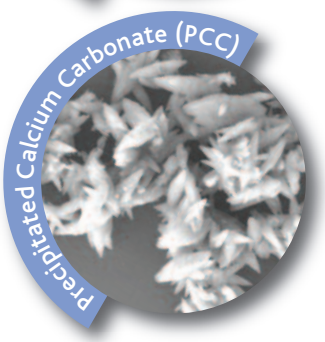


Filler use in North America is different to that in Europe, with considerably more PCC and calcined kaolin used, but almost no chalk, marble or talc is used.









IMERYS Paper & Packaging

Fillers for Newsprint

Filling Practices

The typical circumstances in which the various fillers are used are:

Kaolin/chalk/marble: 2 to 12% loading

- Primarily used in virgin fibre sheets to extend fibre and give similar print characteristics to recycled sheets

PCC: 2 to 12% loading

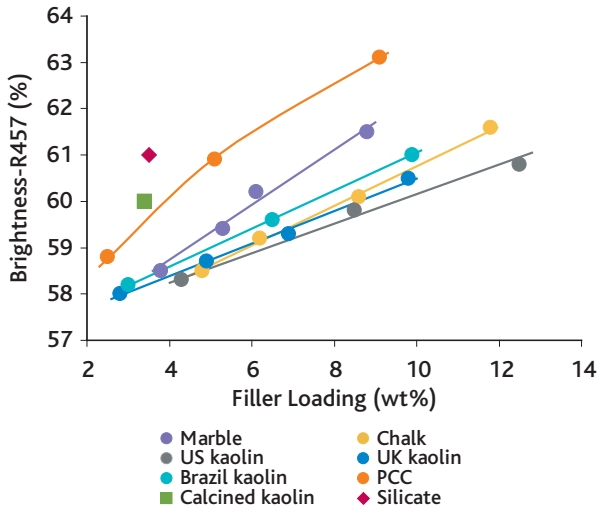
- More commonly found in North Western American mills and some in Asia

Calcined kaolin/synthetic silica: 2 to 8% loading

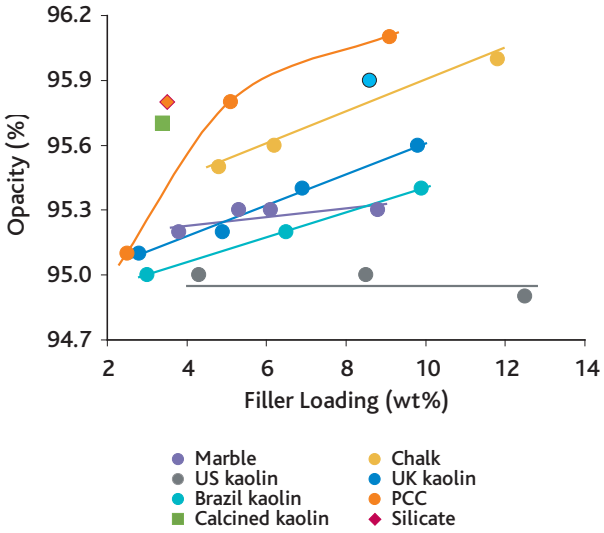
- Used to optimise opacity in low grammage News and Directory paper
- Used to control friction (caused by pitch)
- Excellent as a functional additive to control print through/strike through and as an ink setting aid

Optical and Physical Properties

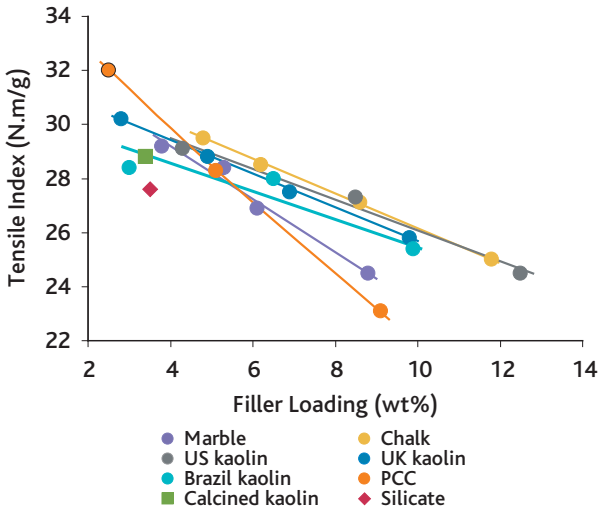
A series of 45 g/m² sheets were prepared in the laboratory using recycled pulp and a selection of fillers. Since the brightness of the newsprint fibres is lower than the fillers, adding any filler improves the sheet brightness, due mainly to the increased light scatter from the pigment as well as the disruption caused by the filler in the fibre mesh.



Opacity improves at the same time by the same mechanisms. Fillers which have the greatest impact on optical performance are structured fillers, such as calcined kaolin and PCC. In this case, the internal pores of the filler are optimally sized to contribute to light scattering.



Although all have an impact on sheet strength, in the case of structured, their enhanced light scattering capacity can be used advantageously in light weight sheets, where even at loadings as low as 2-4%, significant gains in opacity can be achieved. Where strength is less of an issue and cost is the centre of focus, standard filler can also be seen to improve optical values.



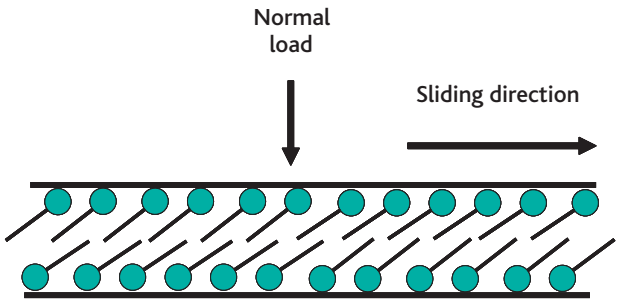
Structured fillers usually have quite large aggregated particle sizes and this tends to increase the porosity of the sheet. They also introduce more micro-porosity which has the positive impact of reducing the penetration of ink into the paper, thus providing excellent strike-through control.

Among the standard fillers, kaolin closes the sheet most effectively and provides a more tortuous path for the ink vehicle. This results in reduced strike through/show through.

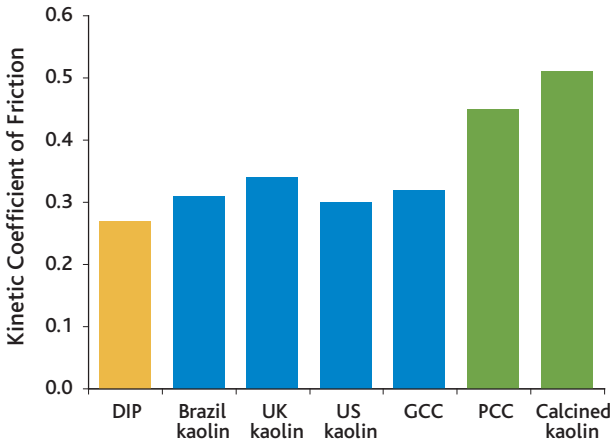
Addition of filler improves sheet smoothness. Structured fillers, like calcined kaolin or PCC, tend to give a smoother surface, followed by kaolin and GCC.

Effect of Fillers on Friction

Newsprint tends to have a low coefficient of friction (COF) because it contains high levels of mechanical or de-inked fibres. This is caused by the presence of naturally-occurring hydrophobic molecules which reduce the polar surface energy of the paper, and which act as lubricants. The molecules usually have straight alkyl chains which can align as the two paper surfaces slide over one another.



This low friction causes telescoping in the reel building process and gives problems at the printing press as the web can "run ahead" or "walk" causing misregister between printing stations. Using the correct filler is a valuable tool for the papermaker to increase COF. To study the effect of fillers on COF, a sliding test is performed with one sheet of paper fixed while a second is pulled across it at a fixed speed. The force required to do this is a measure of the friction between the surfaces.

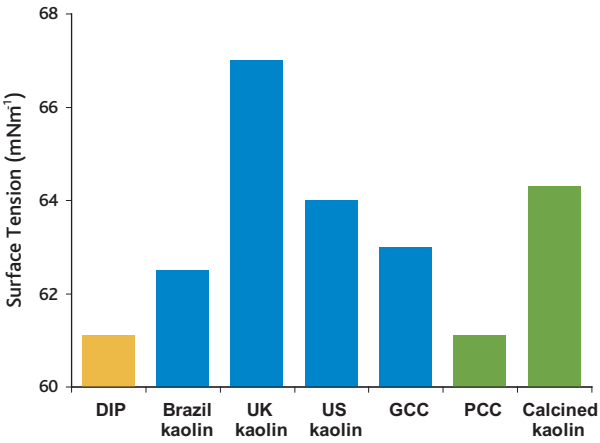


Different fillers have an effect on the COF of hand-sheets made from de-inked pulp. The sheets were made so that the consistency was close to that used on a paper machine. This ensures that the extractives from the pulp are present in realistic concentrations. It is evident that the standard fillers, kaolin and GCC, give a small increase in COF compared with the pulp and recycled filler alone. The calcined kaolin and PCC give significantly higher COF values.

The reason for this is thought to be related to the structured nature of the particles. It has been suggested that the internal particle micro-porosity may be able to contain the oily contaminants and remove them from the surface.

The bulky angular particle shape may also help to promote interlocking between the sliding surfaces.

Certain kaolins, notably those from the UK primary deposit, have the ability to scavenge surface active material from solution in the wet-end. Sedimentary kaolins, from Brazil and the US, GCCs and PCCs, are less effective. The surface tension of the white water from de-inked pulp after equilibration varies with filler type. The highest values are obtained with UK kaolin, indicating more soluble material has been removed. The effect of this on friction is quite small, but may be important for machines that operate on a critical COF level. It may also reduce foaming problems at the wet end.



Effect of Fillers on Paper Machine Runnability

The addition of fillers will also have an impact on paper machine runnability. The size, shape, degree of aggregation and surface chemistry may also induce changes.

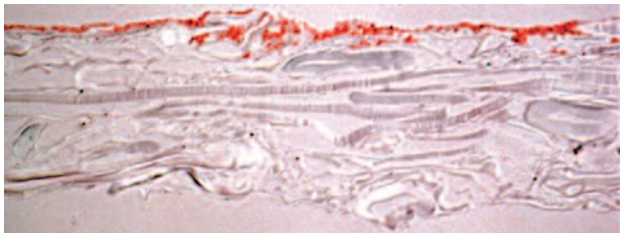
Runnability	Filler Requirement
Fast dewatering	More filler, coarse and steep PSD
Strength	Coarse and steep PSD
Wire & felt life	Low abrasion
Cleaner wet end	Scavenging capacity

Dewatering is usually improved once filler is introduced. Larger particles have been seen to improve dewatering. If paper strength is limited, a coarser pigment with a steep particle size distribution, would give better strength and maintain good runnability at higher loading levels. Low filler abrasion is needed to maximise wire and felt life. The ability of some fillers to scavenge different wood extractives helps to keep paper machine wet end cleaner.

Fillers for Newsprint

Printability

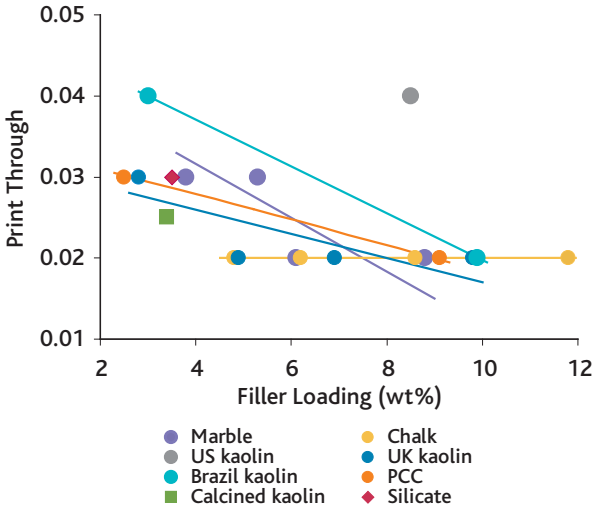
Newsprint is normally printed with non-drying coldset offset inks and a balance is sought between ink hold out and penetration. The ink must remain on or near the surface of the paper to give a good colour density, but have sufficient surface penetration to prevent set-off and ink smearing.

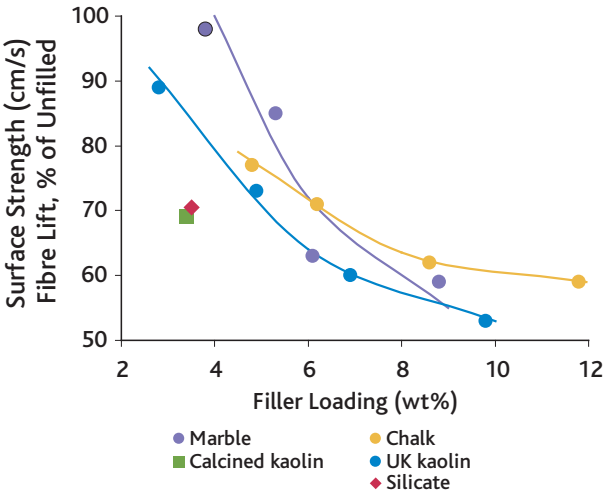


Cross-section through printed paper showing the ink situated in the surface pores.

Fillers increase the opacity of the sheet and also change the pore structure (there is a higher proportion of small pores). This helps prevent ink from being seen from the reverse side of the sheet (print-through and show-through). Structured fillers generally give low print-through.

Addition of filler reduces the surface strength of the paper (as seen by pick and fibre rise). Coarse fillers tend to give less strength reduction than finer fillers. Aggregated fillers give worse surface strength, even when used at lower loading levels.





Summary of Imerys Recomendations

Filler type	Brightness	Opacity	Bulk	Strike through	Friction	Imerys products
UK kaolin	+	+	-	+	+	Intramax, Intrafil
Brazil kaolin	+	+	-	+	=	Capim SBF
US kaolin	+	+	-	+	=	Astrafil K
Ground chalk	+	+	-	+	=	G400, G600, G800
Ground marble	+	+	-	=	=	Intracarb
Scalenohedral PCC	++	++	+	+	++	OptiCal HB
Calcined kaolin	+++	+++	++	++	+++	Alphatex

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