Trends in papermaking minerals used in the Asia-Pacific region

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Introduction

Asia, particularly China has rapidly become a major producer of paper of all types. Demand growth has unambiguously transferred from the West to China.

Printing and writing papers consume increasing amounts of a range of mineral products. Minerals have been utilized in filling and coating papers for many years, but during the past 15 years there have been some significant new trends and paper coating pigment manufacturing & application technologies have evolved considerably, with major implications for mineral suppliers servicing this massive & rapidly growing industry. The conversion of groundwood-containing coated grades to neutral/alkaline sizing has accelerated along with multiple coating technologies.

Key minerals

In the Asian region, six major minerals are used to minimise costs of paper manufacture - along with maximising paper quality.

Minerals used in papermaking can be categorized as follows

Major minerals

* Calcium carbonate
  - o Ground calcium carbonate (GCC)
  - o Precipitated calcium carbonate (PCC)

o Structured & surface-modified calcium carbonate

* Kaolin clay
  - o Hydrous kaolin clay
  - o Calcined kaolin clay
  - o Structured kaolin clay
  - o Engineered kaolin clay (shape-engineered/PSD-engineered)

*Talc (delaminated/surface-modified talc)

Minor minerals

* Titanium dioxide (Rutile and Anatase)
* Bentonite retention aids (modified/ hybrid)
* Others (Satin White, Barium sulfate, Aluminium hydroxide, Fumed silica, Silica gel, Magnesium hydroxide, Huntite & hydromagnesite etc.)

Application of minerals

The mineral content of coated papers has moved upwards with lower cost and higher quality being the main drivers of this trend. Printing & writing papers including coated woodfree and coated mechanical and coated board paper products, each have characteristics, which benefit from various minerals.

Key mineral applications include filling/loading, coating, pigmenting, retention andcleansing.
The purpose of filling paper with minerals is extensive and includes:

* sheet optics such as opacity and brightness
* filling of voids, formation, smoothness
* fibre replacement, cost saving, and
* dimensional stability.

The purpose of coating paper is to enhance printability, smoothness, ink absorption and appearance.

Important end-use properties include:

* colour and brightness
* opacity
* paper and print gloss
* porosity
* ink drying rate and ink absorption/holdout
* surface smoothness/roughness
* offset print appearance
* picking
* gravure printability
* gluing, and feeling or tactility

The mineral characteristics open to a paper-maker through pigment selection include:

1. dispersion
2. particle size
3. brightness
4. aspect ratio
5. Structuring thermal and chemical
6. morphology
7. rheology.

In turn these characteristics influence key pigment and coating operations:

* slurry pump-ability
* ease of make-down
* blade streaking and scratching, and
* dewatering rate and drying rate

Kaolin clay, including calcined, structured and engineered grades, remains important, however Ground calcium carbonate (GCC) and Precipitated calcium carbonate (PCC) have advanced with numerous

technical innovations, such as ultra-fine wet ground, discretely sized and hybrid/ acid-tolerant grades. In some countries, including China, talc remains an important filler.

GCC & PCC is dominant because leading mineral producers assistedpaper-producers to utilize local resources of marble via satellite or near-satellite production facilities.

Kaolin

During the last 10 years, most countries including China in Asia Pacific region have imported Kaolin clay for paper coating from USA, Brazil and Australia. In the paper coating sector, kaolin clay has been the most important mineral for paper coating.
In the paper coating colour formulation, ratio of kaolin clay to GCC and PCC has changed from :

	Kaolin %		GCC %		PCC %	
	1988	1999	1988	1999	1988	1999
Japan	72	58	19	36	9	6
Korea	71	43	21	56	8	1

As the operating speed of the paper machines and coaters have been getting faster during the past decade, better rheology and higher productivity in coating process have been top Issues for paper makers. Therefore, the trend to increasing calcium carbonate & finer kaolin clay has been used in especially coating paper. This occurred in Korea in 1990-91, and in Japan in 1999-2000.
Paper coating kaolin clay has been produced in China and Australia, but most of countries in the Asia Pacific region including Japan, Korea and Indonesia import it from abroad, mainly from USA and Brazil. Furthermore, kaolin clay is still the most important coating mineral for paper coating. Therefore, it is worth reviewing the wet processing steps for kaolin clay:

Blunging - the process of forming a clay-water suspension to transport the clay to degritters and storage tank.
Degritting - the process of removing sand and other debris

Centrifugation - the process of particle size classification to a specific particle size distribution. Centrifugal classifiers separate the coarse and fine clay particles required for particular customer applications.

Blending - different crude slurries are used to adjust product performance and properties.

Magnetic separation removal of magnetic ferric mineral contaminants by high flux magnetic separators.

Leaching - ferruginous removal by treating slurry with sulphuricacid to 3.0 PH, and sodium hydrosulphate, to reduce the iron to soluble ferrous.

Rotary vacuum filters dewatering to 68 to 70% solids and rinsing out any soluble impurities and leaching chemicals.

Re-dispersion - high shear mixing of the filtercake to a slurry and addition of dispersants for optimum slurry viscosity. Excess dispersant can be added for "pre-dispersed" kaolin.

Beneficiation - removal of iron and titanium for brightness improvement by bleaching floatation, selective flocculation, ozonation and magnetic separation.

Spray drying - to ship clay at 99% + dryness

Slurry preparation - to ship clay at 68 to 74% solids.

There are many specialized processes for products of added value including:

Delamination is a processinvolving attrition grinding to cleave stacks of kaolin platelets. The process is generally carried out with coarse clay fractions from which fine particle kaolins have been removed. Resultant products contain high aspect ratio platelets, and those made from Georgia kaolins generally average about 0.15 micrometer in thickness and about 1.6 micrometer in diameter.

The platy nature of delaminated clay makes for poor flow characteristics, but coated paper produced with delaminated clay such as LWC (light weight coated) papers has higher brightness, opacity, print gloss, and porosity than coated paper made with standard kaolinclay.

Calcination -Partially calcined kaolin (metakaolin) is produced by heating in the range of 650 to 750 degree Celsius, which gives a low brightness product, but also one of low dielectric constant and lower abrasion. Fully calcined kaolin is heated to about 1000-1050 degree Celsius. Brightness and abrasion of fully calcined kaolins are high relative to hydrous kaolin, but the dielectric constant and

thermal resistance arising from calcination is of critical importance to certain applications. Aggregate structures formed by the partial fusion of particles during calcination contain voids, which provide enhanced light scattering efficiency.

A major use of calcined kaolin is in the production of SCA papers in the acid papermaking process to improve ink absorption. SCA paper is supercalendered, and is primarily used for consumer magazines, catalogues, and advertising material. The second major use of filler grade is in the production of newsprint or lightly filled mechanical papers to provide extra brightness and opacity. The coating grade of calcined kaolin is used for coating paperboard as titanium extender.

Chemical structuring - is a method of using polymers and dispersants to carefully control particle agglomeration. The resultant clusters contain voids thatprovide enhanced light scattering and oil absorption. Due to the higher viscosity of chemically structured clay, slurries can only be made down to 62 to 64% solids, but coated paper such as rotogravure grades made with chemical pulp will be better in brightness, opacity, porosity, oil absorption and smoothness than coated paper made with standard kaolin clay.
Particle size engineering - is a method of removing ultra fine particles of clay to improve the efficiency of the clay performance in the areas of print gloss, light scatter (improved brightness and opacity) and oil absorption (improved ink drying). This product is a "tailor-made" grade.

Calcium carbonate

Calcium carbonate is consumed in many paper applications for filling & coating. Ground calcium carbonate (GCC) accounts for the majority of consumption; however, PCC (precipitated calcium carbonate) has been used for filling in Japan, China, Indonesia and Thailand. Calcium carbonate is the most widely used coating, extender & filler mineral.

Talc

Talc will remain a most important filler along with growing PCC as filler in Asia Pacific region. Coating talc consumption in Europe has sharply increased from 90,000mt in 1990 to 300,000mt in

2000, and the pitch control talc has been used widely for pulp & paper industries of Europe and North America. Talc will remain the 3rd important coating mineral in the Asia Pacific region.

There are two kinds of talc: microcrystalline talc for paper coating & pitch control and macrocrystalline talc for paper filler. According to coating talc makers, talc can provide advantages for paper producers:

* Elimination of core burst problem for LWC rotogravure printing
* Better printability for gravure printed papers
* Silkfeel for woodfree matt/semi-matt papers
* Waterbased barrier coating for grease resistance and recycleability.
* Low friction properties (sometimes a disadvantage)
* decreased premature breakage of the ink capsules in NCR paper

Titanium Dioxide

Titanium dioxide is used in the paper and paperboard industries to improve whiteness, brightness and opacity. Laminating paper, printing & writing paper, coated board and label papers are the main area of use. Titanium dioxide has a high refractive index, which makes it an efficient opacifying agent especially in papers exposed to moisture or greases. Calcined kaolin clay, engineered kaolin clay and steep GCCs can be used to extend titanium dioxide.

Conclusions

Lower cost of coated paper production

The introduction of low cost, locally produced calcium carbonate provides paper makers with an opportunityto radically revamp their coating minerals mix to improve end-use properties and low cost. In calcium carbonate/kaolin clay based coating system, the coating technologist can lower cost and achieve comparable property development by substituting "high brightness fine clay" with "standard brightness fine clay" and replacing "clay" with "calcium carbonate".

Paper makers in Asia Pacific region currently utilizing large amounts of high brightness kaolin could very quickly substitute lower cost pigments in their coating colour formulation whist retaining current quality standards and avoid the historical practice oftraditional suppliers recommending high cost products.

Improved quality

Still higher brightness, better printability and differentiated paper qualities remain major objectives for the paper manufacturers, and the recent innovations in mineral suppliers have focused clearly on these matters. There have been some shifts in thesources of some of the raw materials and the supply & demand of these will also be covered.

Table 1. Trend of minerals consumption in Japanese paper industry (1,000mt)

	1988	1999-2000
1. Coated paper production		
coated paper	2,468	4,316
coated board	1,342	1,633
2. Paper coating minerals	Metric tonnes - %	Metric tonnes - %
kaolin clay	685 - 72%	1,062 - 58%
WGCC(wet ground)	84 - 9%	642 - 35%
DGCC(dry ground)	100 - 10%	8 - 0.4%
PCC	85 - 9%	109 - 6%
Sub-total	954 - 100%	1,821 - 100%
3. Paper filling minerals		
talc	460	300
others	115(kaolin clay + DGCC)	300(PCC)
4. Others		
TiO2 for paper	17	16
Acid sizing agent	31	37
Neutral sizing agent	2	5

Table 2. Trend of minerals consumption in Korean paper industry

	1990	2000
1. Coated paper production		
Coated paper	333	1,297
Coated board	608	1,223
2. Coating minerals		
Kaolin clay	98/ 71%	172/ 43%
GCC	29/21%(DGCC)	225/ 56%(WGCC)
PCC	11/ 8%	4/ 1%
Sub-total	138/100%	401/100%
3. Paper filling minerals		
talc	110	210
Others	0	90(WGCC)
4. Others		
TiO2 for paper	2	0.5

Table 3. Consumption trend of kaolin clay grade by grade in Japan

	Premium brightness (year: 1990 / 1999)	Standard brightness (year: 1990/ 1999)	Total (year: 1990/ 1999)
Fine fraction (%)	0/ 2	35/42	35/44
No.01 fraction (%)	28/12	3/10	31/22
No.02 fraction (%)	4/ 6	30/28	34/34
Total (%)	32/20	68/78	100/100

Table 4. Consumption trend of kaolin clay grade by grade in Korea

	Premium brightness (year: 1990/ 1999)	Standard brightness (year: 1990/ 1999)	Total (year: 1990/ 1999)
Fine fraction (%)	61/56	25/29	86/85
No. 01 fraction (%)	9/ 3	2/ 4	11/ 7
No. 02 fraction (%)	1/ 1	2/ 7	3/ 8
Total (%)	71/60	29/40	100/100

Summary

The Asia Pacific papermaking giants are China, Japan and Korea followed by Indonesia. The strong trends in recent years have been the move to alkaline / neutral sizing which has assisted the move from kaolin and talc as the major filler minerals to ground calcium carbonate and precipitated calcium carbonate. Kaolin remains important as a constituent in many coating formulations and Chinese-sourced talc, due to its brightness and price will remain important especially in paper filler minerals. The need for ever increasing printing surface quality and continuing efforts by the paper manufacturers to keep costs under control will ensure minerals in papermaking will continue to be a dynamic subject in the years ahead.