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Review

Perspectives of Speciality Chemicals in India

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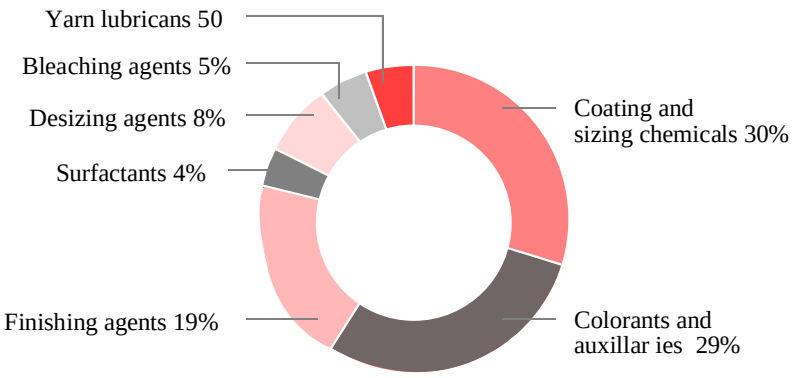
ABSTRACT

Fine Chemicals are substances that are obtained by means of complex synthesis and have a guaranteed degree of purity. Specialty chemicals are a broader term and generally include chemical substances for special applications. The status of production of nine different specialty chemicals in India is presented as a review and future prospectives of these chemicals are discussed.

Graphical Abstract



Breakup of Global textile market.

Keywords: Bulk chemicals, Fine chemicals, Speciality chemicals, Agrochemicals, Polymers, Textile chemicals, Construction chemicals, Flavours, Fragrances, Personal care ingredients, Surfactants, Water treatment, Dyes, Pigments

INTRODUCTION

Bulk chemicals are those made on a very large scale in order to satisfy Global needs. These are sometimes referred to as commodity chemicals or heavy chemicals. Examples include sulphuric acid, nitrogen, oxygen, ethylene, propylene, ammonia, sodium hydroxide etc.,

Fine chemicals are those made in small, limited quantities. These are sometimes referred to as speciality chemicals [1-3]. Manufacture of these chemicals use many small and complicated steps like chemical synthesis, extraction, hydrolysis, catalysis, biotechnology etc.

The definition of specialty chemicals [4] varies widely across the industry. These may be considered as chemicals which are used in low quantities and are targeted towards specific end-use applications. Specialty chemicals, by virtue of being high value, specialized products command higher margins than most bulk products.

Speciality chemicals can be sub-divided based on end-user industries. In addition to end-use driven segments, there are a few categories of specialty chemicals which are used across several end-user segments for similar applications. Popular symbolic representation of nine segments of speciality chemicals is presented in figure 1.

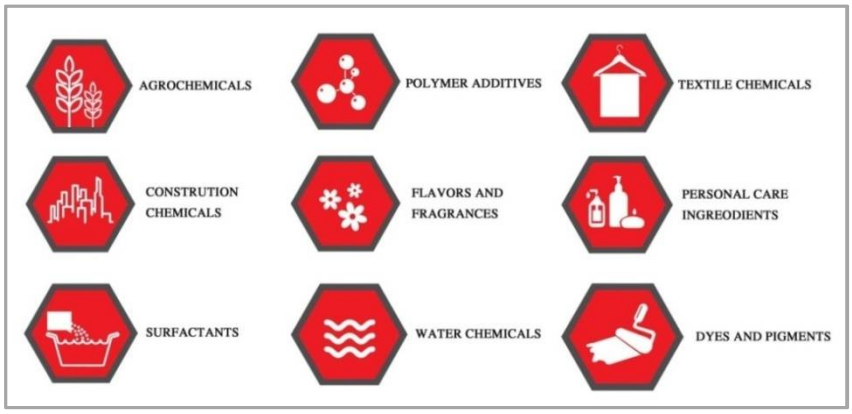


Figure 1. Different segments of speciality chemicals

The performance parameters of these nine segments are summarized in table 1. The Global growth of these chemical segments is progressive and is expected to grow further in future.

Table 1. Summary performance parameters for segments

S.No.	Segment	Market Size	Growth Rate	Overall Attractiveness
1.	Agrochemicals			
2.	Polymer Additives			
3.	Textile Chemicals			
4.	Construction Chemicals			
5.	Flavours and Fragrances			
6.	Personal Care ingredients			
7.	Surfactants			
8.	Water Treatment Chemicals			
9.	Dyes and Pigments			

Agrochemicals: Over the last few decades, agrochemicals has played a vital role in improving agricultural productivity, necessitated by a growing population base and the resultant demand arising from the need to achieve food sufficiency. These fundamental factors will continue to drive growth in the agrochemicals industry going forward. While agrochemicals are a generic term referring to a broad range of chemicals used in crop protection, synthetic fertilizers, hormones and as growth agents.

Agricultural productivity has been a key concern globally, driving significant research efforts across the various aspects, including crop protection chemicals. Agrochemicals can be classified as insecticides, fungicides, herbicides and other pesticides. Familier agrochemical molecules and their typical uses are listed in table 2. Pesticides play an important role in the crop production. World health organisation classified pesticides in to eight types. The extent of danger [5] with these pesticides and relavent examples are listed in table 3.

Table 2. Commonly used agrochemical molecules

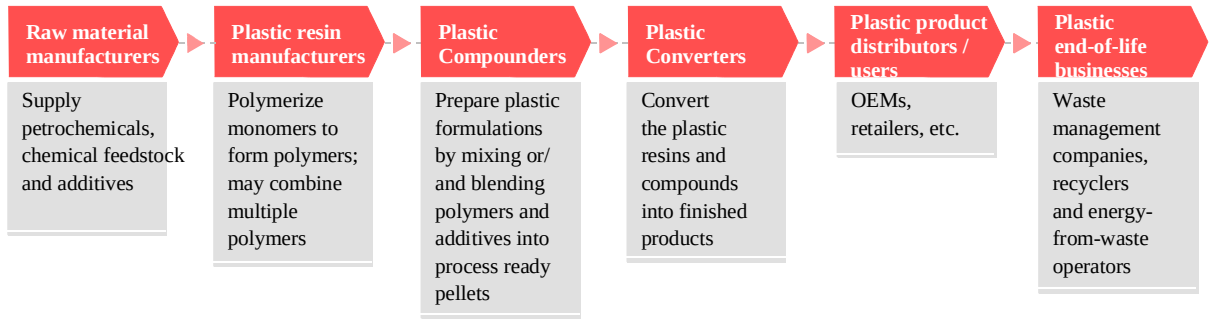
Molecule	Type	Use of the agrochemical
Imidacloprid	Insecticide	Used to control sucking pests - aphids, jassids, thrips, whitefly, brown planthopper and a variety of insects in cotton, rice and vegetable crops
Fipronil	Insecticide	Used to control rice stem borer, diamondback moth of cole crops, early shoot borer of sugarcane and thrips in chilli
Glyphosate	Herbicide	Used to control weeds, especially annual broadleaf weeds and grasses in various crops
Tricyclazole	Fungicide	Used to control leaf blast, node blast and neck blast in rice
Quizalofop	Herbicide	Used to control narrow leaf weeds in broad leaf crops
Dinotefuran	Insecticide	Reliable solution to effectively manage the brown plant hoppers in rice
Hexaconazole	Fungicide	Useful for controlling powdery mildews, rusts and leaf spots in cereals, oil seeds, horticultural and plantoatin crops and also for the effective control of rice sheath blight
Chlorpyrifos	Insecticide	Useful in the control of fruit borers, stem borers and leaf eating caterpillars on a wide range of crops like cotton, pulses, oilseeds, rice, etc
Acephate	Insecticide	Particularly effective on severe infestations of sucking and chewing insects of tobacco, sugarcane, cotton, chillies, vegetables, fruits and cereals
Flonicamid	Insecticide	Control of almost all important aphid species in apples, peaches, wheat, potato, vegetables

Table 3. WHO Classification of hazardous pesticides

S.No.	Extent of danger	Examples
1.	Extremely Hazardous	*Aldicarb, Chlormepos, Disulfoton, Hexachlorobenzene, Phorate, Parathion, Sulfotep, Terbufos*
2.	Highly Hazardous	*Acrolein, Carbofuran, Dinoterb, Famphur, Isoxathion, Mecarbam, Oxamyl, Tefluthrin, Warfarin*
3.	Moderately Hazardous	*Acephate, Allethrin, Bentazone, Butamifos, Carbosulfan, Chlorpyrifos, Cyanazine, DDT, Endosulfan, Fipronil, Imidacloprid, Phenthoate, Quizalofop, Thiacloprid, Tricyclazole, Ziram*
4.	Slightly Hazardous	*Acetochlor, Borax, Butachlor, Chloidazon, Dicloran, Glyphosate, Hexaconazole, Pimaricin, Spinosad, Trietazine*
5.	Active ingredients unlikely to present acute hazard in normal use	*Aclonifen, Bromacil, Captan, Dalapon, Fenclorim, Folpet, Isoxaben, Mancozeb, Neburon, Phthalide, Tebutam, Zineb*
6.	Obsolete or discontinued pesticides	*Aldrin, Barban, Butam, Carbanolate, Clofop, Dieldrin, Erbon, Glyphosine, Mirex, Proxan, Sesamex, Tetrasul*
7.	Pesticides subject to prior informed consent procedure (Rotterdam Convention)	*Aldrin, DDT, Dieldrin, Fluoroacetamide, Heptachlor, Lindane, Pentachlorophenol, Monocrotophos, Parathion*
8.	Gaseous or volatile fumigants (not classified by WHO)	*Aluminium phosphide, Chloropicring, 1,2-Dibromoethane, Ethlene oxide, Formaldehyde, Hydrogen cyanide, Methyl bromide, Phosphine*

The Indian domestic agrochemicals market provides long term growth opportunities. India is also emerging as a major exporter of generic agrochemicals which is likely to further strengthen with a significant number of agrochemicals.

Polymer additives: Polymer additives are substances added to plastic resins to form process ready polymer compounds or to modify or impart specific changes to their property. The result of introducing an additive into a compound can vary from enhancing its properties to merely changing its colour. Additives can also be used to improve the characteristics of polymers such as strength, lustre, durability or heat sensitivity. Polymer additives comprise less than 1% of the total weight of the end product. Tha value chain of plastics is shown in scheme 1.



Scheme 1. Value chain of plastics.

A major challenge faced by plastics segment is environmental impact - a lot of effort is concerted globally on recycling. Addition of fillers and certain colorants may adversely impact the recyclability of plastics. Certain additives, however, help retain properties of the plastics during recycling process. Recycling of plastics, however, is still at a nascent stage in India.

Polymers addives are broadly classifies in to four types.

1. **Plasticizers:** These are additives that improve the ease of processing of intermediates to plastic compounds. They increase fluidity (reducing viscosity), and impart greater flexibility and durability (plasticity) to the end material (plastics). Applications include PVC products, particularly the ones used for cables and wires.

2. **Heat stabilizers:** These protect plastics from the degrading effects of heat. The major application includes PVC products used in construction such as window profiles, pipes and cable ducts.

3. **Antioxidants:** These prevent oxidative degradation (across manufacturing, processing and end-use stages) of polymers. Plastics in order to minimize changes in colour, physical and mechanical properties such that they are within acceptable limits.

4. **Others:** Other significant additives are light stabilizers and flame retardants. Light stabilizers protect polymers (especially polypropylene and polyethylene) from the long term degradation from ultraviolet component of light. Flame retardants inhibit, suppress or delay development of flames to prevent spread of fire.

The Indian polymer additives market segmentation is shown in figure 2. This market of polymer additives accounts for only about 1% of the global market and the growth opportunity has not materialized in full. The model of usage and application of polymers in developed countries suggests that there is a huge market potential in India for similar applications.

Textile chemicals: Textiles require a range of treatment processes before reaching the end-user. Textile chemicals are specialty chemicals used during dyeing and processing of textiles to impart

desired properties to the end product.

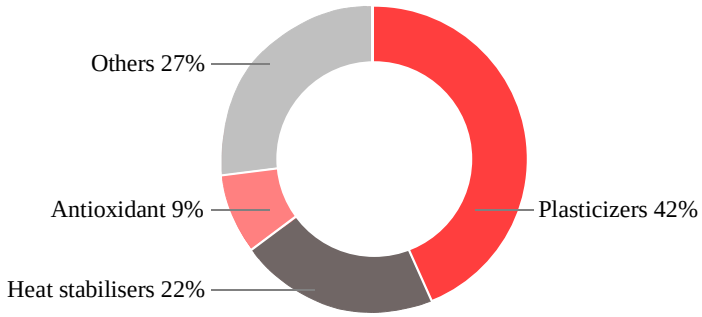


Figure-2. Segmentation of Indian polymer additives

The Indian textile chemical industry is highly fragmented and largely unorganized. The three main applications for textile chemicals are home furnishings, apparels and industrial uses. The various types of textile chemicals include coating and sizing chemicals, colorants and auxiliaries, finishing agents, surfactants, de-sizing agents, bleaching agents and yarn lubricants. Breakup of textile chemical market, based on the product type, is shown in figure 3 and five different stages of textile processing is given in scheme 2.

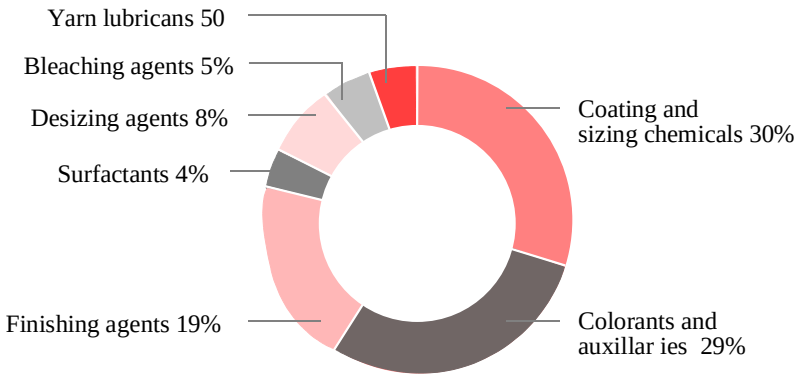
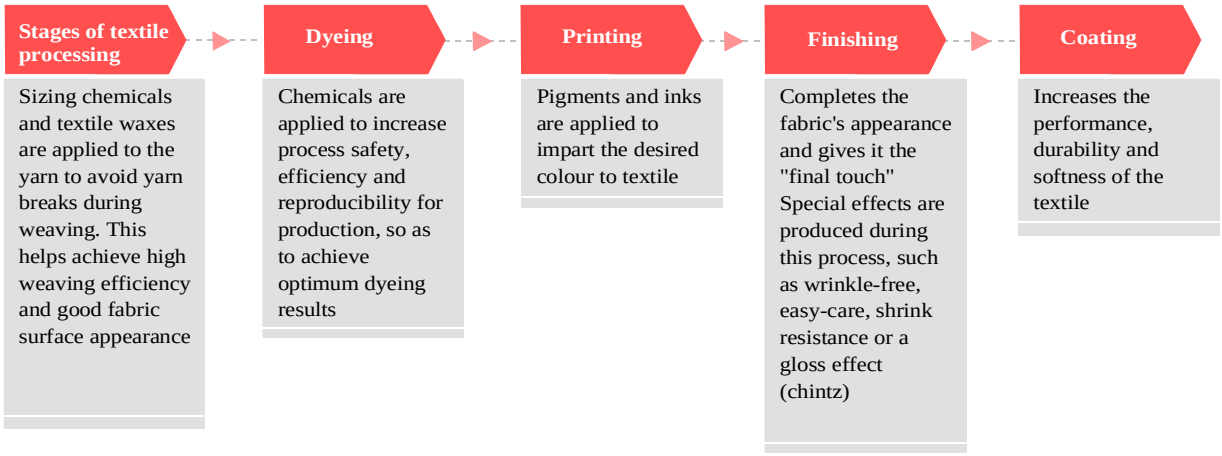


Figure 3. Breakup of Global textile market.



Scheme 2. Five different stages of textile processing.

A large domestic demand for textiles, growth in branded apparel, strength in exports and opportunities for technical textiles, together provide a large and growing market for textile chemicals.

Construction chemicals: Construction chemicals are specialty chemicals used in construction projects (residential, industrial and infrastructure) to increase the structural life or strength, impart additional protection against environmental conditions or to reduce the quantity of raw material required.

The global construction chemicals market has witnessed the emergence of China as a leading consumer over the last decade. The Indian construction chemicals market has quite a few domestic companies, but only a handful have been able to create strong consumer brands of scale. The value chain of construction chemical manufacture is depicted in figure 4.

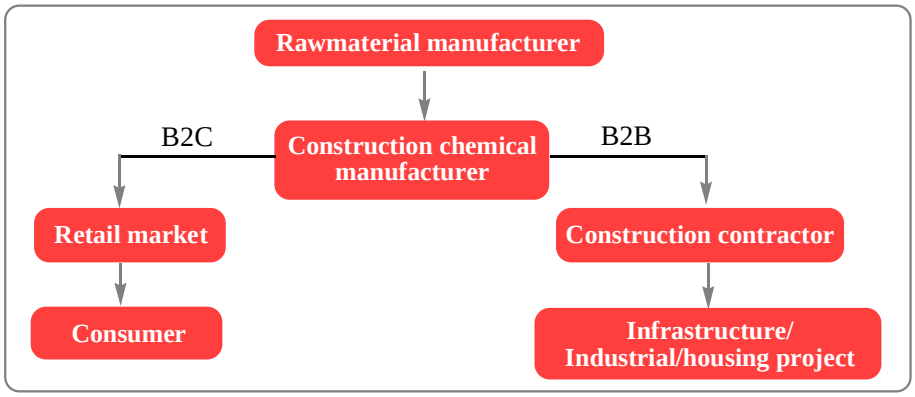


Figure 4. The value chain of raw materials for construction.

Construction chemicals follow both B2B and B2C model for marketing. These models have different products, players and key success factors:

1. B2B: In this model, construction chemical manufacturers cater to various industrial, residential or infrastructure construction projects. In this space, the past track-record of the construction chemical company and ability to meet technical specifications of the project are important factors.

2. B2C: In this model, chemicals are sold through retail outlets directly to consumers or small contractors. Branding and marketing are the most important drivers for this segment. Indian companies dominate this segment with Pidilite as the market leader.

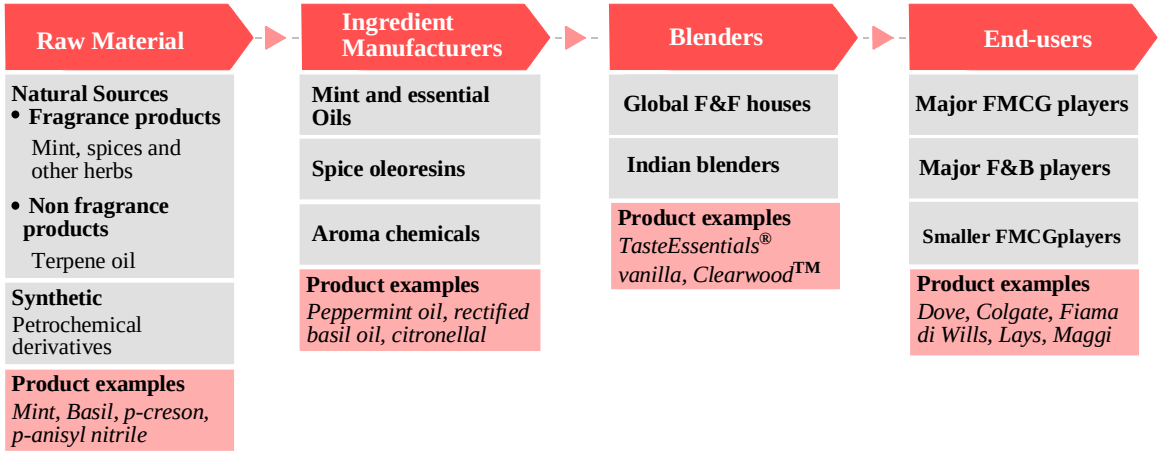
The main growth driver is the increasing demand for finishing chemicals. Recent innovations in finishing chemicals allow a variety of beneficial properties like anti-microbial properties, wrinkle-free properties, stain-resistance, etc. to be imparted to the textile. The use of these chemicals has almost become a norm rather than exception.

The major product categories in construction chemicals are: concrete admixtures, waterproofing chemicals, adhesives and sealants, flooring chemicals, repair and rehabilatation chemicals.

The most significant challenge faced by Indian construction chemical players is the pressure on profitability. Small scale construction projects are highly price-sensitive as the builders involved in such projects are focused on short term returns rather than long term sustenance.

Flavours and Fragrances (F and F): Flavours and fragrances are small but significant constituents of food, beverage and FMCG products respectively. They are directly involved in creating a sensorial connection between the product and its consumer, often contributing to a strong brand recall.

All F and F blends use a large number of ingredients, which can be either natural or synthetic, depending on the source and manufacturing process. India is strongly positioned as a leading natural F and F ingredients supplier to the global market, catering to 60% of the global spice oleoresin demand. With a large growing demand and the resultant opportunities for Indian manufacturers, the market for F and F and ingredients is set to serve up a spicy fare. Value chain in Indian flavours and fragrances is shown in scheme 3, along with illustrative players.



Scheme 3. Value chain of flavours and fragrances.

Flavors and fragrances can be derived from a variety of sources of raw material. Essential oils are distilled from various herbs and spices like mint, rosemary, eucalyptus and others, whereas aroma chemicals are derivatives of organic or inorganic aromatic compounds, which are in turn derived from petrochemicals or from natural sources. The ability to secure a consistent raw material supply is a key advantage for Indian players using natural ingredients, the only challenges being seasonality and variation in yields of natural raw material. Considering the competitive landscape, the ingredients manufacturers in F and F industry are three types.

Type 1. Mint extracts and menthol producers: Some of the leading players are Sharp Global, Hindustan Mint and Agro and K.V. Aromatics.

Type 2. Spice oleoresin manufacturers: For instance, Synthite, Kancor and Plant Lipids.

Type 3. Aroma chemical manufacturers: Privi Organics, Camphor and Allied Products and Eternis are the large producers in India. This segment also faces competition from Chinese aroma chemical manufacturers particularly on pricing. While the quality of ingredients offered by Chinese manufacturers is fairly accepted, continuity of supply and tightening environmental norms are the key risks faced by their customers

India is already in a strong position in terms of raw material availability and can continue to build on this advantage. Indian players in the natural ingredients market will continue to have an advantage in terms of their proximity to the raw material supply.

Personal care ingredients: Personal care products cover a diverse array of products we use in our daily life, including skin care, hair care, cosmetics and oral hygiene products. It represents a large market, dominated by multinational companies with some of the most recognizable brands globally.

While brands are known to all, there is less awareness of the chemistry behind these products or the ingredients constituting them. Ingredients used for personal care products can either be undifferentiated bulk chemicals (waxes, solvents, etc.) or specialty chemicals.

Illustrative composition of a conditioning shampoo is given in Table 4. Deionized water is the major constituent in shampoo. Surfactants also play a good role, though they are inactive. Actives constitute a small part by weight of end product.

Table 4. Illustrative composition of a conditioning shampoo

Ingredient	Weight (%)	Function	Category
Deionized water	68.7%	Diluent	
Carbomer	0.5%	Rheology modifier	Inactive specialty ingredient
Sodium Hydroxide	0.4%	Neutralizer	Bulk chemicals
Glycerin	1.2%	Humectant	Bulk chemicals
Sodium Trideceth Sulfate	13.9%	Surfactant	Inactive specialty ingredient
Cocamidopropyl Betaine	8.0%	Surfactant	Inactive specialty ingredient
Polyquatermium -22	1.0%	Conditioner	Active specialty ingredient
Polyquatermium -53	1.8%	Conditioner	Active specialty ingredient
Citric Acid	0.2%	pH Adjuster	Bulk chemicals
Polyquatermium -10	0.3%	Conditioner	Active specialty ingredient
Ethylexyl Methoxycinnamate	1.0%	UV Filter	Active specialty ingredient
Glycol Disterate	0.8%	Pearlescent Agent	Inactive specialty ingredient
Glyceryl Stearate	1.5%	Pearlescent Agent	Inactive specialty ingredient
PEG-120 Methyl Glucose Trioleate	0.7%	Thickener	Inactive specialty ingredient
Benzyl Alcohol	0.2%	Preservative	Inactive specialty ingredient

Personal care specialty ingredients are classified, based on their role in the product, into active and inactive ingredients. Common active personal care ingredients and their uses are listed in table 5.

Table 5. Common personal care active ingredient

Ingredient name	Chemical used as	Chemical used in
Triclosan	Anti fungal agent	Shampoos and soaps
Hexylresorcinol	Anesthetic, antiseptic and anthelmintic agent	Skin care products including anti ageing creams
Saccharomyces ferment lysate filtrate	Skin conditioning agent	Anti ageing and moisturizing creams
Pro-Cysteine	Anti ageing, and depig-mentation agent	Skin whitening creams
Zinc pyrithione	Anti bacterial agent	Anti dandruff shampoos
Piroctone olamine	Anti fungal agent	Anti dandruff shampoos
Minoxidil	Vasodilator	Hair loss prevention products
Hyaluronic Acid	Anti ageing agent	Anti ageing products
Ethylhexyl triazone	UV agent	Sunscreen

The domestic personal care market presents an interesting opportunity area for active ingredient manufactures. The increase in penetration of rural market will drive the growth of personal care products in the near future. In the urban market premiumisation trend is evident which provide greater market opportunity for high margin active ingredients.

Surfactants: Surfactants or surface active agents are organic compounds that lower surface tension between two liquids or between a liquid and a solid. Functionally, they are used to improve cleaning efficiency, emulsifying, wetting or dispersing actions, solvency, foaming/de-foaming and lubricity of cleaning agents and other products.

Surfactants are mainly classified in to four types. These surfactant types and their respective uses are given in table 6.

Table 6. Four types of surfactants and their uses

S.No.	Surfactants	Characteristics	Uses
1.	Anionic surfactants	High foam and dirt removal properties	Shampoos, toothpastes, body wash formulations, laundry detergents and dishwashing products
2.	Nonionic surfactants	Can be used with high salinity or hard water; compatible with other types, excellent candidates for complex mixtures; low toxicity levels	Cosmetics, personal care products like shampoos, bath and shower products, home care products like liquid detergents
3.	Cationic surfactants	Helps in conditioning due to substantiality to hair and antimicrobial properties	Hair conditioners and fabric softeners
4.	Amphoteric surfactants	Dermatological properties and reduction of skin irritation	Personal care and household cleaning products

Unlike most other segments mentioned in this report, surfactants are not aligned to any particular end-user industry. They find application across a wide array of industries, including home and personal care, textile, water treatment, agrochemicals flavours and fragrances. Surfactants are used most ubiquitously as basic cleaning agents in consumer products such as detergents, shampoos, body washes and toothpastes.

The systemic shift to eco-friendly products is happening as some of the traditional surfactants are known to be toxic to animals, ecosystems and humans, and can increase the diffusion of other environmental contaminants. As a result, there are proposed or existing restrictions on use of some synthetic surfactants.

A surfactant owes its properties to its chemical structure, which comprises a hydrophilic head and a tadpole shaped hydrophobic tail. Surfactants are also often classified by the composition of their head as : anionic, non-ionic, cationic and amphoteric. Breakup of Global market by volume, based on surfactant type is shown in figure 5.

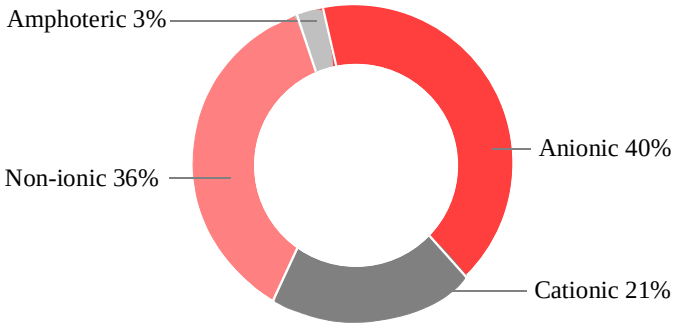


Figure 5. Breakup of surfactant global market (by volume).

Demand for surfactants in India is expected to grow at more than twice the global rate. The segment is expected to witness solid growth, however, profitability would continue to remain challenged in the near term. For Indian players the opportinuty lies in the movement towards specialized surfactants.

Water chemicals: Water treatment chemicals are used to add some specific properties to water or alter the physical or chemical properties of water for domestic, commercial and industrial applications. In some developing countries, chemical water purification is conducted at household level to provide safe drinking water. In developed countries and urban centers of developing countries, this is generally done at the municipal level by civic authorities or by water management organizations.

The industrial applications of water treatment chemicals largely entail waste water management, enhancing efficiency of industrial equipment by minimizing corrosive and other adverse impacts of water. Sector wise water consumption in given in figure 6.

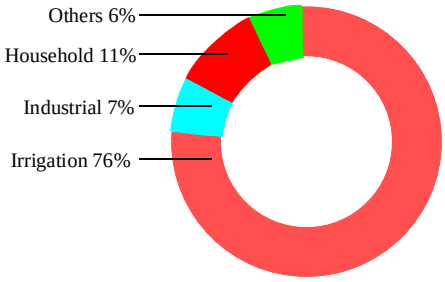


Figure 6. Sector wise water consumption in India

Based on their action, water chemicals are further classified into coagulants, flocculants, biocides, disinfectants, algaecides, defoamers, neutralizing agents, oxidants, oxygen scavengers, pH adjusters, boiler water chemicals, resin cleaners and scale inhibitors.

Water consumption for both industrial and municipal usage are expected to grow rapidly. The industrial segment in India is expected to drive the growth in short term driven by demand from power sector and implementation of stricter effluent norms. The municipal segment is expected to provide a huge growth opportunity in the long term. With growing urbanization, the demand for water supply as well as the waste water treatment is expected to rise in future.

Dyes and Pigments: The most common application of dyes is as colorants for textiles. They are also used in a variety of end applications including but not limited to paper, adhesives, art supplies, food and beverages, ceramics, construction, cosmetics, glass, paints, plastics and soap.

Pigments predominantly find application in paints and coatings, automotive finishes, emulsion paints and distempers. They are also used in printing inks, polyester textiles and plastics like PVC, rubber and synthetic polymers and nylons, cosmetics and paper. The key differences between dyes and pigments are their size and solubility - dyes are soluble while pigments form a suspension – this results in a difference in applications and process of application. Dyes can be classified as : azo dyes, acid direct dyes, disperse dyes, ingrain dyes, solvent dyes, reactive dyes, sulphur dyes, vat dyes. Pigments are mainly classified as : organic pigments and inorganic pigments. The breakup of Indian dye market, based on the end-use, is shown in figure 7.

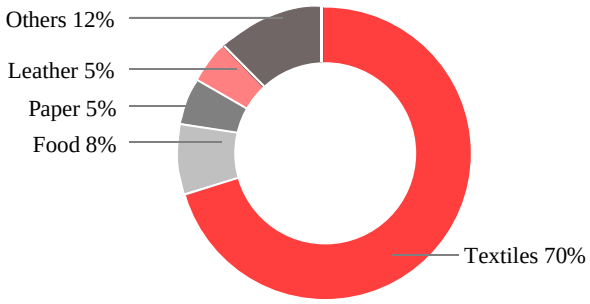


Figure-7. Breakup of Indian dye market

There are two major growth drivers of the Global colorants.

1. Growth in end-user industries: Dyes and pigments are used in a large number of applications. Paints and coatings industry, one of the major users, is expected to grow steadily due to investments in infrastructure and construction. Growth of printing ink, another major end-use, is expected to be

boosted with technological developments including digital inks of eco-friendly inks and steadfast products with better resistance to solvents and cleaners.

2. Demand for high performance pigments (HPP): These are highly durable pigments, resistant to UV radiation, heat and chemicals. Other properties of some of the HPPs include fluorescence, luminescence, thermo-chromatic and certain other effects not provided by ordinary pigments. Due to the weather-fastness property, their growth is largely driven by the automotive sector and outdoor housing coatings and paints for outdoor signs. These are relatively high value pigments and are used in specialized and less price sensitive applications such as automotive and inkjet printing. In this context, high performance pigments are projected to grow at a CAGR of 5% over the next five years.

Environmental consciousness: The use of eco-friendly colorants such as low impact dyes is emerging, with features such as low water requirement to rinse off residues during dyeing and rinsing process, low dye runs off in water creating lower pollution, reclaimability from run-off water which can then be recycled, non-requirement of toxic mordants or heavy metals, high absorption rate requiring less quantities of dyestuff resulting in lighter fabric, etc.

There is significant re-organization taking place in the dye and pigment industry globally. A short to medium term boom for the Indian dye and pigment industry is expected as Indian companies fill in shortages caused by Chinese plant shut downs. The benefits would largely be reaped by scaled up players who are compliant with international environmental and quality standards.

CONCLUSION

Low cost labour and raw material availability have been the advantages enjoyed by Indian manufacturing companies traditionally. Increasingly, though, specialty chemicals companies are focusing beyond these traditional cost advantages. In agrochemicals, for instance, the focus is largely on branding and distribution. Product development capabilities have become increasingly important across segments and account for the difference between top and bottom performers. Surfactants, personal caring rediants, flavours and fragrances are areas where scale and operational efficiency are still the success factors.

There are hundreds of specialty chemical industries in India. The different chemical segments cumulatively constitute a market of about 15 hundred billion rupees in India. However, the market capitalization of seven chemical industries is very dominant. The top specialty chemical industries are listed in table 7, along with the end chemical products.

Table 7. Top Indian speciality chemical Industries

S.No.	Industry Name	Market Capitalisation	Chemical products
1.	Gujarat Fluorochemical Ltd.	31823 Cr	Chloromethane, refrigents, teflon and other plastics.
2.	Aarti Industries Ltd	24795 Cr	Agrochemicals, polymers, surfactants, pigments, home and personal care products.
3.	Atul Ltd	24019 Cr	Phenols, pigments, multifunctional resins and reactive diluents.
4.	Vinathi Organics	20301 Cr	Isobutyl benzene, butylphenols, Butylamine, acrylamide, sulphonic acid salts.
5.	Navin Fluorine International Ltd	18682 Cr	Organofluorines, bulk fluorides and refrigenation gases.
6.	Clean Science and Technology	15543 Cr	Hydroquinone, phenol, anisole, guaiacol and carbodiimide
7.	Alkyl Amines Chemicals Ltd	13027 Cr	Aliphatic amines, agrochemicals, rubber chemicals, water treatment chemicals and pharmaceuticals.

Globally, specialty chemicals are driven by extensive product research, development and innovation [**6-8**], which is a significant differentiator over the commoditized chemical industry. The scenario is now more intensified in Indian specialty chemical industry [**9, 10**], mainly as import substitution and export earnings.

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