Turpentine: A Global Perspective

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Annual world production of turpentine is estimated to exceed 250,000 tons, which is tenfold greater than the production of any other essential oil. This production level reflects turpentine's importance to the world chemical industries as a basic feedstock for the manufacture of a wide range of derivatives. In the fragrance industry, the value of turpentine represents approximately 25% of the value of all aroma chemicals produced both for sale and for internal use each year.

Turpentine Types

The two principal types of turpentine today are gum turpentine, derived from the manual tapping of live pine trees (the gum naval stores industry), and sulfate turpentine, derived from the chemical pulping of pine lumber (the "Kraft" or "sulfate" process). In the latter process, crude sulfate turpentine is recovered along with tall oil rosin as a by-product.

Approximately 50-60% of the 250,000 tons of turpentine produced globally each year is sulfate turpentine. The supply of sulfate turpentine is currently stable, but the prospect exists for a decline in the long run. The supply of gum turpentine, which accounts for 40-50% of the annual world production, also is currently stable, but it has a potential for increase.

A third type of turpentine, wood turpentine, was formerly important, particularly in the U.S. However, the costs of extracting and transporting the pine stump raw material to factories has led to a radical decline in output.

Demand Levels and Usage

Historically, turpentine was first employed in bulk as a solvent. However, this market has declined to comparative insignificance following the advent of the less expensive "white spirit" derived from petroleum.

Global usage of turpentine is now centered on the chemical industries. The cleansing/bactericidal derivative "pine oil" accounts for approximately 50% of turpentine consumption, but over the past two decades this market also has declined. Currently, the growth area for turpentine as a chemical feedstock lies in the aroma chemicals and resin/adhesives manufacturing sectors (Table I).

Table 1. Global demand for turpentine as a chemical feedstock

Usage	Average product price (US$/kg)	Annual consumption (tons)	Growth in demand
For aroma chemicals	>6	100,000*	3-5%/year or 4,000 tons
For resins and adhesives	2	50,000-70,000	2-3%/year or 1,000 tons
For pine oil and as solvent	1.25	130,000-150,000	50% decline in pine oil use since 1970

* 33% as β-pinene

Major Consumers

On a global basis, the major users of turpentine are the leading aroma chemical and resin/adhesive manufacturers: IFF, Haarmann & Reimer, Firmenich, Millenium (formerly Glidco), Arizona, Givaudan-Roure, Quest, Bush Boake Allen, DRT and Hercules.

Principal Aroma Chemical Derivatives

The major aroma chemicals and intermediates produced from turpentine and with world markets exceeding US$10 million are as follows:

- pine oil
- myrcene
- linalool*
- citronellene
- geraniol*
- ionones*
- iso-bornyl acetate
- citronellol*
- citral*

* also derived from petrochemicals

Composition and Price

Gum and sulfate turpentine have different characteristics and price levels and, consequently, there are preferred uses/submarkets for each. The two most important chemical differ-

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ences are the sulfur content and the monoterpene composition. The sulfur present in sulfate turpentine presents problems in some chemical transformations. The monoterpene composition is dependent on the species of pine used.

The major world users want a high pinene content in turpentine and favor β-pinene over α-pinene for many transformations. (China, in contrast, has an industry based on the use of α-pinene because of its comparative availability in China's domestic turpentine.) A high δ-carene content in turpentine is universally disliked by the chemical industry because this compound is difficult to manipulate.

The principal pine species providing major commercial volumes of turpentine with a high total pinene content and a 15% or greater β-pinene content are *Pinus elliottii* (ex. USA) and *P. radiata* (ex. New Zealand).

Gum turpentine is priced at approximately US$1-1.50/kg and sulfate turpentine at approximately US$0.15-0.30/kg. β-Pinene-rich turpentine is usually priced 40-50% higher than α-pinene-rich turpentine.

Price movements affect industry usage patterns. As a-pinene prices rise above pine oil prices or as β-pinene prices exceed resin prices, manufacturers will use more of the feedstock for aroma chemicals and less for resin/adhesives.

Consumption Levels and Trends

Use of turpentine derivatives is not uniform on a global basis. In developed countries the market is mature, with high levels of consumption per capita. In the major emerging consumer markets, current consumption levels are comparatively small, as illustrated for aroma chemicals in Table 2.

Usage is growing in many developing countries, however. In China, for example, short-term turpentine consumption is predicted to increase by 10% annually from the current base of some 50,000 tons.

Sustained economic development and improved disposable income levels in the more populous developing countries, such as China and India, will inevitably lead to a much greater consumption of turpentine derivatives. In the long run, the impact of these new markets is potentially tremendous. Although the main growth area in all such

Table 2. Regional per capita usage of turpentine

Market	Use of aroma chemicals from turpentine (grams/year)	Equivalent turpentine consumption per person
North America and the European Community (600 million people)	100	~3 drops per day
China (1.2 billion people)	6	~1 drop per week

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countries lies with aroma chemicals, pine oil can be a component when the local manufacturing price is competitive with synthetic alternatives.

Supply

As noted earlier, market supplies of turpentine have been almost equally balanced between the sulfate and gum types.

Table 3 shows that the production of sulfate turpentine occurs mainly in the USA, Scandinavia, Russia and New Zealand. In the USA and Russia, the bulk of the production is consumed domestically rather than passing into international trade. Globally there is a move toward using thermomechanical rather than chemical pulping methods in new paper manufacturing plants. This implies a reduction in sulfate turpentine availability in the long term and a greater reliance on gum turpentine.

Gum turpentine production has progressively declined in all developed countries, as labor rates have increased and become uncompetitive. The reduction in gum turpentine supplies from these traditional sources has been made good, until recently, by the emergence of other sources in less high-cost areas, among which China has been prominent (Table 3). However, in the last two years, short supplies of gum turpentine have been experienced, a change somewhat influenced by changes in output and consumption within China. This has been accompanied by a large hike in prices and a movement by some product end-users to petroleum-derived alternatives.

On a worldwide basis, the pine tree resource, both wild forest and plantation-grown, that exists in low labor-cost areas is more than adequate to supply gum turpentine for the predicted growth in demand. However, many suitable pine forests are presently unexploited for this purpose because local foresters and entrepreneurs are ignorant of

Table 3. Average annual tonnage of turpentine from the principal producing and exporting countries in the early 1990s

	Sulfate turpentine		Gum turpentine	
Region or country	Production	Export*	Production	Export*
USA	90,000			
Scandinavia	15,000			
Greece			600	
Russia	10,000		9,000	500
China			50,000	5,500
India (importer)			4,000	nil
Indonesia			12,000	7,500
Vietnam			200	
Brazil			8,000	3,000
Argentina			4,000	2,000
Mexico			4,000	
Honduras			1,000	500
Venezuela			800	
New Zealand	3,000			
South Africa	600	600	400	300

* where figures are available

the market potential. Elsewhere, gum resin productivity is below optimal levels through the failure to adopt modern tapping technology and to take advantage of the known benefits arising from the selection of elite trees in seed multiplication programs for plantations.

In China, output of gum turpentine appears to have been constrained in recent years by the imposition of a national quota on the production of gum rosin, the co-product from crude pine gum.

Future Chinese-Gum Turpentine Production

All market indicators reveal good prospects for increased sales of gum turpentine and pinene isolates from Yunnan Province, an area rich in the *P. kesiyia* pine tree that produces a gum turpentine high in β-pinene content.

Increasing demand for Yunnan's gum turpentine is evident on the Chinese domestic market, along with an apparent downturn in production by former major producer provinces in the "special economic zones." In addition, the international market opportunities are promising. However, Yunnan's success in capturing a larger share of the international market is not dependent simply on increasing gum turpentine output from its current modest level. There are two basic requirements for achieving the desired objective: following good trading practices (including competitive pricing and prompt delivery) and exploiting the province's comparative advantages to the fullest.

The latter point relates to the fact that Yunnan is blessed with a very substantial pine tree resource of *P. kesiyia* that is capable of providing a turpentine with a high β-pinene composition that is very attractive to overseas buyers. No other Chinese province has material of comparable quality. Indeed, Burma is the only other Asian country that has a similar potential, though that country appears unlikely to develop volume production any time soon. Indonesia, now a significant world source, depends on *P. merkusii*, which provides a high α-pinene turpentine of lesser value.

The strategy of the naval stores industry in Yunnan, therefore, should be to place a high priority on development using *P. kesiyia* rather than the other, less-interesting indigenous species *P. yunnanensis*. Additionally, reconsideration should be given to adopting modern tapping methods, which provide higher gum yields at a lower labor cost. This would both improve output and ensure price competitiveness.

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