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SORTING OUT SOLUTIONS

How cigarette filters can be used to meet regulations.

By Mike J. Taylor

Although the pressures on the cigarette industry tend to differ in different parts of the world, a common global trend is the increase in regulations covering many aspects of the industry. The filter has long been recognized as an integral part of the final product and an important tool that enables the cigarette designer to meet a wide range of product parameters. In particular, the filter can help the designer meet regulations relating to maximum yields and reduction of those compounds that are required to be measured and reported. Less obviously, perhaps, the filter can also help differentiate products in markets where advertising is banned, and modify yields for low sidestream or low-ignition-propensity products.

The regulations governing maximum yields can be divided into two main groups: those governing only tar and/or nicotine, (enacted in Russia, Norway, Switzerland, Hungary, Malaysia and Hong Kong, among other countries), and those governing tar, nicotine and carbon monoxide (enacted in Brazil, Australia and the Gulf States, and to take effect in the European Union in 2004). In other major markets, such as China, maximum tar levels are covered by a voluntary agreement.

To produce a cigarette that is acceptable to the consumer, the cigarette designer has to achieve the right balance between draw resistance, taste and impact. It is not simply a case of increasing filter retention—which increases cigarette draw resistance—to give the required tar and/or nicotine yields, or of increasing ventilation levels—which reduces cigarette draw resistance—to give the required carbon monoxide (CO) yield.

CELLULOSE ACETATE ALTERNATIVES. To reduce tar and nicotine without increasing cigarette draw resistance, cigarette makers can use alternatives to cellulose acetate filters. One option is Filtrona's Combined Performance Filter (CPF). This is essentially an acetate filter with a fluted wrap that increases tar/nicotine retention by up to 10 percent compared with a standard mono-acetate filter at the same pressure drop. The CPF filter can also give the cigarette a unique end appearance, which can help protect against counterfeiting and increase brand differentiation and impact; this is especially useful in markets where advertising restrictions exist. The CPF filter is currently used on many brands worldwide but has been particularly successful in the Far East, where it is currently on a large number of brands produced in China and other parts of Asia.

Diagram 1 shows the CPF filter (which can be used with the flutes showing at the mouth end or toward the tobacco if standard appearance is required) and a plot of its tar retention compared with that of a cellulose acetate filter.

A second option is using a filter material with inherently higher retention efficiency than cellulose acetate—pure cellulose. Cellulose, or paper, in a cigarette filter is normally used in a dual configuration with cellulose acetate at the mouth end. This product has the retention performance of paper combined with the taste and appearance benefits of cellulose acetate. Careful use of different segment lengths and types of paper make this one of the most flexible filters in terms of pressure drop/retention relationships. Use of a special type of paper, CREST, which was jointly developed by Filtrona, allows this filter to give the highest retention possible in any commercially available filter. The retention capability of various papers is shown in the plot in **Diagram 2**, along with a plot for a low-denier-per-filament acetate for comparison.

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A reduction in filter diameter also reduces the overall retention and hence efficiency of the filter. However, in general, the use of low-circumference filters is on the increase with the increasing popularity of slim and superslim brands. In many slimline products, either very high pressure drops or very high levels of ventilation are required to meet a particular yield target. CREST is used commercially to overcome the problems associated with either high ventilation or high pressure drop due to its very high retention properties.

CARBON MONOXIDE REDUCTION. In markets where CO is included in the legislated maximum yields, the trend has been to reduce filter efficiency and increase filter ventilation. Ventilation is the only current practical method to reduce CO yields. Simply increasing ventilation can reduce cigarette draw resistance to an unacceptable level. The challenge is to achieve a cigarette with an acceptable draw resistance combined with a ventilation level that significantly reduces CO. This can be achieved by the use of a special high-pressure drop/low-retention filter. A range of these filters is available on the market today.

One of the most prevalent in current commercial use is Filtrona's Coaxial Core Filter (CCF), shown in **Diagram 3**. The CCF filter employs two-filter materials in a coaxial configuration. These materials are commonly low-denier-per-filament tow (high PD) and high-denier-per-filament tow (low PD). Due to the combination of materials and pressure drops, smoke is channeled down the lower PD section of the filter. In effect, this forms a reduced circumference (cross-sectional area) filter. Reducing filter circumference reduces retention efficiency but also increases pressure drop. The resulting high PD permits the use of high ventilation to reduce CO yields while retaining an acceptable cigarette DR. It should also be noted that high levels of ventilation reduce all vapor-phase compounds, so these CO-reducing filters also reduce volatile aldehydes (formaldehyde, acetaldehyde, etc.), hydrocarbons (butadiene, isoprene, etc.), inorganic gases (nitric oxide and hydrogen cyanide) and all other vapor-phase compounds to a similar extent as the CO reduction. **Table 1** shows a typical comparison of CO levels for standard acetate and CCF filters at the same approximate tar yield and cigarette draw resistance.

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FIRE PREVENTION. Though filters cannot be used directly to improve the fire safety of cigarettes or in low sidestream products, the filter still has an important role to play in both areas. Often, the tobacco columns of these products, due to the materials used in their construction, have higher tar, nicotine and especially CO yields than standard products. Thus, cigarette designers looking at low-ignition-propensity and low-sidestream products have the problem of achieving lower tar, nicotine and CO yields while keeping the correct balance between draw resistance, taste and impact. To achieve this, products that will allow higher tar and nicotine retention efficiencies at the same filter pressure drop, such as the CPF filter, can be used. Alternatively, if CO reduction at an acceptable cigarette draw resistance is the primary aim, CO reduction products such as the CCF filter can be used.

CHARCOAL. The other major filter material currently used is activated carbon (charcoal). Activated carbon has a non-crystalline structure with a very highly developed internal surface area, usually produced by the controlled oxidation of coconut shells. Activated by high pressure and high-temperature steam, coconut-shell-based activated carbon is one of the best adsorbent materials known to man and is the most commonly used type of carbon found in cigarette filters. Although not directly responsible for facilitating compliance with current regulations concerned with maximum yields, carbon can have a dramatic impact on smoke chemistry and, to a lesser extent, on taste. The use of carbon fits in with the current trend of yield reductions because it can significantly reduce a wide range of compounds not filtered by standard materials. Carbon can reduce many of the volatile, so-called Hoffmann analytes in smoke, including carbonyls such as formaldehyde, acetaldehyde, acrolein and acetone, as well as hydrocarbons—butadiene, isoprene, toluene and benzene—and other compounds, such as pyridine, hydrogen cyanide and acrylonitrile.

At the moment, in some markets, approximately 44 of these Hoffmann analyte compounds have to be measured and reported on an annual basis. Depending on the type of filter and the weight of carbon used, carbon can give a significant reduction in more than half of the compounds on these lists.

Carbon has applications in many areas because of its filtration and purification properties, such as water treatment. Its past history of use for filtration purposes means that charcoal has long been associated with purity and filtration. The first people to use charcoal as a means of purification were the Romans. The perception of charcoal is important—its filtration and cleansing properties are generally well-understood by consumers.

The dramatic growth of the use of cigarette brands containing carbon filters clearly reveals that consumers are comfortable with the concept of carbon, and—even more important in our industry—with the taste differences imparted by carbon. Consequently, the use of carbon in filters worldwide is growing at significant rates. Indeed, many of the cigarette brands that have seen strong growth in recent years use carbon filters.

A wide range of carbon filters is available; the most common is the active acetate dual filter (AAD), with the tobacco end of the filter containing activated carbon on tow. Triple granular filters (TRG), triple solid filters (TRS) and filters with carbon added to paper (HRVPA) are also available. Such a diverse range of products means that filters containing carbon can be designed to accommodate almost any combination of carbon loading and overall filter retention efficiencies. **Diagram 4** shows these types of filters.

A wide range of other filter types can also be combined with a carbon segment in a dual or triple construction. An example would be the combination of CPF and AAD to give a product a distinct appearance for brand differentiation while simultaneously utilizing the properties of carbon and increased efficiency of the fluted CPF filter.

FUTURE REQUIREMENTS? A possible future requirement of filters will be the ability to selectively remove various target compounds from smoke. In the past, compounds such as hydrogen cyanide, carbon monoxide, nitric oxide, formaldehyde and other aldehydes have been targeted as compounds for selective removal. Although these types of filters are not yet commercially available, they are the subject of much research. In the not too distant future, such products will be another tool in the armory of the cigarette designer.

Current industry trends are toward offering cigarettes with lower and lower yields. There are already many filter types to assist cigarette designers and marketers in enhancing brands while also meeting market and legislative requirements. In the future, this legislation can become only more onerous and prevalent. To meet these demands, new filter innovations that are more complex, more functional and more effective will be required and are being developed.

Table 1:

		Tobacco Column	Standard mono-filteredbrand	CCF Equivalent
Filter	**% TR**	Nil	50	30
Filter Ventilation	**%**	Nil	20	37
Cigarette DR	**mm**	N/A	110	103
Tar Yield	**mg**	25	9.7	9.9
CO Yield	**mg**	13.5	10.5	7.4

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Comment [LW3]: This term should probably be defined in a footnote to the table.

Comment [LW4]: This term probably should also be defined in a footnote.