Chopped Carbon Fiber

When fiber is specifically produced for chopping with multiple end uses the choice of size chemistry is extremely important. The range of matrices used in the composite industry requires that sizing applied to the fibers during manufacture is compatible with the final matrix.

Recent improvements in size chemistry has allowed the industry to move away from solvent based sizes to water based size which makes the sizing process much cleaner and more environmentally friendly. The size applied for fiber to be chopped should be of a low molecular weight which will facilitate de-sizing.

In many cases it is not feasible to produce fibers on line with various size types to match particular matrices. In this case the base size used on the production line will have to be removed so that an appropriate size can be reapplied, although some companies simply "oversize" for example an epoxy fiber size with a nylon size.

Typical size types and their matrices are:

Matrix Type	Size	Matrices
Engineering Thermoplastics	Polyurethane (PU) Polyester	PC, PA, POM, PBT/PET
High Temperature Thermoplastics	Polyimide (PI)	PPS, PEEK, PEI, PPA, PAI, PES PSU
Thermoset	Epoxy	Epoxy, Vinyl Ester Unsaturated Polyester Polyurethane, Phenolic.

Some companies produce unsized fibers to facilitate a much better fiber/matrix bond, Many companies use proprietary sizes developed with specialist companies such as Michelman in the US or Schill & Seilacher in Germany.

Industry requirements are that the chopped fiber has a consistent flow rate and that the fiber mixes well during the compounding phase. A high bulk density is also desired.

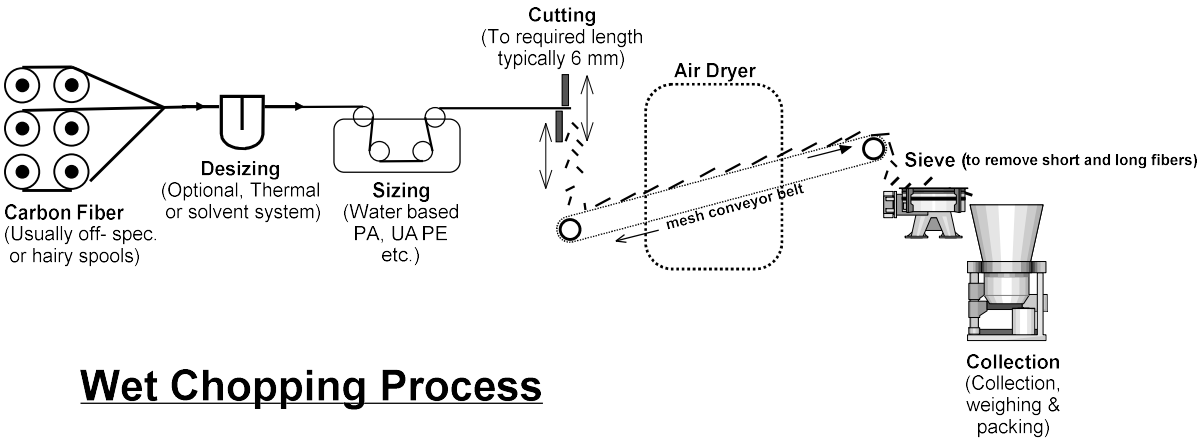
Chopping is particularly useful for improving the value of off-spec material and strands with many broken filaments (hairy strands).

The Chopping Method

There are two methods for chopping; wet or dry. The equipment used is similar but the layout of the equipment changes.

Wet Chopping.

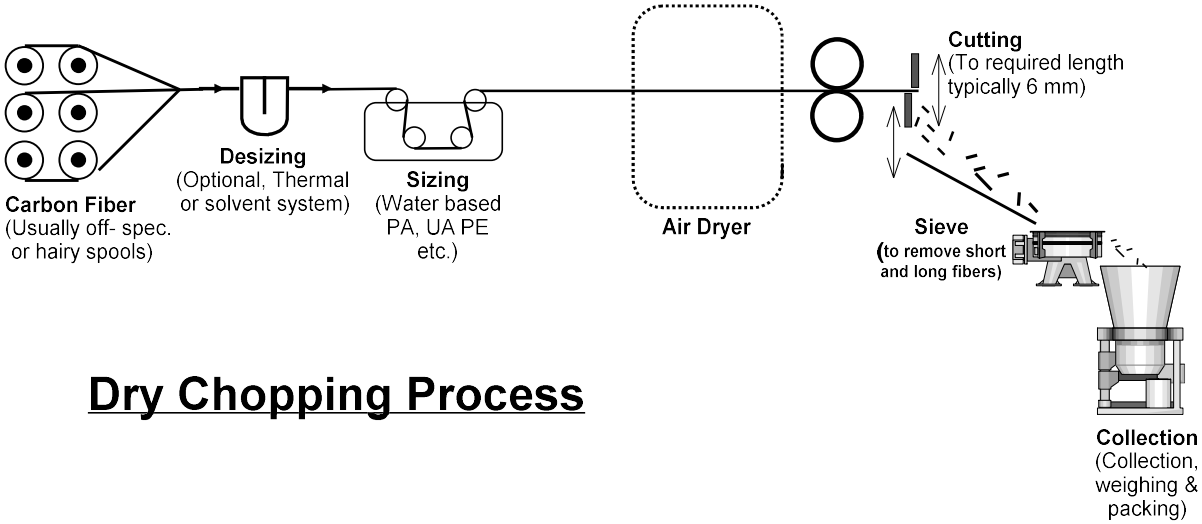
In this case the fiber is chopped directly after size application and requires the use of a drying tunnel.



Wet Chopping Process

Dry Chopping.

The equipment is identical except that as the fiber is sized then dried.



Dry Chopping Process

Equipment.

The line is made up of distinct sections;

Creel, De-sizing, Sizing, Drying, Chopping, Sieving, Packaging

Creel

The creel needs only to be of the simple type with the ability to maintain a constant and consistent tension on the tows during unwinding.

De-sizing

The most common method is to use pyrolysis to remove the size applied on the production line. The temperatures required to do this are relatively low, no more than 400^{o}C, so the pyrolysis oven can be relatively low technology. If water soluble sizes are used the de-sizing unit will take the form of a wash bath.

Sizing.

A simple dip bath with attendant size make-up and circulation unit.

Drying

In the case of wet chopping the drying tunnel would be a horizontal belt drying tunnel, in the case of dry chopping the drying tunnel would be vertical.

Chopping

There are two common methods for chopping carbon fiber, rotary or guillotine.
Rotary chopping machines, such as Finn & Fram operate at higher speeds but have a high cutting head attrition rate. Guillotine chopping machines, such as Berger or Pierret are slower and more accurate.

Sieving

The use of vibratory sieves ensures the reduction of long or short fibers compared to the desired cut length, in the finished product.

Packaging

The use of a vacuum bagging system ensures that each bag of chopped fibers is of the desired weight and the vacuum reduces the bulkiness of the bag for more efficient transportation.

Environmental

As with all industrial processes close attention must be paid to the environmental impacts a proposed process will have. The two sections most likely to have an environmental impact would be de-sizing and sizing. In the case of de-sizing by pyrolysis the fumes generated by the process have to be considered and abatement may be needed before allowing release to the atmosphere. The fumes generated will depend on the size applied when the continuous fiber is produced. A simple burner unit may be all that is required.

Vince Kelly