Table 9 Kevlar and Twaron aramid fiber products (Akzo Nobel, 1998; E.I. Du Pont de Nemours & Co., Bulletin K-1; E.I. Du Pont de Nemours & Co., Bulletin K-5; Yang, 1992).

Product type		*Fiber parameters*		*Typical applications*
Kevlar aramid fiber		Dpf	Denier	
	Filament yarn	1.5, 2.25	1500, 2250, 3000	Tire reinforcement
29	SM filament yarn	1.5, 2.25	200, 1120, 1500, 3000	General purposes
49	HM filament yarn	1.5	195, 1140, 1420	Composites
68	IM filament yarn	2.25	2250, 3000	Cable reinforcement
119	HE filament yarn	1.5, 2.25	1500, 3000	Tire reinforcement
129	HS filament yarn	1.5	1200	Ballistics
KM2	Filament yarn	1.5	1500	Ballistics
T-979	Aramid pulp			Composites
T-983	Aramid pulp			Composites
M/B	Masterbatch			Rubber reinforcement
Twaron aramid fiber		Length, mm	Dtex	
1000	SM filament yarn		400, 840, 1680, 2520, 3360	General purpose
1111	IM filament yarn		420, 126-, 1680, 2520	General purpose
2100	HE filament yarn		1100, 1680, 2520	Elastomer reinforcement
2000	HS filament yarn		840, 950, 1100, 1680, 3360	Ballistics
1055	HM filament yarn		405, 1210, 1610, 2420, 8050	Composites
1056	HM filament yarn		8050	Composites
2200	HM filament yarn		420, 1680, 2520, 3369	Composites
2200	HM filament yarn		8400	Composites
1488	Chopped fiber	1, 2, 6		Composites
1091	Aramid pulp			Composites
1093	Aramid pulp			Composites
1094	Aramid pulp			Composites
1095	Aramid pulp			Composites
1099	Aramid pulp			Composites

of PPD-T is of the order of 20 000 which corresponds to a degree of polymerization of 84 and a chain length of 108 nm. This compares well with the molecular weight and degree of polymerization of nylon 6,6 for industrial fiber.

1.07.3.2 Fiber Preparation

PPD-T fiber is prepared by extruding and spinning the anisotropic solution of PPD-T in concentrated sulfuric acid. The anisotropic behavior of PPD-T/H_2SO_4 solution was discussed in Section 1.07.1.4.

1.07.3.2.1 Fiber spinning

Figure 8 shows a dry-jet wet spinning process specifically designed for converting an anisotropic aramid solution into fibers of high tenacity and high modulus (Blades, 1973a). The dry-jet wet spinning process is quite different from the conventional wet spinning process. In the wet spinning process, the spinning nozzle is immersed in the coagulation liquid. In the dry-jet wet spinning process, the spinning nozzle is kept at a short distance above the coagulating liquid. The wet spinning process has several inherent problems. First, the spinning solution must be kept from freezing inside the nozzle. Second, the spinning solution is exposed to the coagulant as soon as it exits the spinneret nozzle. This prevents the solution from complete attenuation. The dry-jet wet spinning method allows the solution to be kept at a much higher temperature which makes it possible to use a high solution concentration. Furthermore, the air gap permits the extruded solution to be more fully attenuated and develop a higher degree of molecular orientation.

1.07.3.2.2 Heat treatment

The as-spun PPD-T fiber can be treated at high temperature and high tension to increase its crystallinity and degree of crystalline orientation. From variations in spinning and heat treatment, different types of PPD-T fiber products are produced.