PFL Plant at PG Complex, RIL©

Reliance Industries Ltd. (**RIL**) is the largest producer of Polyester Filament Yarn (**PFY**) in India. The total installed capacity of PFY at their Patalganga (**PG**) complex is about one Lakh tonnes per annum. Currently, RIL is augmenting it's PFY capacity by another 1.2 Lakhs tonnes at their Hazira (**HZ**) complex.

There are two variations of the product. **POY** refers to Partially Oriented Yarn. POYs are produced by feeding the polymer from the Continuous Polymerisation (**CP**) unit into the spinning machines. The second variety, viz., Straight Drawn Yarn (**SDY**) is produced by passing the polymer through an extruder. The fibre obtained in this case is both finer and brighter, and has better strength.

Product Variations in PFY

The basic variation in the manufacture of PFY comes from the concept of Denier rating. Denier is a measurement used in yarns and fibres which indicates the weight of 9000 metres. For example 126 denier rating for a fibre would mean that 9000 metres of the fibre would weigh 126 gms. Normally, 51 and 86 denier ratings belong to the SDY category and other ratings such as 126, 235, 115, and 110 refer to POYs produced. However, other variations are introduced due to certain manufacturing aspects.

Manufacturing of PFY

In simple terms, the manufacture of PFY is done in three stages. In the first stage, the pre-polymerisation activities include feeding in the required chemicals and catalysts for further processing. The second stage is the Continuous Polymerisation (**CP**). During this stage, the polymer is created in molten form by a CP unit and sent for spinning. The manufacture of the variations of PFY is organised through two units viz., PFY-I and PFY-II. Together, these have four CP units, that feed the polymer to the spinning machines. The CP units have a fixed maximum capacity at which they can deliver the polymer to the spinning machines.

The molten polymer enters into the spinning machine through a pack. Pack is a small cylindrical assembly "packed" with steel powder that acts as a filter. When the molten polymer passes through the pack, the impurities contained in them are removed. Further variations in manufacture are introduced by the number of holes each pack has. The polymer finally enters the spinning machine where they are finally wound in bobbins.

There are seventeen spinning machines that perform this operation. Typically each spinning machine has 32 positions, with 16 positions on one side and another 16 on the other side. Each position is assigned with eight packs. This means that for every spinning machine there will be (32x8) 216 packs.

Each position has two metering pumps. The purpose of these pumps is to monitor the flow of the polymer as they come out of the CP unit. Thus there are 64 metering pumps altogether that monitor the flow of polymer into each spinning machine. All the 64 metering pumps are controlled by a single invertor.

RIL manufactures a variety of deniers in PFY having different contributions. Table 1 has details on these[1]. Each spinning machine is capable of operating only on a certain range of denier ratings. Table 2 has the relevant details on the number of CPs, their capacities, the metering pump capacities, and the denier range the seventeen machines can process.

Changeover Requirements

Disrupting the production for certain changeover requirements are unavoidable. There are two types of changeovers required. Firstly, the packs have a finite life. Since packs act as filters, over a period of time, the impurities accumulate in the pack and this increases the pressure. When the pressure reaches a threshold level, the metering pumps will not be able to function properly. At this stage, the production needs to be disrupted for a pack change.

A pack changeover involves the following: First the metering pumps are stopped and the CP unit throughput reduced. After the existing pack is removed, the pre-fabricated ready-to-use packs are pre-heated to 280 -300° C and then inserted. The metering pumps are then started and the CP unit's throughput is restored back to it's original value over a period of time. The estimates for reaching stabilisation is currently put at four hours.

The second type of production disruption takes place again because of pack change. Since the packs are unique to the denier rating of the PFY, whenever there is a change in the denier rating of the PFY to be produced, it necessitates change of pack.

The losses due to this are many. The CP unit works continuously and hence the molten polymer will result in wastage. There will also be losses due to quality until the CP unit reaches stabilisation. The other costs include the manpower costs and the opportunity cost of lost production.

Based on the observations during a three month period, data pertaining to change over from one denier rating to another was estimated for certain combinations. Table 3 has the details of the study.

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[1] The notation for Denier rating in table 1 has the following meaning. The first number indicates the denier rating and the second the number of filaments that pass through each pack. The number of filaments equals the number of holes in the pack.

There have been attempts to improve the availability of the spinning machines. For example, alternative materials are being considered for use as filter material instead of steel powder. There has also been a study to understand the impact of certain changes such as increasing the number of invertors and the metering pumps on system availability.

Marketing requirements

RIL has been pursuing a strategy of market presence in all segments. The main reason, seems to be that once the augmented capacity at HZ complex becomes operational, RIL would be in a position to increase the market share almost immediately. This would mean that there will be requirements of certain range of deniers in very small quantities and perhaps in a dis-continuous fashion also. Table 4 indicates the monthly minimum demand to be met for each of the denier rating.

Currently, the demand forecast, denier-wise is being sent by the marketing office on a monthly basis at the end of the previous month. Table 5 has the demand for the various denier ranges during Oct.95 - Dec. 95 and the opening inventory as on October 1, 1995. It was felt that if marketing can provide a reasonably good estimate of the requirements over a slightly larger time frame such as a quarter it would be beneficial. It appears that this view point has some merit, because the existing practice has several implications:

If a particular denier needs to be produced in very small quantity, and there is a demand in the next period also, it would mean that the pack life would not have been fully utilised. Secondly, frequent pack changes and other denier related set up changes would result in capacity losses, quantity losses at the **CP** unit, and the quality losses until the stabilisation stage. On the other hand, it would have been possible to trade off the inventory carrying cost with the costs associated with the above losses and a different plan would have been arrived at. For example, during the period Apr.95 to Sep. 95, there has been consistently a low demand for 75/34 and 110/68 denier ratings. It is not clear whether such an approach has been adopted to decide on the production plans for these denier ratings.

PFY Production related details

The production time per metric tonne of a particular denier rating has been well established by the planning group based on the historical data. It has been found that different denier ratings require different times and also that the yield of the denier also changes. Tables 6 and 7 have details on these. These have been estimated by the planning group over a period of time.

Maintenance of the PFY plant

Each plant has a certain number of maintenance crew attached to it. In addition, the CES has adequate number of maintenance crew that could be utilises as the need arises. Normally, during the beginning of the financial year, CES in consultation with

the respective plants draw the broad plans with regard to the preventive maintenance schedules. However, in reality, the handing over of the plant for such planned maintenance deviates more or less from the planned schedules. In spite of such deviations, the quantum of time allotted for PM schedule in a plant is met with on an average basis.

Unplanned maintenance is also taken up for several reasons. For example, during a scheduled condition monitoring routine, a rush report may trigger an unplanned maintenance. Similarly, occurrence of breakdowns call for unplanned maintenance. The availability of the spinning machines is computed by adjusting for the lost capacity due to planned and unplanned maintenance. While historical data is used to make an estimate of the unplanned maintenance, the PM schedules serve as a basis for computing the capacity loss due to planned maintenance. Table 8 lists the availability of the machines during Apr.95 - Dec. 95.

Table 1.
The details of deniers made and their contribution

No.	Denier rating	Contribution* (Rs. per Kg.)
1	126/34	30.24
2	115/34	31.06
3	235/34	13.29
4	51/14	49.62
5	90/34	40.43
6	75/34	41.43
7	110/68	35.89
8	115/108	45.12

** - Computation of the contribution per Kg of each denier rating was done in the following manner. Initially, forecasts of the price for different qualities of the denier likely to be produced (First quality, substandard, claimless) was arrived at. Based on the past historical data, a weighted average price for a particular denier rating was computed. After taking into account the discount structure and the selling expenses, net price per kg was arrived at. Based on the per kg. cost of PTA and MEG, the total RM cost was estimated. The conversion costs were added to this to obtain the total variable costs. The difference between the net price and the total variable cost constituted the contribution.*

Table 2.
Details regarding Spinning M/Cs and CP units at PFY

Spinning machines details

Spinning machine	CP unit	Metering pump capacity (cc/rev)	Denier range
PFY - I			
1	1	1.50	51 to 126
2A	1	3.00	126 to 260
2B	1	3.00	126 to 260
3	1	3.00	126 to 260
4	1	1.50	51 to 126
7A	2	1.50	51 only
8A	2	3.00	126 to 260
5C	2	1.50	51 to 126
6B	3	1.50	51 to 126
7B/C	3	3.00	126 to 260
8B	3	3.00	126 to 260
PFY - II			
9	5	3.00	126 to 260
10	5	1.20	51 to 145
11	5	1.50	51 to 126
12	5	1.50	51 to 126
13	5	1.50	51 to 126

CP capacities

CP unit No.	Capacity (Kgs/Hr)
CP-1	3000
CP-2	3200
CP-3	3300
CP-5	3000

Table 3.
Data on denier changeover*

Denier Changeover		Prodn. Loss (Kgs)	Avg. Thro'put (Kg/Hr)	Changeover time (Hrs)
From	**To**			
126/34	90/34	700	564	1.24
126/34	235/34	900	494	1.82
90/34	126/34	500	542	0.92
90/34	115/108	650	494	1.32
235/34	90/34	680	480	1.42
235/34	115/34	800	469	1.71
75/34	115/108	760	453	1.68

** This table is based on observations made during a three month period.*
When only pack change is done, time taken is 10 minutes.
Changeover time is computed as a ratio of the production loss to the average throughput.

Table 4.
Data on the monthly minimum demand to be met.

No.	Denier rating	Minimum Demand
1	126/34	4000
2	115/34	650
3	235/34	2000
4	51/14	200
5	90/34	200
6	75/34	30
7	110/68	25
8	115/108	100

Table 5.
Demand of the various denier ranges during Oct. 1995 - Dec. 1995

No.	Denier rating	October 1995	November 1995	December 1995	Opening Inventory (as on Oct.1, 1995.)
1	126/34	6460	6930	7480	397
2	115/34	990	1045	1100	44
3	235/34	3190	3410	3850	122
4	51/14	248	275	303	41
5	90/34	330	385	303	32
6	75/34	83	83	83	0.19
7	110/68	110	28	28	0.11
8	115/108	440	440	440	30

Table 6.
Average yield of the various denier ratings in different machines

PFY - I

	126/34	**115/34**	**235/34**	**51/14**	**75/34**	**90/34**	**110/68**	**115/108**
1	96.80	96.40		93.10	97.00	97.80	96.50	96.30
2A	96.70		96.50					
2B	96.70	96.50	96.70					
3	97.00		96.70					
4	96.80	96.20		92.70	97.20	96.90	95.80	95.90
7A				93.10				
8A	96.70		96.50					
5C	97.20	95.90		92.40	96.50	96.80	95.90	95.40
6B	97.00	95.60		93.10	97.10	97.30	96.50	96.30
7B/C	96.90		96.40					
8B	96.80		96.30					

PFY -II

	126/34	**115/34**	**235/34**	**51/14**	**75/34**	**90/34**	**110/68**	**115/108**
9	97.80		97.50					
10	97.90	97.50		94.10	97.80	98.20	97.50	97.00
11	97.90	97.10		93.80	97.20	98.70	97.00	96.40
12	97.20	97.60		94.00	98.00	98.80		97.30
13	97.30	97.40		93.20	97.20	98.00	96.60	97.30

** A Blank entry signifies that the machine denier rating combination is infeasible.*

Table 7.
Production time (hrs per metric tonne) of the denier ratings in various machines

	126/34	**115/34**	**235/34**	**51/14**	**75/34**	**90/34**	**110/68**	**115/108**
m/c 4	1.78							
m/c 2A,2B	3.20	3.48	1.68					
other m/c s	1.60	1.74	0.84	4.00	2.82	2.40	1.80	1.85

Table 8.
Availability of spinning machines during the period Apr.95 - Dec. 95

	4/95	5/95	6/95	7/95	8/95	9/95	10/95	11/95	12/95
PFY - I									
1	718.6	743.5	719.5	742.2	743.5	719.5	742.2	719.5	743.5
2A	719.0	743.3	719.7	743.1	743.7	719.7	743.7	718.9	743.7
2B	717.2	741.4	717.8	741.3	741.9	717.9	741.9	717.1	741.9
3	716.5	742.3	718.3	741.0	742.3	718.3	741.4	717.0	742.3
4	717.4	742.4	718.4	741.1	741.1	717.4	742.4	717.1	742.4
7A	704,9	728.6	706.4	730.4	729.1	706.4	730.4	704.7	730.4
8A	714.9	737.4	713.5	738.9	737.6	714.8	738.9	713.5	738.9
5C	714.2	738.2	713.6	736.9	738.2	714.2	738.2	712.9	738.2
6B	712.4	736.4	712.4	734.7	736.4	712.4	736.4	711.0	736.4
7B/C	711.1	735.1	711.1	735.1	733.4	711.1	735.1	709.7	735.1
8B	711.5	735.5	709.8	735.5	735.5	711.5	734.2	711.5	735.5

	4/95	5/95	6/95	7/95	8/95	9/95	10/95	11/95	12/95
PFY - II									
9	698.6	726.6	702.6	725.6	726.6	702.6	722.6	702.6	726.6
10	695.1	715.3	695.1	719.1	718.1	695.1	718.1	695.1	715.3
11	695.0	719.0	691.0	719.0	719.0	694.0	719.0	695.0	719.0
12	691.5	714.5	691.5	711.5	715.5	691.5	715.5	691.5	715.5
13	698.5	722.5	697.5	722.5	722.5	694.5	722.5	698.5	721.5

Availability = Total time available in a month - total down time.
All values are in machine hours.
The down time estimate does not include the time lost in changeover from one denier to another and also the time lost in changing the packs.